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Accelerating 5G and 5G-Advanced in Thailand: A roadmap for success

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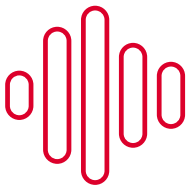
Executive summary

Globally, the transition to a digital economy is accelerating as innovation transforms economic activity. The global economy is increasingly dependent on the cross-border flow of digital information, which simultaneously shapes products, becomes products or facilitates the production or trade of other goods and services. Strengthening mobile connectivity and wireless access technologies, including technologies like 5G and, soon, 5G-Advanced (5G-A), will be key to the economic development of every country. Governments will therefore need to manage and plan radio frequency spectrum strategically, especially bands used for mobile communications.

These efforts are critically important in Thailand, which has seen some of the fastest growth in digital infrastructure and access in the Association of Southeast Asian Nations (ASEAN) region and in Asia, and boasts the second-highest number of internet users in ASEAN, at 50.3 million in Q3 2024.[1]

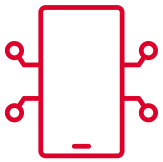
In February 2020, Thailand's regulator, the National Broadcasting and Telecommunications Commission (NBTC), successfully auctioned 2 820 MHz of spectrum across the 700 MHz, 2.6 GHz and 26 GHz bands, making Thailand the leader in assigned mobile spectrum in the ASEAN region. In Q2 2024, 26.6% of connections were 5G connections and 5G coverage reached 95% of the population.[2] Mobile data traffic per connection in Thailand is among the highest in ASEAN.

Figure 1
Thailand's mobile market: key indicators



Total spectrum assigned: 3 220 MHz
Mid-band: 450 MHz

4G population coverage: 99.5%
5G population coverage: 95%



Mobile data per connection per month: 30.6 GB (2024) vs 88.9 GB (2030)

Yet, more work is needed to ensure there are sufficient spectrum resources to support the next phase of 5G development, especially in the crucial mid-band range (1–7 GHz). According to Ookla's September 2024 internet speeds report, Thailand has a relatively low 5G median download speed compared to Malaysia and Singapore – approximately 135 Mbps – due to a lack of 3.5 GHz spectrum assignments.[3]

The GSMA estimates that mid-band 5G spectrum will drive up global GDP by more than $610 billion 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, with Thailand accounting for 18% of the share. Enhanced connectivity supports the Thai tourism industry, which has rebounded strongly, with around 38 million inbound tourists expected in 2024. 5G connectivity and nationwide coverage provided by the country's mobile networks not only meet the lifestyle needs of tourists, but also boost local businesses that depend on tourism, including accommodation providers, restaurants and online venue bookings.[4]

To reap these benefits, mobile network operators (MNOs) will need around 2 GHz of mid-band spectrum this decade. In Thailand, there is

1. GSMA Intelligence, November 2024.
2. Ibid.
3. Johan, A. (3 September 2024). "Asia-Pacific Subscribers Will Benefit from More 5G Mid-band Spectrum". Ookla.
4. Tortermvasana, K. (25 June 2024). "True's growth in 5G revenue hits 15% per year". *Bangkok Post*.

currently only 450 MHz of mid-band spectrum assigned for mobile services.

It is therefore important for Thailand to maintain momentum and prioritise the following actions for 5G and 5G-A development:

- Make at least 300 MHz of spectrum available in the globally harmonised 3.5 GHz band as soon as practicable. Avoid unnecessarily large guard band between mobile and fixed satellite service (FSS). Implement appropriate coexistence measures, such as site shielding and upgrading FSS receiver filters, to allow more spectrum to be assigned for 5G without affecting other users in adjacent bands. Consider a phased approach for the release 3.5 GHz, starting with urban areas where alternatives to television receive-only (TVRO) reception are readily available.
- As part of the NBTC's planned Q1 2025 auction of 850 MHz, 1500 MHz, 1800 MHz, 2.1 GHz and 2.3 GHz, set reasonable reserve prices and auction rules that optimise the use of these IMT bands for public benefit and improve service quality.
- Work towards making around 2 GHz of mid-band spectrum available by developing a spectrum roadmap for 2025–2030, taking into account future international mobile telecommunications (IMT) spectrum supply, including the 4.8 GHz and upper 6 GHz bands.
- Furthermore, as part of the review of Thai television licences, which expire in 2029, consider securing the second digital dividend in the 600 MHz band to extend rural and in-building mobile coverage.

1. Introduction

Globally, the transition to a digital economy is accelerating as innovation transforms economic activity. The global economy is increasingly dependent on the cross-border flow of digital information, which is simultaneously shaping products, becoming products and facilitating the production or trade of other goods and services. Strengthening mobile connectivity and wireless access technologies, including technologies like 5G and, soon, 5G-Advanced (5G-A), will be key to economic development in every country. Governments will therefore need to manage and plan radio frequency spectrum strategically, especially bands that are used for mobile communications.

These efforts are critically important in Thailand, which has seen some of the fastest growth in digital infrastructure and access in the Association of Southeast Asian Nations (ASEAN) region and in Asia, boasting the second-highest number of internet users in ASEAN, at 50.3 million.[5]

Making the most of this opportunity will require proactive efforts in spectrum planning, as the amount of IMT spectrum made available in Thailand has remained unchanged since early 2020, when the 700 MHz, 2.6 GHz and 26 GHz bands were auctioned and assigned. According to Ookla, while Thailand was one of the first markets to launch 5G in the Asia-Pacific region, 5G services using both 700 MHz and 2.6 GHz bands. The *"…full allocation of C-band is still pending, which may challenge the country's ability to fully leverage the capabilities of 5G technology."*[6]

The importance of wireless services for the adoption of 5G and future generations of mobile technologies cannot be understated. The International Telecommunication Union (ITU) World Radiocommunication Conference 2023 (WRC-23) completed the harmonisation of the 3.5 GHz band for the deployment of 5G services and identified additional mid-band spectrum in 6 GHz for future expansion towards 2030. Spectrum harmonisation is important because it ensures stronger mobile connectivity while achieving economies of scale. To date, harmonisation of the 3.5 GHz band has been achieved across Europe, the Middle East and Africa (MENA) and the Americas.[7] This band is already widely deployed for 5G across the Asia-Pacific region.

Increasing smartphone adoption and video usage has driven up mobile data traffic over the past decade, and 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. As of Q2 2024, 285 operators in 114 markets have launched mobile 5G, while 5G fixed wireless access (FWA) services have been launched by 136 operators in 66 markets.[8] 2023 saw 5G surpass 1.6 billion mobile connections globally. 2024 is expected to be another landmark year for 5G, with subscriber growth forecasted at 30%, powering the number of 5G connections to exceed 2 billion.[9]

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

5. Postigo, A. (23 July 2023). "Governing the Digital Economy in Thailand: Domestic Regulations and International Agreements", *Perspective*, ISEAS, Yusof Isaak Institute, Issue 58, p. 3–4.
6. Johan, A. (3 September 2024). "Asia-Pacific Subscribers Will Benefit from More 5G Mid-band Spectrum". Ookla.
7. GSMA. (19 January 2024). "For the benefit of billions: the impact of WRC-23 decisions on spectrum policy in 2024". *Spectrum Policy Trends 2024*.
8. GSMA Intelligence. 5G in Context, Q2 2024.
9. GSMA Intelligence. 5G in Context, Q2 2024.

1.1 Overview of the Thailand mobile market

High-bandwidth internet connectivity is becoming increasingly important for enhancing productivity, social welfare and well-being.

In many emerging markets, where fibre penetration is typically lower or prices higher, there tends to be greater reliance on wireless technology – both mobile and fixed wireless – to meet growing demand for affordable and expandable connectivity. As of 2023, mobile broadband adoption in Thailand was 124 per 100 inhabitants compared to 16 per 100 inhabitants for fixed broadband.[10] As of Q2 2024, network coverage for 3G and 4G services was at 100% and 99.5% of the national population, respectively.

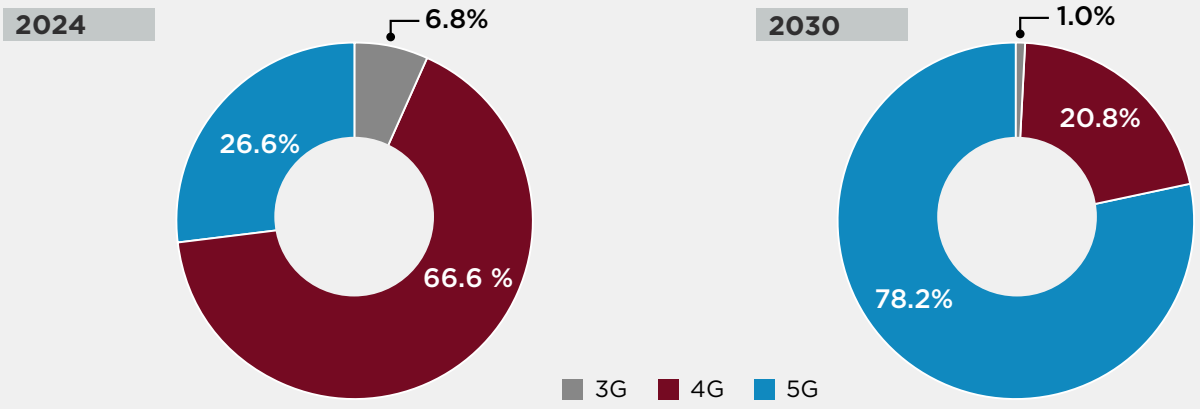
Thailand's mobile market was comprised of the following main players in Q3 2024:

- The 2023 merger of TrueMove and DTAC into True Corp resulted in a 51% market share by connections in 2024.[11]
- Advanced Info Service (AIS), no longer the largest MNO by subscriber base, has 46% market share.
- National Telecom (NT), formed in 2021 following a merger of state-run firms CAT Telecom and TOT, partnered with AIS to support the development of its commercial 6G strategy.[12]

In Thailand, 5G services were launched in early 2020 following the 5G auction in February 2020 (see section 2.2). As of Q3 2024, 5G networks cover more than 95% of Thailand's population[13] and the two leading service providers have around 26.8 million 5G connections (26.6% of total connections). Still, Thailand's median mobile performance in July 2023 places it in the middle of Southeast Asian countries, with a median download speed of 40.6 Mbps and a 13.5 Mbps median upload speed.[14]

The pace of 5G deployment and adoption is forecast to grow over the next three years. By 2028, the number of 5G connections is also forecast to reach 60 million, with 5G networks covering 96% of the population.[15] While 4G will continue to account for most mobile connections, the share of 4G connections has been declining since 2022.[16] Still, 4G remains the most common mobile broadband technology in Thailand in Q3 2024 with 66.6% of mobile connections, while 3G accounts for 6.8% of connections and 5G for 26.6%.[17]

Figure 2
Mobile connections in Thailand, by technology



Source: GSMA Intelligence

10. ITU. (August 2024). *World Telecommunication/ICT Indicators Database*.
11. Somhar, T.T. (2 March 2023). "True Core unveils ambition to be Thailand's leading telecom-tech company". *Nation Thailand.*
12. NT. (3 October 2023). "NT and AIS join forces to increase 4G/5G capability on the 700 MHz spectrum".
13. GSMA Intelligence, November 2024.
14. OECD. (2023). *Extending Broadband Connectivity in Southeast Asia*.
15. GSMA Intelligence, November 2024.
16. Ibid.
17. Ibid.

In Thailand, monthly mobile data traffic per connection has grown from 19.8 GB in 2020 to 30.6 GB as of Q3 2024.[18] This is already significantly higher than neighbouring countries in Southeast Asia. According to Ericsson estimates, mobile data traffic per smartphone in Southeast Asia will grow from 17 GB per month in 2023 to 42 GB by 2029.[19]

At the same time, 5G enterprise use cases are also emerging across different industrial verticals, which will drive growth in cellular Internet of Things (IoT) connections. Across Asia Pacific, MNOs are leveraging the scale and utility of mobile networks and services to offer 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 digital transformation projects across different industries, in turn driving demand for 5G connectivity and economic growth for the rest of the decade.

While around 3,200 MHz of mobile spectrum has been assigned in Thailand, the 26 GHz mmWave band – suitable for localised small cell deployment due to its propagation characteristics – accounts for most of this figure. There has been no change in the total frequency assignments in Thailand according to the *Frequency allocation plan for IMT for Thailand (2024-2028)*. As shown in Table 1, only 450 MHz is currently assigned in the mid-band range, compared to an average of 850 MHz in the Asia-Pacific region today. There is a clear need for more mid-band spectrum to support the development of 5G and service delivery over wide areas through public macro mobile networks.

Table 1
Current IMT spectrum assigned in Thailand

Type of spectrum	Bandwidth assigned	Bands
Low band (sub-1 GHz)	170 MHz	700 MHz, 850 MHz, 900 MHz
Mid-band (1–7 GHz)	450 MHz	1800 MHz, 2.1 GHz, 2.3 GHz, 2.6 GHz
High band (above 24 GHz)	2600 MHz	26 GHz

Source: GSMA, APT

Table 2
Current IMT spectrum assignments for MNOs in Thailand

MNO	700 MHz	850 MHz	900 MHz	1800 MHz	2.1 GHz	2.3 GHz	2.6 GHz	Total low and mid	26 GHz	Total MHz
AIS	2 x 20	–	2 x 10	2 x 20	2 x 15	–	100	**230**	1,200	**1530**
DTAC	2 x 10	–	2 x 5	2 x 5	2 x 15	–	–	**70**	200	**270**
True	2 x 10	–	2 x 10	2 x 15	2 x 15	–	90	**190**	800	**990**
NT	2 x 5	2 x 15	–	–	2 x 15	60	–	**130**	400	**530**
TOTAL	**90**	**30**	**50**	**80**	**120**	**60**	**190**	**620**	**2600**	**3220**
Vacant	0	0	0	70	0	30	0	**100**	0	**100**

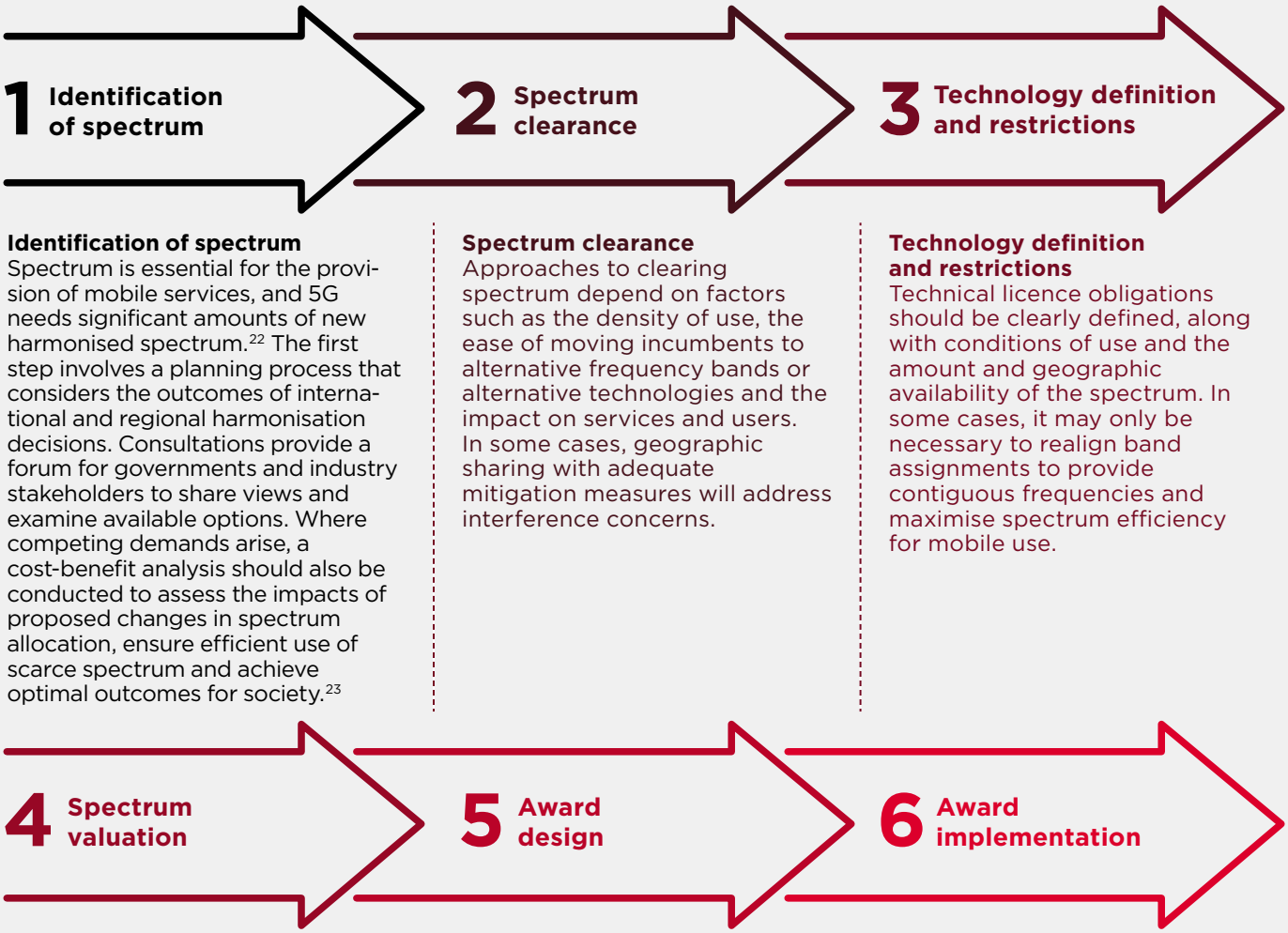
Source: NBTC, November 2024[20]
Note: True and DTAC merged in 2023

18. GSMA Intelligence, November 2024.
19. Ericsson. (27 June 2024). "*Ericsson Mobility Report: 5G subscriptions will be close to 5.6 billion by the end of 2029*". Press release.
20. NBTC. (November 2024). (ร่าง) แนวทางการส่งเสริมและ ประยุกต์ใช้เทคโนโลยี. *5G & Beyond: Guidelines for the Promotion and Application of Technology 5G and Beyond.*

1.2 A spectrum roadmap for 5G and 5G-A

As with all previous generations of mobile services, the road to 5G in every country begins with the release of spectrum to support the network roll out. A typical spectrum roadmap, as illustrated in Figure 3, involves six main steps.[21]

Figure 3
Spectrum roadmap and steps



Identification of spectrum
Spectrum is essential for the provision of mobile services, and 5G needs significant amounts of new harmonised spectrum.[22] The first step involves a planning process that considers the outcomes of international and regional harmonisation decisions. Consultations provide a forum for governments and industry stakeholders to share views and examine available options. Where competing demands arise, a cost-benefit analysis should also be conducted to assess the impacts of proposed changes in spectrum allocation, ensure efficient use of scarce spectrum and achieve optimal outcomes for society.[23]

Spectrum clearance
Approaches to clearing spectrum depend on factors such as the density of use, the ease of moving incumbents to alternative frequency bands or alternative technologies and the impact on services and users. In some cases, geographic sharing with adequate mitigation measures will address interference concerns.

Technology definition and restrictions
Technical licence obligations should be clearly defined, along with conditions of use and the amount and geographic availability of the spectrum. In some cases, it may only be necessary to realign band assignments to provide contiguous frequencies and maximise spectrum efficiency for mobile use.

Spectrum valuation
This step involves assessing the value of spectrum guides upfront, as well as annual fees. There are different valuation approaches, including benchmarking and modelling analysis, and both methods should be used to improve accuracy and capture local market factors. Costs related to licensing obligations should be considered when setting prices for spectrum.

Award design
There are three main approaches to awarding spectrum: auctions, beauty contests and direct award.[24] The approach adopted, and associated licence obligations, must consider policy objectives, available spectrum and market specifics (for example, the number of MNOs or current spectrum holdings). Depending on the availability timeline of different frequency bands and award design, it may be appropriate to have a single multiband award or several separate ones.

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.

21. GSMA. (April 2022). *Roadmaps for awarding 5G spectrum in the APAC region*.
22. The key frequency bands to prioritise for 5G are outlined in section 1.3.
23. GSMA. (January 2022). *Maximising the socio-economic value of spectrum. A best practice guide for the cost-benefit analysis of 5G spectrum assignment*.
24. For the GSMA's position on auction best practice, see: GSMA. (September 2021). *Auction Best Practice: GSMA Public Policy Position*.

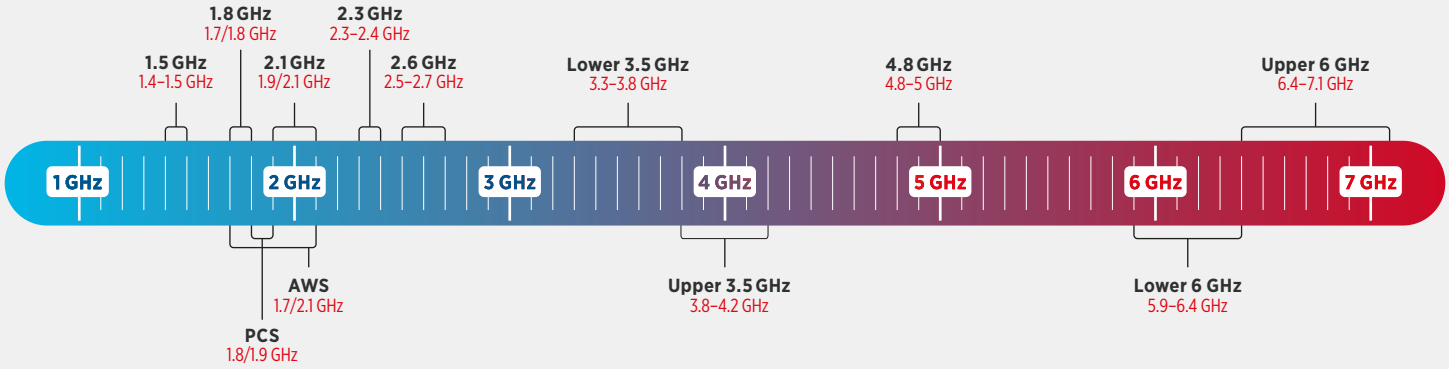
1.3 The key role of mid-band spectrum for 5G and 5G-A

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 uptake, new 5G and 5G-A 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 drive greater demand for mobile data services.

Mid-band frequencies are especially crucial because they provide the capacity and coverage required for mobile networks to offer reliable performance that meet the ITU IMT-2020 requirements[25] across densely populated urban areas. New mobile broadband use cases, such as enhanced mobile broadband (eMBB), fixed wireless access (FWA), IoT and Industry 4.0, all depend on mid-band spectrum. These use cases will increase the impact of mobile services on society and economies.

Mid-band spectrum resources include both lower mid-bands (1500 MHz, 1800 MHz, 2.1 GHz, 2.3 GHz and 2.6 GHz) and upper mid-bands (3.3–4.2 GHz, 4.5–5.0 GHz and 5.925–7.125 GHz). To deliver a 5G service consistent with the ITU IMT-2020 requirements,[26] each MNO will need access to at least 100 MHz of contiguous mid-band spectrum for initial service launch. As adoption grows, more mid-band spectrum will be required. WRC-23 also identified the need for additional spectrum in the low band and in the 3.5 GHz and 6 GHz mid-bands to accommodate growing demand for mobile data.[27]

Figure 4
Mid-band spectrum



Source: GSMA Intelligence

It is estimated that MNOs will need around 2 GHz of mid-band spectrum during this decade.[28] Latest research by the GSMA on the socio-economic benefits of mid-band 5G services indicates that mid-band 5G spectrum will drive up global GDP by more than $610 billion in 2030, accounting for almost 65% of the overall socio-economic value generated by 5G.[29] In Southeast Asia, 5G mid-band services will contribute an additional $35 billion to GDP (0.64% of GDP).

25. ITU. (November 2017). *Minimum requirements related to technical performance for IMT-2020 radio interface(s). Report ITU-R M.2410-0*.
26. User experience of 100 Mbps DL, 50 Mbps UL rates.
27. GSMA. (January 2024). *The impact of WRC-23 decisions on spectrum policy in 2024*.
28. GSMA. (8 July 2021). *5G Mid-Band Spectrum Needs: Vision 2030*.
29. GSMA. (February 2022). *The Socio-Economic Benefits of Mid-Band 5G Services*.

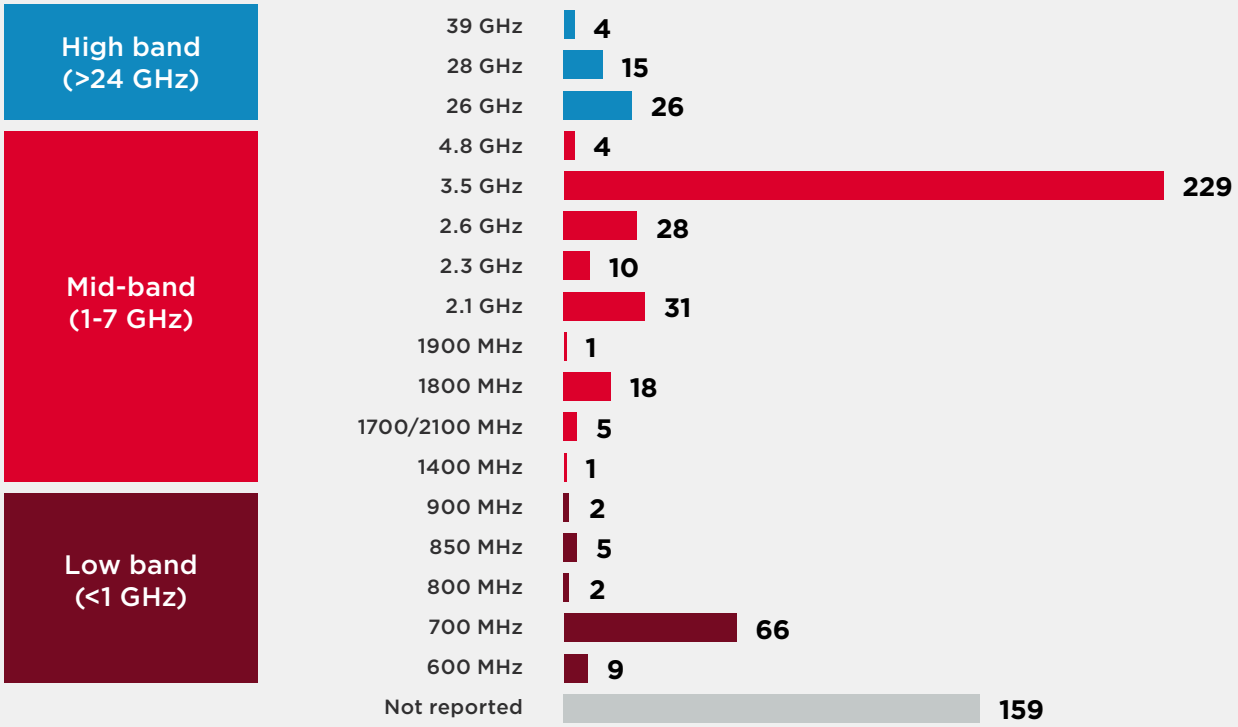
1.3.1 2.6 GHz and 3.5 GHz bands as springboards for 5G

The 3.5 GHz band (n77/78), which is globally harmonised for 5G, has been the basis for the pioneer phase of 5G roll outs in many markets. To date, 3.5 GHz accounts for the majority of 5G network launches globally,[30] driving the wider ecosystem,[31] device diversity and competition. It has been deployed for eMBB, enabling faster data speeds and greater capacity in urban, densely populated areas, as well as for FWA in suburban and rural areas where the availability of fixed broadband tends to be more limited.

The 2.6 GHz band, particularly the n41 Time Division Duplexing (TDD) version, has supported 5G deployment globally, including in Thailand.

Markets using n41 for 5G services include Thailand, United States, China, the Philippines, Vietnam, India, Saudi Arabia and South Africa. According to GSMA Intelligence (GSMAi), 5G deployments in the 2.6 GHz band are the fourth most-supported globally, and of the announced 5G device models supporting key 5G spectrum bands, n41 (2.6 GHz) had the second strongest ecosystem after 3.5 GHz with more than 1,800 device models.[32]

Figure 5
5G network launches by spectrum frequency (up to Q2 2024)



Source: GSMA Intelligence.

Note: Figures refer to launches, not individual MNOs. A range of MNOs have launched their 5G networks on more than one frequency. If an MNO has launched both mobile and fixed wireless 5G networks, then it is counted twice. 3.5 GHz band=3.3–3.8 GHz range. 2.6 GHz band=2.5–2.6 GHz range.

30. Excluding frequencies not reported.
31. Of the announced 5G device models supporting key 5G spectrum bands (end of March 2024), n78 (3.4–3.8 GHz), 5G devices had the strongest ecosystem with nearly 2,000 device models while n77 (3.3–4.2 GHz) had more than 1,600 device models and was the fourth strongest. n41 (2.6 GHz) had the second strongest ecosystem with more than 1,800 device models. See: GSA. (May 2024). *5G Market Snapshot*, p. 4.
32. See GSA. (May 2024). *5G Market Snapshot*, p. 4.

2. Progress on Thailand's spectrum plan for 5G and 5G-A

2.1 Spectrum management in Thailand

The Ministry of Digital Economy and Society (MDES), through its Office of the National Digital Economy and Society Commission (ONDE), is responsible for telecommunications policy in the Kingdom of Thailand. In accordance with the *Act on the Organization to Assign Radio Frequency and to Regulate Broadcasting and Telecommunications Services* (2010) (*as amended*), the NBTC regulates frequency spectrum and licensing in Thailand.

Consistent with the *Thailand Digital Economy and Society Development Plan* (2018–2037), 5-Year Action Plan for Digital Economy and Society (2018–2022) and the NBTC's *Telecommunications Master Plan No. 2* (2019–2023), the NBTC issued a *Spectrum Management Master Plan* in 2019.[33] In that same year, the NBTC also issued the *Notification Re: Criteria for Permitting Frequency Use for Innovation Development and Testing in a Sandbox Area (Sandbox Notification).* The NBTC more recently proposed a revised spectrum roadmap: the *Frequency allocation plan for IMT for Thailand (2024-2028)*.[34] The spectrum plan was revised to reflect research conducted by the NBTC and Thailand's international obligations following revisions to Radio Regulations at WRC-23, which will come into effect on 1 January 2025.[35]

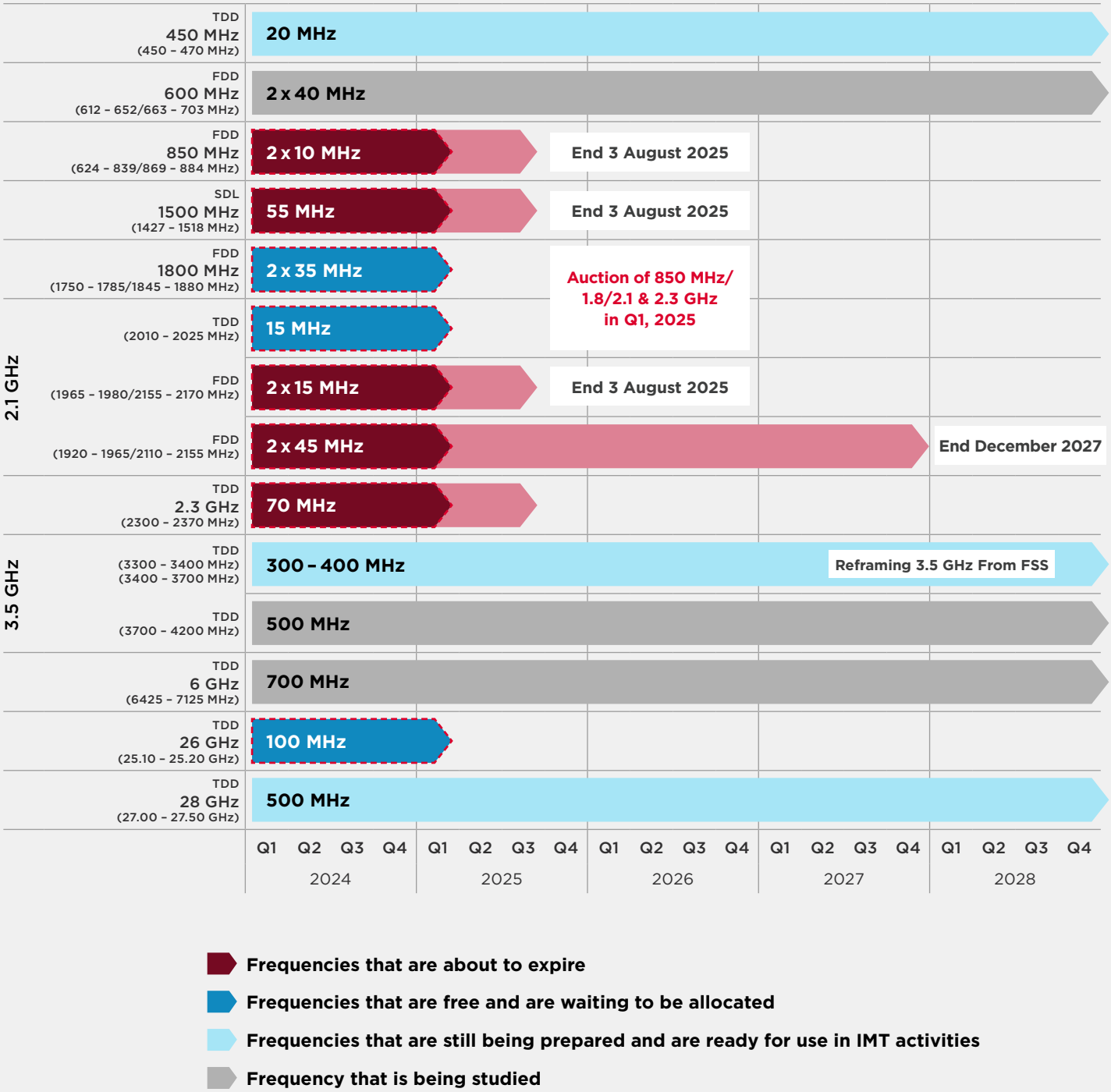
The 2024–2028 spectrum roadmap, shown in Figure 6, sets out future spectrum allocations in four categories: (1) spectrum that is about to expire; (2) vacant spectrum; (3) spectrum that is still being prepared for allocation; and (4) spectrum still under study. The roadmap strives to ensure efficient and competitive use of spectrum for public benefit across all of Thailand, the development of the digital economy and the strengthening of digital infrastructure. According to the roadmap, 365 MHz mid-band spectrum will be available for future assignments, but there are questions as to whether this will be sufficient.[36]

The roadmap mentions the development of 5G technology "and beyond", and while the 2-Year Action Plan for Promoting the Adoption of 5G Technology in Thailand (2021–2022) has already been announced, phase 2 of the plan (2023–2027) remains under development.[37] It is expected to be completed by the end of 2024.[38]

33. NBTC. (2019). *Spectrum Allocation Plan for the International Mobile Telecommunication business of Thailand, the 5-year period (2019–2023)*, revised edition (in Thai).
34. As translated in: ร่าง แผนการจัดสรรคลื่นความถี่ฯ ระยะ 5 ปี พ.ศ
35. As translated in: เอกสารการรับฟังความคิดเห็นฯ
36. Saneh Saiwong. April 2024.
37. Saffa, A. (11 October 2023). "Empowering Thailand's Digital Future". OpenGov Asia.
38. Tortermvasana, K. (11 December 2023). "Spectrum Roadmap Prepared". Bangkok Post.

Figure 6
Thailand spectrum roadmap 2024–2028

NBTC Frequency allocation plan for IMT business



Source: NBTC (November 2024)

Following the successful auction and assignment of the 700 MHz, 2.6 GHz and 26 GHz bands in February 2020, the NBTC is now planning to auction the 3.5 GHz band for 5G services in 2026–2027.[39]

The roadmap also considers spectrum allocation for the transition from 5.5G (otherwise known as 5G-A) to 6G technology. The roadmap would be divided into two phases covering the 3.5 GHz range (3.3-4.0 GHz), and the upper 6 GHz band (6.425–7.125 GHz).

The first phase involves spectrum in the 3.5 GHz range to support 5G public mobile services and private networks. Different options for private networks are under consideration including licensing on a revenue-sharing basis. For the public mobile services, the NBTC is expected to assign spectrum in the 3.3–3.6 GHz frequencies by 2026 or 2027. Further availability of the 3.7–4.0 GHz range is being considered for 2030.[40]

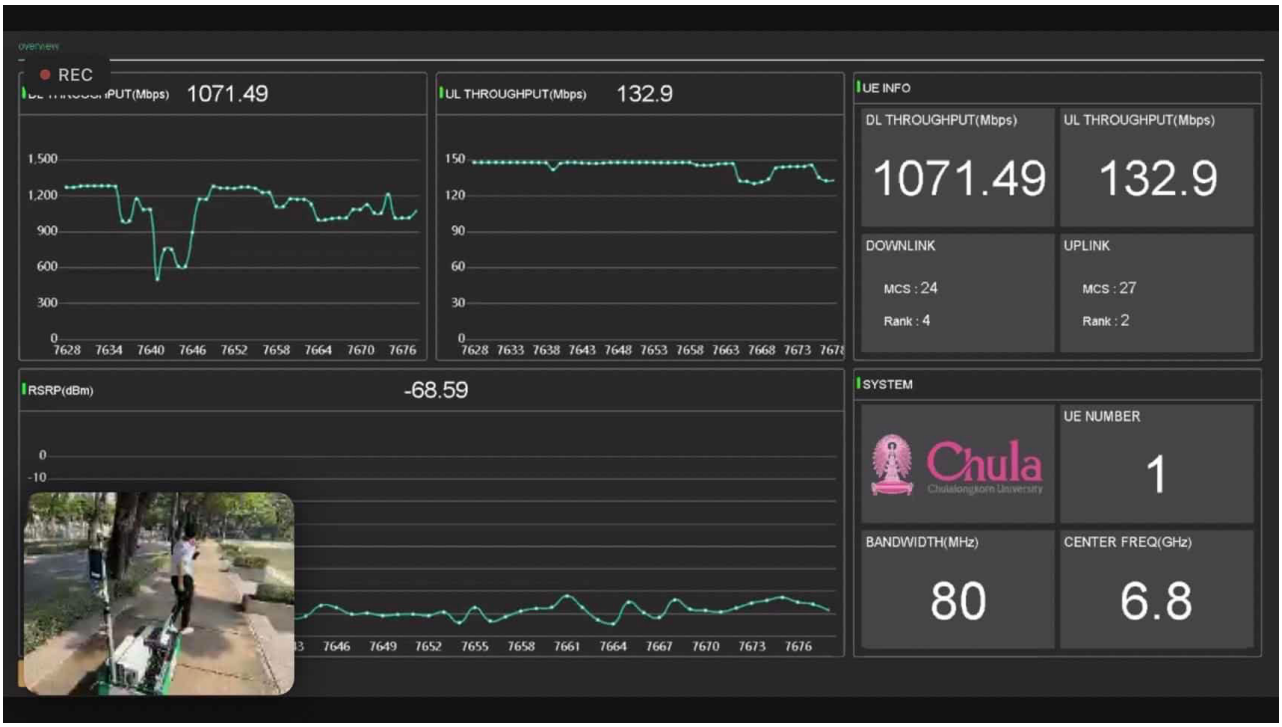
At WRC-23, countries in each of the three ITU Regions identified the 6.425–7.125 GHz band for IMT use. The NBTC has been in conversation with major vendors regarding its development plan for the upper 6 GHz band, with spectrum in the 6G and the upper band possibly allocated by 2030.[41] Trials have shown that 6 GHz can deliver comparable indoor coverage to the 3.5 GHz range. As the following case study demonstrates, the overall performance of the upper 6 GHz band for IMT services is excellent.

39. The Nation. (6 September 2024). "Two mobile spectrum to open for bidding early next year".
40. Tortermvasana, K. (11 December 2023). "Spectrum Roadmap Prepared". Bangkok Post.
41. Ibid.

CASE STUDY

5G in the 6 GHz frequency band: a test in the Chula Sandbox

In March 2023, Chula Unisearch (from the Department of Electrical Engineering at Chulalongkorn University) partnered with Huawei Technologies to conduct a study of the use of 5G technology in the 6 GHz frequency band, with the goal of evaluating its behaviour and key properties. In particular, the study evaluated the technical aspects, performance metrics and data transmission capabilities. Research involved representatives from 10 countries in Southeast Asia and South Asia, with the test performed in the Chula Sandbox area.



Source: Chula Unisearch

The study showed very encouraging results for outdoor use (O2O) of the 6 GHz band, finding an average download speed of more than 1 Gbps, with 72% of the test area tested on 80 Mbps bandwidth. In terms of indoor use (O2I), average download speed was 550 Mbps. The study concluded that the 6 GHz band can be used for mobile services using 5G technology and other nascent technologies such as 5.5G (5G-A).

These findings are significant as the 6 GHz band has been described as critical for ensuring better connectivity through balanced coverage and capacity in the provision of 5G services. Expanding 5G's bandwidth by using 6 GHz spectrum is understood to improve overall network performance while reducing the need for greater network density.[42]

42. Papronpat, N. (30 May 2023). "5G on 6 GHz Frequency Test in Chula Sandbox".

2.2 Thailand's 5G spectrum auction

Thailand's first 5G spectrum auction was held in February 2020 for frequencies in the 700 MHz, 2.6 GHz and 26 GHz bands.

Both AIS[43] and TrueMove H[44] deployed their 5G networks after the spectrum auction in early 2020, using their newly purchased 2.6 GHz spectrum. DTAC launched 5G services using their 700 MHz spectrum holdings in February 2021.[45]

A merger between DTAC and TrueMove announced in November 2021 was finalised in March 2023, creating the largest mobile vendor in Thailand by number of subscribers and reducing the number of major MNOs to two. In September 2023, True Corp announced its Single Grid initiative, which aims to consolidate the True and DTAC networks by combining their base station towers and spectrum resources. As of November 2023, 76% of customers could access both networks on the 2.6 GHz and 700 MHz bands, with an expected completion date for the initiative set for 2025.[46]

In January 2024, True took over the payment of DTAC's licence fees for the 2 x 5 MHz spectrum in the 890–895/935–940 MHz band that they secured in October 2018. While DTAC did not secure any frequencies in the 2.6 GHz band during the 2020 spectrum auction and had to deploy 5G in the 700 MHz band instead, DTAC has been able to operate in the 2.6 GHz band since the merger was finalised.[47]

The combined True-DTAC network therefore has assigned spectrum in the 700 MHz, 850 MHz, 1800 MHz, 2.1 GHz, 2.3 GHz, 2.6 GHz and 26 GHz bands. AIS has similar IMT spectrum holdings.

Thailand is set to auction spectrum in the 850 MHz, 1500 MHz, 1800 MHz, 2.1 GHz and 2.3 GHz bands in the first quarter of 2025. This strategic initiative is part of the NBTC's broader spectrum management strategy for 2025–2030. By making these frequencies available, Thailand aims to advance telecommunications infrastructure to support the development of 5G-A and set the stage for future 6G systems. The current licences for the 2.1 GHz and 2.3 GHz bands, held by NT, will expire in September 2025.

In addition to the upcoming auction, Thailand's spectrum management strategy includes plans to make available the 3.5 GHz band currently used by digital TV broadcasters. The NBTC plans to auction this band for mobile use in 2027, aligning with global trends and ITU recommendations that favour its use for mobile networks.[48]

43. GSMA. (3 March 2020). "AIS is the first operator in Thailand to launch 5G network nationwide".
44. Tortermvasana, K. (17 March 2020). "True Move debuts 5G on newly bought bandwidth". *Bangkok Post.*
45. Telecompaper (23 February 2021). "Dtac launches 5G serfvice on 700 MHz spectrum".
46. Tanner, J. (9 November 2023). "True-Dtac spectrum consolidation is boosting signal quality: CTO". *Developing Telecoms.*
47. Wyrzykowski, R. (9 May 2023). "The DTAC-TrueMove H merger is helping to boost users' 5G speeds and video experience". *Opensignal.*
48. Digwatch. (12 September 2024). "Thailand to auction 2.1 GHz and 2.3 GHz bands for 5G-A and 6G".

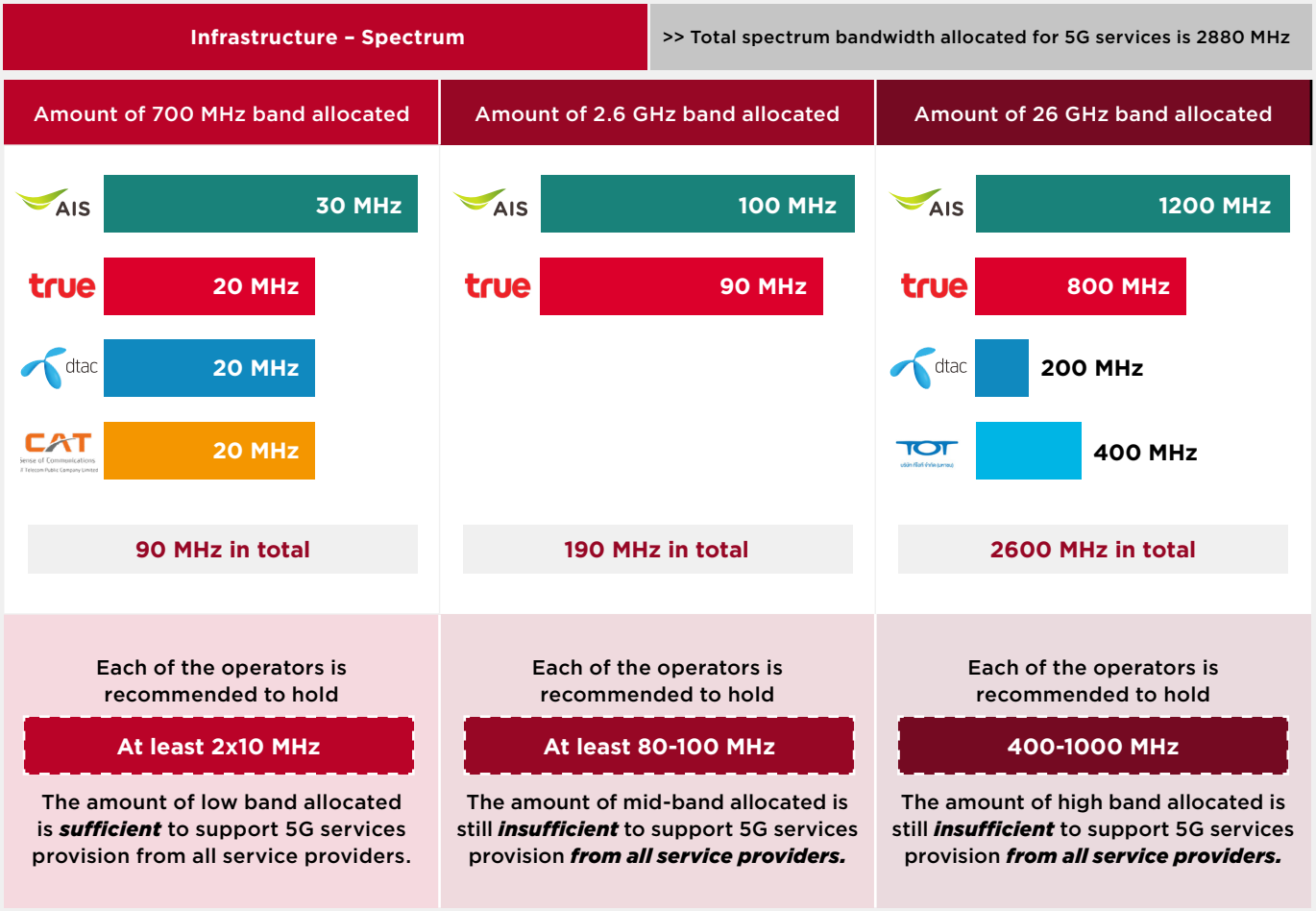
3 Key challenges and recommendations to secure sufficient spectrum for 5G and 5G-A in Thailand

3.1 Key spectrum challenges

Although Thailand has made a significant amount of spectrum available for 5G services – some of the highest in the ASEAN region – Figure 7 shows that much of it is in the mmWave range.

In the mid-band range, there is still insufficient mid-band spectrum to address growing demand for 5G across the whole country and for future 5G-A/6G services.

Figure 7
Current 5G spectrum assignments in Thailand (excluding legacy IMT holdings)



Source: ONDE, Action Plan for Promoting the Adoption of 5G Technology in Thailand Phase 1, released February 2022, p. 36.
Note: True and DTAC merged in 2023

The importance of mid-band frequencies is well recognised. As indicated by ONDE, *"The mid-band allocation is still insufficient for the 5G service to support all service providers in the future in terms of the network capacity and coverage. Therefore, the regulatory agencies should allocate additional mid-band in the future."*[49]

North America, Japan, China and many European markets have assigned considerably more mid-band spectrum for 5G/IMT, including 400 MHz or more in the 3.5 GHz band. In Thailand, the need to address this shortfall is recognised.[50] The current proposal is to refarm an additional 200–300 MHz[51] of mid-band spectrum from the 3.4–3.7 GHz range (in addition to the 190 MHz currently assigned in 2.6 GHz) for 5G services.

49. ONDE, *Action Plan for Promoting the Adoption of 5G Technology in Thailand Phase 1*, released February 2022, p. 36.
50. In another regional example, Australia has increased the amount of 3.5 GHz band allocated for 5G/IMT services. See: Australian Communications and Media Authority (ACMA). www.acma.gov.au/consultations/2022-03/proposed-spectrum-re-allocation-declaration-34-ghz-and-37-ghz-bands
51. ONDE highlights that the volume of 3.4–3.7 GHz band to be allocated will depend on the specified guard band.

The key challenge is the current use of the extended C-band (3.4–3.7 GHz) and standard C-band (3.7–4.2 GHz) frequencies for satellite services in Thailand, as there are an estimated 10 million or more TVRO services in operation, according to the NBTC. This challenge is explored in more detail in section 3.3.

In relation to the 28 GHz band, a key question is how much mmWave band spectrum to make available. In January 2023, the NBTC prepared a draft regulation on the use of the 28 GHz spectrum range. The draft follows the NBTC guidelines approved in October 2022, which allowed all satellite-related service applications to use the 27.5–29.5 GHz frequency range. These services included Geostationary-Satellite Orbit (GSO) and Non-Geostationary-Satellite Orbit (NGSO) gateways, earth stations in motion and high-density applications in the fixed-satellite service.[52] In June 2023, major satellite companies such as Amazon (Project Kuiper), OneWeb and Starlink reported that the mixed use of 28 GHz spectrum for terrestrial and space-based systems would create imbalances, asserting that this allocation system had failed in Thailand.[53] It is also unclear whether there is any demand for additional mmWave spectrum to be allocated for IMT purposes, as Thai MNOs have not deployed networks using their 26 GHz spectrum and are not currently carrying traffic.[54]

3.2 Cross-border coordination

Geography and population density mean that cross-border interference issues in the 700 MHz, 2.6 GHz and 3.5 GHz bands are more likely between Thailand and Malaysia, Cambodia[55] and Lao PDR rather than Myanmar. This is because Myanmar has not currently assigned the 700 MHz and 3.5 GHz bands, and its 2.6 GHz band also uses TDD technology and joint coordination has already been agreed.

Need for 700 MHz band coordination

As part of the migration from analogue to digital TV, the 700 MHz band has been fully cleared and assigned in Thailand, Malaysia and Lao PDR. However, since Cambodia has yet to undertake this migration, there will be a need for cross-border frequency coordination given the likely harmful interference with IMT services in Thailand from analogue and digital terrestrial TV broadcasting services. Key areas to the east of the country are most likely to be affected and the need for coordination has already been discussed and agreed upon.[56] However, such interference is likely to be short-term as the current plan in Cambodia is for the digital dividend to be secured after the migration to digital TV and 2 x 45 MHz of 700 MHz spectrum to be awarded in Q1 2026.

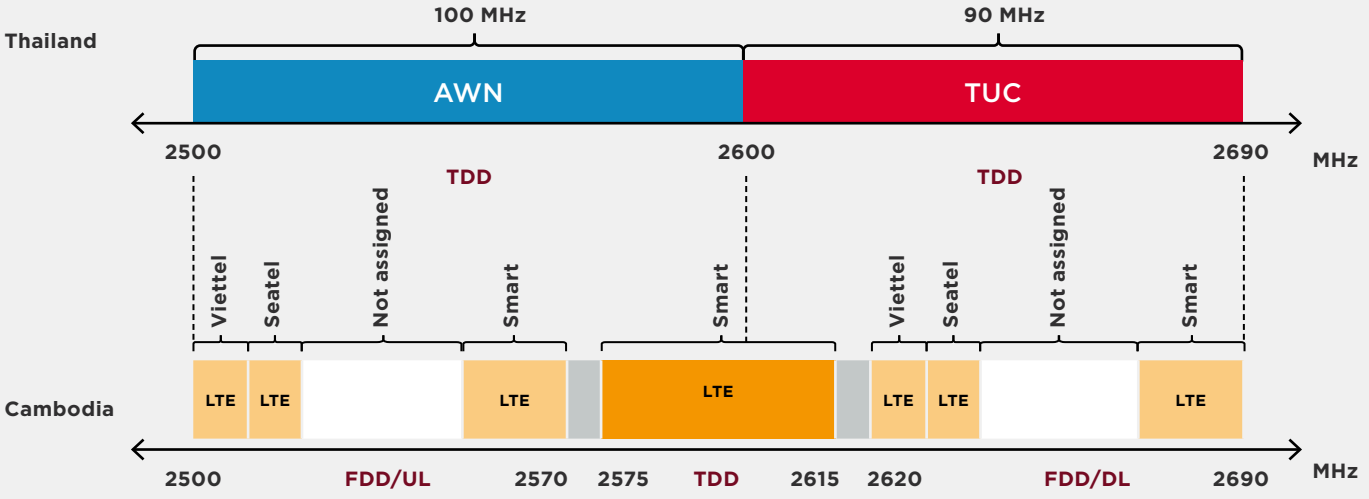
Need for 2.6 GHz band coordination

In the 2.6 GHz band, Thailand has assigned IMT spectrum based on the TDD n41 band plan. Thailand's ASEAN neighbours Cambodia, Lao PDR and Malaysia, currently use the hybrid FDD/TDD configuration (b7/b38) for 4G services in this band. This raises possible co-channel interference between FDD and TDD services and synchronisation issues between TDD networks in the various border regions. As both Thailand and Vietnam use n41 in the 2.6 GHz band, there would be significant benefits for Cambodia in transitioning its 2.6 GHz band channel plan to TDD, but the commercial and technical viability of such a transition will depend on the number of 2.6 GHz FDD-deployed sites by Metfone and Smart Axiata in Cambodia.

In June 2024, Thailand and Cambodia met to manage cross-border interference in the 2.6 GHz spectrum band. The signal level of -115dBm/5MHz was less restrictive than that of Thailand's management of cross-border interference with Malaysia at -120dBm/5MHz. The defined coordination distance from the border is the same at 1 km.

52. Bangkok Post. (20 January 2023). "NBTC preps draft spectrum regulation"
53. Parbat, K. (9 June 2023). "28 GHz spectrum allotments for 5G have failed in Korea, US, Japan, Thailand: Satcos to TRAI". *The Economic Times.*
54. Where 5G traffic is only to be carried on low and mid-band spectrum in Thailand. See: Johan, A. (3 September 2024). "Asia-Pacific Subscribers will benefit from more 5G Mid-band spectrum". Ookla.
55. The border between Thailand and Cambodia is also more complex given border demarcation issues between the two countries. See: Nanuam, W. (2 September 2022). "Cambodian border growing clearer". *Bangkok Post.*
56. See the Minutes of the Meeting of the Working Group Prepared for the Joint Technical Committee Meeting on Coordination and Allocation of Frequency Waves in the Border Area of Thailand and Neighbouring Countries, No. 1/2567, 8 February 2567 (2024). (In Thai).

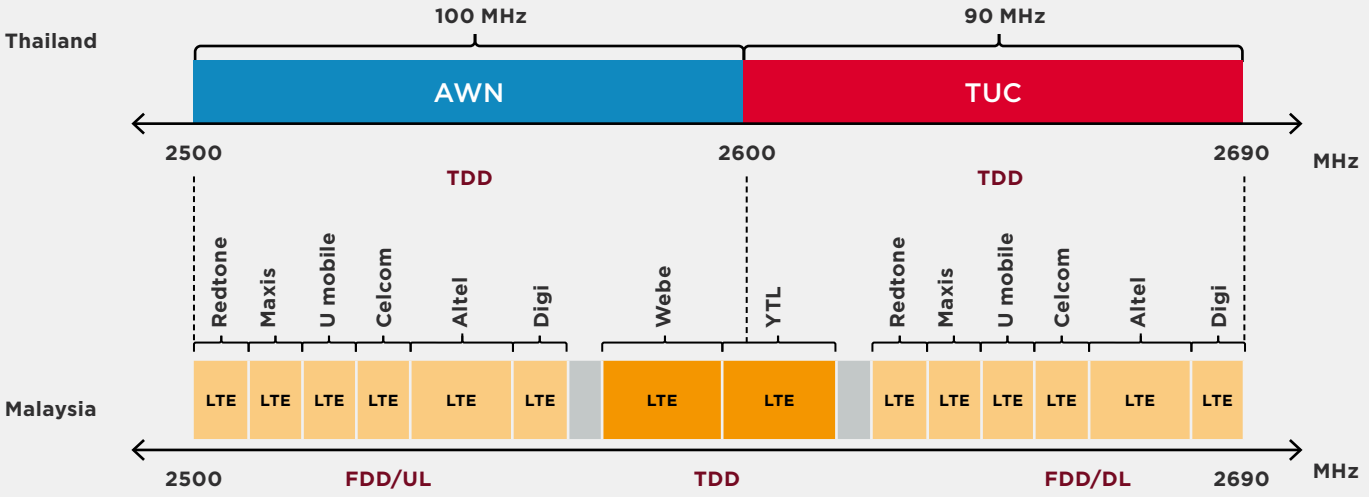
Figure 8
Thailand-Cambodia's agreed cross-border coordination approaches



Source: NBTC, 2024.
Note: Currently substantial 2.6 GHz band spectrum is vacant in Cambodia arising from an international arbitration.

Thailand has agreed with Malaysia, and its other neighbours through various Joint Technical Committee (JTC) meetings, to adopt the coordination parameters in relation to the 2.6 GHz band (see, for example, the cross-border coordination approaches agreed by Malaysia and Thailand in Figure 9). Similar approaches could be adopted in relation to the 2.3 GHz and 3.5 GHz bands.[57]

Figure 9
Malaysia-Thailand agreed cross-border coordination approaches



Source: JTC Thailand-Malaysia 17 May 2021

57. Alternatively, when MNOs deploy TDD 2.6 GHz (n41) and FDD 2.6 GHz (n7), the coordination distance of TDD and FDD sites should be less than 1 km with back-to-back transit and signal level limited to less than -110dBm. Ideally, countries should synchronise their TDD 2.6 GHz networks; otherwise, a 10 km isolation distance is likely to be required.

Table 3
Malaysia-Thailand cross-border coordination

Frequency band	Technology	Coordination parameters	
		Signal level (dBm)	Defined distance from the border (km)
2.6 GHz	LTE/5G TDD – LTE (FDD)	-120 dBm/5 MHz	1 km
	LTE/5G TDD – LTE (TDD)	ECC Rec (11)05/ ECC Rec (14)04	1 km

Source: JTC Thailand-Malaysia 17 May 2021

Thailand, led by the NBTC along with neighbouring countries, have undertaken various information exchanges on frequency planning and 5G deployment plans, joint testing of interference situations and assessing solutions to prevent harmful interference. It is important to continue these discussions to ensure all MNOs and relevant stakeholders have the requisite information to plan their 5G deployments.

3.3 Near-term actions

While Thailand has already taken significant steps to make IMT spectrum available, including auctioning the 700 MHz and 2.6 GHz bands, additional spectrum is needed to support the development of the country's digital economy with 5G-A. The following actions, focussed on the 3.5 GHz and legacy bands, are recommended to overcome these challenges.

Recommendation:

3.5 GHz band – As detailed above, there are significant challenges for Thailand to make the 3.5 GHz band available for 5G services, especially in the amounts needed to address the shortfall in mid-band spectrum.

- **Supply** – At least 300 MHz of 3.5 GHz spectrum in the 3.3–3.7 GHz range should be made available for 5G use as soon as practicable. If the full 300 MHz is not possible initially, 200 MHz should be released first, consistent with phased approaches in other markets. 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 spectrum released should be subject to the condition that the band is reorganised to create larger contiguous blocks of spectrum. The aim is to provide the option for all MNOs, including the newly merged NT, to secure up to 100 MHz of contiguous spectrum in this band.
- **Clearance and/or mitigation measures** – To facilitate the release of 3.5 GHz spectrum, Thailand should accelerate clearance or introduce adequate mitigation measures to ensure coexistence with incumbent users in the band.
- **Efficient guard band** – Thailand should adopt guard bands that maximise spectral efficiency. Heavy use of the 3.5 GHz band for 5G means there are both studies and real-world regulatory examples of the necessary guard band between 5G and FSS. They have concluded that a guard band in the range of 18[58] to 25 MHz[59] is needed. In Canada[60] and the U.S.,[61] a guard band of 20 MHz has been adopted.

58. See the 2019 Transfinite study, which concluded that an 18 MHz guard band is sufficient to mitigate co-frequency interference. Transfinite Systems. (August 2019). *Report for GSMA on the mitigations required for adjacent channel compatibility between IMT and ubiquitous FSS Earth Stations in the 3.4 – 3.8 GHz frequency band*.
59. For example, in Brazil, there is only a guard band of 25 MHz.
60. ISED. (May 2021). *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*.
61. FCC. (3 March 2020). *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*.

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, while in Taiwan a guard band of 44 MHz is used. Vietnam has only a 20 MHz guard band planned in the 3.5 GHz band, from 3980–4000 MHz.

In addition to guard bands, other possible measures to ensure coexistence between IMT and FSS include:[62]

- 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
- Detailed coordination

- **Phased introduction by geography** – Thailand should consider whether to adopt a policy of geographical separation for very small aperture terminal (VSAT) in regional and rural areas while restricting the use of satellite direct-to-home (DTH) and television receive-only (TVRO) in the 3.4–3.7 GHz band spectrum in key urban areas such as Bangkok, and/or the top 10 urban areas of the country.[63] This approach would allow 5G 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 in other parts of Thailand where fewer alternatives are available. A decision on the future deployment of 5G in rural regions can be reviewed and taken at a later stage depending on changes in demand.

Recommendation:

Legacy bands – There is good reason for the NBTC to consider making spectrum available in the 1800 MHz and 2.3 GHz bands, which are either vacant or likely to be vacated (in the case of the 2.3 GHz band) to MNOs with adjustments in price levels. These will be important to support 4G services, which will continue to coexist alongside 5G well into the 2030s. The NBTC should consider options to structure the award of unassigned spectrum to align with the licence end date of the entire bands, which would be ideal from a spectrum management perspective.

62. GSMA. (August 2019). *Roadmap for C-Band Spectrum in ASEAN*, p. 5.
63. Including, for example, Greater Bangkok, Chiang Mai, Nakhon Ratchasima, Hat Yai and Udon Thani.

3.4 Medium-term actions to address future IMT spectrum needs in 2025–2030

It is important to recognise that the 5G journey is only just beginning. For the rest of the decade and beyond, 5G and 6G will become central to mobile connectivity and underpin Thailand's digital transformation and economic growth. It is therefore important for policymakers and regulators to take a long-term view of 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.[64] At present, only around 450 MHz of mid-band spectrum has been assigned for IMT in Thailand. Even with the inclusion of the 3.5 GHz bands, the total supply of mid-band spectrum in Thailand will still be significantly below the 2 GHz required for IMT by 2030.

Thus, the following actions are recommended for Thailand:

- Assess options to expand 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 upper 6 GHz (6.425-7.125 GHz)[65] to support further development of 5G and the future proofing of spectrum for 6G.
- 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 part of the review[66] of existing Thai television licences, which expire in 2029, consider securing the second digital dividend in the 600 MHz band to extend rural and in-building mobile coverage.
- Facilitate the orderly switch-off of legacy IMT networks in Thailand, notably 2G services which account for less than 0.1% of total connections.

3.5 Planning for 6G

According to the ITU framework for the development of standards and radio interface technologies, the next generation of mobile systems (popularly known as 6G) is expected to be commercially available around 2030.[67]

Terrestrial wireless systems to be developed within this timeframe will be the next drivers of innovative radiocommunication systems, promoting digital equity and advancing universal connectivity. These outcomes are expected to help address growing environmental, social, and economic sustainability issues, and will align with the Paris Agreement of the United Nations Framework Convention on Climate Change.[68]

Companies and industry associations are in the process of submitting proposals for the IMT-2030 Radio Interface Technology (RIT) for ITU-R consideration by early 2027. Submissions will then be evaluated, with the objective of finalising 6G technology standards by 2030.[69]

64. Coleago Consulting and GSMA. (July 2021). *Estimating the mid-band spectrum needs in the 2025-2030 time frame*.
65. 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 published a cost-benefit analysis for different authorisation models for the 6GHz band in a number of countries. See: GSMA Intelligence. (January 2022). *The socioeconomic benefits of the 6 GHz band*.
66. Tortermvasana, K. (9 September 2024). "Keeping screens flickering". Bangkok Post; The Nation. (29 August 2024). "NBTC to take up with government woes of digital TV operators".
67. ITU. (November 2023). *Recommendation ITU-R M.2160*.
68. ITU. (1 December 2023). "ITU advances the development of IMT-2030 for 6G mobile technologies".
69. Ibid.

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