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LEGAL FRAMEWORKS FOR SPECTRUM SHARING: UNLOCKING INDONESIA'S BROADBAND POTENTIAL

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ABSTRACT

This article analyzes the application of spectrum sharing regulations in mobile broadband technology in Indonesia. Since 2019, the country has witnessed significant progress in the widespread adoption of 4G LTE broadband network infrastructure. However, the development of 5G telecommunications technology remains nascent, operating in a non-standalone mode that relies on existing 4G LTE infrastructure and is currently available only in several major cities. To improve service quality and increase accessibility to 4G LTE and 5G broadband networks, a clear and comprehensive legal framework is essential. This framework should facilitate the sharing of 4G LTE infrastructure, particularly radio frequency spectrum, with 5G technology, thereby enhancing broadband coverage in underdeveloped, frontier, and outermost regions. The Indonesian government has enacted the Job Creation Law, which addresses spectrum sharing in the telecommunications sector. This research employs a normative juridical approach, integrating both primary and secondary data analysis to examine the legal framework governing spectrum sharing. It specifically investigates the impact of the Job Creation Law on the implementation of spectrum sharing in Indonesia's telecommunications landscape. The findings indicate that the current spectrum sharing policy is insufficiently supportive of 4G LTE technology, thereby impeding the deployment of 5G non-standalone technology in underdeveloped, frontier, and outermost areas. To remedy this situation, spectrum sharing policies must ensure non-discriminatory access, be responsive to market demands, and adapt to technological advancements. Moreover, the study highlights the importance of collaborative efforts among stakeholders in crafting spectrum sharing provisions that address the needs of both 4G LTE and 5G technologies.

Keywords: *Spectrum Sharing Policy; Mobile Broadband; Mobile Technology*

INTRODUCTION

The rapid evolution of internet-based services has presented Indonesia's telecommunications sector with a unique opportunity to redefine its role, drive innovation, and shape the country's digital future[1] The digital revolution has propelled telecommunications forward, transforming it from a basic voice and text service to a sophisticated, efficient, and cost-effective infrastructure that empowers seamless information sharing and collaboration[2]. Mobile broadband stands out as a cost-effective solution, offering data packages that are more budget-friendly than traditional voice and text services. This technology empowers users to access a wide range of online services through over-the-top applications, enabling efficient and convenient online activities on mobile devices. Currently, the most widely used mobile broadband services is 4 Generation Long Term Evolution (4G LTE) or International Mobile Telecommunications Advanced Standard (IMT-Advanced Standard), which require mobile telecommunications Radio Frequency Spectrum (RFS) resources with a minimum bandwidth of 40 MHz and a maximum of 100 MHz[3] however, the surge in mobile broadband traffic has led to a scarcity of mobile telecommunications Radio Frequency Spectrum, posing a significant challenge to the industry[4]

The scarcity of RFS for mobile broadband services can be mitigated through three key strategies: rearranging and unifying Radio Frequency Bands (RFB) through refarming, sharing RFB among telecommunications network operators, and leveraging millimeter wave (mmWave) allocations. Among these options, spectrum sharing is viewed by European and US regulators as a feasible method to allocate more Radio Frequency Spectrum for the current mobile broadband technology transition[5]

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[1] Ahmad M. Ramli et al., "Collaboration Principles between Telecommunication Operators and Over-The-Top (OTT) Platform Providers in the Context of the Indonesian Job Creation Regulation," *Journal of Telecommunications and the Digital Economy* 10, no. 1 (March 29, 2022): 50–66, https://doi.org/10.18080/jtde.v10n1.461.
[2] Tasya Safiranita Ramli, *Hak Cipta Dalam Media Over The Top* (Bandung : Refika Aditama, 2022).
[3] Martha Zemeda, "LTE-Advanced Physical Layer Design and Test Challenges: Carrier Aggregation," *Microwave Journal* 54 (2011): 20–24, https://openurl.ebsco.com/EPDB%3Agcd%3A7%3A31161015/detailv2?sid=ebsco%3Aplink%3Ascholar&id=ebsco%3Agcd%3A67408021&crl=c&link_origin=scholar.google.com.
[4] Moch Umar Hidayat, "Analisa Efektifitas Ran Sharing Pada Perusahaan Telekomunikasi (Studi Kasus RAN Sharing XL-Indosat)," *Jurnal Telekomunikasi Dan Komputer* 10, no. 1 (April 8, 2020): 8–18, https://doi.org/10.22441/incomtech.v10i1.7410.
[5] M. Majid Butt et al., "Fair Dynamic Spectrum Management in Licensed Shared Access Systems," *IEEE Systems Journal* 13, no. 3 (September 2019): 2363–74, https://doi.org/10.1109/JSYST.2018.2869274.

Over the past decade, Directorate General of Resources Management and Equipment of Posts and Informatics (DG-RMEPI) under the Ministry of Communications and Informatics (MCI) has successfully implemented refarming, resulting in a well-organized allocation of mobile broadband RFS in Indonesia[6]. Refarming the RFS of cellular telecommunications is not enough to overcome the shortage of Radio Frequencies (RFs) in mobile broadband services with 4G LTE technology, particularly those with high user density. To address this issue, spectrum sharing can be employed as an interim solution, bridging the gap until the deployment of 5G technology or the International Mobile Telecommunications - 2020 Standard (IMT-2020 Standard), which demands Radio Frequency (RF) resources with a minimum bandwidth of 100 MHz to 1 GHz in mmWave allocations[7]. In addition, spectrum sharing facilitates the implementation of active infrastructure sharing using the Multi-Operator Core Network (MOCN) approach, enabling telecommunications network operators to achieve significant cost efficiencies, with potential reductions in Operational Expenditure (OPEX) and Capital Expenditure (CAPEX) of up to 40 percent.[8]

The regulation of spectrum sharing is implicit in Law No. 6 of 2023 on the Stipulation of Government Regulation in Lieu of Law No. 2 of 2022 on Job Creation into Law (Job Creation Law) in the Telecommunications sector which expands the scope of Law No. 36 of 1999 on Telecommunications (Telecommunications Law) by adding the provision of spectrum sharing cooperation in Paragraph (6) Article 33 of the Job Creation Law which explains that holders of business licenses related to the use of radio frequency spectrum for telecommunications operations can do: a. cooperation in the use of RFS for the application of new technology and/or b. transfer of the use of RFS, with other telecommunications operators. The provision of spectrum sharing is further regulated in Article 50 of Government Regulation No. 46 of 2021 on Posts, Telecommunications, and Broadcasting (GR PTB), which explains that telecommunications network operators have

[6] R. Fandi and Karin, "Hanya Butuh 2 Minggu, Ditjen SDPPI Selesaikan Refarming Pita 2,3 GHz," *Kementerian Komunikasi Dan Digital*, 2023, https://www.postel.go.id/berita-hanya-butuh-2-minggu-ditjen-sdppi-selesaikan-refarming-pita-2-3-ghz-27-5877.
[7] International Telecommunication Union, "Report ITU-R M.2410-0: Minimum Requirements Related to Technical Performance for IMT-2020 Radio Interface(s)," 2017, https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-PDF-E.pdf.
[8] Cholid Mawardi, "Analisa Regulasi Network Sharing Berbasis Multi Operator Core Network (MOCN)," *Jurnal Telekomunikasi Dan Komputer* 9, no. 3 (December 21, 2019): 141–50, https://doi.org/10.22441/incomtech.v9i3.6667.

been given permission to cooperate in the use of RFS for the application of new technology in Indonesia in accordance with the Job Creation Law. The application of new technology in spectrum sharing provisions requires further investigation, given the significance of 4G LTE technology infrastructure development as a national strategic project. This project aims to address the digital divide by extending connectivity to underdeveloped, frontier, and outermost areas, ultimately facilitating widespread digital transformation[9]**.** This article discusses how spectrum sharing regulation applied to mobile broadband technology in Indonesia in terms of Legal Theory as Indonesian Transformation Infrastructure, Legal Theory as Indonesian Transformation Infrastructure is a theory that conceives law as an instrument for fostering positive change and achieving prosperity. Its core aim is to utilize law as a transformative tool, guiding and expediting the progressive development of all state elements.

RESEARCH METHODS

This research employs a normative juridical methodology, integrating secondary and primary data analysis to provide a comprehensive understanding of the legal framework governing spectrum sharing. The normative juridical approach involves a meticulous literature review, examining secondary data from various sources, including laws, research findings, and other references, as well as primary data, analyzed qualitatively.[10] Secondary data is collected through a comprehensive literature review of relevant laws, regulations, books, legal journals, and other pertinent materials, which are subsequently analyzed in this research[11]. The secondary data encompasses a broad range of legal materials, including primary, secondary, and tertiary sources. Primary legal materials comprise the Telecommunication Law, the Job Creation Law, and its implementing regulations, such as the GR PTB.

Secondary legal materials include legal literature and reading sources related to mobile telecommunications infrastructure sharing. Furthermore, tertiary legal materials were collected through virtual data collection, involving online research and internet-

[9] Dian Erika Nugraheny, "Lanjutkan Proyek BTS 4G, Pemerintah: Supaya Publik Tak Dirugikan," *Kompas.Com*, 2023, https://nasional.kompas.com/read/2023/05/23/06000021/lanjutkan-proyek-bts-4g-pemerintah--supaya-publik-tak-dirugikan?page=all.
[10] D Budhijanto, *Cyberlaw Dan Revolusi Industri 4.0* (Bandung : Logoz Publishing, 2019).
[11] Soerjono Soekanto, *Pengantar Penelitian Hukum* (Jakarta: UI-Press, 2010).

based reference materials. This research adopts a descriptive-analytical approach, combining secondary data description and analysis with primary data to provide insights into the Telecommunication Law, the Job Creation Law, and its implementing regulations, such as the GR PTB, and their impact on spectrum sharing policies and practices.

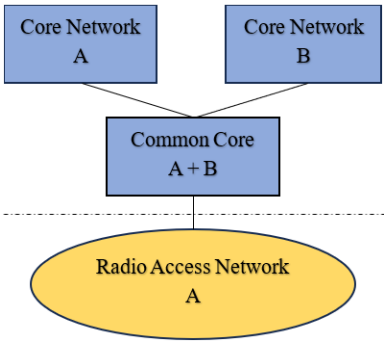
RESEARCH OUTCOME AND DISCUSSION

1. Spectrum Sharing Concept, Collaboration, Regulatory Framework, and Implementation in Indonesia

a. Spectrum sharing concept

Spectrum sharing refers to a collaborative approach in which multiple telecommunications network operators share RF resources to optimize their utilization and efficiency[12]. The 3rd Generation Partnership Project (3GPP) first introduced the concept of spectrum sharing in the context of the 3G telecommunications technology standard or IMT-2000 Standard. This concept involves telecommunications network operators collaborating to share RFS resources for delivering telecommunications services. To achieve this, licensed operators divide their Radio Frequency Bands (RFBs) with other operators. As outlined by the 3GPP, a standard spectrum sharing scenario involves connecting the Core Network (CN) to a shared Radio Access Network (RAN) with integrated routing functions. This architecture enables seamless spectrum sharing cooperation in 3G technology by facilitating connections between multiple CN nodes and shared RAN nodes[13].

[12] Constantinos B. Papadias, Konstantinos Ntougias, and Georgios K. Papageorgiou, "The Role of Antenna Arrays in Spectrum Sharing," in *Spectrum Sharing: The Next Frontier in Wireless Networks* (Wiley, 2020), 229–56, https://doi.org/10.1002/9781119551539.ch12.
[13] 3rd Generation Partnership Project, "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service Aspects and Requirements for Network Sharing; (Release 6)," *3rd Generation Partnership Project* 9 (2002): 1–15, https://www.3gpp.org/ftp/Specs/archive/22_series/22.951/22951-200.zip.



Picture 1. 3GPP Spectrum Sharing Scenario[14]

The evolution of telecommunications technology led to the development of the 4G LTE telecommunications technology standard. In 4G LTE technology, spectrum sharing is implemented through Carrier Aggregation (CA), which combines multiple LTE carriers to increase the bandwidth of the RFB, data transmission speed, and network capacity. CA can be achieved through Interband or Intraband methods. Interband CA involves applying spectrum sharing across different RFBs or non-contiguous RFBs, while Intraband CA applies spectrum sharing within the same RFB or adjacent RFBs[15]. Intraband CA is the most suitable spectrum sharing method for 4G LTE technology in Indonesia, where the allocation of RF for broadband services is well-planned and organized[16]

4G LTE CA can indirectly facilitate the introduction of 5G technology by leveraging the existing 4G LTE infrastructure. In a 5G Non-Standalone (5G NSA) implementation, the 5G RAN is placed on top of the existing 4G LTE CN, 4G LTE intraband CA can help increase network capacity and performance in support of 5G services. Combining the two technologies can increase data rates, increase the amount of data successfully transmitted from one point to another in the network over a period of time, and improve network performance and provide a smooth and efficient transition to introduce 5G technology to users, before the entire 5G Standalone (5G SA) telecommunications infrastructure is built which

[14] 3rd Generation Partnership Project.
[15] Yun Ye et al., "Overview of LTE Spectrum Sharing Technologies," *IEEE Access* 4 (2016): 8105–15, https://doi.org/10.1109/ACCESS.2016.2626719.
[16] Biro Humas Kementrian Komdigi, "[SIARAN PERS No. 46/HM/KOMINFO/03/2023] Kominfo Tuntaskan Refarming Pita Frekuensi Radio 2,3 GHz," *Komdigi.Go.Id*, 2023, https://www.infopublik.id/kategori/siaran-pers/727731/index.html.

have a CN and dedicated RFS allocation to improve the latency, reliability, and efficiency of 5G technology connectivity[17]

The advent of 5G technology has revolutionized spectrum sharing with the introduction of Dynamic Spectrum Sharing (DSS). DSS is a 5G technology feature that enables telecommunications network providers to utilize the same RFS for 4G LTE and 5G technologies. DSS uses a 5G CN that manages the RFS more efficiently, providing better data transfer speeds and network performance than 4G LTE. DSS also increases 5G coverage by allowing mobile telecom providers to utilize existing infrastructure for both 4G LTE and 5G services. For example, Vodafone Germany saw a five-fold increase in coverage by launching 5G on 700 MHz spectrum using DSS. Overall, DSS can improve efficiency and throughput in 4G LTE and 5G broadband services, regardless of the RFB used[18]

The implementation of spectrum sharing, which has been technically feasible since 3G technology and has evolved with 4G LTE and 5G, offers numerous benefits, including enhanced efficiency, capacity, and network quality. Moreover, spectrum sharing can lead to cost savings in managing RFS through collaborative operations, ultimately increasing accessibility to telecommunications services in underserved areas, provided that the necessary cellular infrastructure is in place. While spectrum sharing presents significant advantages, it also poses several challenges that must be addressed to ensure seamless implementation, including:[19]

1) Reduced Incentives for Investment: Shared spectrum resources may lead to licensed telecommunications network providers being less motivated to invest in new infrastructure if they are required to share resources with other providers without sufficient returns;
2) Network Resilience: The use of spectrum sharing increases the risk of network disruptions, and when these disruptions occur, they have the potential to impact a larger number of users;

[17] Nokia.com, "5G Carrier Aggregation Explained," *Nokia.Com*, 2024, https://www.nokia.com/about-us/newsroom/articles/5g-carrier-aggregation-explained/.
[18] E Gubbins, "Dynamic Spectrum Sharing: It's Not Just for 4G and 5G," *Networkmatter.Com*, 2020, https://networkmatter.com/2020/07/02/dynamic-spectrum-sharing-its-not-just-for-4g-and-5g/.
[19] The Digital Regulation Platform, "Digital Regulation Platform: The Infrastructure Sharing Imperative," *Digitalregulation.Org*, 2022, https://digitalregulation.org/the-infrastructure-sharing-imperative/.

3) Regulatory Challenges: Designing spectrum sharing regulations is a delicate balancing act, requiring policymakers to navigate the technical complexities of spectrum sharing while promoting competition and protecting consumer interests;
4) Risk of Collusion: Spectrum sharing arrangements may facilitate collusion among participating telecommunications network providers, potentially hindering new entrants from joining the shared spectrum;
5) Operational Coordination Difficulties: Coordinating operational aspects of spectrum sharing among telecommunications network providers can be intricate and time-consuming, increasing the likelihood of conflicts without clear guideline.

Overcoming the hurdles in spectrum sharing implementation demands a thoughtful and strategic approach, incorporating the following key strategies:[20]

1) Encouraging investment with financial incentives, including subsidies or reduced taxes, seeks to stimulate licensed telecommunications network providers to invest in cutting-edge infrastructure;
2) Enhancing network resilience through balanced infrastructure, such as building redundant networks and implementing backup systems to mitigate the risk of network disruptions;
3) Establishing a flexible and effective regulatory framework for spectrum sharing, which fosters competition, innovation, and consumer protection;
4) Mitigating the risk of collusion among telecommunications network providers by implementing robust monitoring and regulatory frameworks for spectrum sharing;
5) Establishing clear and effective guidelines for operational coordination of spectrum sharing among telecommunications network providers, including conflict resolution procedures to ensure swift and effective dispute resolution.

[20] The Digital Regulation Platform.

The proactive measures proposed are intended to mitigate the challenges of spectrum sharing implementation, ultimately leading to a more efficient, innovative, and competitive telecommunications sector.

b. Spectrum sharing collaboration

Spectrum sharing among telecom operators is founded on collaborative business arrangements, utilizing the Licensed Shared Access (LSA) framework to facilitate cooperation. LSA is a cooperation model with licensing that allows secondary users to use RFBs that have been granted to holders of rights to use the RFS or primary users, with the aim that secondary users, including primary users, can provide a certain quality of service by following the sharing rules outlined in their rights and obligations to use the RFS[21]

The holder of the right to use the RFS is a telecommunications network provider that has RFBL that can operate in the RF range according to the band license, this is an advantage for the holder of the right to use the RFS because no other system can cause interference when operating in the RFB at the same priority level, therefore RFBL are subject to high licensing fees, on the other hand RFBL can result in wasteful costs, when the RFS is not used for a certain period of time or in a certain area, while other telecommunications network providers experience a deficit of RFS.[22]

LSA is not a new license, but a regulatory approach that focuses on the efficient use of RFS in RFBs that have been determined for telecommunications network operators that already have licenses, by adding telecommunications network operators with additional licenses in the same radio frequency bands. The LSA approach requires collaboration from various parties, especially primary and secondary users in the spectrum sharing cooperation mechanism in order to ensure healthy business competition and the government has the role of controlling and supervising RFS users to ensure healthy business competition practices carried out by communication providers in spectrum sharing cooperation with the aim

[21] European Commission, "Radio Spectrum Policy Group; RSPG Opinion on Licensed Shared Access," 2013, https://circabc.europa.eu/sd/d/3958ecef-c25e-4e4f-8e3b-469d1db6bc07/RSPG13-538_RSPG-Opinion-on-LSA%20.pdf.
[22] Roya H. Tehrani et al., "Licensed Spectrum Sharing Schemes for Mobile Operators: A Survey and Outlook," *IEEE Communications Surveys & Tutorials* 18, no. 4 (2016): 2591–2623, https://doi.org/10.1109/COMST.2016.2583499.

that the telecommunications industry in Indonesia can compete fairly and not harm the public interest and state/national interests.[23]

c. Spectrum sharing regulation in Indonesia

The provision of spectrum sharing in Indonesia was initially regulated in Paragraph (1) of Article 14 of Government Regulation No. 53/2000 on the Use of Radio Frequency Spectrum and Satellite Orbit, namely the establishment of RFBs and/or RF channels can be used jointly, but the use of spectrum sharing can not necessarily be implemented because there is a provision in Paragraph (1) of Article 25 of the same regulation, stating that the holder of a RF allocation does not transfer the RF allocation it has obtained, thus there is a contradiction of articles related to the use of spectrum sharing in the same regulation making spectrum sharing cannot be implemented by telecommunications network operators. After the issuance of the Job Creation Law, the use of spectrum sharing is explained in Article 33 (telecommunications sector) which states that the Central Government can determine the use of spectrum sharing of RF by cooperating for the application of new technology. As a further provision of the Job Creation Law, Article 50 GR PTB states (1) Telecommunications network operators holding a license to use RFS may cooperate in the use of RFS for the application of new technology with other telecommunications network operators and/or special telecommunications operators. (2) New technology as referred to in paragraph (1) refers to telecommunications technology whose implementation in the territory of the unitary state of the Republic of Indonesia is carried out after the enactment of the Job Creation Law. In the explanation of Article 50 Paragraph (2), it is mentioned that an example of new technology in cellular mobile networks is International Mobile Telecommunications - 2020 (IMT-2020), this shows that the provisions for spectrum sharing are limited to the use of new telecommunications technology, namely 5G or IMT-2020.

The utilization of spectrum sharing refers to the arrangement and allocation of RFBs of Indonesian mobile telecommunications as stipulated in the Regulation of

[23] Mohan Rifqo Virhani, "Kajian Hukum Penerapan Prinsip Netral Teknologi Dalam Pemanfaatan Spectrum Sharing (Study on Implementation of Neutral Technology Law on Spectrum Sharing)," *Buletin Pos Dan Telekomunikasi* 13, no. 2 (December 29, 2015): 177–90, https://doi.org/10.17933/bpostel.2015.130206.

the Minister of Communication and Informatics No. 19 of 2015 on the Arrangement of 1800 MHz RFB for the Purpose of Mobile Mobile Network Operation, and Regulation of the Minister of Communication and Informatics No. 12 of 2017 on the Use of Technology in RFBs 450 MHz, 900 MHz, 2.1 GHz, and 2.3 GHz for Mobile Network Operation (RMCI UTRFBs), as well as Regulation of the Minister of Communication and Informatics No. 12 of 2022 on Indonesian RFS Allocation Table, with a description of the arrangement of RFS bands of mobile telecommunications in Table 1.

Table 1. RFB Arrangement for Cellular Telecommunications in Indonesia

No.	Frequency Band	Frequency (MHz)		Frequency Bandwidth (MHz)		Mode
		Uplink	Downlink	Uplink	Downlink	
1	2	3	4	5	6	7
1.	450	450 - 457,5	460 - 467,5	7,5	7,5	FDD
2.	800	824 - 835	869 - 880	11	11	FDD
3.	900	880 - 915	925 - 960	35	35	FDD
4.	1800	1710 - 1785	1805 - 1880	75	75	FDD
5.	2100	1920 - 1980	2110 - 2170	60	60	FDD
6.	2300	2300 - 2390		90		TDD
Total				**278,5**	**278,5**	

The allocation of RFBs 450, 800, 900, 1800, 2100, and 2300 are 7.5 MHz, 11 MHz, 35 MHz, 75 MHz, 60 MH, and 90 MHz with a total cellular RF bandwidth allocation of 278.5 MHz and almost all RFBs are determined to operate in the Frequency Division Duplexing (FDD) mode of use except the 2300 frequency band using the Time Division Duplexing (TDD) mode of use. Article 1 RMCI UTRFBs explains FDD is a type of telecommunication mode through RFs whose uplink and downlink are paired in the RF dimension, so that uplink and downlink use different RFBs and TDD is a type of telecommunication mode through RFs whose uplink and downlink are paired in the time dimension, so that uplink and downlink use the same RFB. 4G LTE technology generally uses FDD mode and 5G technology can use FDD mode as an option, but TDD mode is considered more efficient for 5G due to its flexibility in setting time slots for uplink and downlink.

After the RFB License of PT Net Satu Indonesia was revoked on November 30, 2021[24]**.** CNBC Berita Tech as well as the merger of telecommunications network providers, PT Indosat, Tbk. and PT Hutchsion 3 Indonesia. Tbk. into one entity under PT Indosat, Tbk. which is effective on January 4, 2022[25], there are currently four cellular telecommunications network providers in Indonesia, namely PT XL Axiata, Tbk. (XL), PT Smart Telecom, Tbk. (Smart), PT Indosat, Tbk. (Indosat), and PT Telekomunikasi Seluler, Tbk. (Telkomsel)[26].The RF bandwidth of each telecommunications network operator in the allocation of RFS bands for cellular telecommunications in Indonesia is as shown in Table 2.

Table 2. RF Bandwidth of Cellular Telecommunications in Indonesia[27]

No.	Mobile Network Operator	Downlink Frequency Bandwidth (MHz)						
		450	800	900	1800	2100	2300	Total
1	2	3	4	5	6	7	8	9
1.	PT. Smartfren Telecom Tbk.	-	11	-	-	-	40	51
2.	PT. Telekomunikasi Seluler Tbk.	-	-	15	22,5	20	50	107,5
3.	PT. Indosat Tbk.	-	-	12,5	30	25	-	67,5
4.	PT. XL Axiata Tbk.	-	-	7,5	22,5	15	-	45
Total		**0**	**11**	**35**	**75**	**60**	**90**	**271**

The total sum of mobile telecommunications RFBs usage in the 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, and 2300 MHz bands amounted to 271 MHz or 100 percent of the allocated 271 MHz in the same bands and there were mobile telecommunications RFS bands that were not used due to revocation of RFB License in the 450 band. Mobile telecommunication RF bandwidth arrangement in the 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, and 2300 MHz bands amounted to 271 MHz with the allocation of 4G LTE technology use of 181 MHz or 66.8 percent and the allocation of 5G technology use of 90 MHz or 33.2

[24] CNBC Indonesia, "Izin Frekuensi Dicabut Kominfo, Net1 Indonesia Angkat Bicara," *CNBC Indonesia*, 2021, https://www.cnbcindonesia.com/tech/20211203145726-37-296479/izin-frekuensi-dicabut-kominfo-net1-indonesia-angkat-bicara.
[25] Gumilar Pandu, "Indosat-Tri Resmikan Merger Hari Ini Jadi Indosat Ooredoo Hutchison," *Bisnis.Com*, 2022, https://market.bisnis.com/read/20220104/192/1485040/indosat-tri-resmikan-merger-hari-ini-jadi-indosat-ooredoo-hutchison.
[26] Direktorat Telekomunikasi, "Data Penyelenggaraan Jaringan Telekomunikasi," dittel.kominfo, 2024, https://dittel.kominfo.go.id/informasi/data_penyelenggara_jaringan_telekomunikasi.
[27] Wahyunanda Kusuma Pertiwi and Oik Yusuf, "Daftar Pita Frekuensi Operator Seluler Di Indonesia Dan Alokasinya," *Kompas.Com* , 2021, https://tekno.kompas.com/read/2021/06/24/16020067/daftar-pita-frekuensi-operator-seluler-di-indonesia-dan-alokasinya.

percent, this shows the availability of RFBs for mobile broadband services with 4G LTE technology is wider than 5G technology.

In 2019 broadband network infrastructure or 4G LTE Base Transceiver Station (BTS) has been built and spread around 97 percent in Indonesia and still continues[28] cumulatively in 2023 the construction of 4G LTE BTS throughout Indonesia carried out by four telecommunications network providers reached 459,114 units, consisting of 183,621 Telkomsel BTS units, 172,115 Indosat BTS units, and 103,408 XL BTS units.[29] Smart has also operated as many as 44,000 units of 4G LTE BTS throughout Indonesia after adding 1000 new BTS units in a number of cities in East Java in 2023[30] thus the total 4G LTE BTS throughout Indonesia has reached 503,144 units from four telecommunications network providers and 4G LTE infrastructure development will continue until all underdeveloped, frontier and outermost areas are served 100 percent with 4G LTE mobile broadband services as part of the national digital transformation acceleration program[31].

d. Spectrum sharing implementation in Indonesia

Since May 2021, 5G telecommunications networks have been present in nine cities in Indonesia, namely Jabodetabek, Bandung, Surakarta, Surabaya, Batam, Medan Balikpapan, Denpasar, and Makassar. The deployment of 5G technology by telecommunications network providers requires a 5G Operational Eligibility Certificate (5G OEC). The 5G OEC is issued by the Ministry of Communication and Information, which is carried out in accordance with the mandate of Article 4 of the Minister of Communication and Information Regulation Number 5 of 2021 concerning Telecommunications Operations. Telecommunications network

[28] Haryanto Agus Tri, "Kominfo Optimis Seluruh Indonesia Terselimuti 4G Di 2019 ," *Detikinet*, 2019, https://inet.detik.com/telecommunication/d-4440304/kominfo-optimis-seluruh-indonesia-terselimuti-4g-di-2019.
[29] J. C Suhartanto and Leo Dwi Jatmiko, "Ekspansi 4G Disebut Perlu Dilanjutkan 4 Tahun Lagi, Baru Pindah 5G," *Bisnis.Com*, 2023, https://teknologi.bisnis.com/read/20231221/101/1725939/ekspansi-4g-disebut-perlu-dilanjutkan-4-tahun-lagi-baru-pindah-5g.
[30] Smartfren, "Smartfren Tambah 1000 BTS Baru Di Jawa Timur," *Smartfren.Com*, 2023, https://www.smartfren.com/connect-with-us/whats-new/featured/smartfren-tambah-1000-bts-baru-di-jawa-timur/54571/.
[31] Biro Humas Kementrian Komdigi, "[SIARAN PERS No. 84/HM/KOMINFO/05/2023] Jadi Program Strategis Nasional, Kominfo Lanjutkan Penyediaan BTS 4G," *Komdigi.Go.Id*, 2023, https://www.infopublik.id/kategori/siaran-pers/743137/index.html.

operators that have obtained 5G OEC in 2021 are Telkomsel, Indosat, XL[32] and followed by Smart in 2022[33]**.** Referring to the 5G OEC of four telecommunications network operators, the allocation of cellular technology use in each RFS band of telecommunications network operators as of August 2023 is as shown in Table 3.

Table 3. RFBs for Mobile Telecommunication Network Operators in Indonesia[34]

Frequency Band	Telecommunication Network Operator	Frequency (MHz)		Mobile Technology
		Uplink	Downlink	
1	2	3	4	5
800	PT. Smartfren Telecom Tbk.	824 - 835	869 - 880	4G LTE
900	PT. Telekomunikasi Seluler Tbk.	880 - 895	925 - 940	GSM 900 / 4G LTE
	PT. Indosat Tbk.	895 - 907,5	940 - 952,5	GSM 900 / 4G LTE
	PT. XL Axiata Tbk.	907,5 - 915	952,5 - 960	GSM 900 / 4G LTE
1800	PT. XL Axiata Tbk.	1710 - 1732,5	1805 - 1827,5	GSM 1800 / 4G LTE
	PT. Indosat Tbk.	1732,5 - 1742,5	1827,5 - 1837,5	GSM 1800 / 4G LTE / 5G
		1742,5 - 1762,5	1837,5 - 1857,5	
	PT. Telekomunikasi Seluler Tbk.	1762,5 - 1785	1857,5 - 1880	GSM 1800 / 4G LTE
2100	PT. Indosat Tbk.	1920 - 1925	2110 - 2115	4G LTE/ 5G
		1925 - 1930	2115 - 2120	
		1930 - 1935	2120 - 2125	
		1935 - 1940	2125 - 2130	
		1940 - 1945	2130 - 2135	
	PT. XL Axiata Tbk.	1945 - 1950	2135 - 2140	4G LTE/ 5G
		1950 - 1955	2140 - 2145	
		1955 - 1960	2145 - 2150	
	PT. Telekomunikasi Seluler Tbk.	1960 - 1965	2150 - 2155	4G LTE/ 5G
		1965 - 1970	2155 - 2160	
		1970 - 1975	2160 - 2165	
		1975 - 1980	2165 - 2170	
2300	PT. Telekomunikasi Seluler Tbk.	2300	2350	4G LTE/ 5G
	PT. Smartfren Telecom Tbk.	2350	2390	4G LTE/ 5G

The current implementation of 5G technology by Indonesian telecommunications network operators is confined to the 1800 MHz, 2100 MHz, and 2300 MHz Radio Frequency Bands, relying on existing 4G LTE network infrastructure or 5G NSA architecture. As 5G SA infrastructure is not yet available, Consequently, the availability of BTS providing 5G connections is restricted to select locations within nine cities in Indonesia, with each operator

[32] Biro Humas Kementerian Komdigi, "Tiga Operator Layani 5G, Menkominfo Minta Pabrikan Siapkan TKDN 5G," *Kementerian Komunikasi Dan Digital*, 2021, https://www.postel.go.id/berita-tiga-operator-layani-5g-menkominfo-minta-pabrikan%20-%20siapkan-tkdn-5g-27-5290.

[33] Agus Tri Haryanto, "Ssst! Smartfren Direstui Kominfo Jualan Layanan 5G," *DetikInet*, 2023, https://inet.detik.com/telecommunication/d-6629056/ssst-smartfren-direstui-kominfo-jualan-layanan-5g.

[34] Jatmiko Leo Dwi, "Posisi Spektrum Frekuensi Telkomsel, Indosat (ISAT), XL Axiata (EXCL) Dan Smartfren (FREN)," *Teknologi.Bisnis.Com*, 2023, https://teknologi.bisnis.com/read/20230813/101/1684366/posisi-spektrum-frekuensi-telkomsel-indosat-isat-xl-axiata-excl-dan-smartfren-fren-2023.

independently determining the deployment locations for 5G technology[35]. This indicates that 4G LTE RFS plays a more dominant role in providing mobile broadband services that cover almost all regions in Indonesia, whereas 5G RFS is still in its infancy, operating on a Non-Standalone (NSA) basis, leveraging 4G LTE broadband network infrastructure as the foundation for 5G operations, and is only available in a limited number of cities, excluding underdeveloped, frontier, and outermost areas[36].

2. Spectrum sharing cooperation regulation: the theory of law as Indonesia's transformation infrastructure

The theory of law as Indonesia's transformation infrastructure cannot be separated from the thoughts of Ahmad M. Ramli. The idea of theory of law as Indonesia's transformation infrastructure is the development of Mochtar Kusumaatmadja's theory of development law also known as the Unpad Mazhab. Ramli posits that the advent of Industry 5.0 has far-reaching implications for economic, social, and cultural life, necessitating the incorporation of non-legal elements, such as technology, into the legal paradigm. This perspective empowers the law to play a pivotal role in accelerating and guiding technological transformation, ultimately enhancing societal welfare in alignment with Pancasila ideology[37].

The theory of law as Indonesia's transformation infrastructure advocates for the law as a catalyst for positive societal change, driving prosperity and progress. Ultimately, the law should not only safeguard justice and order but also serve as a transformative infrastructure, guiding the nation's development and modernization. This perspective views the law as a dynamic, holistic entity encompassing principles, norms, institutions, and processes that adapt to the evolving landscape, including the rapid growth of telecommunications technology in the digital age.

[35] Livia Kristianti, "Akademisi Nilai Pentingnya Operator Seluler Perluas Jangkauan 5G," *Antaranews.Com*, 2024, https://www.antaranews.com/berita/4073328/akade%20misi-nilai-pentingnya-operator-seluler-perluas-jangkauan-5g.
[36] Biro Humas Kementrian Komdigi, "Paparkan Agenda Bangun Infrastruktur Digital, Menteri Johnny: Tahun Depan Berlanjut!," *Komdigi.Go.Id*, 2021, https://pressrelease.kontan.co.id/release/paparkan-agenda-bangun-infrastruktur-digital-menteri-johnny-tahun-depan-berlanjut?page=1.
[37] A. M Ramli and T. S Ramli, *Hukum Sebagai Infrastruktur Transformasi Indonesia - Regulasi Dan Kebijakan Digital* (Bandung: Refika Aditama, 2022).

The provision of spectrum sharing in Indonesia in Paragraph (1) of Article 50 of GR PTB, as a further provision of Paragraph (6) of Article 33 of the Job Creation Law, states that telecommunications network operators holding licenses to use RFS may cooperate in the use of RFS for the application of new technology with other telecommunications network operators and/or special telecommunications operators. The new technology referred to according to the explanation of Paragraph (2) of Article 50 of GR PTB is 5G or IMT-2020, contrary to the provisions that restrict spectrum sharing to 5G technology alone, neglecting lower technologies such as 4G LTE, where spectrum sharing can also be leveraged for mobile broadband services with a broader RFB. Given the widespread deployment of 4G LTE telecommunications infrastructure across Indonesia and its inclusion in the national digital transformation acceleration program, the utilization of spectrum sharing should encompass 4G LTE technology. This notion can be further explored through several principles outlined in the theory of law as Indonesia's transformation infrastructure, specifically:

(1) Equal Access Principle, Industrial Revolution 5.0 is a human cyber physical system consisting of human collaboration, cyber systems, and physical systems to achieve optimal goals[38]**.** The concept of industrial revolution 5.0 emerged when concerns arose over the application of industry 4.0 (cyber physical system) which could replace the role of humans by machines. This concern led to the idea of society 5.0 which was initiated by the Japanese government in order to take advantage of the development of industry 4.0 by viewing technology not to replace the role of humans, but to make humans central in technology and civilization[39]**.** The Japanese government defines society 5.0 as a human-centered society that aims to balance economic progress and social issues through an integrated system between the virtual and physical worlds[40] thus the transformation towards a 5.0 society will make humans and technology coexist to improve the quality of life[41].The importance of equal access

[38] Ji Zhou et al., "Human–Cyber–Physical Systems (HCPSs) in the Context of New-Generation Intelligent Manufacturing," *Engineering* 5, no. 4 (August 2019): 624–36, https://doi.org/10.1016/j.eng.2019.07.015.
[39] D Budhijanto, *E-Government Law & Regulations Sistem Pemerintahan Berbasis Elektronik (SPBE) Di Indonesia* (Bandung : Logoz Publishing, 2022).
[40] L Oktavianni, "Society 5.0: Masyarakat Super Cerdas, Definisi Dan Penerapannya," *Dicoding.Com*, 2023, https://dicoding.com/blog/society-5-0-masyarakat-super-cerdas-definisi-dan-penerapannya/.
[41] Tasya Safiranita Ramli et al., *Hak Cipta Dalam Perspektif Cyber Law* (Bandung: Refika Aditama, 2023).

to technology cannot be overstated, as it forms the backbone of Indonesia's transformation into a digital economy. To this end, the law must ensure that all stakeholders have equal access to relevant technological developments, facilitating collaborative efforts to provide reliable telecommunications services. In the context of spectrum sharing, regulators must prioritize non-discriminatory access, encompassing all relevant technologies, including 4G LTE and 5G. By broadening the scope of spectrum sharing to include 4G LTE technology, regulators can ensure that all technological devices have equal access to Radio Frequency resources, thereby promoting digital inclusivity and supporting Indonesia's transition to Industry 5.0;

(2) Responsive and Adaptive Principles, Indonesian society has entered the information age which makes information systems widely used and trusted in almost every sector of life,[42] this is inseparable from the development of telecommunications technology that facilitates the development of information technology and computers (ITC) so that information can be conveyed quickly and accurately[43] Legal evolution is needed to be able to adapt quickly to changes in social interactions in society that were once conventionally slowly transformed towards digital, this ultimately changed the character and lifestyle of people who are increasingly dependent on digital space by using digital devices from various technologies in activities in the real world, According to Friedrich Carl Von Savigny, the law is a reflection of the soul of the nation and the feeling of justice grows in the soul of the nation,[44] therefore the law must be adaptable to societal changes, including technological advancements that are still widely used by the community. As the use of digital devices intensifies, necessitating faster and more reliable data transfer connectivity, the law must evolve to strike a balance between stability and change, as advocated by Roscoe Pound. This means the law must be responsive and adaptive to technological advancements, bridging the gap between relevant technologies to ensure the community can harness their benefits and gradually adjust to new innovations. In the context of spectrum

[42] Sinta Dewi Rosadi, *Cyber Law : Aspek Data Privasi Menurut Hukum Internasional, Regional, Dan Nasional* (Bandung: Refika Aditama, 2022).
[43] P Nababan and Darwanto, *Kajian Kebijakan Teknologi Informasi Dan Komunikasi* (Jakarta: Institute for Criminal Justice Reform, 2015).
[44] I. D. G Atmadja and I. N. P Budiartha, *Teori-Teori Hukum* (Malang: Setara Press, 2018).

sharing, revising the rules to include 4G LTE technology alongside 5G is a step that demonstrates responsiveness and adaptability to market needs and dynamic technological developments;

(3) Collaboration Principle, Technological transformation is a multifaceted phenomenon, with far-reaching implications across various sectors and involving multiple stakeholders. In the economic realm, collaboration is essential for fostering a climate of healthy competition, particularly in the context of limited technological resources. This, in turn, encourages optimal resource utilization, reduces capital costs, promotes innovation, and prevents market concentration, ultimately providing consumers with a diverse range of choices[45]. The transition to the digital era is a collective responsibility, requiring the collaboration of multiple stakeholders to formulate and implement policies that drive the development of ICT in Indonesia. In the context of spectrum sharing, cooperation among interested parties is crucial for mutual benefit, ensuring fair business competition among telecommunications network operators. The government plays a vital role in overseeing the implementation of spectrum sharing. Through collaborative efforts, all parties can reach a mutually beneficial agreement, minimizing losses and supporting the inclusive and sustainable transformation of the telecommunications industry. Therefore, collaboration is essential for establishing spectrum sharing rules that accelerate digital transformation with mobile broadband services across Indonesia, taking into account the readiness of 4G LTE technology infrastructure compared to 5G infrastructure, which is still under development, particularly in underdeveloped, frontier, and outermost areas.

In line with the legal principles outlined in the theory of law as Indonesia's transformation infrastructure, the provisions limiting spectrum sharing to 5G technology can be extended to cover 4G LTE technology, adopting an approach that integrates the Equal Access Principle, Responsive and Adaptive Principles, and Collaboration Principle.

[45] Komisi Pengawas Persaingan Usaha, *Untaian Pemikiran Sewindu Hukum Persaingan Usaha* (Jakarta: KPPU, 2008).

CONCLUSION

The advent of 3G technology marked the beginning of significant developments in spectrum sharing, and its evolution continues with the emergence of 5G. Data from the Ministry of Communication and Information Technology reveals that spectrum sharing can increase network capacity by 30% and reduce operational costs by 25%. Given that 5G technology relies heavily on 4G LTE infrastructure, particularly in terms of radio frequency spectrum, and considering the crucial role that 4G LTE continues to play in delivering mobile broadband services across Indonesia, it is essential to extend spectrum sharing to 4G LTE. This will expedite the provision of mobile broadband services to underserved, remote, and outermost areas. A comprehensive technical and economic analysis has demonstrated that implementing spectrum sharing in 4G LTE technology can significantly enhance service quality, reduce operational costs, and promote more efficient use of spectrum resources. Furthermore, an in-depth examination of spectrum sharing provisions for 5G technology through the lens of the Theory of Law as Infrastructure for Indonesia's Transformation reveals several key insights. These include the need for spectrum sharing provisions to ensure equitable access to both 4G LTE and 5G technologies, promoting a level playing field. Additionally, these provisions must be agile and responsive to the rapidly evolving technological landscape, incorporating flexible adjustments to accommodate 4G LTE technology alongside 5G. Collaboration among stakeholders is also crucial in the development of spectrum sharing provisions, facilitating accelerated digital transformation, promoting the proliferation of mobile broadband services, and bridging the digital divide across Indonesia.

In light of the existing 4G LTE infrastructure and the ongoing development of 5G infrastructure, particularly in underserved areas, it is imperative to broaden the scope of spectrum sharing implementation to encompass 4G LTE technology in conjunction with 5G. To achieve this, several recommendations can be implemented: (a) establishing a working team comprising representatives from the government, telecommunications network operators, and other stakeholders to develop effective and adaptive spectrum sharing regulations; (b). developing a clear and measurable action plan for the implementation of spectrum sharing in 4G LTE technology; and (c) conducting

monitoring and evaluation of the implementation of spectrum sharing in 4G LTE technology to ensure that the desired objectives are achieved.

When developing spectrum sharing policies, it is essential to ensure non-discriminatory access, responsiveness to market needs, and adaptability to technological developments. This study emphasizes the importance of collaborative efforts among stakeholders in developing spectrum sharing provisions that cater to relevant technologies, including 4G LTE and 5G. By doing so, the implementation of spectrum sharing can become more effective and efficient, accelerating the provision of mobile broadband services throughout Indonesia and ultimately bridging the digital divide.

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