GSMA

IMT Spectrum Harmonisation in ASEAN:

Building digital infrastructure through spectrum planning towards 2030

February 2026

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

We invite you to find out more at gsma.com

The Association of Southeast Asian Nations (ASEAN) was established on 8 August 1967. The ASEAN Member States are Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor Leste and Vietnam. The ASEAN Secretariat is based in Jakarta, Indonesia.

This study, led by GSMA with the support of Windsor Place Consulting and industry partners Ericsson, Huawei and Nokia, was carried out from March 2025 to December 2025 under the framework of the ASEAN Digital Masterplan 2025. The objective is to support ASEAN Member States (AMS) in their spectrum planning processes by providing relevant and up-to-date market, technical and industry information, and best practices in spectrum management.

We are grateful to ASEAN Member States, ASEAN Secretariat, ASEAN Telecommunications Regulators' Council (ATRC) and Sub-Working Group on Spectrum Management (SSM) for the support and the contributions to this report.

Contents

Acronyms and abbreviations

2G, 3G, 4G, 5G, 6G	Second, Third, Fourth, Fifth, Sixth Generation
5G SA	5G Standalone
5GC	5G Core
ADGMIN	ASEAN Digital Ministers
AI	Artificial Intelligence
AMS	ASEAN Member State
AMS/MMS	Aeronautical and Maritime Mobile Services
APT	Asia-Pacific Telecommunity
AR	Augmented Reality
ASEAN	Association of Southeast Asian Nations
AWG	APT Wireless Group
CA	Carrier Aggregation
CapEx	Capital Expenditure
CSP	Cloud Service Provider
dBW	decibel Watt
DSO	Digital Switch Over
DTH	Direct-to-Home
DTIP	Data Transmission Industry Participant
DTT	Digital Terrestrial Television
DTV	Digital Television
ECC	Electronic Communications Committee
EDT	Energy Detection Threshold
EESS	Earth Exploration Satellite Service
EIRP	Effective Isotropic Radiated Power
eMBB	enhanced Mobile Broadband
EPC	Evolved Packet Core
FDD	Frequency Division Duplexing
FS	Fixed Service
FSS	Fixed Satellite Service
FWA	Fixed Wireless Access
GB	Gigabyte
GHz	Gigahertz
HSR	High-Speed Rail
IIoT	Industrial Internet of Things
IMT	International Mobile Telecommunications
ITU	International Telecommunication Union
LAA	Licensed Assisted Access
LMIC	Low- and Middle-Income Country
LNB	Low Noise Block
Mbps	Megabits per second
MFCN	Mobile/Fixed Communications Networks
MHz	Megahertz
MIMO	Mobile Input Mobile Output
mMTC	Massive Machine Type Communications
MNO	Mobile Network Operator
MR	Mixed Reality
ms	millisecond
MSS	Mobile Satellite Service
MVNO	Mobile Virtual Network Operator
NPV	Net Present Value
NR	New Radio
NSA	Non-Standalone
NTN	Non-Terrestrial Network
OpEx	Operating Expenses
PFD	Power Flux Density
PoC	Proof of Concept
pp	percentage point
PPDR	Public Protection and Disaster Relief
PSMB	Public Safety Mobile Broadband
RedCap	Reduced Capability
RLAN	Radio Local Area Network
RSPG	Radio Spectrum Policy Group
SAB	Services Ancillary to Broadcasting
SAP	Services Ancillary to Program
SBA	Service-Based Architecture
SDL	Supplementary Downlink
SSB	Synchronisation Signal Block
TDD	Time Division Duplex
URLLC	Ultra Reliable and Low Latency Communications
V2X	Vehicle to Everything
VAT	Value Added Tax
VoLTE	Voice over LTE
VoNR	Voice over New Radio
WRC	World Radiocommunication Conference
XR	Extended Reality

List of figures

List of tables

Executive summary

Digital infrastructure forms the basis of the digital economy. For the mobile industry to advance and support national digital transformation ambitions, policy and regulatory environments must be conducive to sustainable investment, long-term growth and innovation. This begins with spectrum policy.

The speed and quality of mobile are directly linked to spectrum, and increasing the availability of harmonised spectrum capacity, from World Radiocommunication Conferences (WRCs) to regional and national processes, will lead to better services delivered from less costly networks. More consumers can use 5G and fewer base stations mean lower carbon emissions. However, if governments and regulators fail to reach an agreement, the benefits of harmonisation will be lost, reducing the potential for ecosystem scale.

Under the ASEAN Digital Masterplan 2025 (ADM 2025), the enabling action (EA2.6) "Ensure increased and harmonised spectrum allocation across the region" is ranked as high importance. Specifically, it is noted that:

"Having sufficient and suitable spectrum is key to many initiatives including introducing 5G, using mobile to deliver coverage and connectivity in rural areas and enabling IoT solutions. While there is much discussion and intra ASEAN initiatives, more could be done. ASEAN should build on the AIM2020 work to deliver the harmonisation recommended, provide guidance on best practice licensing and award, and continue to assess future harmonisation needs."[1]

This enabling action is closely aligned with the GSMA's goal to drive innovation, set standards and support the development of mobile technology to maximise its benefits for economy and society.[2]

The objective of this study is to support ASEAN Member States (AMS) in their spectrum planning processes by providing relevant and up-to-date market, technical and industry information and best practices on spectrum management. This will support AMS in working closely and collaboratively to increase the supply of harmonised spectrum nationally and across ASEAN, improving digitalisation, growth and innovation, and benefiting the population of ASEAN. The study is based on desk research and analysis of inputs from ASEAN regulators, GSMA Intelligence resources and contributions from mobile industry partners. The findings are intended to inform ASEAN policymakers and regulators on strategic priorities and actionable recommendations to maximise the benefits of digitalisation in Southeast Asia.

1 ASEAN. (2021). ASEAN Digital Masterplan 2025.
2 The GSMA is a global organisation unifying the more than 1,000 mobile operators and businesses across the ecosystem to advance innovation and reduce inequalities around the world. For more information, see: https://www.gsma.com/about-us/

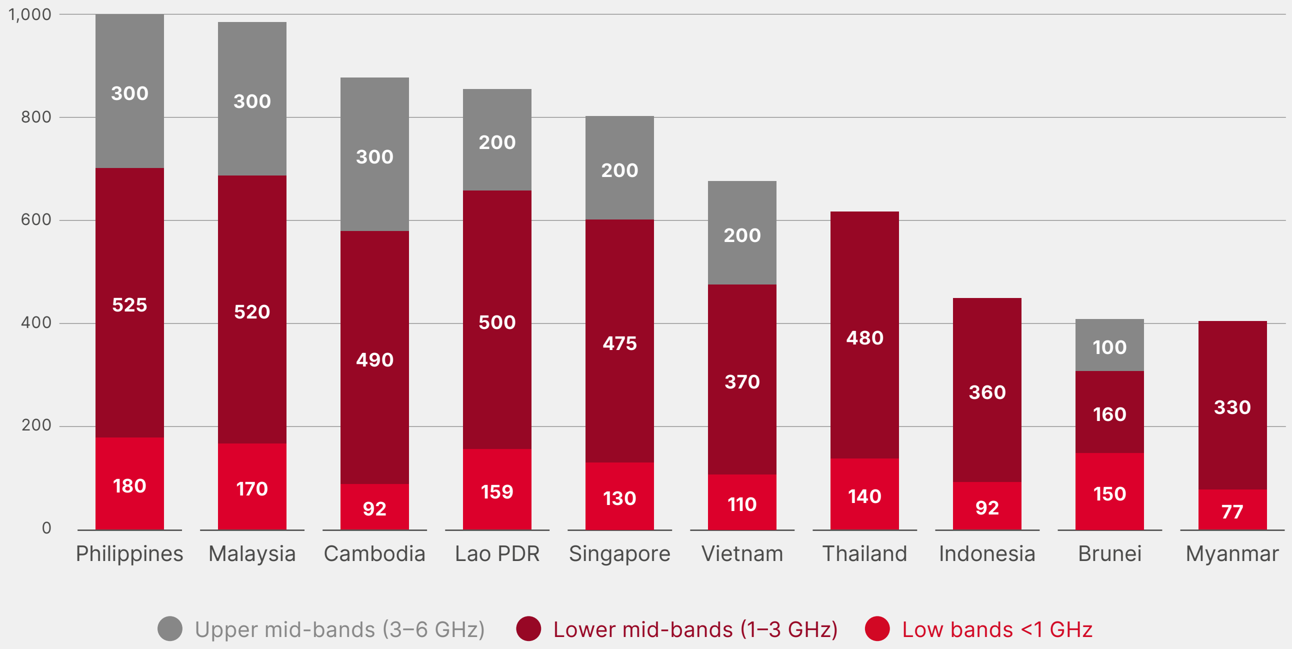
Status of mobile connectivity and IMT spectrum in ASEAN

5G technology is becoming an important enabler of digitalisation initiatives throughout the ASEAN region. As of late 2025, commercial 5G services have been launched in eight AMS, with Malaysia, the Philippines, Singapore, Thailand and Vietnam taking the lead in deploying 5G Standalone (5G SA) networks. A ninth AMS, Cambodia, is scheduled to launch 5G services in January 2026. These deployments lay the foundation for advanced solutions in key sectors, such as transportation, energy, urban infrastructure and digital health. As 5G deployment continues to 2030, the ASEAN region is expected to add more than 330 million 5G connections and 5G will account for 42% of total mobile connections, up from 9% in 2024.

Despite significant progress, there are notable disparities in spectrum availability and regulatory readiness in ASEAN countries. While Malaysia, the Philippines, Singapore and Vietnam have assigned substantial spectrum in the core low and mid-bands for IMT services, others, including Thailand, Indonesia and Myanmar, lag in spectrum assignment, particularly in the crucial 3.5 GHz band. Harmonised spectrum planning and proactive regulatory frameworks remain essential for facilitating cross-border coordination, mitigating interference and ensuring optimal conditions for 5G and future 6G development.

Figure 1

Spectrum assigned to mobile operators in low and mid-bands (MHz), December 2025



Source: GSMA compilation of AMS questionnaire and industry data, excluding regional and government/railway networks, and Licence Assisted Access (LAA).

Mobile technologies continue to evolve

Advancements in 5G technology, particularly the transition from 5G to 5G-Advanced, continue to bring a range of new network capabilities that can be translated into new industrial applications and consumer propositions. The latest 3GPP Release-18 introduces improved Multiple Input Multiple Output (MIMO) technology, multi-carrier operation and enhanced mobility, which support smart connectivity and uplink-centric communications. As 5G-Advanced evolves, it will play an important role in bridging 5G to 6G.

The preparation for IMT-2030/6G is underway, promising ultra-fast data rates, lower latency, enhanced energy efficiency and new capabilities driven by artificial intelligence (AI). The ITU-R Working Party 5D has outlined a detailed timeline to finalise specifications for IMT-2030 by 2030. With 6G, wide contiguous spectrum bandwidth of at least 200–400 MHz will be essential to enable broad coverage, mobility and a seamless evolution from 5G.

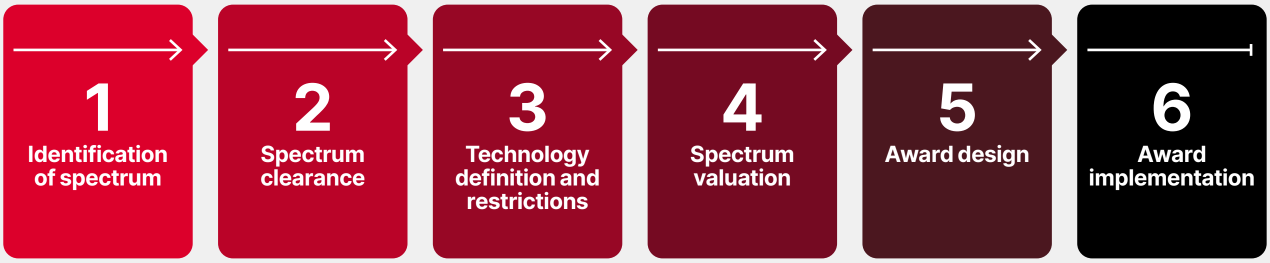
Developing spectrum roadmaps for long-term planning

Mid-band spectrum has been the main driver of 5G launches so far and is expected to help realise most of the socio-economic benefits in the next decade. The GSMA estimates 2 GHz of mid-band spectrum per country will be needed for 5G, on average, by 2030. Meeting spectrum needs in this range is vital to the future of 5G and requires a clear spectrum roadmap from policymakers.

Developing a spectrum roadmap can help ensure there is enough spectrum to meet continued growth in demand for mobile services in the short and long term. Roadmaps help governments forecast future trends and manage their work. They also provide certainty for the mobile industry to invest in new technologies and deploy networks. Roadmaps typically involve the steps outlined in Figure 2.

Figure 2

Key steps in developing a spectrum roadmap



1. Identification of spectrum:
Plan spectrum allocation based on international and regional harmonisation; consult stakeholders; conduct cost-benefit analysis for optimal use.

2. Spectrum clearance:
Clear spectrum by relocating incumbents or enabling geographic sharing to mitigate interference.

3. Technology definition and restrictions:
Define licence obligations, usage conditions, spectrum amount and location; realign bands for contiguous frequencies if needed.

4. Spectrum valuation and pricing:
Set spectrum fees using benchmarking and modelling, factoring in market conditions and licensing costs.

5. Award design:
Choose between auctions, beauty contests or direct awards based on policy, available spectrum and market specifics.

6. Award implementation:
Provide detailed documentation to guide the award process and outline all licence requirements.

Addressing technical issues in IMT bands

This study has identified several IMT bands as key spectrum planning priorities for ASEAN:

- Near term (within two years): 700 MHz, 2.6 GHz, 3.5 GHz
- Mid- to long term (3–5 years): 600 MHz, 1500 MHz, 4.8 GHz and upper 6 GHz

The key issues and proposed actions for these bands are summarised in Table 1.

Table 1:

Key issues and proposed actions for IMT bands

Timing	Band	Status and key issues	Proposed approach / actions
Near term	**700 MHz**	– Cleared and assigned in 7 AMS – Pending DSO/ASO in Cambodia and award in Indonesia, Myanmar	– Complete DSO, when – Assign full 2×45 MHz for mobile
Near term	**2.6 GHz**	– Assignments in 8 AMS – Cross-border coordination challenges due to different band plans across ASEAN – FDD/TDD in Cambodia, Lao PDR, Malaysia, Singapore; TDD-only in Indonesia, Philippines, Thailand, Vietnam – TDD synchronisation issues	– Consider moving towards harmonised full TDD (n41) band plan – Licence expiry in Malaysia and Singapore offer possible option for reorganisation
Near term	**3.5 GHz**	– Varying amounts assigned across ASEAN – Difficulties with incumbent FSS use in Indonesia and Thailand, delaying availability	– Implement mitigation measures for FSS and release band for 5G, considering need for 100 MHz per operator – Consider further expansion of 3.5 GHz in longer term, factoring in FSS usage trends
Mid-long term	**600 MHz**	– New band for expansion of low-band supply – Incumbent users include DTT and wireless mics – DTT restacking and cross-border coordination challenges	– Review DTT usage and consider possible timescales for 600 MHz refarming – Adopt APT 600 MHz band plan
Mid-long term	**1.5 GHz**	– Assigned in 2 AMS but different band plans – Nascent ecosystem but growing – Compatibility with adjacent band users (EESS, MSS)	– Review current usage, in-band and adjacent band – Monitor developments and include 1.5 GHz in long-term roadmap
Mid-long term	**6 GHz**	– Upper 6 GHz is key band for 5G expansion and 6G – Coordination with incumbent FS and FSS users is feasible – IMT–Wi-Fi sharing in U6 GHz not feasible	– Prioritise full 6.425–7.125 GHz range for IMT as part of long-term roadmap – Join Region 3 footnote at WRC-27 – Plan for full-power macrocell IMT deployment
Mid-long term	**4.8 GHz**	– Potential new IMT band but issues with stringent power restrictions in some AMS – Adjacent to 4.4–4.8 GHz which is under study for IMT at WRC-27	– Plan for IMT use subject to market demand – Monitor developments around 4.4–4.8 GHz

Adopting best practices in spectrum management

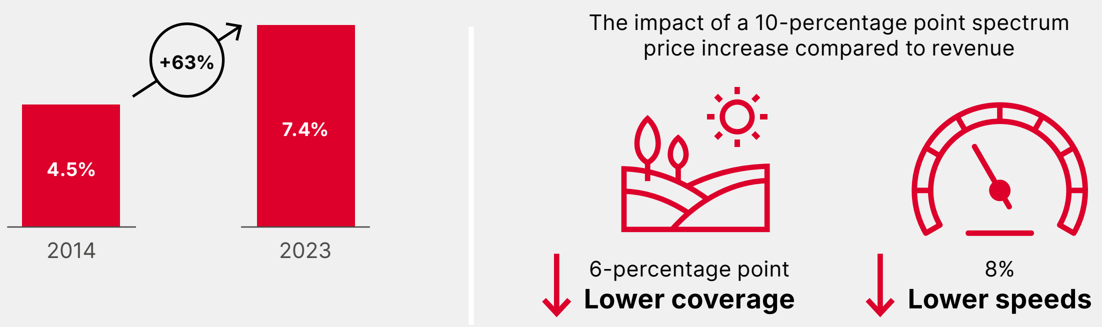
The process of making spectrum available for mobile and maximising the socio-economic benefits involve crucial decisions around spectrum pricing, licensing and assignment approaches.

Spectrum pricing for sustainable investment

Over the past decade, the aggregate cost of spectrum has increased by 63%, reaching more than 7% of mobile network operators' (MNOs) recurring revenues in 2023. The rising cost of spectrum affects the viability of investments in the long term and has a negative impact on consumers, limiting affordability and slowing adoption. GSMA research shows that a 10 percentage point (pp) higher spectrum cost to revenue ratio leads to 6 pp lower coverage and 8% slower speeds.

Figure 3

Rising spectrum costs and impact on market outcomes



Source: GSMA Intelligence

High spectrum prices are typically the result of national policy decisions, such as setting excessive reserve prices, making an insufficient amount of spectrum available for auction, a lack of clarity on future releases or unknown renewal processes for expiring licences. Adopting the right spectrum pricing policy can help relieve the spectrum cost burden on MNOs and support sustainable investment, which contribute to better networks and consumer outcomes. For future awards, ASEAN regulators should consider mechanisms that allow MNOs to exchange financial payments for investment commitments.

Supportive framework for 2G and 3G network sunsets

Sunsetting legacy 2G and 3G are integral to network transformation strategies and improving efficient use of spectrum resources through 4G and 5G. In the ASEAN region, MNOs are at different stages of the network sunset journey, just as they are with 5G deployment.

The process of switching off 2G and 3G networks should be dictated by market conditions. However, regulators can provide a guiding framework and implement measures to assist MNOs in making a smooth transition when shutting down 2G and 3G, such as implementing full technology neutrality, driving uptake of 4G and VoLTE-enabled devices and supporting communications campaigns to raise awareness among consumers and businesses to accelerate technology migration.

Enabling enterprise digitalisation by balancing the needs of public and private networks

When supporting the digitalisation of industry, it is crucial for policymakers and regulators to meet the needs of both public mobile and enterprise users. There are different approaches to enabling spectrum access for private networks including set-asides, spectrum sharing or licensing spectrum with leasing obligations.

Global evidence indicates that spectrum set-asides, which are highly interventionist, do not have a positive impact on the digitalisation of enterprises. Conversely, spectrum set-asides, particularly in core spectrum bands for mobile, can have a substantial negative impact on public mobile network users.

Spectrum-sharing approaches can be complex to implement and carry risks of uncertainty of access and tenure, as well as potential interference issues. Well-designed licence conditions for MNOs are the least intrusive mechanism for delivering private mobile networks and supporting the digitalisation of industry.

Next steps

The ASEAN region stands at a pivotal juncture in its digital transformation journey. The successful deployment and evolution of 5G and future mobile technologies will be instrumental in unlocking broad socio-economic benefits, enhancing regional competitiveness and fostering innovation.

It is crucial for stakeholders across government and industry to collaborate on forward-looking strategies that prioritise spectrum efficiency, regulatory certainty and inclusive digital access. By embracing these priorities, ASEAN can position itself as a global leader in mobile innovation, driving sustainable growth and resilience in the digital era.

While significant progress has been made in network roll-out and user adoption, persistent challenges in spectrum allocation, harmonisation, assignment and management must be addressed to realise the full potential of advanced connectivity. To this end, the study has developed the ASEAN IMT Spectrum Index, as shown in Figure 4. The Index provides a snapshot of the status of IMT assignments in low and mid-bands across ASEAN against a target for each band.

Figure 4

ASEAN IMT Spectrum Index 2025 (low and mid-bands)

Band	3GPP	Target MHz	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
700 MHz	n28	90	80	0	0	90	80	0	90	70	90	40
800 MHz	n5	30	0	21.6	22	20	20	12.5	0	0	0	0
900 MHz	n8	70	70	70	70	48.8	70	64.4	70	60	50	70
1800 MHz	n3	150	80	150	150	150	150	150	150	150	80	150
2100 MHz	n1	120	80	120	120	120	100	120	120	120	120	120
2300 MHz	n40	90	0	40	90	90	90	20	90	40	70	0
2600 MHz	n7/38/41	190	0	180	0	140	180	40	185	165	190	100
3500 MHz	n77/78	400	100	300	0	200	300	0	300	200	0	200
Total		**1130**	**410**	**881.6**	**452**	**858.8**	**990**	**406.9**	**1005**	**805**	**600**	**680**
	% achieved		**36%**	**78%**	**40%**	**76%**	**88%**	**36%**	**89%**	**71%**	**53%**	**60%**

● Fully/mostly assigned band ● Partially assigned band ● Not asssigned

Notes: IMT spectrum assignments (excluding 1500 MHz and high bands) as of December 2025.
Source: AMS Questionnaire responses, 2025 and WPC.

Going forward, it is recommended, especially with the entry of Timor-Leste in ASEAN in late-2025, that the IMT Spectrum Index be reviewed and updated annually by the ASEAN Telecommunications Regulators Council (ATRC) and reported on to the ASEAN Digital Ministers (ADGMIN). The aim of the IMT Spectrum Index is to encourage all AMS to assign the maximum possible IMT spectrum in the low and mid-bands to support their respective digital economies and overall digital connectivity across the region. A worthwhile goal would be a pan-ASEAN IMT Spectrum Index average of more than 90%, with similar index scores in all AMS. Such an exercise would also enable AMS to track the region's progress towards greater spectrum harmonisation and to include new bands in the index to support the evolution of mobile technologies towards 6G in the 2030s and beyond.

01.
IMT spectrum: status and future plans in ASEAN

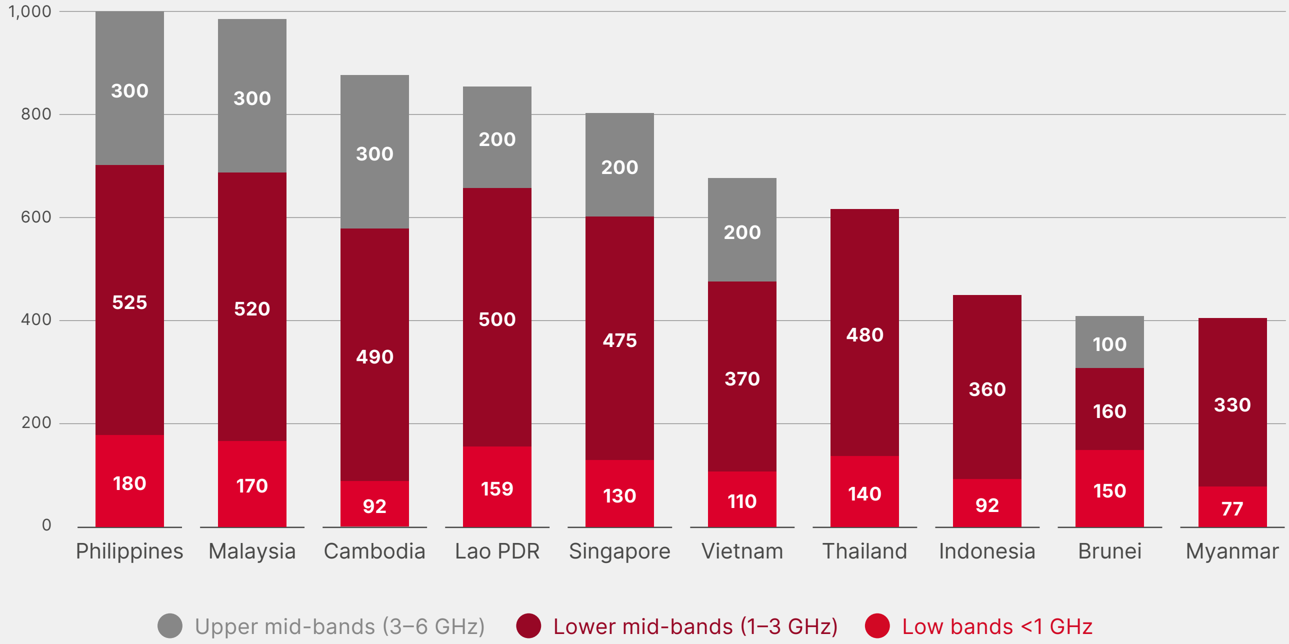
This chapter discusses survey data received from ASEAN Member States (AMS) in relation to current and future IMT spectrum plans.[3] This discussion focuses on the harmonisation of spectrum bands in line with international standards. Harmonised spectrum facilitates cross-border coordination by standardising frequency usage. Greater regional cooperation in spectrum management and planning does not just mitigate interference issues, it also supports optimal transition to 5G and future technology generations.

While countries such as the Philippines, Malaysia, Singapore and Vietnam have made a reasonable amount of core low- and mid-band spectrum available for IMT services, others like Thailand, Indonesia and Myanmar have not (see Figure 5). Freeing up spectrum for IMT, 3.5 GHz band spectrum especially, is critical for 5G and future 6G development. Technical and financial considerations are an important part of this process, especially the availability of technology-neutral licences, large contiguous blocks of spectrum and spectrum sold at reasonable prices. Additionally, the availability of spectrum roadmaps enables mobile network operators (MNOs) and government stakeholders to operate with regulatory certainty regarding when spectrum will be made available.

3 The project team would like to express our gratitude to ASEAN regulators for their contributions to this study.

Figure 5

Spectrum assigned to MNOs (MHz, December 2025)



Source: GSMA compilation of AMS Questionnaire and industry data excluding regional and government/railway networks, and LAA.

As a rapidly evolving region, ASEAN is within reach of realising broad socio-economic benefits from the uptake of more advanced mobile technologies.

Harmonised spectrum standards play a less obvious but vital role in ensuring that connectivity has the greatest potential impact on development.

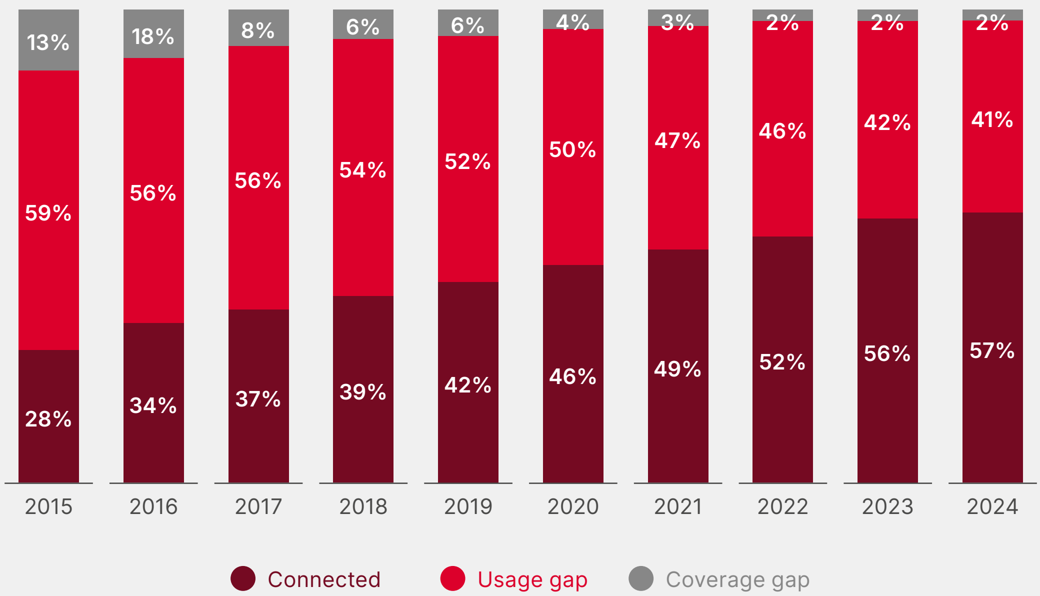
1.1 The state of mobile internet in ASEAN

More people than ever before are connecting to the internet via mobile in ASEAN. Over the past 10 years, the number of unique mobile internet users[4] has grown from around 180 million to 397 million. This has been driven by the expansion of mobile networks and increasing availability and affordability of mobile devices and services. The coverage gap – those living in areas without mobile broadband coverage – has dropped to less than 2%, with more than 98% of the ASEAN population now living within the footprint of a mobile broadband network. In terms of the unconnected, most of those live in areas with mobile broadband coverage (i.e. the usage gap) but face other barriers to adoption.

Figure 6

Mobile internet connectivity in ASEAN, 2015–2024

Percentage of population



Source: GSMA Intelligence

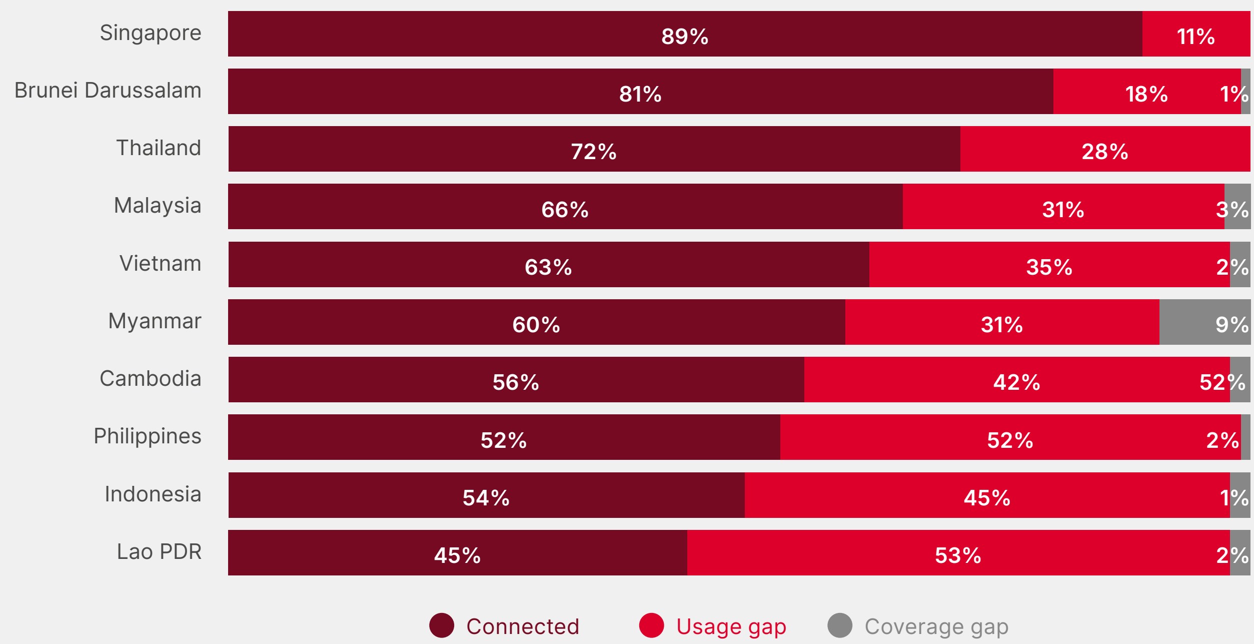
Across ASEAN, there is considerable variation among countries, particularly in terms of connected population and the usage gap shown in Figure 7. This ranges from 89% in Singapore to 45% in Lao PDR. While there are still coverage gaps, they are typically less than 3%, with the exception of Myanmar.

4 This refers to a person who uses internet services on a mobile device. Mobile internet services are defined as any activities that use mobile data. A unique subscriber can have multiple connections.

Figure 7

Mobile internet connectivity in ASEAN Member States, 2024

Percentage of population, 2024



Source: GSMA Intelligence

5G is the most advanced wireless technology yet and at the end of 2023, four years after its arrival, the number of 5G connections worldwide surpassed 1.5 billion, making it the fastest-growing mobile broadband technology to date.[5]

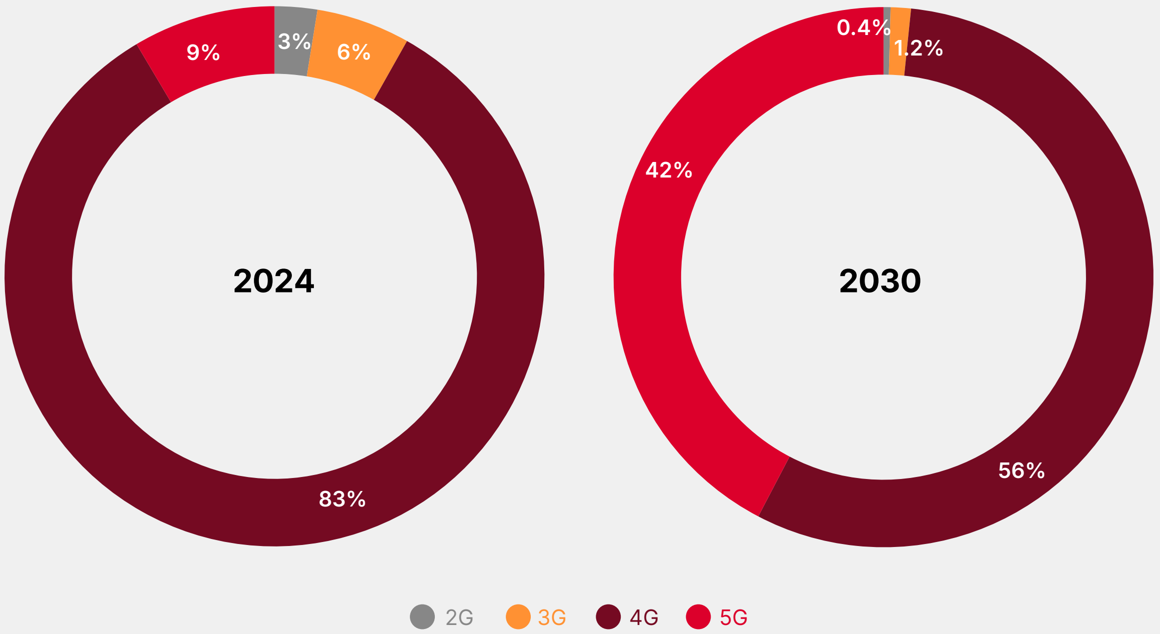
The share of mobile connections on 4G is beginning to wane as 5G commercialisation gathers pace. As of December 2024, 305 MNOs in 121 markets had launched commercial 5G mobile services. More countries are expected to follow, with 80 MNOs from 60 markets announcing launch plans for mobile 5G services in the coming years. The number of 5G connections worldwide surpassed 2 billion at the end of 2024 and by 2028, 5G adoption will surpass 4G.[6]

In Southeast Asia, 5G is still at a relatively early stage. As of 2024, 5G connections comprised 9% of total mobile connections compared to 83% for 4G.[7] However, 5G adoption will gather pace over the next few years with the arrival of cheaper 5G smartphones, new spectrum assignments and large-scale network deployment. By 2030, the percentage of 5G connections will reach 42% with 4G's share declining to 56%, as indicated in . This represents the addition of more than 330 million 5G connections between 2025 and 2030 across all AMS (see Figure 9).

5 It took 10 years for 3G to reach the same milestone and more than five years for 4G.
6 GSMA. (2025). The Mobile Economy 2025.
7 This is reflected in the amount of time spent across network technologies based on data from Opensignal, with 4G currently accounting for the majority of time. See Appendix C for more information.

Figure 8

Percentage of connections in ASEAN by technology



Source: GSMA Intelligence

Figure 9

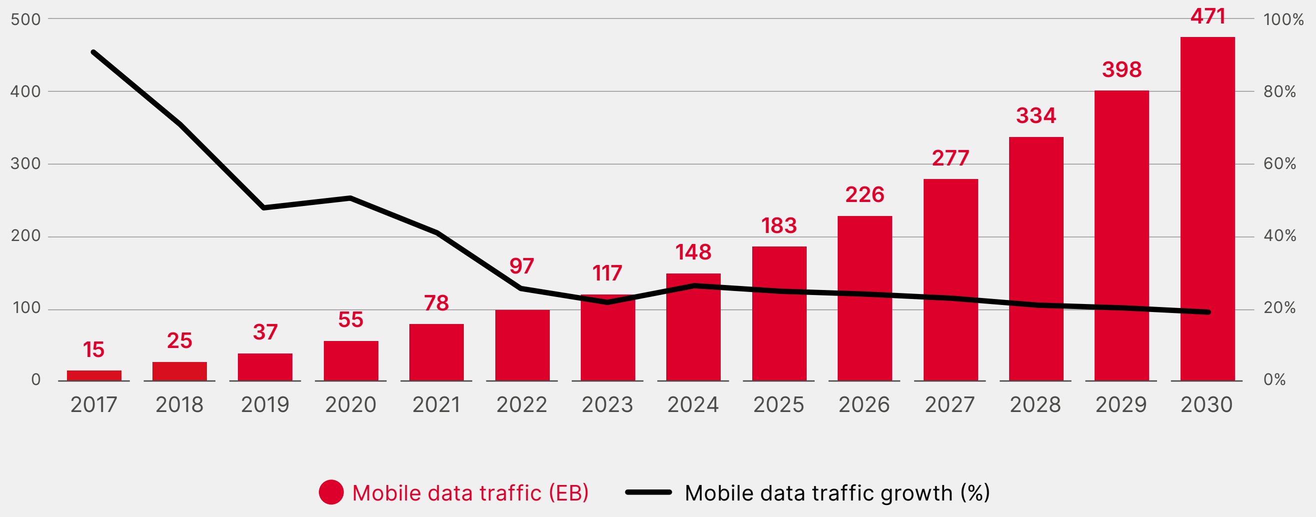
Total number of new 5G connections by AMS (millions), 2025–2030

Source: GSMA Intelligence

Mobile data traffic in ASEAN has experienced massive growth globally over the past decade, driven by the increasing adoption of smartphones and growing consumption of both short-form and long-form video content. In ASEAN markets such as Indonesia, Malaysia, Philippines, Thailand and Vietnam, mobile-first consumers are driving significant growth in mobile data consumption. From 2018 to 2024, the total mobile data traffic in ASEAN grew by almost six-fold from 25 EB to 148 EB, as shown in Figure 10.

Figure 10

Mobile data traffic growth in ASEAN

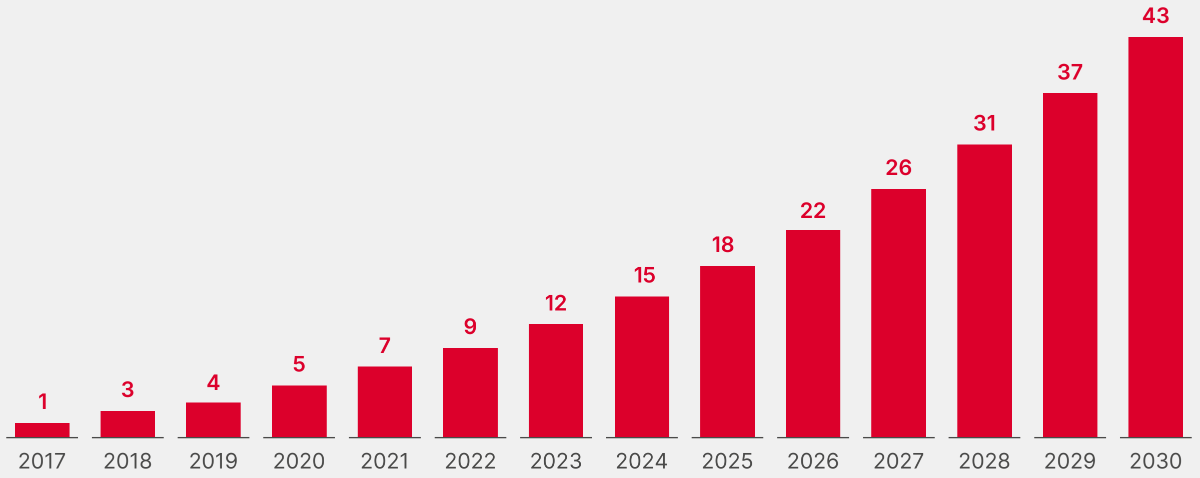


Source: GSMA Intelligence

These trends are expected to continue with the growing consumption of video on social media platforms and the rise of AI-generated content and services, which will drive new demands on mobile networks, particularly for uplink traffic. Mobile data traffic is forecast to rise three-fold by 2030, with the average monthly data usage per mobile connection rising from 15 GB in 2024 to 43 GB in 2030, as illustrated in Figure 11.

Figure 11

Mobile data usage per connection (GB per month)



Source: GSMA Intelligence

1.2 Spectrum supply in ASEAN

Timely access to IMT spectrum bands, particularly in the mid-band range, is essential to support data traffic growth on existing networks, 5G expansion and future 6G development. The assignments in various IMT bands for each AMS are detailed in Table 2. Traditional IMT spectrum bands such as the 900, 1800 and 2100 MHz, which were originally identified for IMT services in World Administrative Radio Conferences (WARC) 1979 and 1992, are generally assigned to a greater degree than mid-band and high-band spectrum. As a result, bands such as 2.6 GHz (originally identified for IMT at WRC-2000), and 700 MHz, 2.3 GHz and 3.4-3.6 GHz bands (originally identified for IMT WRC-2007) have only been partially assigned across ASEAN. The high bands – 26 GHz and 28 GHz – have been assigned in Malaysia, the Philippines, Singapore and Thailand. Moreover, not all assignments are complete as partial spectrum assignments of the bands are also quite common. Multiple network technology generations from 2G to 5G are deployed across these bands in AMS.[8]

Table 2:

Overview of IMT spectrum assignments in AMS

IMT spectrum assigned

	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
700 MHz		Post-ASO	2026			Vacant		2×35 MHz		2×20 MHz
800/850 MHz										
900 MHz										
1500 MHz									20 MHz	
1800 MHz									80 MHz	
2100 MHz										
2300 MHz		40 MHz				20 MHz		40 MHz	70 MHz	
2600 MHz			2026			40 MHz				100 MHz
3.3–4.2 GHz	100 MHz	300 MHz	2027?	200 MHz	300 MHz		300 MHz	200 MHz		200 MHz
26 GHz			2026?				Available			
28 GHz										

Source: AMS Questionnaire responses, 2025 and WPC, December 2025. VN 700 MHz figure is post-current auctions. Teal represents bands that are fully or mostly assigned. Orange means partially assigned.

1.2.1 Status of low bands (below 1 GHz)

Low-band spectrum serves two key requirements for 5G deployments. First, its superior propagation characteristics make it particularly suitable for providing coverage in rural and remote areas. This is especially important in low- and middle-income countries (LMICs) that have large populations living in rural and sparsely populated areas where network deployments are much less economically sustainable.

Second, low bands are better able to penetrate buildings and serve built-up areas, providing "deep" indoor coverage as well as capacity in urban areas, including locations where people live and work. Thus, assigning sufficient low-band spectrum is critical to addressing long-term demand for 5G in urban as well as rural areas.

The Asia-Pacific Telecommunity (APT) 700 MHz band (n28) is core low-band spectrum and particularly useful for coverage. This is because the propagation characteristics of this digital dividend band provide greater geographic reach and coverage and better in-building penetration relative to higher frequency IMT spectrum bands. It is critical as a connectivity layer and arguably essential if voice services are to be migrated to Voice over LTE (VoLTE) or Voice over 5G New Radio (VoNR).

8 See Appendix C for details on readings recorded by spectrum bands based on Opensignal data.

Table 3 shows the current state of low-band spectrum assignments in the ASEAN region. The 900 MHz (n8) spectrum band is the most commonly assigned band in the region, with all 10 AMS assigning the spectrum. The 850 MHz band is also assigned in some AMS. Most countries in ASEAN have made assignments in the 700 MHz band for IMT, and some AMS like Brunei, Malaysia, Singapore and Thailand are already using the band for 5G technology.

Table 3:

Overview of low-band spectrum assignments in AMS

	Low-band spectrum (<1 GHz)									
	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
700 MHz assigned?	Yes	No. Post ASO	Planned 2026	Yes	Yes	No	Yes	Yes - Partial	Yes	Yes - Partial
Assignment	2×40 MHz	None	None	2×45 MHz	2×40 MHz	None	2×45 MHz	2×35 MHz	2×45 MHz	2×20 MHz
Technology	4G/5G			n/a	5G		4G	4G/5G	4G/5G	4G & above
Licence expiry	2040, 2041			Every year	Every year		Indetermi-nate	2040	2035, 2036	2040
800/850 MHz assigned?	No	Yes	Yes	Yes	Yes	Yes	No	No	Vacant	No
Assignment		2×5.4 MHz	2×11 MHz	N/A	2×10 MHz	Not avail-able			2×5 MHz	
Technology		4G	4G	4G	4G	CDMA				
Licence expiry		2042	2030	Every year	2027	N/A				
900 MHz assigned?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Assignment	2×35 MHz	2×35 MHz	2×35 MHz	2×24.4 MHz	2×35 MHz	N/A	Various	2×30 MHz	2×25 MHz	2×34.8 MHz
Technology	3G	2G/3G/ 4G	2G/4G	2G	2G/4G	2G/3G/ 4G	2G/4G	4G/5G	2G/3G/ 4G/5G	2G/3G/ 4G/5G
Licence expiry	2028, 2039	2043	2030	Every year	2027/ 2032	N/A	Indetermi-nate	2033	2031, 2033	2024, 2026

Source: AMS Questionnaire responses, AMS regulator websites and WPC industry research, December 2025

1.2.2 Status of lower mid-bands (1–3 GHz)

Mid-band spectrum is necessary for the increased bandwidth and capacity that 5G applications require. With their larger bandwidths compared to low bands, mid-bands provide a balance of coverage and capacity, playing a key role in meeting demand for mobile data services in dense urban environments. The GSMA estimates that 2 GHz of mid-band spectrum per country will be required for 5G, on average.[9]

The 1800, 2100, 2300 and 2600 MHz bands are all established spectrum bands that were harmonised and available for IMT usage before the WRC-07. Specifically, the 1800 and 2100 MHz bands were harmonised at the WARC 1992 as part of IMT-2000 while the 2.6 GHz spectrum band was harmonised at the WRC-2000. The 2.3 GHz band and other IMT bands were harmonised at the WRC-07 in 2007. Some ASEAN countries are now making the 1500 MHz band available either for broadband wireless access with a TDD configuration or as a supplementary downlink (SDL). An update on lower mid-band spectrum assignments in the ASEAN region is summarised in Table 4.

The 1800 MHz band (n3) has been assigned in all ASEAN markets, albeit only partially in Thailand as high reserve prices in previous auctions has meant that a significant portion of the band remains unassigned. While the 1800 MHz band was originally designed and used for 2G services, it has been refarmed for LTE/4G services in many markets. MNOs in some AMS, namely Indonesia, the Philippines and Vietnam, have refarmed the spectrum for 5G services using dynamic spectrum sharing (DSS).

Similarly, the 2100 MHz band (n1) has been assigned in all AMS. It was originally harmonised for W-CDMA/3G but has since been refarmed for LTE/4G and, more recently, in Indonesia and Singapore for 5G. In contrast, the 2300 MHz (n40) band has had more limited adoption in ASEAN with only four of 10 AMS (Indonesia, Lao PDR, Malaysia and the Philippines) fully assigning the 90 MHz spectrum, while Cambodia, Myanmar, Singapore and Thailand have partially assigned spectrum in 2.3 GHz band. Myanmar has assigned 20 MHz to MPT and reserved another 20 MHz for government use. This band has not been assigned in Brunei due to limited demand and preference for other IMT bands given their larger bandwidth and stronger ecosystems. In Vietnam, there was an unsuccessful attempt to auction the 2.3 GHz band in 2023 due to excessively high reserve prices, small 30 MHz blocks and other licence obligations linked to the spectrum.

Lastly, it should be noted that the 2.6 GHz band has been broadly assigned across ASEAN. While the FDD/TDD hybrid band plan (n7/n38) for this band was preferred originally, this is no longer the case. Now, the vast majority of AMS, and especially the larger countries, prefer the TDD (n41) option as it is more flexible and allows higher mobile broadband downloads. Only Brunei and Indonesia have not assigned the 2.6 GHz band, but Indonesia plans to soon. Previously, 150 MHz of the 2.6 GHz band in Indonesia was assigned to direct-to-home (DTH) satellite services until the end of 2024. This has delayed the refarming of the band for much-needed mobile broadband services. It should also be noted that 90 MHz of the available spectrum in the 2.6 GHz band in Vietnam is yet to be fully assigned although it is understood that it has been assigned to GTel for public safety broadband purposes.

It is noted that:

- In ASEAN, the assignment of the 2.3 and 2.6 GHz bands to multiple MNOs has necessitated synchronisation and the adoption of the common frame structure domestically and, in some cases, internationally. For example, in the 2.3 GHz band there is a multi-party agreement addressing these issues between Indonesia, Malaysia and Singapore.
- It is understood that Lao PDR has made the decision to transition the 2.6 GHz band from the hybrid band plan to TDD n41 for 2025–2026, while in Malaysia the MCMC has a similar plan for 2027, around the time that spectrum licences need to be renewed.

9 GSMA. (2021). Vision 2030: Insights for Mid-band Spectrum Needs.

Table 4:

Overview of lower mid-band spectrum assignments in AMS

	Lower mid-band spectrum (1.5 to 2.6 GHz)									
	Brunei	**Cambodia**	**Indonesia**	**Lao PDR**	**Malaysia**	**Myanmar**	**Philippines**	**Singapore**	**Thailand**	**Vietnam**
1500 MHz assigned?	No	No	Yes	No	No	No	No	No	Yes	No
Assignment	-	-	80 MHz	-	-	-	-	-	20 MHz	-
Band plan	-	-	TDD	-	-	-	-	-	SDL	-
Licence expiry	-	-	2035	-	-	-	-	-	2040	-
1800 MHz assigned?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes - Partial	Yes
Assignment	2×40 MHz	2×75 MHz	2×75 MHz	2×75 MHz	2×75 MHz	2×75 MHz	2×75 MHz	2×75 MHz	2×40 MHz	2×75 MHz
Technology	4G/5G	2G/4G	2G/4G/5G	4G	4G	4G	4G	4G	4G	2G/4G/5G
Licence expiry	2028–2039	2043	2030	Every year	2032	2029	Indeterminate	2030	2033	2024, 2039
2100 MHz assigned?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Assignment	2×40 MHz	2×60 MHz	2×60 MHz	2×60 MHz	2×50 MHz	2×60 MHz	2×60 MHz	2×60 MHz	2×60 MHz	2×60 MHz
Technology	3G/4G	3G/4G	4G/5G	3G/4G	4G	3G/4G	4G	5G	3G/4G/5G	3G/4G/5G
Licence expiry	2028/2029	2039	2026–2033	Every year	2034/2037	2029	Indeterminate	2036	2027, 2040	2024, 2039
2.3 GHz assigned	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Assignment	-	40 MHz	90 MHz	90 MHz	90 MHz	20 MHz	90 MHz	40 MHz	70 MHz	-
Technology	-	4G	4G/5G	2G	4G	4G	4G	4G	4G/5G	-
Licence expiry	-	n/a	2027–2034	Every year	2028	-		2033	2040	-
2.6 GHz assigned?	No	Yes	Planned 2026	Yes	Yes	Yes	Yes	Yes	Yes	Yes, partial
Assignment	-	180 MHz	-	180 MHz	180 MHz	40 MHz	180 MHz	165 MHz	190 MHz	100 MHz
Technology	-	4G FDD/TDD	-	4G FDD/TDD	4G FDD/TDD	4G TDD	4G/5G	4G FDD/TDD	4G/5G	4G/5G
Licence expiry	-	2043	-	Every year	2027	2029	Indeterminate	2030-2033	2035	2039

Source: AMS Questionnaire responses, AMS regulator websites and WPC industry research, December 2025.

1.2.3 Status of 3.5 GHz across ASEAN

The 3.5 GHz band – covering 3.3-3.8 GHz (n78) and more broadly 3.3–4.2 GHz (n77) – is the pioneer spectrum band for 5G deployment. Globally since 2019, national regulators, including many in the Asia Pacific region, have either assigned this spectrum for mobile services or plan to do so. There is now extensive 5G coverage using the band in Asia Pacific covering more than 3.3 billion people (approximately 77% of the region's population), as well an excellent ecosystem of 3.5 GHz band-supported devices, ensuring ubiquitous and affordable smartphones and other devices.

Due to its propagation characteristics and the potential for large contiguous bandwidth, the 3.5 GHz band is an ideal frequency band for 5G as it can provide both capacity (the amount of data traffic it can support) and coverage (the distance the radio signals travel). High-speed enhanced mobile broadband services need to be capable of delivering peak download speeds of at least 20 Gbps, a reliable 100 Mbps user experience data rate in urban areas and 4 millisecond (ms) latency. The 3.5 GHz band is key for delivering Enhanced Mobile Broadband (eMBB) and to enable good 5G service performance; 100 MHz of 3.5 GHz spectrum per MNO is preferred.

The 3.5 GHz band (3.3–4.2 GHz) has been the basis for the first phase of 5G roll-outs in many markets. This includes the 3.3–3.8 GHz range, which is widely harmonised for 5G, as well as the 3.8–4.2 GHz range, which has been assigned in several markets globally. To date, 3.5 GHz accounts for the majority of global 5G network launches,[10] in turn driving the wider ecosystem,[11] device diversity and competition. It has been deployed for eMBB, enabling faster data speeds and greater capacity for densely populated urban areas, as well as for fixed wireless access (FWA) in suburban and rural areas where the availability of fixed broadband tends to be more limited.

Many ASEAN countries have either assigned the 3.5 GHz band or are planning for its release in the near future. The countries that have assigned spectrum in the 3.5 GHz band tend to have made assignments ranging from 100 MHz up to 300 MHz of spectrum. For example, the Philippines and recently Malaysia have assigned 300 MHz whereas Brunei has assigned 100 MHz of spectrum in the band. In line with GSMA recommendations, it is optimal for regulators to assign contiguous spectrum in this band, given its balance of coverage and capacity that is well-suited to city-wide coverage for 5G services.[12] The release of frequencies in this band is important to support the deployment of 5G services, the status of which is detailed in Table 5.

Table 5:

Use of the 3.5 GHz band in AMS

	3.5 GHz band (n77/78)									
	Brunei	**Cambodia**	**Indonesia**	**Lao PDR**	**Malaysia**	**Myanmar**	**Philippines**	**Singapore**	**Thailand**	**Vietnam**
Assigned?	Yes 100 MHz	Yes 300 MHz	No	Yes 200 MHz	Yes 300 MHz	No	Yes 300 MHz	Yes 200 MHz	No	Yes 200 MHz
Planned for release?			2027			TBD			TBD	
Technol-ogy	5G	5G		5G	5G		5G	5G		5G
Lot sizes	100 MHz	100 MHz		100 MHz	100/200 MHz		Various	100 MHz		100 MHz
Challeng-es	Migrating incumbent users (FSS)		Migrating incumbent users; Compen-sation for satellite operators; Coex-istence mitigation between IMT and FSS		Availabili-ty for IMT remains a challenge due to FSS needs; In-dustry de-mand for dedicated spectrum for 5G enterprise use		Already assigned for some time	Limited spectrum available given FSS	Consider-able FSS usage including TVROs	Protection of satellite control stations used for maritime emergen-cy moni-toring
Licenced users	UNN	Metfone, Smart Axiata, Cellcard		LTC, STL	DNB, U-Mobile		DITO, Smart, Globe Telecom and others	M1 and StarHub Mobile; Singtel Mobile		VNPT and Mobifone
Licence expiring	2043	2040		Annual	Annual		Indetermi-nate	2035		2039

Source: AMS Questionnaire responses, AMS regulator websites and WPC industry research, December 2025.

10 Excluding frequencies not reported.

11 Of the announced 5G device models supporting key 5G spectrum bands (end March 2025), n78 (3.4–3.8 GHz) 5G devices had the strongest ecosystem with nearly 2,500 device models, while n77 (3.3–4.2 GHz) had more than 2,100 device models and was the fourth strongest. n41 (2.6 GHz) had the second strongest ecosystem with more than 2,300 device models. See: GSA. (April 2025). 5G Market Snapshot, p. 4.

12 GSMA. (2022). 5G Spectrum Public Policy Paper.

Some ASEAN countries are facing similar challenges with the assignment of the 3.5 GHz band in terms of the migration of incumbent users and coexistence with FSS/satellite operators. Where there is heavy satellite usage in countries like Indonesia, considerable time and effort will be needed to optimise the use of the 3.5 GHz band for 5G, particularly in major cities and industrial complexes. In Indonesia, for instance, there are four satellites that currently utilise standard and extended C-Band spectrum, which cause major spectrum management challenges for refarming the band in Indonesia.

Freeing up 3.5 GHz band spectrum could require government support and funding for service and device migration involving Low-Noise Block (LNB) downconverter replacement combined with the use of new filters. Even then, only an initial 200 to 300 MHz of spectrum may be made available for IMT/5G services. In the 2030s, additional 3.5 GHz band spectrum should become available if current satellite services utilising the C-Band are moved to higher satellite bands. Thus, while C-band satellite services continue to be important, there is a global trend towards the use of higher bands for satellite.

MNOs should also have the flexibility to use their assigned IMT spectrum for mobile broadband and/or FWA services. Globally, high speed FWA services using 4G/5G technologies are proving a very competitive product with fixed broadband services.[13]

Facilitating contiguous assignments of spectrum blocks

Contiguous spectrum blocks enhance the performance of mobile services, enabling faster download speeds, lower latency and higher spectral efficiency. All these factors can support an optimal transition to 5G for mobile and fixed wireless access, as well as for repurposing existing mobile bands. Regulators and governments have an important role to play in ensuring that MNOs have access to contiguous blocks of spectrum.

In countries where there is extensive incumbent use (e.g. ubiquitous FSS deployment), the potential frequencies available for 5G could be in non-contiguous ranges within the 3.3–3.8 GHz band (e.g. Lao PDR and Vietnam). While 5G NR systems can be configured for any sub-band within a tuning range, for example, for 3.3–3.8 GHz (n78) it would be preferable to facilitate assignments in contiguous rather than non-contiguous blocks to avoid the need for intra-band carrier aggregation (CA), which reduces complexity and power consumption and improves spectrum efficiency and network performance.

13 See: GSA. (29 April 2024). FWA Device Ecosystem Company Directory v11; and Ericsson. (June 2024). Ericsson Mobility Report, p. 18.

1.2.4 ASEAN IMT Spectrum Index

To provide a quantitative analysis of the assignment of IMT bands across ASEAN, an **ASEAN IMT Spectrum Index** for IMT band assignments has been developed as part of this study.[14]

Figure 12

ASEAN IMT Spectrum Index 2025 (low and mid-bands)

Band	3GPP	Target MHz	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
700 MHz	n28	90	80	0	0	90	80	0	90	70	90	40
800 MHz	n5	30	0	21.6	22	20	20	12.5	0	0	0	0
900 MHz	n8	70	70	70	70	48.8	70	64.4	70	60	50	70
1800 MHz	n3	150	80	150	150	150	150	150	150	150	80	150
2100 MHz	n1	120	80	120	120	120	100	120	120	120	120	120
2300 MHz	n40	90	0	40	90	90	90	20	90	40	70	0
2600 MHz	n7/38/41	190	0	180	0	140	180	40	185	165	190	100
3500 MHz	n77/78	400	100	300	0	200	300	0	300	200	0	200
Total		**1130**	**410**	**881.6**	**452**	**858.8**	**990**	**406.9**	**1005**	**805**	**600**	**680**
		% achieved	**36%**	**78%**	**40%**	**76%**	**88%**	**36%**	**89%**	**71%**	**53%**	**60%**

Fully/mostly assigned band · Partially assigned band · Not asssigned

Notes: IMT spectrum assignments (excluding 1500 MHz and high bands) as of December 2025. The 3GPP band numbers denote 5G bands but it is noted that 4G or earlier generations may still be in use for some bands.
Source: AMS Questionnaire responses, 2025 AMS regulator websites and WPC.

Unfortunately, a significant amount of low and mid-band IMT band spectrum has not been assigned in AMS. Excluding the 1500 MHz and high bands, the Philippines and Malaysia have assigned nearly 90% of all assigned IMT spectrum. They are followed by Cambodia (78%) with its recent release of 3.5 GHz band spectrum, Lao PDR (76%) and Singapore (71%). Vietnam is the fastest mover in terms of the proportion of new IMT spectrum assigned in the past 12 months with 60%, followed by Thailand (53%) and Indonesia (40%). Myanmar and Brunei are both at 36% (although Brunei's small population does not warrant the assignment of the same quantum of IMT spectrum as larger AMS).

In the case of low-band spectrum, despite more than a decade passing since the first ASEAN decisions[15] to transition from analogue to digital television, the full 700 MHz band has not been assigned in several AMS, for a variety of reasons. These include the analogue TV switchover being incomplete, the spectrum award still in the planning phase or spectrum reserved for public safety and other uses. In contrast, the 900 MHz band is widely utilised across ASEAN while 850 MHz band assignments vary by AMS. Malaysia has the largest amount of low-band (sub-1 GHz) IMT spectrum assigned (89%), followed by Lao PDR (84%), the Philippines (84%), Brunei (79%) and Thailand (74%). Other AMS, in order, are Singapore (68%), Vietnam (58%), Indonesia (48%), Cambodia (48%) and Myanmar (40%).

14 At this time, the ASEAN IMT Spectrum Index focuses on core low and mid-band spectrum and does not cover high-band IMT spectrum assignments. The 1500 MHz is not included given that it is a relatively nascent band, but can be included in future updates of the index.

15 See: 10th AMRI in Lao PDR in 2009 and 13th TELMIN in Singapore in 2013; GSMA. (August 2018). Securing the digital dividend across the entire ASEAN: A report on the status of the implementation of the APT700 band for ATRC, pp. 11–12. Also see the 2013 announcement.

Figure 13

ASEAN IMT Spectrum Index 2025 (low bands)

Band	3GPP	Target MHz	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
700 MHz	n28	90	80	0	0	90	80	0	90	70	90	40
800 MHz	n5	30	0	21.6	22	20	20	12.5	0	0	0	0
900 MHz	n8	70	70	70	70	48.8	70	64.4	70	60	50	70
Total		**190**	**150**	**91.6**	**92**	**158.8**	**170**	**76.9**	**160**	**130**	**140**	**110**
		% achieved	**79%**	**48%**	**48%**	**84%**	**89%**	**40%**	**84%**	**68%**	**74%**	**58%**

Fully/mostly assigned band   Partially assigned band   Not asssigned

Notes: IMT spectrum assignments as of December 2025. The 3GPP band numbers denote 5G bands but it is noted that 4G or earlier generations may still be in use for some bands.
Source: AMS Questionnaire responses (2025) and WPC.

In the case of **mid-band spectrum**, the total amount varies markedly with the range of assignments from 330 to 845 MHz of spectrum (excluding Brunei, where only 260 MHz of mid-band spectrum for IMT has been assigned given its small population). This means that mid-band supply in all AMS today is significantly below the GSMA's estimated average mid-band needs of 2 GHz by 2030.

In the ASEAN mid-band IMT Spectrum Index, the Philippines (89%) is the leader with 845 MHz of total mid-band spectrum assigned. Second is Malaysia (88%), followed by Cambodia (83%) Lao PDR (74%) and Singapore (71%). Other AMS are ranked as follows: Vietnam (60%), Thailand (48%), Indonesia (38%), Myanmar (35%) and Brunei (27%).

Figure 14

ASEAN IMT Spectrum Index 2025 (mid-bands)

Band	3GPP	Target MHz	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
1800 MHz	n3	150	80	150	150	150	150	150	150	150	80	150
2100 MHz	n1	120	80	120	120	120	100	120	120	120	120	120
2300 MHz	n40	90	0	40	90	90	90	20	90	40	70	0
2600 MHz	n7/38/41	190	0	180	0	140	180	40	185	165	190	100
3500 MHz	n77/78	400	100	300	0	200	300	0	300	200	0	200
Total		**950**	**260**	**790**	**360**	**700**	**840**	**330**	**845**	**675**	**460**	**570**
		% achieved	**27%**	**83%**	**38%**	**74%**	**88%**	**35%**	**89%**	**71%**	**48%**	**60%**

Fully/mostly assigned band   Partially assigned band   Not asssigned

Notes: IMT spectrum assignments (excluding 1500 MHz) as of December 2025. The 3GPP band numbers denote 5G bands but it is noted that 4G or earlier generations may still be in use for some bands.
Source: AMS Questionnaire responses, 2025 and WPC.

It is recommended, especially with the entry of Timor-Leste in ASEAN in late-2025, that the IMT Spectrum Index be reviewed and updated annually by the ATRC and reported to the ASEAN Digital Ministers (ADGMIN). The aim of publishing the IMT Spectrum Index is to encourage all AMS to assign the maximum possible IMT spectrum in the low and mid-bands to support their respective digital economies and overall digital connectivity across the region. A worthwhile objective would be a pan-ASEAN IMT Spectrum Index average of more than 90%, with all AMS having similar index scores. Such an exercise would also enable AMS to track the region's progress towards greater spectrum harmonisation and to include new bands in the index to support the evolution of mobile technologies towards 6G in 2030 and beyond.

02.
The evolution of mobile technology

Compared to previous generations of mobile technology, 5G, the fifth-generation mobile network technology, brings faster speeds, lower latency and expanded capacity, reshaping the telecoms landscape. It connects diverse devices, empowering MNOs to customise connectivity for specific enterprise or application needs in an increasingly interconnected world.

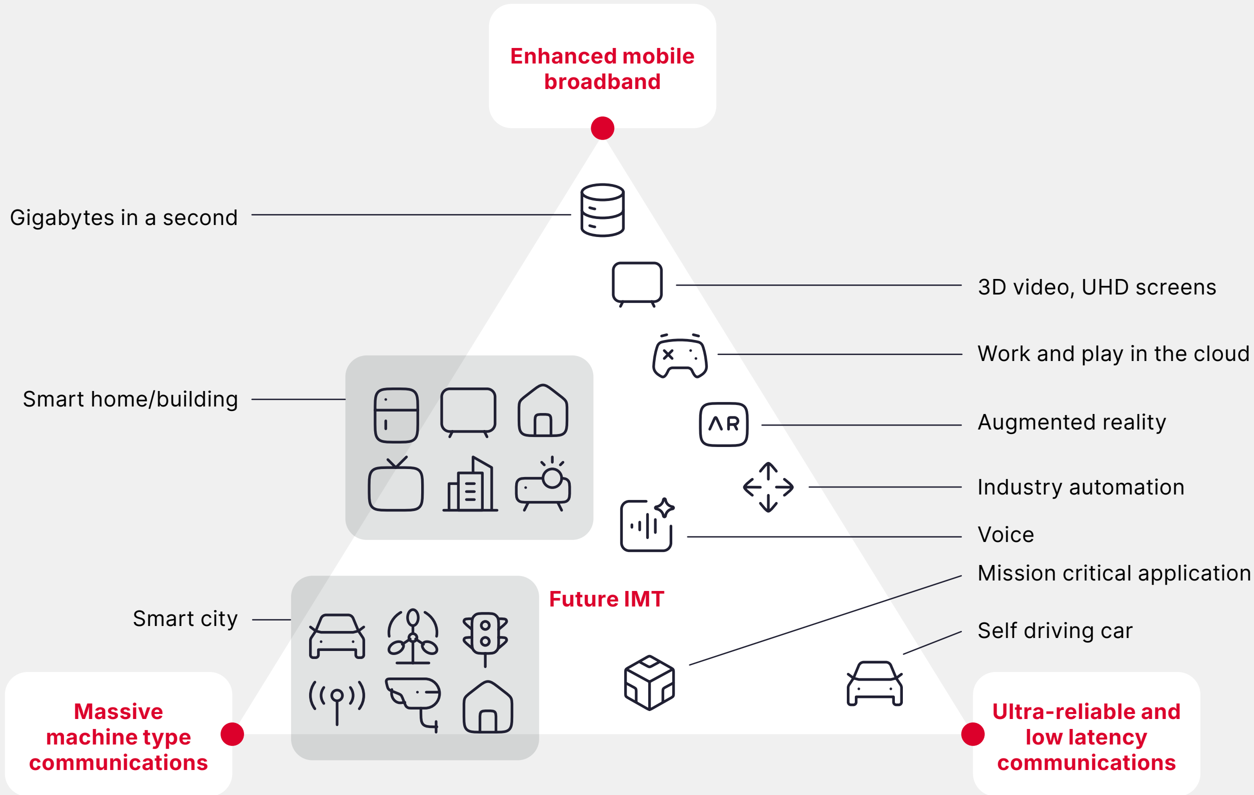
Designed to be highly versatile, 5G can deliver super-fast and responsive connectivity, while also supporting large numbers of simultaneous connections reliably and securely. Crucially, 5G is the first wireless technology reliable enough to replace cables for mission-critical applications, giving all kinds of businesses much greater flexibility and reducing costs. In some markets, 5G is also bringing high-speed broadband to communities beyond the reach of fixed networks.

2.1 5G use cases

5G use case scenarios specified by ITU-R IMT-2020, are broadly described as: enhanced Mobile Broadband (eMBB), Ultra Reliable and Low Latency Communications (URLLC) and Massive Machine Type Communications (mMTC), as shown in Figure 15.

Figure 15

Usage scenarios for IMT, 2020 and beyond



Source: ITU, Recommendation ITU-R M.2083-0 (09/2015).

3GPP Release-15, the first release for 5G, emphasised capabilities to enhance capacity and enable high peak rates. These characteristics primarily paved the way for MNOs to monetise 5G enabled mobility and fixed wireless broadband services. While a Non-Standalone (NSA) architecture was feasible to launch the initial wave of 5G services, migration to Standalone (SA) remains vital to address the broader palette of 5G use cases and monetisation opportunities.

3GPP Release-16 is built upon the foundation established by Release-15, introducing several key capabilities aimed at enhancing 5G networks and making them applicable across various industries. As the second phase of 5G standards development, Release-16 focused on optimising performance, efficiency and flexibility.

Key capabilities introduced in 3GPP Release-16 include:

1. **Ultra-Reliable Low-Latency Communications (URLLC) enhancements:** Improved reliability and lower latency for mission-critical applications such as industrial automation, autonomous vehicles and remote healthcare.
2. **Network slicing improvements:** Enhanced network slicing capabilities allowed for more sophisticated customisation and management of virtual networks, enabling MNOs to tailor services more precisely to different user groups and industries.
3. **Vehicle-to-Everything (V2X) communications:** Expanded support for V2X communications, facilitating advanced automotive applications such as safety systems, traffic management and autonomous driving through enhanced connectivity between vehicles and infrastructure.
4. **Industrial IoT (IIoT) enhancements:** Optimisations for industrial IoT applications, focusing on improving connectivity, reliability and scalability for smart manufacturing and Industry 4.0 initiatives.
5. **Positioning services:** Enhanced positioning capabilities were introduced, enabling more accurate location tracking for applications like asset tracking, navigation and emergency services.
6. **Public safety enhancements:** Features aimed at improving communication capabilities for public safety organisations, ensuring reliable and secure connectivity during emergencies.

3GPP Release-17 continued the evolution of 5G, enhancing existing capabilities and expanding the scope of 5G applications. This release aimed to increase the versatility, efficiency and performance of 5G networks across various sectors. Key capabilities introduced in 3GPP Release-17 include:

1. **Extended Reality (XR) support:** Optimisations for XR applications, including virtual reality (VR), augmented reality (AR) and mixed reality (MR). These enhancements aim to support high-quality immersive experiences with reduced latency and improved data rates.
2. **Enhancements for Massive Machine-Type Communications (mMTC):** Improvements to support large-scale IoT deployments, focusing on better resource allocation, efficiency and scalability for connecting massive numbers of devices.
3. **Reduced Capability (RedCap) devices:** Targeting IoT applications that require lower data rates and less complexity, such as wearables and sensors, making 5G more accessible for diverse applications.
4. **Non-Terrestrial Networks (NTN):** Support for NTN, including satellite communications, enabling 5G to reach areas without terrestrial coverage and enhancing global connectivity.
5. **Network slicing enhancements:** Advancements allowing for more dynamic and efficient management of network resources, improving service delivery for specific use cases and industries.
6. **Vehicle-to-Everything (V2X) extensions:** Expanded V2X capabilities to support more advanced vehicle communications, including improved safety features and autonomous driving functionalities.
7. **Positioning enhancements:** Capabilities providing more accurate and reliable location services for applications such as navigation, asset tracking and emergency response.

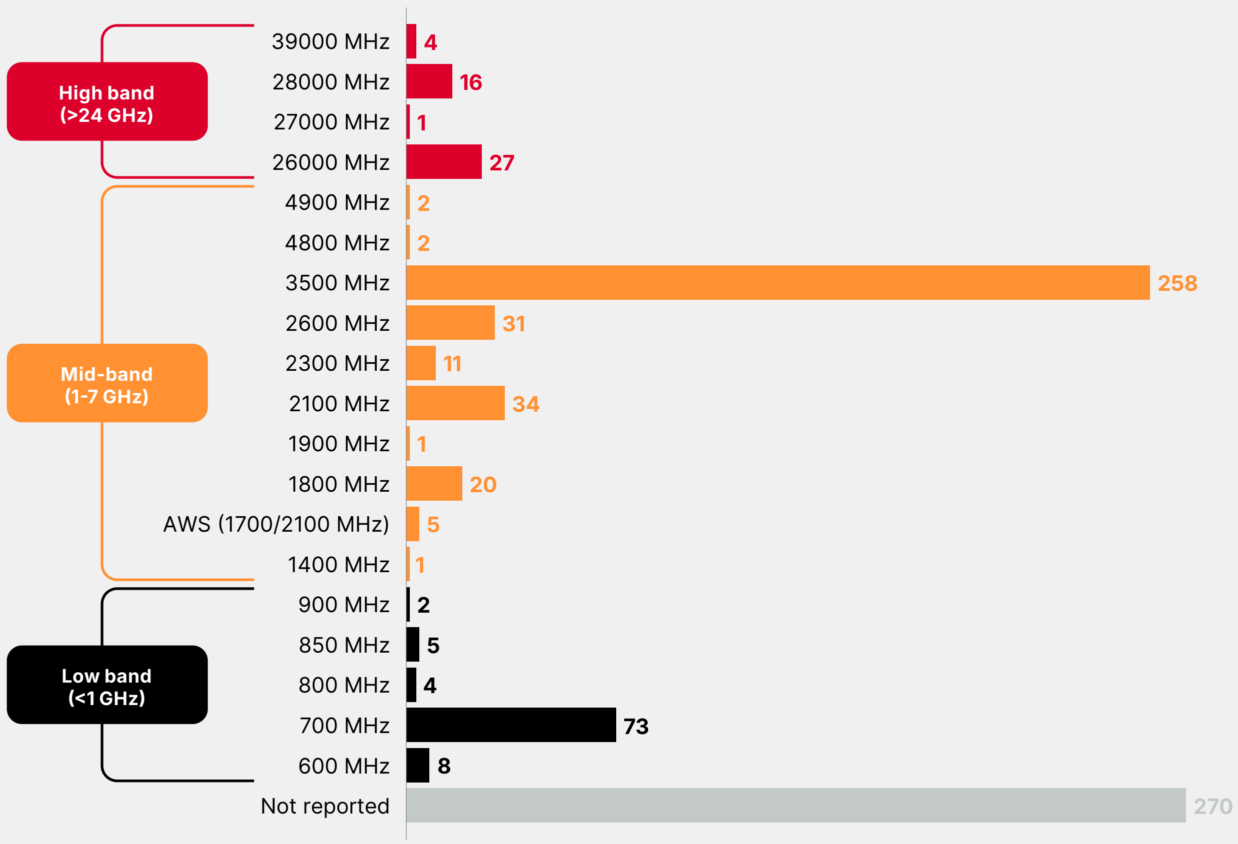
5G SA is essential to the majority of capability enhancements aimed at enabling URLLC and mMTC segments and addressing the needs of consumer and enterprise services with advanced, differentiated services.

2.2 Mobile ecosystem update

Mid-band (3.5 GHz) spectrum dominates 5G launches. By the end of Q2 2025, 361 MNOs had launched 5G services.[16] Of these, 218 MNOs (deploying a total of 260 networks, including FWA launches) used 3.5 GHz for their 5G networks, representing more than 60% of total 5G launches. MNOs are also increasing their 5G coverage by deploying 5G services in other bands, with 700 MHz emerging as a key coverage band, accounting for more than 77% of 5G network launches in low-band spectrum. 5G has also boosted the commercialisation of FWA. By the end of Q2 2025, 170 fixed broadband service providers in 78 markets had launched commercial 5G FWA services.[17] Figure 16 shows the live 5G networks by spectrum bands globally.

Figure 16

Live 5G networks globally, by spectrum band



Note: Figures refer to launches, not individual operators. 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, it is counted twice. 3.5 GHz band = 3.3–4.2 GHz range. 2600 MHz band = 2500–2600 MHz range.
Source: GSMA Intelligence (December 2025)

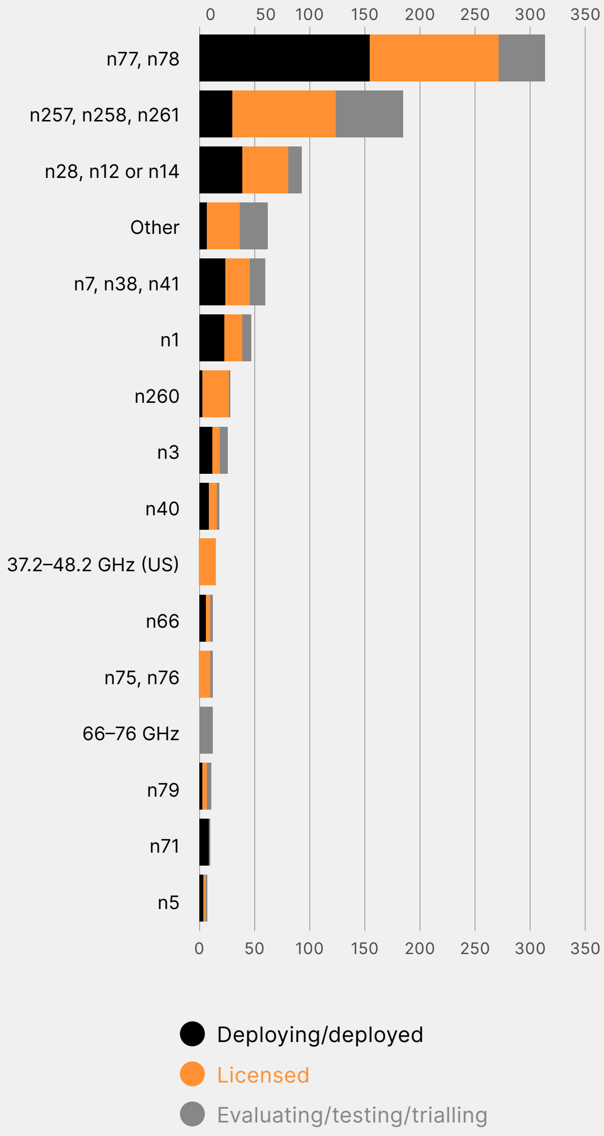
The device ecosystem reflects the 5G network deployments with core bands, such as 3.5 GHz, 2.6 GHz, 2.1 GHz and 700 MHz, having the largest number of devices (Figure 17).

16 GSMA Intelligence. (September 2025). Spectrum Navigator, Q2 2025.
17 GSMA Intelligence. (September 2025). Fixed Broadband and FWA Markets, Q2 2025.

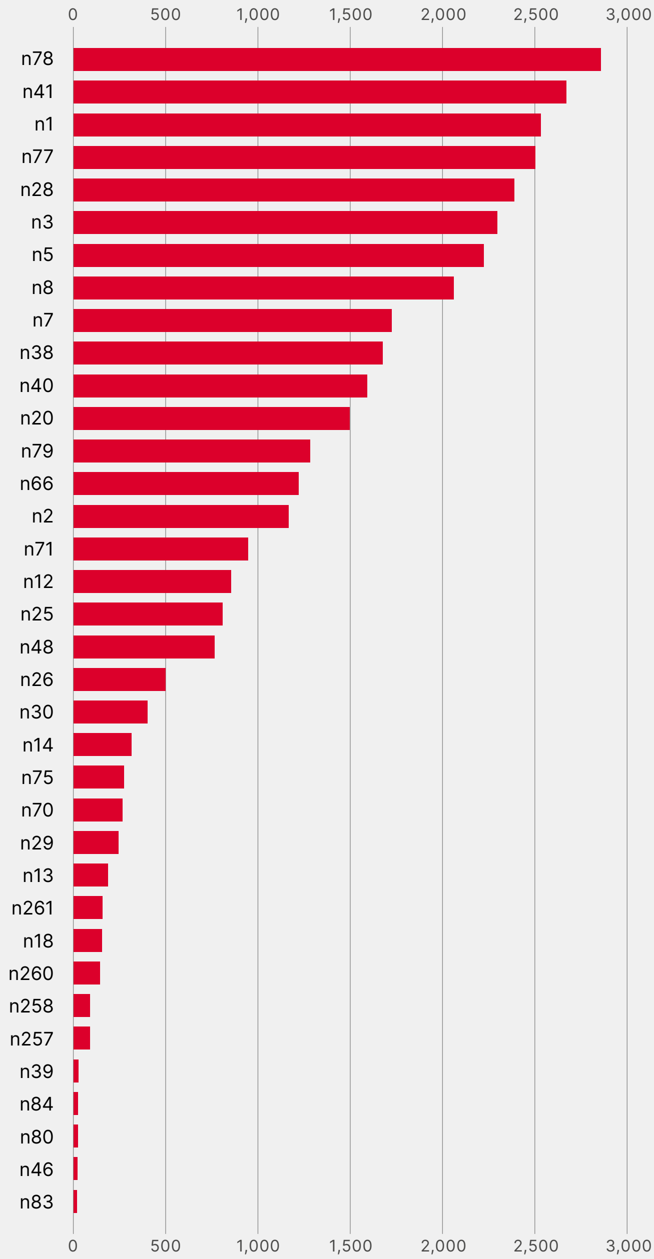
Figure 17

Global status of 5G ecosystem

Operators investing in key 5G spectrum bands (end of October 2025)



Announced 5G device models supporting key 5G spectrum bands (end of October 2025)



Source: GSA

5G Standalone (SA) is required to meet 5G-Advanced capabilities and 5G SA network deployments are scaling up worldwide as the SA ecosystem matures. As of August 2025, more than 70 MNOs in 43 countries have launched 5G SA services, with 173 MNOs in 70 countries investing in the technology.

Figure 18

Status of 5G SA and its ecosystem (as of August 2025)

Source: GSA, 5G Standalone August 2025.

5G RedCap was identified in 3GPP Release 17 to deliver improvements in device cost, power and complexity. These characteristics ensure RedCap can be used for various use cases, such as IoT, industrial, wearables and sensors. RedCap operates on 5G SA, and although 5G RedCap is still in early stages, more than 30 operators in 20 countries are conducting trials and tests.

Figure 19
RedCap use cases

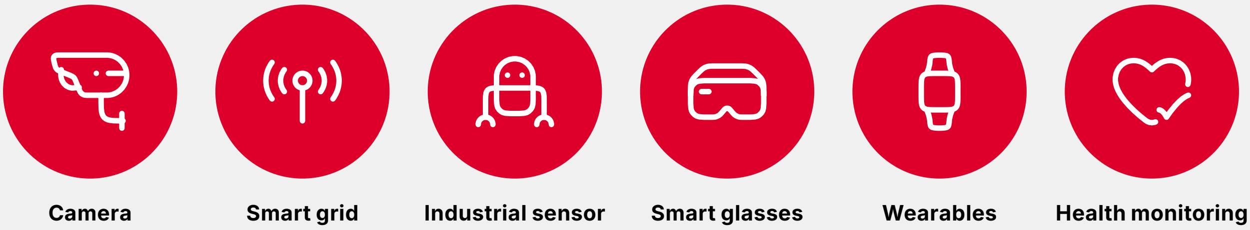
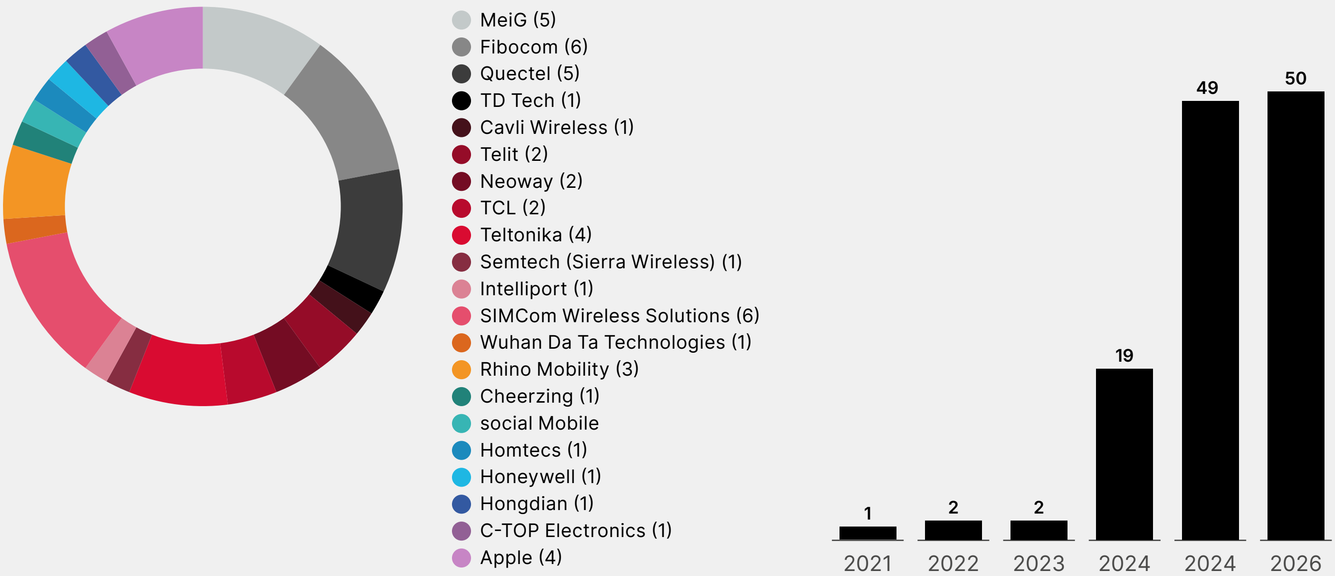


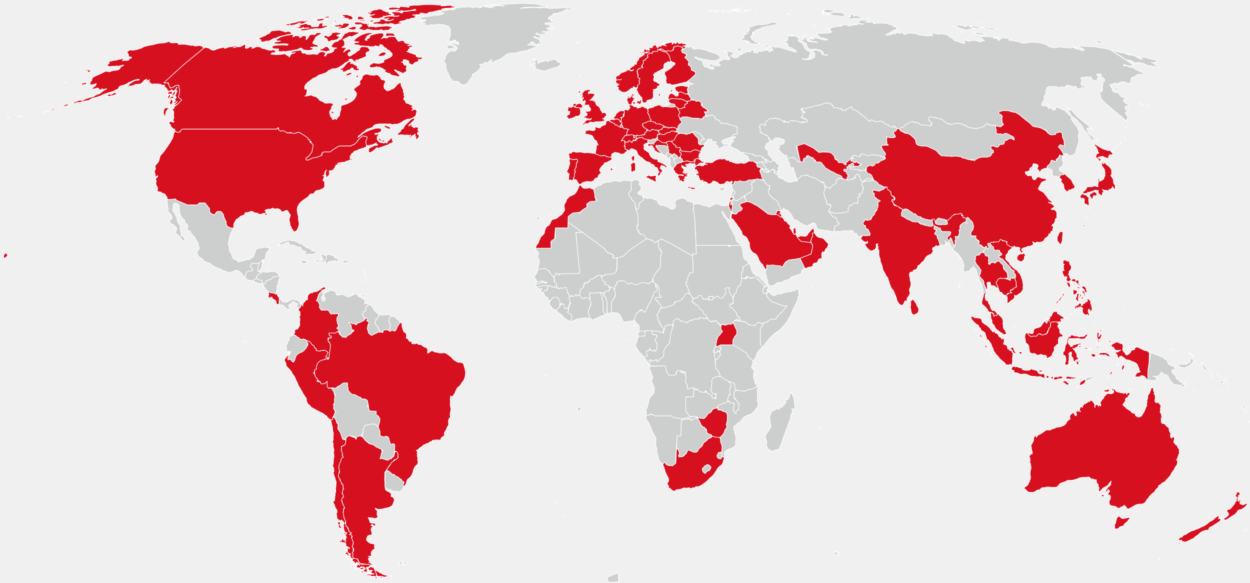
Figure 20
RedCap device/chipset and number of supporting RedCap devices/chipsets, by year



Source: GSA GaMBoD

Figure 21

Countries and territories with operators identified as investing in public 5G SA networks



Source: GSA

2.3 5G Non-Standalone vs Standalone deployment strategies

Since 2019, global 5G deployments have progressed rapidly, with notable advancements in North America and parts of Southeast Asia. Initial deployments focused on 5G Non-Standalone (NSA) architectures using existing 4G infrastructure to quickly enable enhanced mobile broadband services. This approach allowed for quicker market entry and capture of 5G service revenues.

While NSA proved effective for rapid initial deployment, in hindsight, the NSA mode poses material limitations to realizing the full potential of 5G. For example, tactical use of dynamic spectrum sharing (DSS) on low FDD bands was an effective tool to way to offer wide-area 5G NR service. However, where DSS was deployed with limited or no new 5G spectrum, end user experience on 5G was barely distinguishable from 4G. In certain scenarios, it could be worse than 4G depending on Carrier Aggregation (CA) band combination and device (UE) support.

Due to the nature of EN-DC (Evolved UTRAN-NR Dual Connectivity) inherent with NSA, access to NR spectrum depends on cell coverage in the 4G anchor band. In turn, the limiting factor for 5G service availability is coverage of the 4G anchor band. In contexts where an MNO is required to use an existing FDD mid-band as the EN-DC anchor, the coverage can even more limited, even when 5G NR is deployed on a low FDD band.

5G services based on NSA have increased revenues for MNOs, primarily in enhanced mobile broadband and fixed wireless access. The increased data speeds and capacity provided by 5G have generally improved user experiences, driving higher adoption rates and data consumption. However, the characteristics of NSA inherently limit 5G use cases such as ultra-low latency services and dynamic network slicing.

To capture the full value of 5G, SA is a critical step in the evolution of the network. Besides RAN aspects, the introduction of 5G Core (5GC) is necessary to realise SA. 5GC is a fundamentally new architecture compared to 4G's evolved packet core (EPC), and is typically realised via a container-based and cloud-native software stack. Deployment of a new core represents a significant modernisation effort in any MNO's environment. However, MNOs that have made this step early in the 5G life cycle are arguably in a better position to capture the full potential of 5G and effectively monetise the investment than ones that have not.

2.4 Benefits of 5G SA vs NSA

5G SA offers several advantages over 5G NSA in terms of both network efficiency and cost per bit delivered. These benefits (shown in Figure 22) stem from the distinct architectural differences between SA and NSA, as well as the advanced capabilities inherent in a fully realised 5G network.

Figure 22

Benefits of 5G Standalone

Network efficiency	**Optimised network architecture:** — **Dedicated 5G core:** Unlike NSA, which relies on the existing 4G LTE core for control functions, SA operates on a dedicated 5G core network. This architecture is specifically designed to optimise 5G functionalities, leading to more efficient data handling and lower latency. — **Service-based architecture (SBA):** SA leverages a service-based architecture, allowing network functions to communicate via standardised APIs. This modular approach enhances flexibility and scalability, optimising resource allocation and reducing network congestion.
Advanced features	— **Network slicing:** SA enables network slicing, allowing multiple virtual networks to be created on the same physical infrastructure. Each slice can be customised to meet specific service requirements, optimising resource use and improving overall network efficiency. — **Ultra-Reliable Low-Latency Communication (URLLC):** SA supports URLLC, crucial for applications requiring real-time data transmission, such as autonomous vehicles and remote surgery. This capability enhances network responsiveness and reliability compared to NSA.
Lower operational costs	— **Cloud-native infrastructure:** SA's cloud-native architecture allows for better scalability and automation, reducing operational costs associated with network management. This translates to lower costs per bit as cloud service providers (CSPs) can handle increased data traffic more efficiently. — **Efficient resource allocation:** With capabilities like network slicing and advanced analytics, SA networks can allocate resources more precisely based on demand, minimising waste and optimising cost efficiency.
Enhanced revenue opportunities	— **Diverse service offerings:** SA supports a wider range of services, underpinned by capabilities designed to enable differentiated connectivity. By tailoring services to specific use cases and customer needs, SA offers a path to further monetise the 5G investment. — **Innovation and ecosystem expansion:** SA enables CSPs to offer innovative services and expand their ecosystems through partnerships and third-party development. These opportunities can lead to increased demand and higher network utilisation, reducing the cost per bit delivered.
Long-term investment benefits:	— **Future-proof infrastructure:** Investing in SA infrastructure ensures long-term benefits by providing a future-proof network capable of supporting emerging technologies and applications. This strategic investment results in a more sustainable and cost-effective model compared to NSA, which would otherwise drive ongoing reliance on legacy systems.

2.5 5G-Advanced to 6G

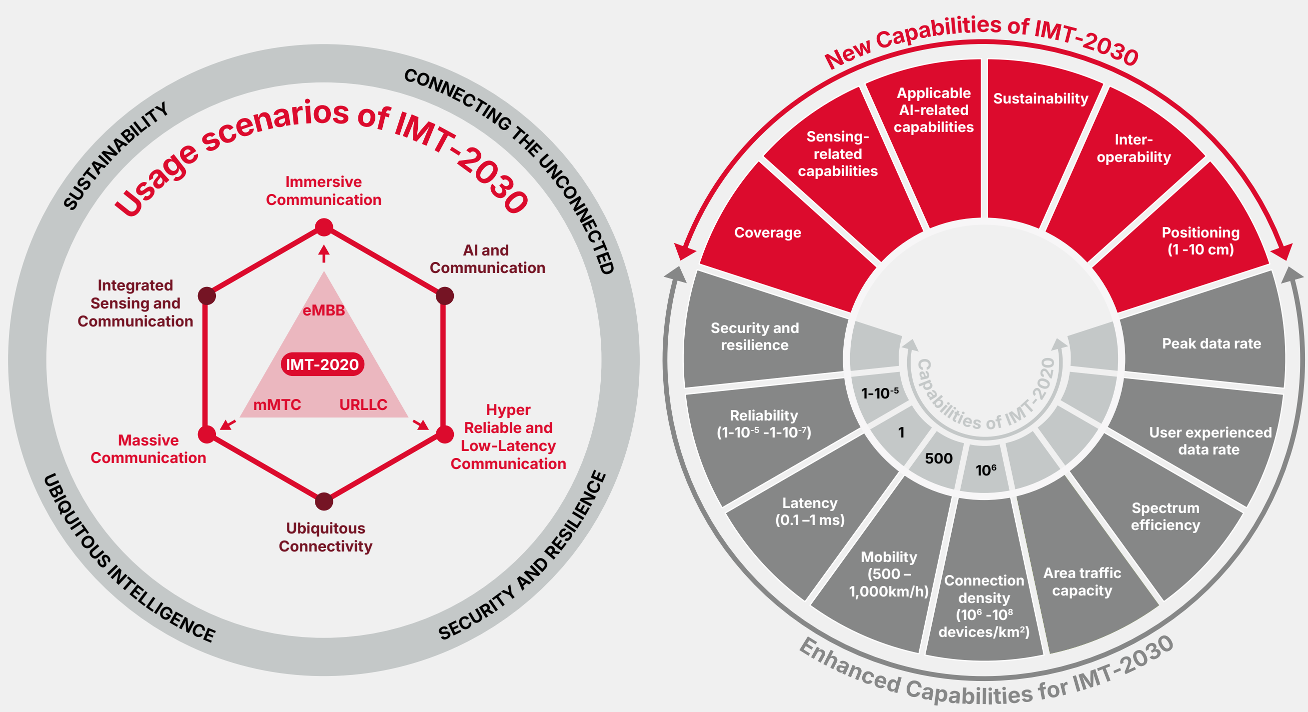
3GPP Release-18, the inaugural release of 5G-Advanced, was introduced in 2022. 5G-Advanced in Release-18 provides enhancements to existing 5G features, such as advanced UL/DL MIMO, enhanced multi-carrier operation and enhanced mobility. 5G-Advanced also provides all kinds of smart connectivity, including services that focus on uplink communication and connect people moving at high velocities. As it evolves, 5G-Advanced will play an important role in bridging 5G to 6G.

The deployment of 5G-Advanced has started in some countries. In the United Arab Emirates (UAE) operators achieved 5–10 Gbps network speeds by using more than 300 MHz TDD bandwidth, which greatly improves the user experience. MNOs in China have deployed 5G-Advanced deployment in 300 cities since 2024, with the aim to provide 10 Gbps data rate in some major cities, and to provide connectivity to industry.

While 5G and 5G-Advanced are being deployed, preparations for IMT-2030/6G have begun. 6G promises ultra-fast data rates with lower latency, significant energy efficiency and greater reliability, in addition to sensing connectivity, immersive communications and communications powered by AI, as shown in Figure 23.

Figure 23

Usage scenarios and capabilities of IMT-2030



NOTE: The range of values given for capabilities are estimated targets for research and investigation of IMT-2030.
Source: ITU, Recommendation ITU-R M.2160-0 (11/2023)

ITU-R Working Party 5D has developed a work plan and timeline for IMT-2030. According to the timeline, WP5D has finalised a New ITU-R Recommendation M.2160, "Framework and overall objectives of the future development of IMT for 2030 and beyond", and ITU-R Report M.2516, "Future Technology Trends". The process is planned to be finalised with a new ITU Recommendation on the detailed specifications for the radio interfaces of IMT-2030 by 2030.

Like previous cellular generations, the success of IMT-2030/6G will depend on providing wide contiguous coverage, serve both indoor and outdoor users and enable mobility. From this perspective, spectrum with wide and continuous bandwidth is essential to support the evolution of IMT from 5G to 5G-Advanced and 6G.

03.
Developing spectrum roadmaps

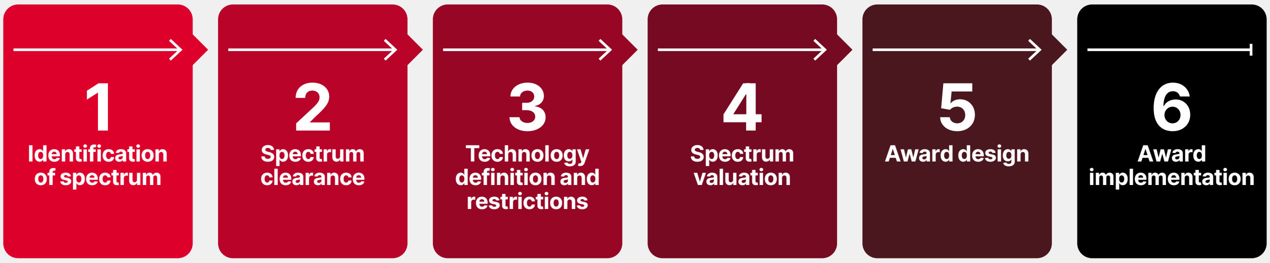
Spectrum roadmaps are critical for governments that want to maximise the benefits of mobile connectivity. While 5G networks are well established in advanced mobile markets, the pace of 5G development differs significantly across countries and regions, including in Southeast Asia. Developing a spectrum roadmap can help ensure there is enough spectrum to meet continued growth in demand for mobile services in the short and long term. Roadmaps help governments forecast future trends and manage their work. For the mobile industry, roadmaps provide greater certainty for investment in new technologies, network deployment and business development based on the government's future spectrum assignment, renewal plans and management.

As with all previous generations of mobile services, the road to 5G in every country starts with the release of spectrum to support the network roll-out. A typical spectrum roadmap, as illustrated in Figure 24, involves the following steps.[18]

18 See: GSMA. (April 2022). Roadmaps for awarding 5G spectrum in the APAC region.

Figure 24

Key steps in developing a spectrum roadmap



1. Identification of spectrum.

Spectrum is essential for the provision of mobile services, and 5G needs significant new harmonised spectrum.[19] This first step involves an initial 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 the different options available. Where competing demands arise, a cost-benefit analysis should be conducted to assess the impacts of proposed changes in spectrum assignment and to ensure efficient use of scarce spectrum and achieve optimal outcomes for society.[20]

2. Spectrum clearance.

Approaches for clearing spectrum depend on factors such as the density of use; 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.

3. Technology definition and restrictions.

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

4. Spectrum valuation and pricing.

Assessing the value of spectrum guides upfront and 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 relating to licensing obligations should be taken into account when setting prices for spectrum.

5. Award design.

There are three main approaches to awarding spectrum: auctions, beauty contests and direct award.[21] The approach adopted, and associated licence obligations, will need to consider policy objectives, available spectrum and market specifics (for example, the number of MNOs or current spectrum holdings). Depending on the timescales for availability of different frequency bands and award design, it may be appropriate to have a single multi-band award or several separate ones.

6. Award implementation.

The final step is the actual award. This will normally be underpinned by documentation that provides all the necessary details of the award process, the spectrum on offer, licence obligations and other essential information for potential licensees.

19 The key frequency bands to prioritise for 5G are outlined in Section 1.3.
20 See: GSMA. (January 2022). Maximising the socio-economic value of spectrum. A best practice guide for the cost-benefit analysis of 5G spectrum assignment.
21 See: GSMA auction best practice position.

In the Asia-Pacific region, even when the 3.5 GHz band has been released for IMT/5G, the quantum of the band released for IMT/5G is often low (often 200 or below MHz). To deliver on the promise of 5G and take advantage of its many benefits, it is important for ASEAN regulators to develop a roadmap for the release of as much of the 3.5 GHz band as possible, including clearing additional spectrum for release on a nationwide or regional basis.

ASEAN countries are at various stages of formulating spectrum roadmaps. These roadmaps address the future release of spectrum and plan for the renewal of bands that have already been assigned. A summary of each country's progress is found in Table 6. Some countries, such as Brunei, the Philippines and Cambodia are still in the process of formalising a spectrum plan. By contrast, Vietnam[22] and Indonesia lead by example by having planned for the release of spectrum in the short, medium and long-term. Although Myanmar has a roadmap in place to address the future release of 3.5 GHz by 2024, according to the IMT spectrum assignment information provided, this has not yet happened. While beneficial, spectrum roadmaps do not necessarily guarantee timely assignments, so implementation is key.

Table 6:

The status of spectrum roadmaps in AMS

Spectrum roadmaps and future planning

	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
Spectrum roadmap?	No formal roadmap	Not available but 5G Roadmap (2025)	Yes	Long-term only	MCMC currently working on a Spectrum Outlook (expected mid-2026)	Yes	Within one year of the passage of the Konektadong Pinoy IRR (Nov 2026)	Not available	Yes	Yes, new National Radio Frequency Master Plan, Decision No. 37/2025/QD-TTg (Oct 2025)
Short term		Release of 2×30 MHz of 2.6 GHz under consideration (or refarming to n41); 26 GHz band available	Release of 700 MHz, 2.6 GHz and 26 GHz Renewal 2.1 GHz		Reassignment of spectrum expiring in 2027 and 2028	2.3 GHz (2022), 700 MHz, 2.6 GHz, 3.5 GHz (2024) 4.8 GHz for 5G release in 2026			Release of 1400 MHz, 1800 MHz, 2010 MHz and 25.1 GHz Renewal of 850 MHz, 2.1 GHz and 2.3 GHz	3400–3560 MHz, 6425–7125 MHz partially or entirely designated for IMT
Medium term	100 MHz from 3.5–3.6 GHz remains vacant	MPTC/TRC working with Ministry of Information on release of 700 MHz in 2026	Plan for release of 3.3 GHz and 3.5 GHz Plan for renewal of 2.3 GHz							600 MHz band and LEO/NGSO officially included in roadmap
Long term		Additional 3.5 GHz band depending on cross-border coordination	Renewal of 800 MHz, 900 MHz and 1800 MHz	4900 MHz and 25.25–27.5 GHz	Additional spectrum based on WRC-27 outcome; reassignment of spectrum expiring in 2032, 2034 and 2037	Release of 600 MHz				
Timing uncertain					Planning for bands due to expire within five years and 5G spectrum issues				Study 600 MHz, 3700–4200 MHz and 6400–7200 MHz bands	900 MHz re-auction New IMT-2030 studies

Source: AMS Questionnaire responses, 2025 AMS regulator websites and WPC industry research, December 2025, https://www.slideshare.net/slideshow/mcmcspectrumplan2022pdf/261708365; Sroy Kimneng, MPTC, 5G Development in Cambodia; AITI, Country Update: Brunei Darussalam's Journey towards 5G; and ARFM, 5G Deployment in Vietnam and Lessons Learned, ASEAN 5G Conference, Ninh Binh, Vietnam, 27 October 2025.

22 See: https://www.vietnam.vn/en/ban-hanh-quy-hoach-pho-tan-so-vo-tuyen-dien-quoc-gia and https://www.luatvietnam.net/en/national-radio-frequency-allocation-planning-from-november-20-2025-vbpl138708.vlo.

3.1 Spectrum assignments, trading and refarming

Across ASEAN Member States (AMS) there is considerable variation in how IMT spectrum is assigned to MNOs and other market participants. Spectrum auctions are favoured in Indonesia, Thailand and Vietnam, while administrative awards are preferred in Brunei, Malaysia, Lao PDR, the Philippines and Cambodia. In Myanmar (albeit previously) and Singapore, several different approaches have been used, including beauty contests, calls for proposals, direct awards and auctions. It should also be noted there has been some policy consideration in the Philippines, Malaysia and Cambodia as to whether to assign IMT spectrum bands via auction in the future.

In relation to IMT spectrum renewals, AMS have again adopted a variety of measures, including spectrum auctions (e.g. Thailand, proposed in Indonesia and Vietnam), while renewal with refarming of spectrum to support competition and ensure contiguous spectrum assignments (i.e. in 5 MHz blocks) has been the practice in Malaysia. Indonesia strongly supports band restacking to ensure contiguous spectrum assignments (e.g. including 1.8, 2.1 and the 2.3 GHz bands). All AMS generally support regulatory certainty in relation to spectrum licences. However, in the Philippines where there are indeterminate licence periods, recent legislation amendments (discussed elsewhere in detail in this report) may result in the adoption of new assignment and renewal processes.

Having the right regulatory features in place can facilitate the process of spectrum harmonisation, in particular provisions that deal with spectrum trading and spectrum refarming. An overview of where ASEAN countries stand on these regulatory features is detailed in Table 7, showing that spectrum trading and refarming is a common feature in the region and often requires approval from the relevant government ministry or regulator. The only exceptions are Thailand and the Philippines, which do not permit spectrum trading, although both allow for spectrum refarming subject to regulatory oversight.

Table 7:

Comparison of spectrum trading and refarming rules in ASEAN

	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
Spectrum trading?	Yes	No	Yes	Yes	Yes	Not available	No	Yes	Not permitted	Yes
Conditions?	Regulator approval	Not allowed	Min-isterial approval	Min-isterial approval	Reg. 19 of Spectrum Regulations	Not available		Regulator approval		Auction spectrum tradeable after five years
Spectrum refarming?	Yes	Yes	Yes		Yes	Yes	Yes	Yes, possible	Yes	Yes
Conditions?	Regulator approval, technology requirements, service requirements, migration strategy, coverage of rural areas	Sub-Decree 217 regulates	Subject to Article 6 of Minister of Communications Reg No 5 of 2019		Subject to conditions set by MCMC	Spectrum rules regulate	NTC responsible	Subject to IMDA's approval	Subject to reg-ulations/ NBTC	Set by Circulars on Band Planning

Source: AMS Questionnaire responses, 2025.

3.2 Technology-neutral licensing

The adoption of technology neutral licensing frameworks constitutes best practice for ASEAN Member States. These kinds of frameworks allow MNOs to refarm spectrum used for legacy GSM (2G) or 3G to 4G and 5G technology based on market demand. As a result, both spectral efficiency and market efficiency are maximised in tandem, and users benefit from higher quality broadband coverage, higher data speeds and lower mobile data prices.[23]

Since 2019, there has been a significant increase in the commercial launches of 5G services in the ASEAN region. It is crucial that MNOs have the flexibility to refarm existing spectrum holdings to 5G. With the exception of Cambodia and Malaysia, most AMS have adopted technology-neutral licence frameworks, as shown in Table 8.

Table 8:

Comparison of licensing frameworks in AMS according to technology neutrality

Technology-neutral spectrum licensing?									
Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
Yes	No, 5G has only been recently permitted	3GPP Standards only	Yes	No. 700 & 2600 MHz & 28 GHz 5G only	Yes	Yes	No	Yes	Mostly up to 5G*

Source: AMS Questionnaire responses, 2025; AMS regulator presentations.

3.3 Planning for 6G

As highlighted in Section 2.5, international planning for mobile technologies in the 2030s is underway with 3GPP developing detailed 6G standards while the ITU specifies IMT-2030, including parameters, evaluation criteria and spectrum requirements. Governments and regulators are developing a long-term global spectrum roadmap for mobile, and the ITU's WRC-27 process, along with its working parties such as WP 5D, is working to pave the way to 6G development.

6G technology will initially operate simultaneously with 5G. MNOs will migrate currently available bands to 6G when possible and appropriate, but customers and use cases will still rely on earlier generations years after the launch of 6G. Technology-neutral spectrum will be required but, with capacity already used up for 5G services, existing spectrum alone cannot serve migration to 6G.

6G will use mmWave for the busiest locations, such as stadiums, train stations and airports, and low bands will be required to deliver crucial digital equality between urban and rural areas as well as deep indoor penetration. However, a lot of emphasis will be placed on finding the right mid-band assignments to deliver city-wide connectivity on macro-cell networks.

Bands such as 6 GHz can be brought into play by many governments to carry the next phase of data growth, which may be in the short or medium term depending on the country. Beyond 6 GHz, and some possible expansion of bands such as 3.5 GHz in some countries, the solution to future spectrum requirements lies in the WRC-27 process.

Agenda Item 1.7 of WRC-27 will study the following bands for IMT:

- 4.4–4.8 GHz
- 7.125–7.25 GHz and 7.75-8.4 GHz (Region 1)
- 7.125–8.4 GHz (Regions 2 and 3)
- 14.8-15.35 GHz

To realise the full benefits of 6G in a macro-mobile urban environment, 200–400 MHz channels will be required for each operator going into the 2030s as shown in Figure 25. The mobile ecosystem is working with governments and international bodies to ascertain which bands may be used for the future expansion of mobile in preparation for WRC-27.

23 GSMA. (2019). The Benefits of Technology Neutral Spectrum Licences.

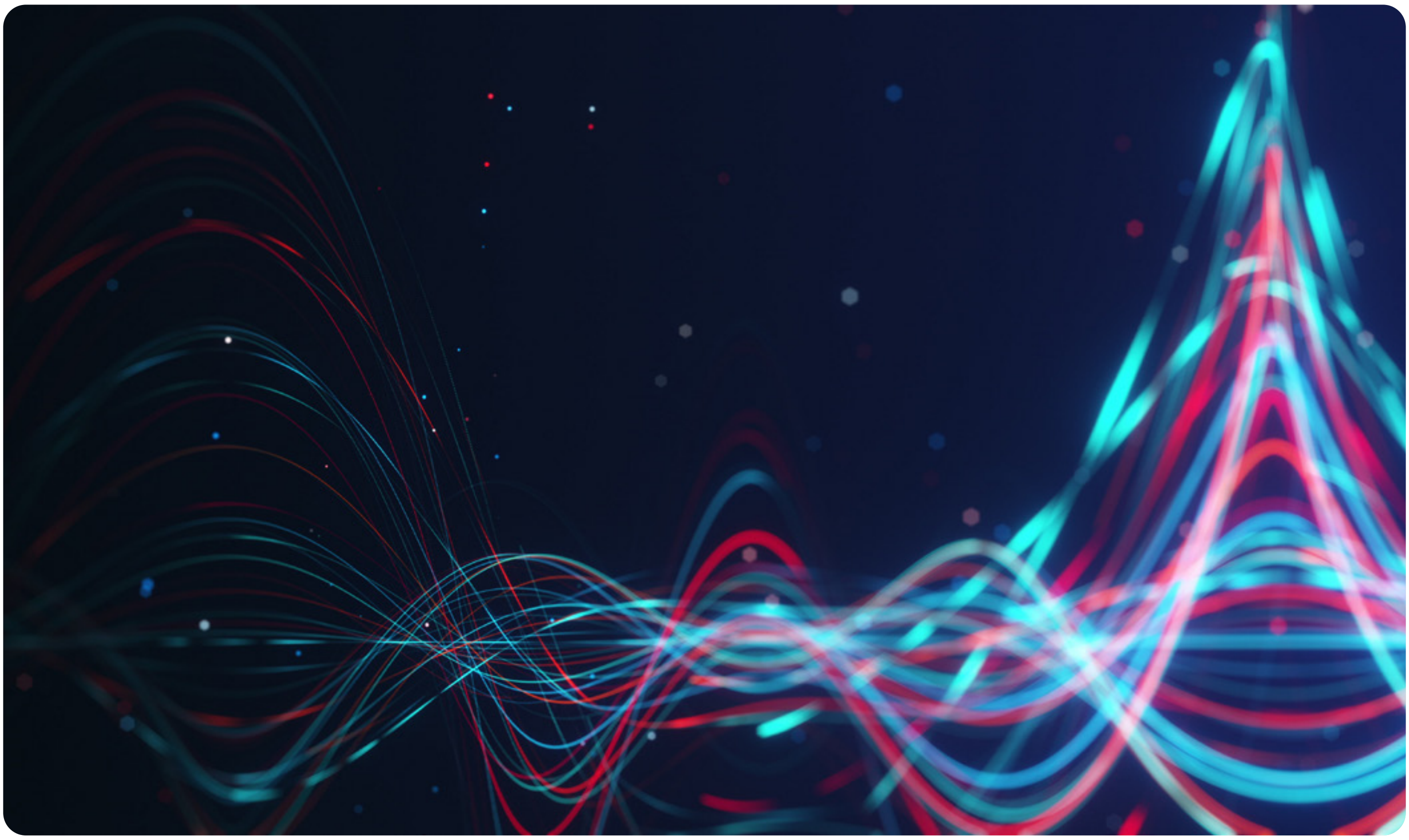
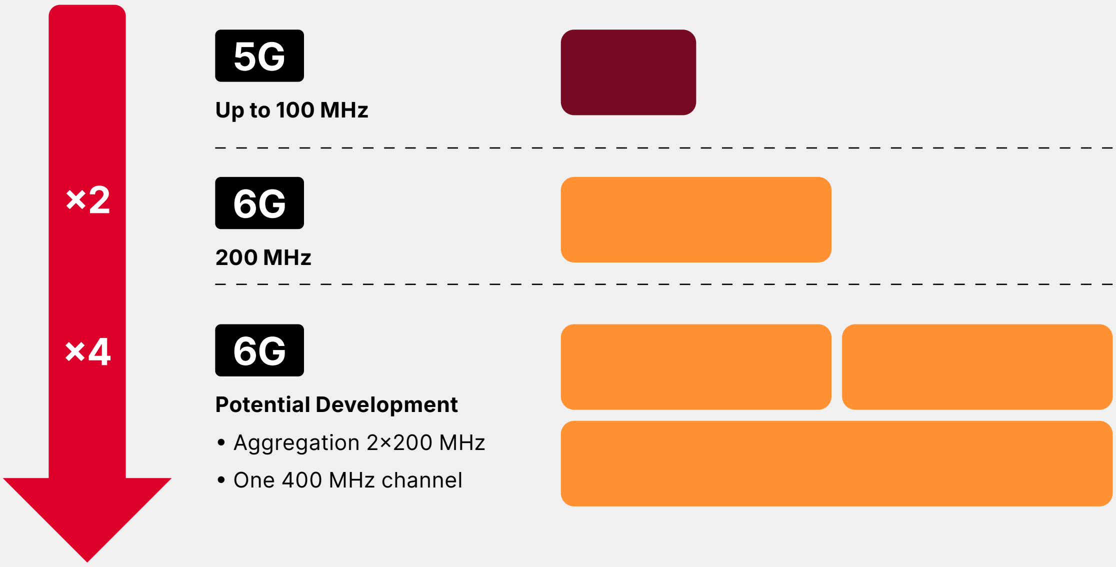


Figure 25

Mid-band channel options for 6G



Source: GSMA

A long-term roadmap will help provide certainty around the supply of future spectrum for 6G, thus ensuring the evolution of mobile technology and setting the foundations for digital innovation in the next decade.

04.
Technical assessment

This section provides an evaluation of the main technical and coexistence issues associated with several key bands for mobile services in ASEAN Member States. The analysis discusses incumbent services (in-band and adjacent), the feasibility of coexistence between incumbent usage and mobile and the actions and arrangements necessary to enable effective mobile implementation.

The first section discusses the bands considered high priority in the near term (within two years or earlier), namely 700 MHz, 2.6 GHz and 3.5 GHz, followed by those that are important for planning in the mid- to longer term (3–5 years), namely 600 MHz, 1500 MHz, upper 6 GHz and 4.8 GHz.

4.1 700 MHz band

The 700 MHz band is the "digital dividend" spectrum in the Asia Pacific region, offering the opportunity to expand the scarce supply of sub-1 GHz frequencies. In the ASEAN region, good progress has been made on the 700 MHz release for IMT. Seven countries have assigned 700 MHz spectrum, although in several cases the full 2×45 MHz (703–748/758–803 MHz) has not been assigned (see Table 2).

Meanwhile, Cambodia has not yet completed its Digital Switch Over (DSO), and as analogue TV broadcasting is still in operation, this has delayed the availability of 700 MHz for IMT.[24] In Indonesia and Myanmar, the process for assignment of 700 MHz band to MNOs has been delayed despite DSO being completed or the band being vacant.

4.1.1 Issues and challenges

The DSO process involves migration from analogue television to digital terrestrial television broadcasting to free up low-band spectrum for IMT and take advantage of more spectrally efficient broadcasting technologies. Details of the DSO process have been covered extensively by the GSMA[25] and the ITU.[26]

There is a clear trend, not only across Asia Pacific but also globally, in using the 700 MHz band lor IMT. Full harmonisation across ASEAN will enable better coverage and better service quality, as well as bring connectivity to more rural areas, providing users with access to education, financial and health services. At the same time, harmonisation will reduce potential cross-border interference issues between IMT and other incumbent users, such as broadcast TV and Services Ancillary to Broadcasting (SAB)/Services Ancillary to Program (SAP) (e.g. wireless microphones).

Countries that are still completing the migration to digital terrestrial television (DTT) face common challenges. Some arise from efforts to enable digital transformation, such as funding, technical expertise and regulatory challenges, while others relate to the digital migration process itself, such as legal challenges from broadcasters, consumer outreach and the provision of new TV receivers, such as set-top boxes.[27]

Having completed the DSO process, the following issues will need to be addressed for the 700 MHz band to be used for mobile:

- Award design, including lot sizes, spectrum prices and licence conditions
- Establishment of rules for coexistence of adjacent services and related guard bands
- Phasing out of other incumbent users in the 700 MHz band (for example, wireless microphones)
- Considerations for Public Protection and Disaster Relief (PPDR).

More information and guidelines on the above issues are set out in the GSMA report, Securing the digital dividend across the entire ASEAN.[28]

4.1.2 Proposed approach and actions

For the remaining ASEAN countries that have yet to assign the 700 MHz band, the conversion to DTT, band clearance and implementation of the APT 700 band plan for mobile broadband services must be prioritised in the near term.

International experience suggests the importance of flexibility and continued engagement with stakeholders and consumers to meet the overall goal of completing DSO and releasing low-band spectrum for mobile.[29] Preparation for IMT spectrum assignments can start once the DSO process is underway. While 700 MHz should eventually be available nationwide, a phased approach can be adopted with spectrum gradually made available by geographic region or cluster, with appropriate discounts on payable spectrum fees.

In the longer term, ASEAN countries should seek to expand low-band spectrum supply below 700 MHz as DTT usage trends evolve and the proportion of households relying on DTT as the primary TV platform declines.

24 The Philippines is the other country that has yet to switch off analogue TV, although the 700 MHz band is not affected as TV broadcasting operates below 698 MHz.
25 GSMA. (August 2017). Practical Recommendations to Digital Migration in ASEAN.
26 ITU. (2012). Guidelines for the Transition from Analogue to Digital Broadcasting, 2012 edition (for Asia Pacific) and 2014 edition.
27 See: GSMA. (October 2022). Digital Switchover in Sub-Saharan Africa: Bringing Low-Band Connectivity Within Reach.
28 GSMA. (August 2018). Securing the digital dividend across the entire ASEAN.
29 ITU. (2018). Digital dividends: Insights for spectrum decisions.

4.2 2.6 GHz band

The 2.6 GHz band (2500–2690 MHz) is identified for IMT globally and formally included in the Radio Regulations in accordance with Resolution 223 (Rev. WRC-15).[30] The ITU Recommendation ITU-R M.1036-7 (12/2023)[31] defined three alternative channel arrangements for the 2.6 GHz band plan, as detailed below and shown in Figure 26:

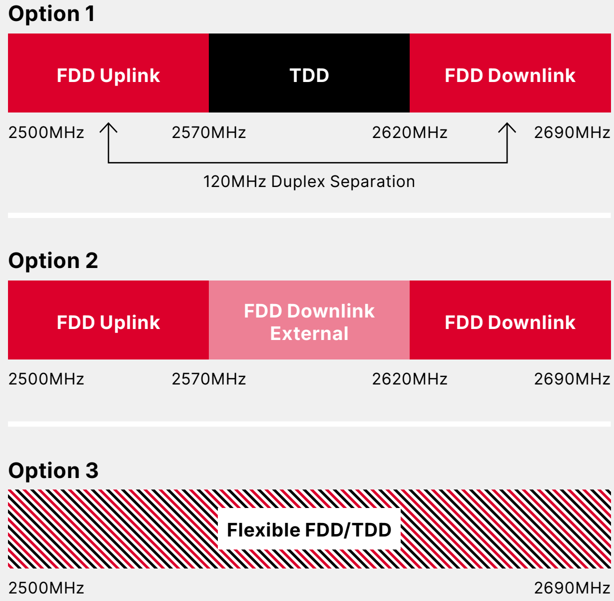
- **C1:** Preconfigured paired (FDD) and unpaired (TDD) spectrum – 2×70 MHz for FDD and 50 MHz for TDD
- **C2:** Paired spectrum only, with the uplink portion of some pairs in another undetermined band
- **C3:** Flexibility – licensees/regulators can decide how to assign the spectrum to paired (FDD) or unpaired (TDD) operation

The C1 band plan, comprising the 3GPP Band 7 (FDD) and Band 38 (TDD), has been widely adopted in Europe and is also used in Latin America and parts of Asia Pacific. In ASEAN, Singapore (which licensed the band in May 2005), Cambodia (2012), Malaysia (2013)[32] and Lao PDR (2015) use the same band plan.

Driven by China,[33] Japan, India and the United States (the latter especially as an upgrade path from WiMAX), assignments of the 2.6 GHz band post-2017 generally followed the C3 band plan for TDD use given its advantages and potential for wider channel bandwidths for 5G. The TD-LTE variant in the 2.6 GHz band is harmonised globally as LTE Band 41.[34]

Figure 26

Channel arrangements for the 2.6 GHz bands



Source: GSMA

AMS that have assigned the 2.6 GHz band more recently have opted for the full TDD configuration. The first ASEAN country to do so was the Philippines (2017), but Myanmar (2016 – originally TDD b38 but confirmed as n41 in 2020[35]), Thailand (2020), Vietnam (2024) and Indonesia (planned for 2026), have all adopted Band 41, or n41 as it is known in 5G New Radio.

30 ITU. (2016). Radio Regulations, Footnote 5.384A.
31 ITU. (2023). Recommendation ITU-R M.1036-7 (12/2023).
32 MCMC, Standard Radio System Plan, Requirements for International Mobile Telecommunications (IMT) Systems operating in the Frequency Band 2500 MHz to 2690 MHz, SRSP-523, 28 November 2012.
33 See, for example, China, Status updates on the 2300–2400 MHz band in ITU-R WP5D; DocumentAWF-9/INP-26, 9th Meeting of the APT Wireless Forum (AWF-9), 13 September 2010.
34 Windsor Place Consulting. (October 2018). Powered Evolution to 5G: The compelling case to adopt and/or transition to LTE Band 41 in the 2.6 GHz spectrum band in Asia and globally. Since 3GPP Release 8 (in early 2009) included LTE, the 3GPP has been committed to ensuring it supported not only FDD but also TDD spectrum. This is because within the globally assigned IMT spectrum bands for mobile broadband, there are significant spectrum resources suitable for TDD LTE deployment. Common 3GPP specifications for both FDD LTE and TD-LTE ensure devices are able to support both the FDD and TDD interfaces on the same chipset.
35 Ministry of Transport and Communications, Posts and Telecommunications Department. (March 2020). Frequency Arrangement in 2.6 GHz Spectrum and Network Synchronization for TDD for Myanmar.

Table 9 provides a summary of the 2.6 GHz assignments across ASEAN. In brief, the hybrid FDD-TDD (b7/38) band plan has been adopted in Cambodia, Lao PDR, Malaysia and Singapore, and is mostly used for 4G services. In Myanmar, Philippines, Thailand, Vietnam and Indonesia (planned), the band is used in the full TDD mode (b/n41). The Philippines, Thailand and Vietnam use this spectrum for 5G services.[36]

Brunei has not yet assigned the band given its smaller population and the extensive use of the 700 MHz (n28) and 3.5 GHz band (n77/78) for 5G services. As it stands, ASEAN countries representing more than 90% of the total ASEAN population either use or plan to use the full TDD band plan for 2.6 GHz.

Table 9:

Summary of current 2.6 GHz band assignments in ASEAN

2.6 GHz	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
Assigned?	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes, partial
MHz as-signed	-	180	-	180	180	40	180	165	190	100
Technology	-	4G	5G planned	4G	4G	4G TDD	4G/5G	4G	4G/5G	5G
Band plan	-	B7/38	N41	B7 (B41 planned)	B7/38	B38/ B41	N41	B7/38	N41	N41
Licence expiry	-	2043	-	Annual	2027	2029	Indeter-minate	2030–2033	2035	2039

Source: GSMA with WPC input, December 2025

4.2.1 Issues and challenges

Channel interference between FDD and TDD services

Both FDD/TDD (b/n7/38) and TDD (b/n41) band plans are well supported in terms of smartphone and devices.[37] However, the current fragmented nature of frequency arrangements across ASEAN is sub-optimal in terms of efficiency, ease of coordination and future development. Specifically, it raises possible co-channel interference between FDD and TDD services and synchronisation issues between TDD networks in the various border regions.

The most significant co-channel interference between FDD and TDD services is in the border regions between Malaysia and Thailand, Lao PDR and Thailand, and Cambodia with Thailand and Vietnam. Possible future interference issues may arise between Singapore and Indonesia in the Bintan/ Bantam region post Indonesia's assignment the 2.6 GHz band under a n41 bandplan. This is shown in Figure 27.

Where MNOs in neighbouring countries both deploy TDD services in the 2.6 GHz band, network clock synchronisation should be maintained, otherwise a 10 km isolation distance will be required given the interference. Further, when MNOs deploy different TDD and FDD services in the 2.6 GHz band in different neighbouring countries, 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 -110 dBm.

Given such interference and the ability to maximise the use of this band for future 5G services, there has been debate in both Lao PDR[38] and Cambodia to move to n41 TDD band plans in 2025–2026. As Malaysia's current 2.6 GHz licences are expiring in 2027, it is also considering whether to make changes as part of the MCMC's current spectrum outlook process.

36 Kechiche, S. (10 October 2025). "Building ASEAN Digital Infrastructure: The Role of Spectrum". Opensignal.
37 GSA. (August 2025). 5G Market Snapshot, p. 4; GSA. (September 2025). LTE Ecosystem, pp. 3–4.
38 Nathavong, P., Ministry of Technology and Communications (MTC). (2023). "ICT Development in Lao PDR". ITU-ITTLLDC Seminar 2023. Ulaanbaatar, Mongolia, 26–28 September 2023.

Figure 27

Status of 2.6 GHz band plans in ASEAN

Source: GSMA, October 2025.

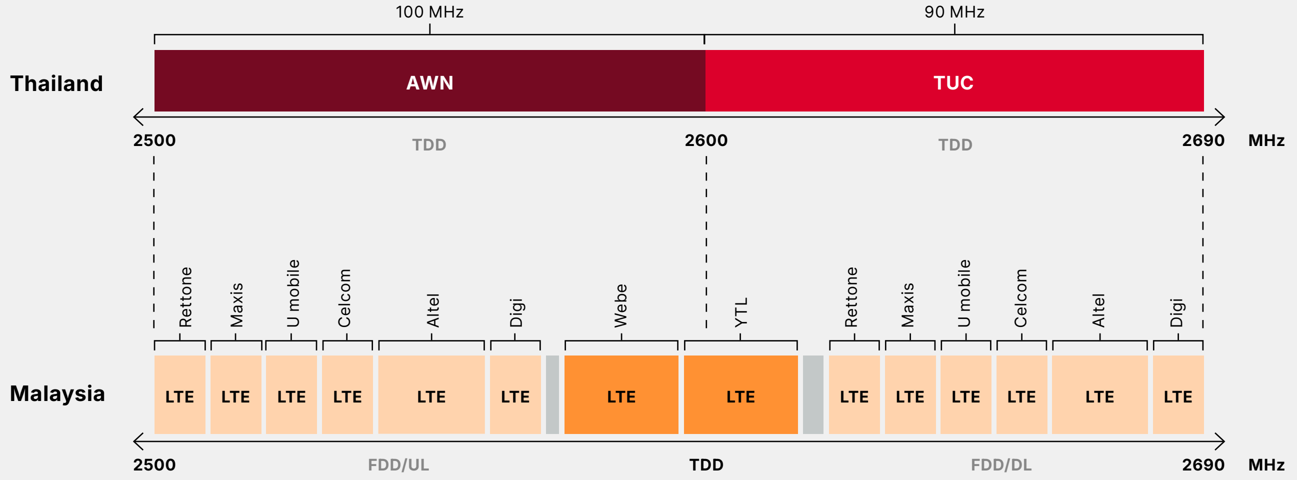
Thailand, led by the NBTC, along with its neighbouring countries,[39] have undertaken various information exchanges on frequency planning and 5G deployment plans, joint testing of interference situations and assessing solutions to prevent harmful interference. It is important to continue these discussions to ensure all MNOs and relevant stakeholders have the requisite information to plan their 5G deployments.[40]

In one example, Malaysia and Thailand have agreed to a cross-border coordination approach. Thailand has agreed with Malaysia, and its other neighbours through various JTC meetings, to adopt coordination parameters in relation to the 2.6 GHz band (see Figure 28) and mitigate interference.

39 Including Malaysia, Cambodia, Lao PDR and Myanmar.
40 GSMA. (December 2024). Accelerating 5G and 5G-Advanced in Thailand: A roadmap for success, pp. 22–24.

Figure 28

Malaysia and Thailand's agreed cross-border coordination approach to the 2.6 GHz band



Frequency band	Technology	Co-ordination Parameter	
		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

Going forward, it is suggested that ASEAN moves towards the harmonisation of 2.6 GHz band plans to TDD n41, which is more optimal for 5G and future services. Assuming that Lao PDR and Cambodia are able to reorganise their 2.6 GHz band plans, pan-ASEAN harmonisation could be possible around 2030, in line with the expiry of 2.6 GHz licences in Malaysia (2026–27) and Singapore (2030).

Need for synchronisation and common frame structures

All TDD networks, whether they are LTE/4G or 5G networks, operating in the same frequency range and within the same geographic area need to be synchronised. Synchronisation is the best way to ensure efficient spectrum usage and to avoid harmful interference, which has a major impact on both network performance and coverage.

This is well understood by ASEAN regulators. For example, in Vietnam, Decree 13 /2023/TT-BTTTT of 23 November 2023 provides in Article 2(3) that, in relation to the 3.5 GHz band, "Organizations licensed to use the frequency band in the 3600-3980 MHz band are responsible for synchronizing the data frames of the TDD method and coordinating with other organizations licensed in this band to avoid harmful interference."

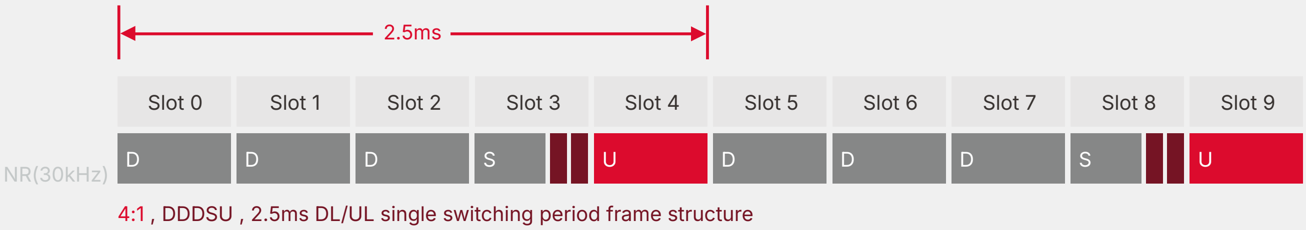
To ensure coexistence at a national level, it is strongly recommended that all 4G/5G networks operating within the 2.6 GHz band use synchronisation parameters. The choice of synchronisation parameters is influenced by the required network performance, whether there are incumbent users in the band and the approach of neighbouring countries.[41]

The amount of observed traffic on 4G and 5G networks between the user device and the base station (the uplink) and vice versa (the downlink) is often asymmetrical. Thus, the typical approach is to agree to a 4:1 or 3:1 (downlink-uplink) profile. The recommended national frame structure for the 3.5 GHz (n77/78) band is set out in Figure 29. This frame structure could also be adopted for the 2.6 GHz band for 5G services.

41 See: CEPT (8 March 2019). ECC Report 296, National synchronization regulatory framework options in 3400-3800 MHz: a toolbox for coexistence of MFCNs in synchronised, unsynchronised and semi-synchronised operation in 3400-3800 MHz; GSMA. (April 2020). 5G TDD Synchronisation, Guidelines and Recommendations for the Coexistence of TDD Networks in the 3.5 GHz Range.

Figure 29

Recommended national frame structure for 5G services in the 2.6 GHz band



However, if 4G/LTE TDD networks are to be concurrently deployed in the 2.6 GHz bands, a 5 ms frame structure of 8:2 (DDDDDDDSUU) should be adopted to be compatible with LTE TDD networks. This may be necessary as an initial deployment phase and to address cross-border issues between neighbouring ASEAN countries. Other options include different profiles such as Low Latency (DSDU), High Throughput (DDSU, DDDSU) and a variant (DDDDSU DDSUU).

4.2.2 Proposed approach and actions

In summary, the proposed approach and actions for the 2.6 GHz band are as follows:

- Consider moving to a harmonised TDD band plan (n41) to reduce the challenges of cross-border coordination.
- Synchronise TDD networks based on industry recommendations to address domestic competition and cross-border issues.
- Develop a future upgrade path/evolution to 5G and beyond to make more efficient use of spectrum in the long term with the use of n41 in the 2.6 GHz band. TDD technology offers a viable path from 4G to 5G networks and services.

Such actions will maximise spectrum efficiency and the use of 2.6 GHz to expand mobile capacity. TDD deployments based on an n41 band plan facilitate the delivery of high-quality wireless broadband services at lower cost per MB/GB for MNOs through:

- Higher throughput performance based on massive MIMO antenna technology
- Lower operating expenses (OpEx), due to more compact equipment size
- Lower capital expenditure (CapEx), including less need for filters, as no filtering is needed between FDD and TDD services.

This cost efficiency facilitates more affordable services and ultimately supports national broadband development goals – a benefit evident in the large-scale network deployment observed in Asian and other ASEAN countries that have adopted n41. Further, n41 utilising TDD technology achieves significantly higher spectral efficiency than spectrum that utilises FDD technology – consistent with exemplar spectrum management regulatory objectives in most ASEAN jurisdictions.

4.3 3.5 GHz band

The 3.5 GHz frequency band is a core band for 5G and is widely deployed globally. Among ASEAN countries, six have assigned it for 5G (see section 1.2.3, Table 5). However, the amount of assigned bandwidth varies between 100 MHz and 300 MHz and, in general, ASEAN lags other regions and leading markets around the world in terms of the availability of 3.5 GHz.

4.3.1 Issues and challenges

The 3.5 GHz band spans from 3.3 GHz to 4.2 GHz. One common challenge faced by ASEAN countries in making the 3.5 GHz band available for IMT is coexistence with incumbent users such as FSS. Coexistence depends on the characteristics of incumbent services, the extent of deployment and type of sharing envisioned (co-channel or adjacent channel). In general, there are two approaches to releasing spectrum for mobile use:

- Accommodating both mobile and existing users with suitable mitigation measures
- Clearing the band (or parts of it) by migrating existing users to alternative bands or technologies

Table 10 summarises the coexistence approaches with typical incumbent services, including Fixed Satellite Service (FSS), Fixed Service (FS) and Radiolocation.[42]

Table 10:

IMT coexistence potential and approaches with incumbent services in the 3.5 GHz band

Incumbent service (type of deployment)	Co-channel	Adjacent channel
FSS (limited earth stations)	Yes, with detailed coordination / mitigation measures	Yes, with detailed coordination / mitigation measures
FSS (ubiquitous deployment, e.g. TVROs or VSATs)	No	Yes, with suitable guard band
FS (limited point-to-point links)	Yes, with detailed coordination / mitigation measures	Yes, with detailed coordination / mitigation measures
FS (ubiquitous point-to-point links)	No	Yes, with suitable guard band
FS (point-to-multipoint/BWA)	Yes, with mitigation measures, e.g. synchronisation	Yes
Radiolocation / radars	May be possible with detailed coordination	Probably, with detailed coordination

Source: GSMA. Roadmap for C-band spectrum in ASEAN.

Several ASEAN countries, including Indonesia and Thailand, are facing similar challenges in the assignment of the 3.5 GHz band with regards to the migration of incumbent users and coexistence with FSS/ satellite operators.

As summarised in Table 10, co-channel sharing with FSS (limited FSS earth station) would be possible only with detailed coordination and mitigation measures. Where there is heavy satellite use in countries like Indonesia, co-channel sharing would not be practical. Co-channel sharing with ubiquitous FSS (e.g. TVRO in Thailand) would also not be feasible.

42 There have been some concerns about 5G deployment in 3.5 GHz and aviation altimeters in the adjacent 4.2–4.4 GHz band. However, to date, live 5G networks in more than 90 countries use spectrum in the 3.5 GHz band with no reported instances of interference from 5G to radio altimeter. For more information on 5G and radio altimeters coexistence, see: GSMA. (October 2025). 5G and Radio Altimeters Coexistence in 3.3–4.2 GHz.

When considering coexistence with FSS, adjacent channel sharing with mitigation/guard band is a more practical approach, and has been implemented in many countries. The major mitigation measures are:

- **Frequency separation with guard band** is a common approach that has been implemented in many countries. The size of the guard band varies in different markets. An excessive guard band of 100 MHz is used in some cases, while there are also examples of smaller guard bands, such as 50 MHz in Singapore. A few countries adopt even less than 50 MHz, for example, 20 MHz in Vietnam and the US, and 30 MHz in India. The bandwidth of the guard band depends on the IMT characteristic, FSS receiver characteristic and the deployment scenarios (e.g. antenna height, propagation characteristic).
- **Improve FSS earth station receiver performance**, for example, to improve filtering at the FSS receiver. The replacement of LNB downconverter will likely require government support and funding.
- **Other measures** such as exclusion zone and antenna tilt.

More details on the mitigation measures for IMT and FSS can be found in ***APT Report 112***,[43] ***ITU-R Report S.2546***[44] and GSMA resources.[45]

While C-band satellite services continue to be important, there is a global trend in the use of higher bands for satellite provision. In the long term, the migration of FSS to other bands (Ku/Ka bands) should be considered by ASEAN Member States. This could facilitate the expansion of the 3.5 GHz band for IMT. For example, Brazil has decided to migrate C-band TVRO to Ku-band to facilitate the availability of 3.5 GHz for mobile.[46] In Vietnam, the ARFM is planning to further expand the 3.5 GHz from 3.4 to 3.98 GHz upon the expiry of Vinasat-1, which is currently using the extended C-band. This would enable up to 580 MHz of the 3.5 GHz band for IMT, putting Vietnam ahead of other AMS in terms of 3.5 GHz availability.

4.3.2 Proposed approach and actions

As a core mid-band frequency range, 3.5 GHz can balance coverage and capacity, providing an ideal environment for 5G connectivity. Given the developed ecosystem of the 3.5 GHz band, timely assignment is essential for all ASEAN countries, particularly those that have yet to assign any spectrum in this band.

The proposed actions for ASEAN are to:

- Ensure the provision of sufficient bandwidth for MNOs with 100 MHz per MNO for initial phase of 5G roll-out.
- Assess the nature and scale of FSS deployments, including long-term usage trends, potential interference scenarios and possible mitigation measures.
- Conduct a cost-benefit analysis to identify the best option for maximising the benefits of spectrum use for IMT.
- Consider possibilities for further expansion to 3.3–3.4 GHz and above 3.7 GHz in the long term.

43 Asia-Pacific Telecommunity. (September 2021). APT Report on Mitigation Measures to Improve Sharing and Compatibility between 4G-LTE and 5G-NR Systems and Other Systems Operating in Portions of 3300–4200 MHz.
44 ITU. (2024). ITU-R Report S.2546: Mitigation measures between FSS and IMT in the frequency band 3 400-3 600 MHz.
45 GSMA. (6 October 2021). "The 3.5 GHz Range in the 5G Era".
46 GSMA. (22 December 2021). "Brazil multi-band auction: one of the largest in mobile history".

4.4 600 MHz band

The 600 MHz band is a relatively new band for IMT and has been assigned by several countries in North America (e.g. Canada, US) and the Middle East (Saudi Arabia, UAE). In ITU Region 3, the 600 MHz band has a co-primary mobile allocation and several administrations, including Bangladesh, Lao PDR, Maldives, New Zealand and Vietnam, have also identified 600 MHz for IMT under footnote 5.296A, while others, including Australia and India, are also considering 600 MHz for future mobile use.

There are two possible band options in the 600 MHz range, namely the North America 600 MHz band plan (n71) and the APT 600 MHz band plan (n105), which offer 2×35 MHz and 2×40 MHz respectively, as shown in Table 11. India has adopted the APT 600 MHz band plan, and in September 2025 the regulator TRAI launched a public consultation on the next IMT spectrum auction, including the 600 MHz band.

Table 11:

Band plans for 600 MHz mobile

3GPP band	Recommendation ITU-R M.1036	Uplink	Downlink	Channel sizes
N71	A12	663–698 MHz	617–652 MHz	5, 10, 15, 20 MHz
N105	A13	663–703 MHz	612–652 MHz	5, 10, 15, 20 MHz

The APT Wireless Group (AWG) has been working on 600 MHz frequency arrangements since 2020 and the APT 600 MHz band plan was approved at AWG-30 in September 2022.[47]

The plan was developed by considering compatibility with APT 700 MHz band, eliminating the 5 MHz gap (698–703 MHz) that would not be usable for mobile.

4.4.1 Issues and challenges

The addition of 2×40 MHz of 600 MHz spectrum for IMT offers significant advantages for ASEAN as this would represent a potential 50% expansion of low-band supply. However, there are several issues and challenges:

- **Cross-border interference:** The implementation of technical and regulatory measures through cross-border agreements is necessary to ensure interference-free spectrum use when plans for this spectrum differ across borders, as further described below.
- **Broadcast TV utilisation and DTT restacking:** Existing broadcast TV services could be using parts of the 600 MHz range and any restacking exercise and timing of release may be dependent on licence expiry dates.
- **SAB/SAP or PMSE considerations:** Wireless microphones typically operate in sub-700 MHz bands. The introduction of 600 MHz mobile is likely to require SAB/SAP users to switch to 500 MHz and/or consider alternative frequency bands.

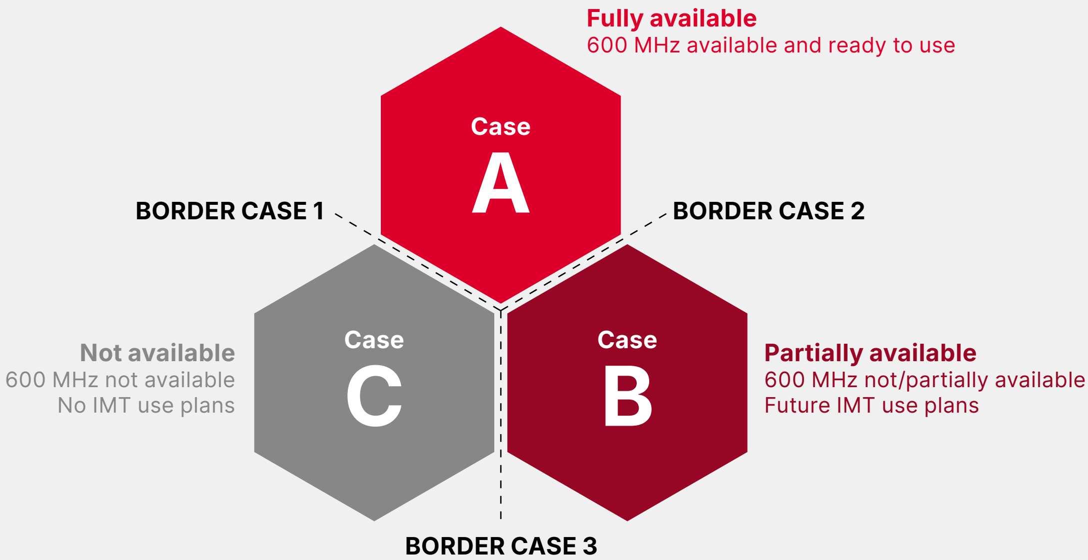
47 APT. (2017). APT/AWG/REP-79 (Rev.2). APT Report on frequency arrangements for IMT in the band 470-703 MHz.

Cross-border coordination issues

There are likely to be differences among neighbouring countries in current or future 600 MHz use, including the pace of IMT deployment. As a result, there are three possibilities when considering the 600 MHz band for IMT implementation, which are shown in Figure 30.

Figure 30

Possible cases of 600 MHz cross-border considerations



Source: TMG

When countries with shared borders have similar plans for 600 MHz, cross-border coordination agreements are simpler. For instance, the key considerations for bilateral agreements are:

- **Both countries in case A:** The agreement is similar to those signed for other IMT bands. In this case, administrations should work on reaching border agreements to deploy IMT in the 600 MHz band as soon as possible.
- **Both countries in case B:** A timeline should be established for IMT implementation, possibly including plans to allow simultaneous, temporary IMT and digital television (DTV) use in both countries.
- **Both countries in case C:** The countries should continue to engage on their respective spectrum needs, potentially allowing future adoption of the 600 MHz band for IMT.

When countries with shared borders have different plans or timings for future 600 MHz usage, cooperation will be key for each country to have the flexibility to use the band for specific applications. The different approaches and considerations for these cases are summarised in Table 12.

Table 12:

Approaches to cross-border coordination when 600 MHz usage differs

Border case	Situation	Approach
Case 1	When IMT use is not planned on one side (C),but the band is fully available for IMT deployment on the other (A)	An agreement to use the 600 MHz band for both broadcasting and IMT should be drafted with both parties considering the timing of the IMT implementation, including ways to accommodate IMT use in the border area.
Case 2	When the band is fully available for IMT deployment on one side (A) but only partially on the other (B)	An agreement to use the 600 MHz band for both broadcast and IMT should be drafted, with both parties considering the timing of the IMT implementation and proposing a time frame for the necessary migration.
Case 3	When IMT is not planned on one side (C) but the band is partially available for deployment on the other (B)	Countries should begin to consider plans for spectrum use in the border area that consider the expected future use of the band.

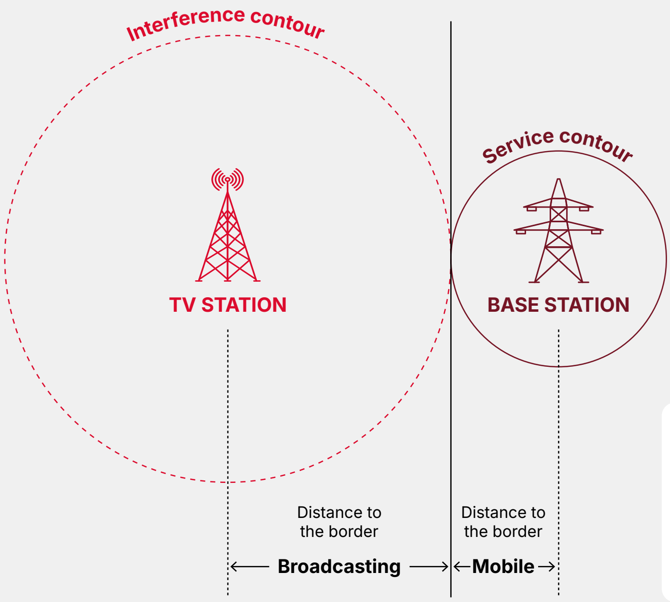
Based on technical studies of IMT and broadcasting, it is possible to determine interference and service contours for coordination purposes. Examples of distances to support the determination of coordination zones are shown in Figure 31.

Compatibility with neighbouring countries' stations may be determined by studying a real-world example of a specific location, for instance, where no harmful interference occurs even when stations are close together given the terrain. In some cases, coexistence of IMT and DTV stations in the same frequency range at a border may not be feasible. In this case, prioritising DTV channel migration to reduce interference risk is preferable. Another option is to divide the use of the band to accommodate the implementation of IMT on one side of the border while still protecting DTV channels operating on the other side.[48]

48 For more details, see: TMG. (October 2023). Guidelines for implementation of IMT in UHF bands.

Figure 31

Example distances to determine the coordination zone



Interference scenario	Interference contour	Service area contour
IMT into broadcasting	**13 km** (from IMT base station)	**39 km** (from DTV station)
Broadcasting into IMT	**70 km** (from DTV station)	**12 km** (from IMT base station)

Source: TMG

4.4.2 Proposed approach and actions

The use of the 600 MHz band for IMT is a valuable option for countries looking for cost-effective methods to increase the capacity of mobile networks in rural areas, including providing service to critical infrastructure such as roads, ports and mines. For instance, making 20 MHz of spectrum available per MNO in the 600 MHz band can enable 21% fewer sites for equivalent coverage, while 40 MHz supports sufficient cell-edge speeds with 33% fewer sites.[49]

The following actions are proposed for policymakers in AMS:

— Review DTT usage and consider potential timescales for refarming 600 MHz for IMT.

— Adopt the APT 600 MHz band plan to maximise low-band spectrum supply and consider IMT identification by joining RR footnote 5.296A.

— Develop a long-term strategy for 600 MHz that considers other users, including in neighbouring countries, and associated cross-border coordination scenarios and issues.

49 GSMA and Coleago Consulting. (2022). Vision 2030: Low-Band Spectrum for 5G.

4.5 1500 MHz band

The 1500 MHz band (1427–1518MHz) is identified for IMT in R3 in accordance with Resolution 223 (Rev.WRC-19) and Resolution 761 (Rev.WRC-19).

There are three band plans for 1500 MHz: SDL, FDD and TDD, as summarised in Table 13.

Table 13:

L-band band plan options defined by 3GPP

	4G LTE	5G NR
SDL	Band 32: 1452–1496 MHz	
	Band 75: 1432–1517 MHz	N75: 1432–1517 MHz
	Band 76: 1427–1432 MHz	
FDD	Band 11: 1427.9–1447.9/ 1475.9-1495.9 MHz	
	Band 21: 1447.9–1462.9/1495.9-1510.9 MHz	
	Band 74: 1427–1470/1475-1518 MHz	N74: 1427–1470/1475–1518 MHz
TDD	Band 45: 1447–1467MHz	
	Band 50: 1432–1517 MHz	
	Band 51: 1427–1432 MHz	N51: 1427–1432 MHz

In Europe, the SDL band plan was adopted for 1452–1492 MHz in 2013 and extended to include 1427–1452 MHz and 1492–1518 MHz in 2017. The 1500 MHz band has been assigned in several EU countries, most recently in Slovakia where 1.5 GHz was awarded to four MNOs in July 2025 with each receiving 20 MHz of SDL spectrum. There are also other countries, such as Saudi Arabia, planning to use the SDL plan.

In Asia Pacific, Japan has adopted the FDD band plan, where 2×35MHz (1 427.9–1 462.9 MHz/ 1 475.9–1 510.9 MHz) is used. In India, the regulator TRAI launched a public consultation in September 2025 on auction plans for IMT bands.[50] The 1427–1518 MHz is set to be available by the end of 2026 with the band plan under consultation.

In ASEAN, Thailand has adopted the SDL band plan for 1500 MHz and auctioned 55 MHz (1452–1507 MHz) in June 2025, with one MNO acquiring 20 MHz.[51] Separately, Indonesia has adopted the TDD band plan and auctioned 1432–1512 MHz for fixed wireless access in October 2025.[52]

4.5.1 Issues and challenges

The challenges with the 1500 MHz band are mainly compatibility with adjacent band services. In the lower adjacent band, there is allocation of Earth Exploration Satellite Service (EESS) (passive) in the frequency band 1 400–1 427 MHz. In the upper adjacent band, there is mobile satellite service (MSS) allocation in the frequency band 1 518–1 525 MHz and 1 525–1 559 MHz.

Compatibility with EESS (passive) in 1 400–1 427 MHz

Resolution 750 (Rev.WRC-19) stipulates that the unwanted emissions from IMT stations in the 1 427–1 452 MHz band do not exceed the corresponding limits (see Table 14).

50 TRAI. (30 September 2025). Auction of Radio Frequency Spectrum in the Frequency Bands Identified for IMT.
51 NBTC. (2025). Spectrum Auction 2025.
52 Komdigi. Results for 1.4 GHz auction.

Table 14:

Limits of unwanted emission power from Res.750 (REV.WRC-19)

EESS (passive) band	Active service band	Active service	Limits of unwanted emission power from active service stations in a specified bandwidth within the EESS (passive) band1
1 400– 1 427 MHz	1 427– 1 452 MHz	Mobile	−72 dBW in the 27 MHz of the EESS (passive) band for IMT base stations −62 dBW in the 27 MHz of the EESS (passive) band for IMT mobile stations2,3

Notes to Table 14:

1. The unwanted emission power level is to be understood here as the level measured at the antenna port, unless it is specified in terms of total radiated power (TRP).
2. This limit does not apply to mobile stations in the IMT systems for which the notification information has been received by BR by 28 November 2015. For those systems, −60 dBW/27 MHz applies as the recommended value.
3. The unwanted emission power level is to be understood here as the level measured with the mobile station transmitting at an average output power of 15 dBm.

In addition, in the IMT SDL and TDD band plan, 1 427–1 432 MHz (n76/n51) is defined separately from 1 432–1 517 MHz (n75/n50) and 5 MHz in the 1 427–1 432 MHz can be treated as the guard band between IMT and EESS.

Compatibility with MSS service above 1 518 MHz

To achieve compatibility between IMT and MSS, mitigation techniques including guard band and out-of-band limit should be considered.

In the SDL and TDD band plan definitions, the upper limit of IMT is 1517 MHz, keeping 1 MHz (1517–1518 MHz) as the guard band between IMT and MSS. The FDD band plan, band 74/n 74 is defined in 1427–1470/1475–1518 MHz. In practice, Japan has only deployed FDD IMT networks in portions of the band, with an upper limit of 1510.9 MHz.

In Europe, the Electronic Communications Committee (ECC) Decision (17)06 defined a maximum of 58 dBm/5 MHz in-band e.i.r.p. of IMT in the frequency 1512–1517 MHz, and the out-of-block EIRP limit of IMT base station, -0.8dBm/MHz in 1518–1520 MHz and -30dBm/MHz in 1520–1559MHz.

Recommendation ITU-R M.2159-0, “Technical and regulatory measures to provide compatibility between international mobile telecommunications and mobile-satellite services with respect to mobile-satellite services operations in the frequency band 1 518 1 525 MHz for administrations wishing to implement international mobile telecommunications in the frequency band 1 492-1 518 MHz”, considers several options for emission levels from IMT equipment operating in band 1 492-1 518 MHz to protect MSS.[53] The European example is included as one of the options in this recommendation.

One difficulty in ensuring compatibility between IMT and MSS is that some legacy mobile earth stations do not have adequate blocking capability. Under Recommendation ITU-R M.2159, -30 dBm blocking levels for the new mobile earth stations is recommended for consideration.

4.5.2 Proposed approach and actions

Given its location in the lower to mid-band range, 1500 MHz can provide good coverage. To make 1500 MHz available for IMT, it is suggested that AMS:

— Review current usage, including in-band or adjacent band users

— Monitor developments in the mobile ecosystem. The equipment and device ecosystem in 1500 MHz is growing. According to GSA data, more than 200 devices are available for n75 as of May 2025.

— Include 1500 MHz for IMT as part of long-term planning.

53 ITU Recommendation ITU-R M.2159-0 (12/2023).

4.6 Upper 6 GHz band

In Southeast Asia, 5G deployment and adoption is gathering pace. As discussed in Section 1.2, 5G connections are projected to grow by more than three-fold over the next five years. As adoption expands so will the demand for spectrum, especially in mid-bands for city-wide and indoor capacity. The full availability of the upper 6 GHz band (6.425–7.125 GHz) for mobile networks is crucial to support continued growth of mobile connectivity and set the stage for next-generation 6G services.

One of the significant outcomes of the ITU World Radiocommunication Conference 2023 (WRC-23) was the identification of additional mid-band spectrum in 6 GHz to meet the growing demand for mobile data.[54] Countries representing 60% of the global population sought inclusion in the identification of the upper part of the band (6.425–7.125 GHz) for licensed mobile, and with decisions after WRC-23, that footprint will now cover 80% of the world's citizens.

Following WRC-23, the upper 6 GHz band has been assigned in United Arab Emirates (UAE) and Hong Kong.

- **UAE:** the entire upper 6 GHz band was assigned to two MNOs (two blocks of 350 MHz each) in November 2024.[55]
- **Hong Kong:** 300 MHz within 6.425–7.125 GHz was assigned through auction to three MNOs in November 2024.[56]

In Europe, the Radio Spectrum Policy Group (RSPG) published its ***Draft Opinion on Long-term vision for the upper 6 GHz band*** in November 2025.[57] Under the Opinion, 540 MHz (6.585–7.125 GHz) are designated now for priority mobile use, with an additional 160 MHz (6.425–6.585 GHz) or 125 MHz (7.125–7.250 GHz) to be confirmed after WRC-27. Many countries are also making decisions on the upper 6 GHz IMT at the national level. A summary of the latest developments in Asia Pacific and Latin America is provided in Table 15.

54 The upper 6 GHz band (6.425–7.125 GHz) is identified for IMT by countries in the three ITU regions through footnote No. 5.457D, 5.457E and 5.457F.
55 Telecom Review. (29 November 2024). "TDRA Announces Allocation of 600 MHz and 6 GHz bands for IMT".
56 Office of the Communications Authority (OFCA). (29 November 2024). "Conclusion of Auction in Radio Spectrum in 6/7 GHz Band". Press release.
57 Radio Spectrum Policy Group. (12 November 2025). Opinion on Long-term vision for the upper 6 GHz band.

Table 15:
Status of upper 6 GHz planning for IMT

Asia Pacific	Latin America
India — January 2025: 6425–7125 MHz is decided for IMT in National Frequency Allocation Plan (NFAP). — July 2025: India introduced the plan to join the IMT footnote on 6425-7025 MHz for Region 3 (RR No. 5.457D) in its contribution (APG27-2/INP-36) to the 2nd Meeting of the APT Conference Preparatory Group for WRC-27 (APG27-2). — September 2025: TRAI launched a public consultation on the next IMT spectrum auction, which could include the upper 6GHz. **China** — June 2023: 6425–7125 MHz is identified for IMT in the National Frequency Allocation Table. — Trial was conducted in 2025. **Australia** — ACMA provisionally decided to allocate 515 MHz for IMT (6585–7100 MHz). **Vietnam** — October 2025: 6425–7125 MHz is intended to be partially or entirely allocated for IMT in National Radio Frequency Spectrum Planning. **Japan** — September 2025: MIC (Ministry of Internal Affairs & Communications) issued a public consultation on its spectrum action plan, which included consideration of IMT use in U6 GHz. **Indonesia** — U6 GHz for IMT is included in the national spectrum roadmap. It is planned to identify IMT in 6425–7025MHz at WRC-27. **Bangladesh** — July 2025: Bangladesh introduced the plan to join the IMT footnote on 6425–7025 MHz for Region 3 (RR No. 5.457D) in its contribution (APG27-2/INP-15) to APG27-2. **Thailand** — U6 GHz is included in the spectrum roadmap for further study for IMT.	**Brazil** — The full 5925–7125 MHz was allocated to unlicensed RLAN in 2021. — Identified 6425–7125 MHz for IMT at WRC-23. — May 2024: Anatel proposed a change to its certification regulations to restrict unlicensed RLANs to 5925–6425 MHz. — February 2025: Anatel's BoD approved a proposal for release of several bands, to be submitted for public consultation. The proposal is to license U6GHz in 2026. **Chile** — October 2020: the entire 6 GHz band (5.925-7.125 GHz) was allocated for RLAN based on Resolution No. 1,807. — September 2022: the Chilean telecommunications regulator, Subtel, through Resolution No. 2,844, decided to review its previous decision and make available only the lower 6 GHz band (5.925–6.425 GHz) for unlicensed use. **Honduras** — Conatel allocated the full band to RLANs in 2021. — Conatel consulted in 2023 on a reduction of the RLAN allocation to the 5.925–6.425 GHz band. — Following the WRC-23, Conatel updated its national frequency allocation table in 2024. The update limits the WAS/RLAN allocation to 5.925–6.425 GHz (note HND40A).

There have been various IMT trials on 6 GHz since 2022. There are no technical barriers to developing and commercialising 6 GHz IMT solutions. Device and infrastructure trials have shown the capabilities of the band. With the first upper 6 GHz assignments finalised at the end of 2024, some key players in mobile device component and network infrastructure ecosystems are indicating that commercial base stations would be available around 2026. Commercial chipsets are available now – the MediaTek M90 Modem within a standard smartphone was used in a recent test conducted by Vodafone.[58] For more information on recent trials, see Appendix D.

58 Vodafone. (13 October 2025). "Vodafone's world first 6GHZ spectrum test positions Europe to lead in in advanced 5G and 6G".

4.6.1 Issues and challenges

Coexistence with FS and FSS in U6 GHz

The major service allocations in the upper 6 GHz band are FS and FSS. During the WRC-23 cycle, the coexistence issues involving IMT, FS and FSS were extensively studied.

For IMT coexistence with FSS uplink, Resolution 220 (WRC-23) defines an Expected EIRP mask to ensure protection while allowing the deployment of macro-cellular IMT base stations in the band. 3GPP specified the NR band n104 for licensed use of the upper 6 GHz band in 2022. Followed by the definition of Expected EIRP mask in Res. 220 (WRC-23), 3GPP further specified the Expected EIRP mask of NR band n104 base station and its conformance test requirement in TS 38.104[59] and TS 38.141-2.[60]

Following the guidance from Res. 220, WP5D has developed a new Report ITU-R M. [FS-IMT Coordination] "Guidance for national and bilateral coordination of stations in the fixed service with IMT stations in the frequency band 6 425-7 125 MHz on the coordination of FS stations and IMT stations", which was finalised in October 2025.[61] Recommendation ITU-R M.1036 has also been revised with the N1 definition for the frequency arrangements in 6 425–7 125 MHz.

With the well-defined technical conditions from WRC-23, the conformance specifications from 3GPP and the guidance on coordination from ITU-R, coexistence between IMT and FS/FSS can be achieved in upper 6 GHz.

Shared use of IMT and Wi-Fi is not feasible

There have been discussions on possibilities for shared use of IMT and Wi-Fi on the upper 6 GHz band. Studies conducted by CEPT have examined the sharing potential between FS and WAS/RLAN systems. However, uncertainties remain about interference from pulse or burst transmissions.

ECC Report 366, "Feasibility of a potential shared use of the 6425–7125 MHz frequency band between Mobile/Fixed Communications Networks (MFCN) and Wireless Access Systems including Radio Local Area Networks (WAS/RLAN)",[62] indicates that shared use between IMT with full power and Wi-Fi operating on the same frequency/channel is not possible, as there are negative consequences for Wi-Fi spectrum access and the user experience of both technologies.

- Where IMT signal can be detected by Wi-Fi, Wi-Fi would either cease transmission or take some other mitigating measure, such as switching to another channel.
- If IMT signal cannot be detected by Wi-Fi (due to the lower IMT signal levels), Wi-Fi would continue to transmit. This leads to interference between Wi-Fi and IMT in both directions. Wi-Fi performance would be significantly degraded and IMT performance somewhat degraded.

Due to the difficulties of shared use of the two technologies, another idea was to introduce new cross-technology signalling to improve the detection of IMT signal by Wi-Fi, compared to current energy detection thresholds (EDT). For example, Wi-Fi equipment decodes an IEEE 802.11bc signal that is broadcast by MFCN base stations (which current base stations do not do today); or Wi-Fi equipment decodes the 5G NR synchronisation signal block (SSB) signal that is broadcasted by MFCN base stations (which Wi-Fi does not do today).

However, such cross-technology signalling is not a reliable approach, as it might have a high probability of misdetection. It also requires standardisation and agreement by industries and changes to the hardware and software of both IMT and Wi-Fi, which increases costs. The complexities highlighted in the ECC report clearly show the difficulties in implementing any shared use between IMT that is designed to operate under the individual authorisation regime, and Wi-Fi that is designed to operate in licence-exempt spectrum.

The impracticality of shared use between IMT and Wi-Fi is also proven in recent trials. BT and Nokia have collaborated to conduct a proof of concept (PoC) trial of a mobile radio network operating in the upper 6 GHz spectrum band in the UK in May 2025. In addition to testing the coverage and performance of upper 6 GHz IMT, it was also observed during the trial that when operating Wi-Fi equipment using the same frequencies as mobile in the upper 6 GHz band, there was a high risk of substantial impact on performance of both mobile and Wi-Fi due to mutual interference.[63] For detailed information, see Appendix D.

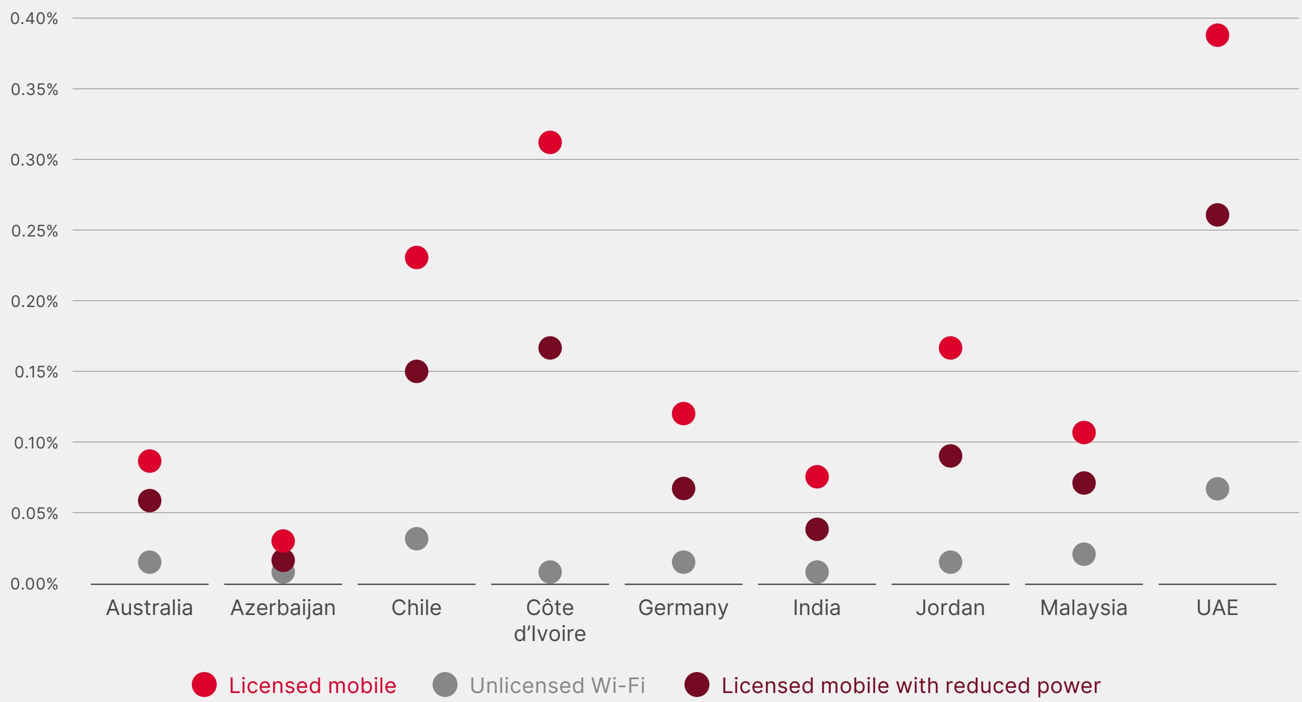
59 https://www.3gpp.org/ftp/Specs/archive/38_series/38.104/38104-j20.zip
60 https://www.3gpp.org/ftp/Specs/archive/38_series/38.141-2/38141-2-j20.zip
61 ITU. (2025). Guidance for national and bilateral coordination of stations in the fixed service with IMT stations in the frequency band 6 425–7 125 MHz.
62 CEPT. (2025). ECC Report 366.
63 BT Group. (July 2025). Use of U6 GHz band for mobile.

4.6.2 Proposed approach and actions

A GSMA study in 2024 assessed different policy options for the upper 6 GHz band (licensed mobile, unlicensed RLAN and licensed mobile with reduced power) and found the greatest economic benefit was always achieved under the first scenario, where the upper 6 GHz band is assigned to licensed macro-cell mobile use with standard power levels. This is because mobile networks are more likely than Wi-Fi to face capacity constraints through to 2035, making additional spectrum critical for enhancing network performance and broader economic value. Figure 32 summarises the results of the countries included in the study.[64]

Figure 32

Economic benefits of U6 GHz in nine countries (proportion of expected GDP in 2035)



Source: GSMA Intelligence
Note: The results represent the net present value (NPV) of economic benefits from 2023–2035, expressed as a proportion of expected GDP in 2035 for each country.

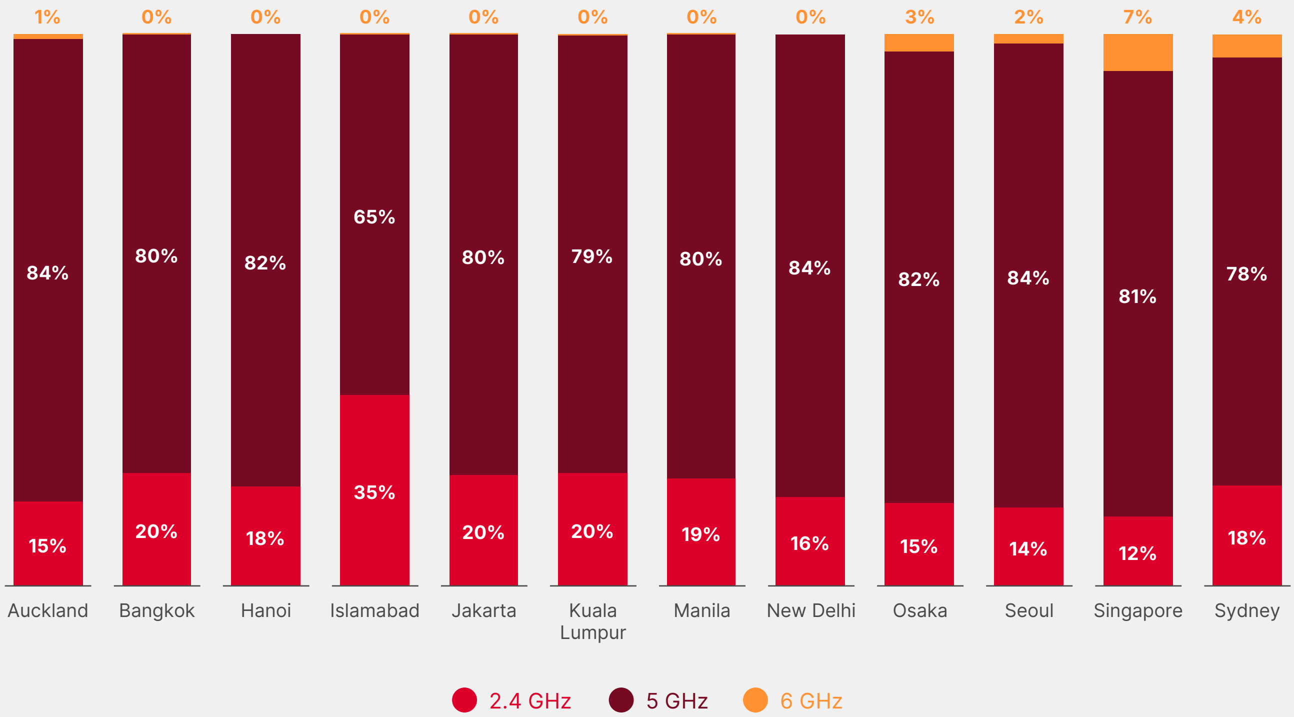
There is also significant scope to improve the efficiency of unlicensed Wi-Fi spectrum use. The type of Wi-Fi technology has a significant impact on user experience. Download speeds on Wi-Fi 6/6E are up to 15 times faster than Wi-Fi 4. However, the legacy Wi-Fi devices in wide use today are Wi-Fi 4 devices. Upgrading to the latest Wi-Fi 6 technology allows for greater efficiency, while optimising indoor deployments (for example, with additional access points, mesh network solutions and using Wi-Fi boosters) can also improve Wi-Fi quality.

Data gathered by Ookla across APAC during Q2 2025 in 12 cities shows that some countries had very limited scans using Wi-Fi 6E across the 6 GHz band.[65] Others have only single-digit percentages of total Wi-Fi scans in the 6 GHz band. Even in South Korea, the only APAC country to have opened the entire 6 GHz band (5.925–7.125 GHz) for Wi-Fi, just 2% of Wi-Fi 6/6E scans in Seoul were using this band. Spectrum in the 2.4 GHz and 5 GHz Wi-Fi ranges is carrying the majority of today's APAC Wi-Fi traffic, leaving the 5.925–6.425 GHz band open to the future evolution of Wi-Fi technology.

64 GSMA. (September 2024). Mobile Evolution in 6 GHz.
65 Across the 12 markets, the majority (except India) have made the lower 6 GHz (5.925–6.425 GHz) band available for unlicensed use, including Wi-Fi, as of Q2 2025. In South Korea, the entire 6 GHz (5.925–7.125 GHz) band was made available for Wi-Fi in 2020.

Figure 33

Distribution of Wi-Fi 6/6E scans by band



Source: GSMA Intelligence analysis based on Speedtest intelligence data provided by Ookla

Licensed spectrum in the full upper 6 GHz band can ensure that mobile connectivity will support ASEAN's digital ambitions into the 2030s. The spectrum capacity in the lower 6 GHz band is more than adequate for Wi-Fi evolution in APAC.

For ASEAN countries, the upper 6 GHz band is a critical opportunity to support growing demand for data driven by 5G adoption and provide a pathway to 6G. Therefore, the following actions are proposed for AMS:

- Identify the entire upper 6 GHz range for long-term planning for 6G in the national spectrum roadmap and update the national frequency table.
- Plan for 200–400 MHz channels and full-power macro-cell IMT, without additional power restrictions or sharing mechanisms.
- Put a moratorium on FS licences in the upper 6 GHz band and develop a clearance plan for fixed links.
- Join the Region 3 footnote in 6425–7025 MHz (No. 5.457D) at WRC-27.

4.7 4.8 GHz band

The 4.8 GHz (4.8–4.99 GHz) has been identified for IMT through Radio Regulations Nos. 5.441B since WRC-15. About 50 countries are included in this footnote, which provides a good foundation for potential harmonisation of the band. The 4.8 GHz band has been assigned and used for public mobile networks in China and Japan. Among AMS, Cambodia, Lao PDR and Vietnam are within this footnote while Thailand is also considering options for IMT in this band.

The frequency range 4400–5000 MHz is defined as 3GPP band n79 under TDD mode. The n79 ecosystem is mature. According to GSA data (May 2025), more than 1,000 devices are available for band n79.

4.7.1 Issues and challenges

The RR Nos. 5.441B specifies a stringent power flux density (PFD) criterion for IMT of -155 dB(W/(m2·1MHz)) up to 19 km above sea level at 20 km from the coast since WRC-15. A few countries, including Cambodia, Lao PDR and Vietnam, are exempted from this PFD criterion, see resolve 5 of Resolution 223 (Rev.WRC-23).

The PFD criterion was discussed at WRC-15, WRC-19 and WRC-23. The three WRCs could not reach agreement on the need for protection and associated conditions of aeronautical and maritime mobile services (AMS/MMS) station operation in international airspace and waters in the 4 800–4 990 MHz band from IMT stations operating on national territories. Due to diverging views on the relevance of a PFD criterion to protect AMS/MMS, its value, conditions and the frequency band for its application, no solution could be reached to resolve this issue. Therefore, WRC-23 decided to keep the regulatory and technical conditions in No. 5.441B unchanged. The WRC-23 also decided not to continue further studies.

4.7.2 Proposed approach and actions

WRC-27 AI 1.7 will study several bands for IMT identification, including 4.4–4.8 GHz. If 4.4–4.8 GHz can be identified for IMT, there is potential for the 4.5 GHz range to provide a large continuous bandwidth up to nearly 600 MHz from 4.4–4.99GHz.

Therefore, it is suggested that AMS:

- Plan 4.8–4.99 GHz for IMT when there is demand from the market.
- Follow ongoing studies at ITU-R relating to WRC-27 Agenda Item 1.7 and consider the possibility to identify 4.4–4.8 GHz for IMT.

05.
Spectrum management and licensing best practices

Following the identification of spectrum, definition of technical conditions and spectrum clearance, the process of making spectrum available will involve decisions around spectrum pricing, licensing and assignment approaches. This section discusses several key policy aspects of spectrum management and licensing of mobile spectrum.

5.1 Spectrum valuation and pricing

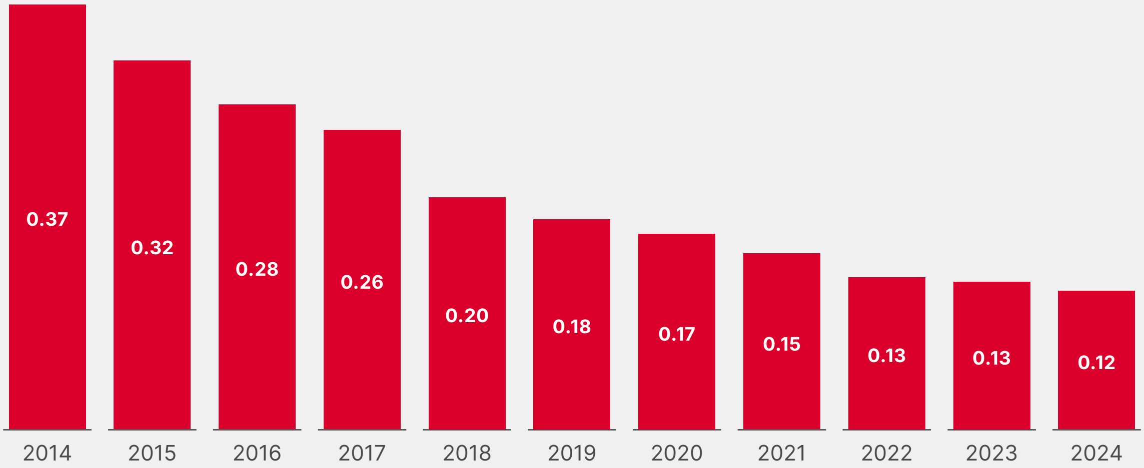
The primary goal of charging a fee for spectrum is to award it to those who will use it most efficiently to deliver maximum benefits for society. A well-designed auction will assign spectrum to those who value it most, providing an incentive for them to use it efficiently through investment in widespread, high-quality mobile networks. However, there is sometimes the tendency for governments to seek to maximise income from spectrum awards, which can come at the expense of efficient spectrum use and the wider economy.

In the past decade, there has been a significant increase in demand for mobile data to support activities such as streaming, social media and video calls. To ensure that mobile networks can keep up, MNOs have invested in 4G and 5G infrastructure and acquired the rights to use additional radio frequencies. With more radio spectrum, users experience better network quality and speeds, and this in turn has powered the growth of the digital economy.

However, market conditions have also changed during this period. MNOs offer higher value services while prices for consumers have fallen. Globally, the average consumer now pays less for mobile connectivity services than a decade ago. Average revenue per GB of data also declined by 96% between 2016 and 2024. The average revenue that MNOs generate per MHz of spectrum declined by 67% between 2014 and 2024, as illustrated in Figure 34. This reduction highlights the need to assess how spectrum prices have responded to changing market conditions.

Figure 34

Average monthly recurring revenue per MHz per connection ($, inflation adjusted)

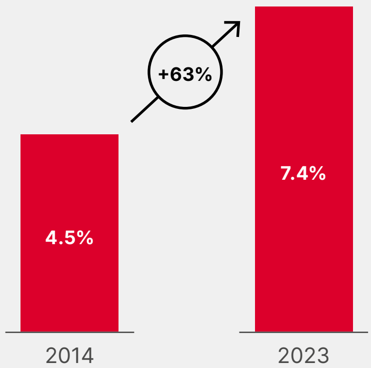


Source: GSMA Intelligence

On the other hand, the total costs paid by MNOs over the past decade have been growing, as shown in Figure 35. GSMA analysis shows that aggregate spectrum cost has increased by 63% annually, reaching more than 7% of MNOs' recurring revenues in 2023 (Figure 35). The increases in accumulated spectrum cost globally have varied. In some countries, such as Canada and Thailand, the ongoing cost of spectrum increased by a factor of three or more, predominantly driven by additions of new spectrum. In other countries, such as Italy and Spain, growth was somewhat moderated, as some of the expensive licences acquired in the early 2000s have expired and renewed at lower or no further cost.

Figure 35

Global spectrum cost to recurring revenue ratio (%)



Source: GSMA Intelligence

5.1.1 Impact of high spectrum costs

High spectrum cost affects the viability of investments and consequently generates a negative impact on consumers, limiting affordability and slowing adoption. GSMA research on global spectrum pricing trends has found that a 10 percentage point (pp) higher spectrum cost to revenue ratio leads to network coverage that is up to 6 pp lower.[66] There is a similar negative effect on network speeds. A 10 pp higher spectrum cost leads to a reduction in download speeds of 8% and a reduction in upload speeds of 6% (Figure 36).

Figure 36

Impact of spectrum costs on market outcomes

The impact of a 10-percentage point spectrum price increase compared to revenue

↓ 6-percentage point **Lower coverage**

↓ 8% **Lower speeds**

Source: GSMA

Making more spectrum available also has positive impacts. 10% more spectrum results in coverage that is greater by up to 1.5 pp. The additional capacity provided by spectrum also leads to higher network speeds. 10% more spectrum leads to 4% faster network download speeds and 2% faster upload speeds. Latencies fall by 1% for every 10% increase in available spectrum.

These results highlight the effects of spectrum prices and availability that should be considered by spectrum managers seeking to maximise its social value. Assigning more spectrum at affordable prices increases the availability and quality of mobile services offered to consumers, which is key to closing the remaining coverage gap and reducing the technology divide between and within countries.

5.1.2 Pricing best practices

Extremely high-priced auctions are typically the result of national policy decisions, such as setting excessive reserve prices, making an insufficient amount of spectrum available for auction, a lack of clarity on future releases or unknown renewal processes for expiring licences. Such factors can create uncertainty or artificial scarcity, resulting in MNOs bidding above their true valuation of the spectrum licences on offer.

Adopting the right spectrum pricing policy can help relieve the spectrum cost burden on MNOs and support sustainable investment, which contribute to better networks and consumer outcomes. Regulators can play a role in the rationalisation of spectrum cost for new spectrum awards and licence renewals, as shown in Table 16.

66 GSMA. (May 2025). Global Spectrum Pricing.

Table 16:

Spectrum pricing recommendations

New spectrum	Licence renewal
1. Regulators should not anchor administratively set prices to historical prices and outdated benchmarks. 2. Setting reserve prices at a low level allows room for price discovery and minimises the risk of unsold spectrum. 3. Making all spectrum allocated to mobile services available to operators ensures there is no artificial scarcity and supports better outcomes for consumers. 4. The cost of meeting obligations or investment commitments attached to spectrum licences should be reflected in their price.	1. Fees should not be linked to historical spectrum prices, given the decrease in underlying value. 2. Renewal fees contribute to the build up of spectrum cost and can have negative impacts on consumers. A spectrum trading framework can provide the same incentives without imposing additional costs. 3. Regulators can consider renewals in exchange for investment commitments for coverage or quality of service. 4. Alternatively, administrative review can be the most cost-effective way of ensuring that spectrum remains in efficient use.

Source: GSMA

5.1.3 International examples

Around the world, many regulators have already identified the need for innovative approaches to deliver necessary cost reductions. Over the past years, licensing processes using a combination of obligations and lower spectrum costs have been used by governments as a mechanism to help improve network quality, especially in rural areas. Recent multiband auctions using longer licence terms and a flexible approach to obligations serve as examples of a robust approach to maximising spectrum value. Cost-free renewals and renewals in exchange for investment commitments also serve as examples of alternative approaches that seek to ensure efficient spectrum use and maximise the benefits of connectivity.

Some examples of such approaches are:

— Austrian regulator RTR used bidding related to coverage commitments for its 700 MHz auction. In the first stage, winning bidders for each 700 MHz lot had to commit to providing coverage to 150 underserved communities. In the second stage, bidders could voluntarily commit to cover additional communities in exchange for a bid discount.

— The Ministry of ICT (MinTIC) in Colombia chose an auction format in which the total bid for the 700 MHz band was a combination of cash and coverage commitments. In the second part of the auction, the number of underserved areas the MNOs were willing to cover was turned into a cash-equivalent value.

— In New Zealand, the Ministry of Business, Innovation & Employment (MBIE) used an administrative award for 3.5 GHz, offering 80 MHz to each MNO for NZD 24 million in financial contributions towards improving rural connectivity and commitments to speed up 5G deployment to specific towns in rural areas across the country.

— In Vietnam, the 2.6 GHz and 3.7 GHz spectrum was auctioned in 2024 after the Authority of Radio Frequency Management (ARFM) reduced reserve prices significantly following the unsuccessful auction for 2.3 GHz. To provide incentives to speed up 5G deployment, a subsidy scheme was introduced that allowed MNOs to claim back up to 15% of network expenditure if they met a target of 20,000 5G base stations by the end of 2025. Furthermore, in a recent presentation to the ASEAN 5G Conference, ARFM stated that one of the key lessons learned on 5G deployment was the need for affordable spectrum costs. It considers that spectrum costs exceeding 10% of revenues results in reduced network investment and degraded service quality. In contrast, if spectrum costs less than 5% of revenues, there is continued strong investment and improved service quality. The ARFM considers that the best-quality mobile networks are in countries with spectrum costs below 5% of revenue. Due to these factors, Vietnam adjusted its starting price policy, significantly reducing it to ensure moderate spectrum costs. After the recent auctions, it is calculated that the spectrum costs for Vietnamese MNOs are approximately 6% of annual revenue or lower.[67]

Additional examples are available on the GSMA's resource page on spectrum licensing.[68]

67 ARFM. (2025). "5G Deployment in Vietnam and Lessons Learned", ASEAN 5G Conference, Ninh Binh, Vietnam, 27 October 2025, p. 4.
68 GSMA. (27 February 2023). "Spectrum Licensing – Best Practice for Mobile Networks".

5.2 Spectrum renewals

The mobile industry differs from most other industries in that the ongoing right to a critical resource is often not guaranteed and subject to periodic reviews by authorities. Many countries continue to license the use of spectrum for finite and/or short periods. Depending on the approach to licence renewals, this may lead to uncertainty for MNOs and customers, harming investment, innovation, competition and efficiency.

Various renewal approaches are available to regulators when spectrum is already licensed to an MNO. MNOs may not invest in their networks or compete as much for customers if there is uncertainty over future spectrum rights. Regulators therefore serve consumers best by creating certainty and ensuring licence renewal decisions are made five years ahead of the renewal date.

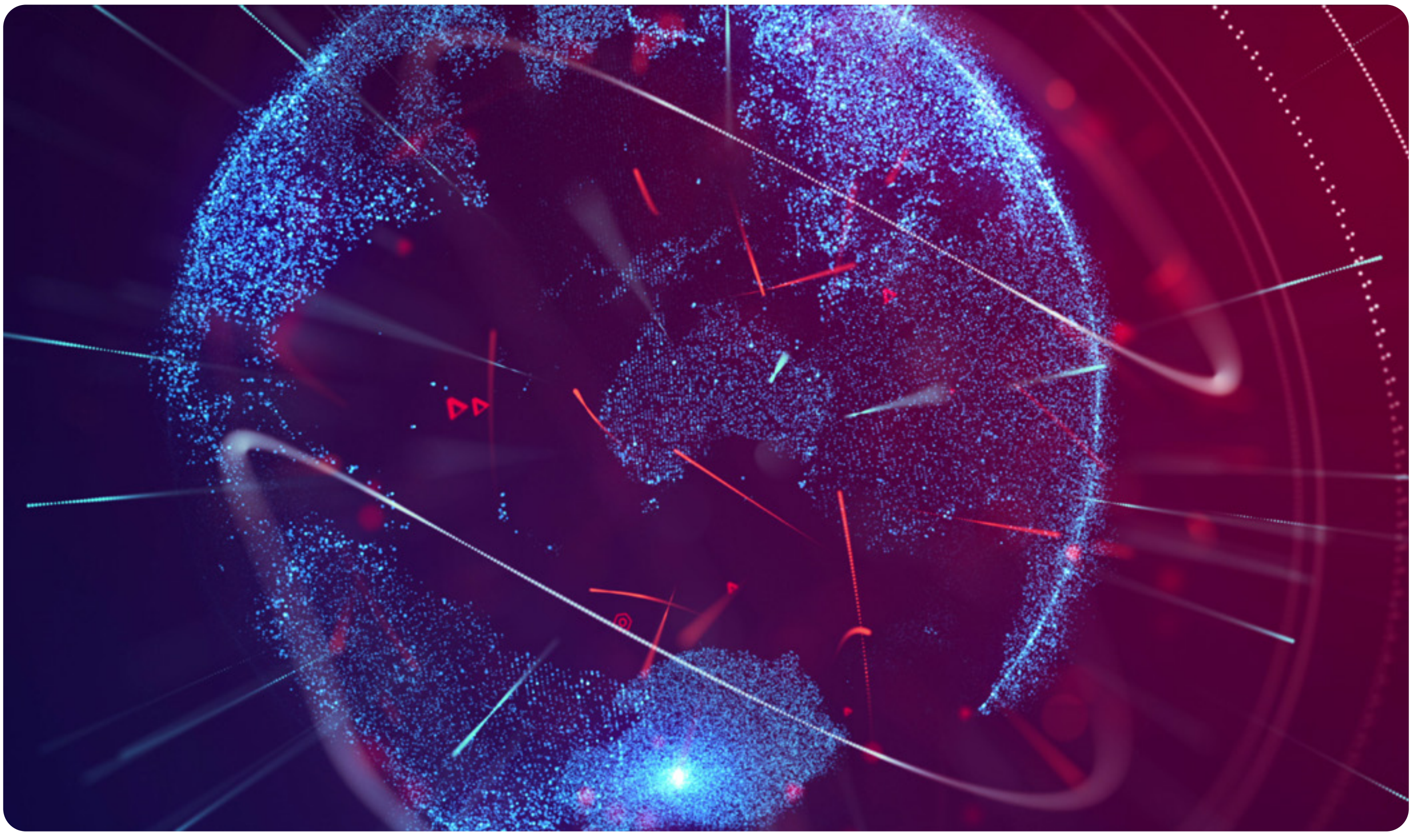
Uncertainty can be further minimised by creating a presumption of renewal unless a breach of licence condition has occurred, a fundamental reallocation of spectrum to a new service is required or an overriding policy need arises.

Table 17:

Comparison of spectrum renewal approaches

Renewal tools	Advantages	Disadvantages	Recommendations
Presumption of renewal	— Offers certainty for future investment in the sector — Minimises customer service disruption from operators losing spectrum and needing to reconfigure networks or exit the market — In conjunction with trading, supports efficient spectrum use over time	— In extreme circumstances, spectrum may be better re-assigned (for spectrum replanning, a serious breach of conditions, or if spectrum is left idle)	Minimise uncertainty by creating a presumption of renewal unless there is a serious breach of conditions or if the spectrum is left idle.
Re-auctioning	— Promotes efficient outcomes / efficient use of spectrum (i.e., those that value it most are assigned spectrum)	— Discourages long-term network investment — May be disruptive to users and existing businesses as current operators risk losing critical spectrum — May be subject to 'gaming'; therefore, auction design is critical — Auction prices carry a greater risk of the licence cost undermining operators' investment capabilities	The details of the implementation should be transparent and focused on future certainty.
Hybrid solution	— Attempts to balance achieving some predictability and some flexibility	— May discourage long-term network investment — Risk of customer service disruptions and QoS challenges — Potential costs associated with reconfiguring networks can hinder benefits — Trading off predictability for flexibility would only be beneficial in some circumstances	Prioritise the objectives of promoting efficient use of spectrum and network investment while also ensuring effective competition.

Source: GSMA



5.2.1 International examples

In 2018, the French regulator Arcep renewed licences for 900, 1800 and 2100 MHz, due to expire between 2021 and 2024. Given some concerns over low availability of 4G in rural areas, Arcep agreed with MNOs to trade the licence renewal fee for the acceleration of 4G roll-out and provide "nationwide, high-quality mobile coverage for everyone in France". Government and local authorities identified areas that need to bolster regional development through improved coverage, and progress by MNOs on the "New Deal" targets were monitored closely by Arcep.[69] To date, a number of achievements have been made.

In another example, the Canadian regulator ISED chose to renew licences in the 2.5 GHz band with no upfront fee if licence holders could demonstrate they were offering a minimum level of population coverage, ranging from 15% to 50% in different regions of Canada.[70]

Some countries have gone further, requiring no obligations when renewing spectrum. Spain's Ministry of Economic Affairs and Digital Transformation enabled a one-time extension to existing spectrum licences, at no upfront cost or related obligations, for a period of up to 10 years and with a maximum licence term of 40 years. The ministry's objective was to enable MNOs to "amortise [a] period of investments demanded by the telecommunications sector for a longer time".[71] In Brazil, one of the key aspects of the 2021 multiband auction of 700 MHz, 2.3 GHz, 3.5 GHz and 26 GHz was the inclusion of automatic renewal clauses in the licences, subject to the MNOs fulfilling coverage and service obligations.[72]

69 Arcep. (11 December 2025). Suivi du New Deal Mobile.
70 GSMA. (2025). Spectrum Licensing Best Practice – Canada.
71 GSMA. (2025). Spectrum Licensing Best Practice – Spain.
72 GSMA. (2023). Spectrum Licensing Best Practice – Brazil.

5.3 Network sunsets

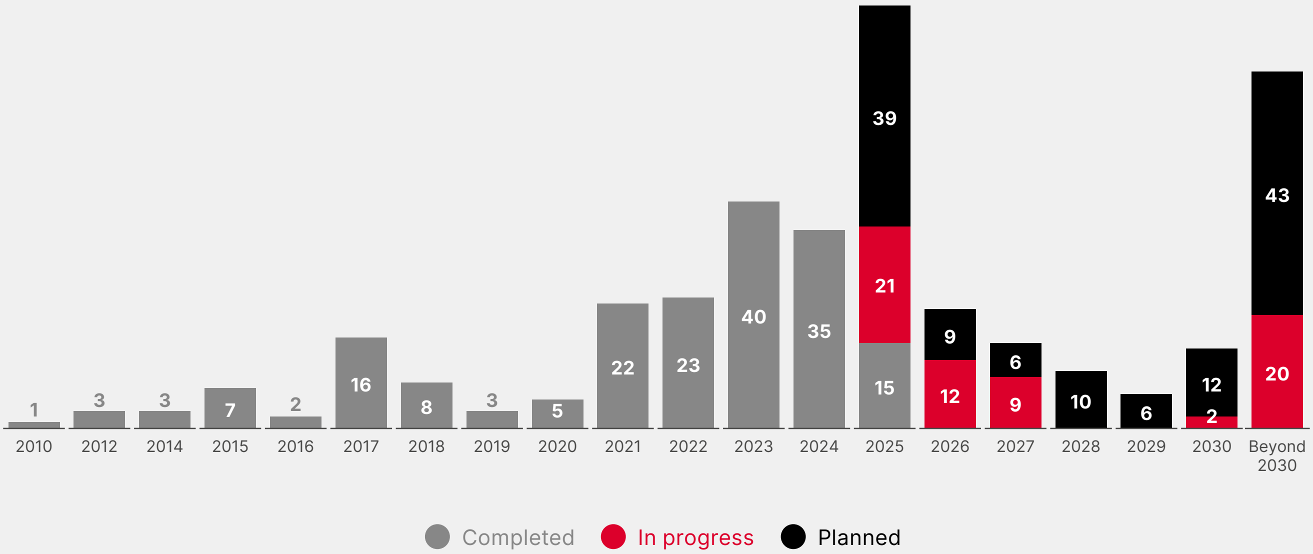
Sunsetting legacy 2G and 3G are integral to network transformation strategies. The adoption of 5G has spurred momentum behind network sunsets. Network sunsets are being driven by declining traffic on legacy network generations, the financial burden of maintaining legacy infrastructure, the ongoing shift to open, cloud-native, AI-native networks and the necessity to use spectrum resources efficiently by migrating to newer technologies.

According to GSMA Intelligence, between 2010 and Q2 2025, there were 183 network sunsets in 81 countries, more than three-quarters of which have been shut down since the introduction of 5G in 2020. Another 126 networks are planned to be shut down by 2030, with 75 expected in 2025, as shown in Figure 37.[73]

The continuous evolution of technology increases the demand for additional spectrum resources by different communications service providers. This makes it critical for MNOs to optimise and efficiently use their existing spectrum assets. The need for additional spectrum to serve 4G and 5G capacity, alongside declining traffic on legacy networks and higher maintenance costs, make network sunsets an attractive decision for MNOs.

Figure 37

Network sunsets by completion year



Source: GSMA Intelligence, August 2025

3G sunsets outpace 2G sunsets. Asia Pacific led the way in network sunsets early on, shutting down 31 networks by 2020, mostly 2G. This was driven by strong 4G adoption, causing the decline in 2G connections from 80% of total connections in 2012 to 40% by 2017, leading MNOs to sunset 2G networks and migrate spectrum resources to 4G networks. The arrival of 5G in 2020 necessitated efficient spectrum use, prompting other regions to begin network shutdowns. In some regions, such as Europe, 2G has remained essential for emergency services and 3G shutdowns have taken precedence; as a result, 3G sunsets outpaced 2G sunsets by 2023.

The most migrated frequencies as part of network sunsets are 900 and 2100 MHz, with 1800 MHz close behind. These bands are globally harmonised for 2G and 3G with an established ecosystem. Migration of these frequencies to newer technology generations is therefore relatively simple. Moreover, these bands offer a favourable blend of coverage and capacity, making them particularly suitable for migration.

In the ASEAN region, 2G has been switched off in Brunei and Singapore while 3G has been switched off in Indonesia, Malaysia and Singapore. There are ongoing plans for either 2G or 3G sunsets across most other ASEAN countries. See Appendix G for more details.

73 GSMA Intelligence. (August 2025). Network Sunsets, Q2 2025.

5.3.1 Challenges for MNOs

There are clear benefits for MNOs to plan on decommissioning 2G and 3G networks. However, MNOs in many countries face significant roadblocks in their network sunset journeys. Common challenges include the lack of technology-neutral policies, reliance on legacy 2G/3G networks for critical services (such as e-call or SOS), public utilities (such as meters and elevators) still being configured to these networks and the affordability of 4G/5G devices.

For MNOs, some of the common issues that need to be addressed are:

- **Minimising coverage impact** – ensuring nationwide 4G and VoLTE coverage, including remote and black spot areas, before switching off 2G/3G networks.
- **Communication and support to customers** – developing communication campaigns with advance notice and handset replacement schemes to support customer transitions; provide extended notice and collaboration for critical IoT and public service users.
- **IoT devices with roaming SIMs** – ensuring upgrades for IoT devices with roaming SIMs, which can be complex and time consuming due to indirect MNO relationships and supply chain challenges.
- **Shared roadmap with mobile virtual network operators (MVNOs)** – working with MVNOs to coordinate transition plans and customer communications.
- **Nationwide VoLTE coverage** – ensuring nationwide VoLTE coverage as 2G/3G networks are switched off. For emergency services transitioning to 4G networks, it is crucial that e-call services function effectively on VoLTE networks.
- **Minimising impact to roaming customers** – securing global VoLTE roaming agreements to minimise disruption for roaming customers during network sunsets.

5.3.2 Best practices for network sunsets

On average, it takes 2–4 years between sunset announcement and actual network switch-off. Typically, MNOs implement a phased or staggered schedule for network sunset, where each phase involves shutting down networks in specific areas or cities. This approach allows MNOs to focus on transitioning one set of customers at a time.

For MNOs, it is important to develop a roadmap for essential network preparation requirements, including 4G coverage expansion, VoLTE deployment and roaming agreements. This should align with local market realities and serve as a guide for the time frame of the legacy network sunsets.

As there are strong incentives for the industry to work towards switching off legacy networks, governments and regulators should avoid mandating specific sunset timelines. Instead, the process should be dictated by market conditions. However, regulators can provide a guiding framework and implement policy measures to assist MNOs in the network sunset process, including:

- Eliminating taxes on 4G and VoLTE-enabled devices to drive uptake among consumers, especially for low-income segments of the population.
- Engaging with MNOs with a view to providing the necessary regulatory support, and addressing any transitional issues that may arise with legacy network sunsets when the process eventually begins in their market.
- Supporting efforts to raise awareness among consumers and businesses around the opportunity to upgrade to newer technologies and accelerate the migration from legacy networks.
- Creating a conducive environment to support investment in 4G and 5G networks to enable the transition. Examples include implementing full technology neutrality where it does not yet exist and using fiscal incentives to stimulate spectrum refarming for 4G and 5G services.

5.4 Spectrum for enterprises

The digitalisation of industry is a priority for every country as governments seek to deliver economic growth, and enterprises seek to enhance productivity and streamline their businesses through effective access to connectivity. While private mobile networks do not necessarily require 5G NR technologies, as many rely on LTE, the 5G era has provided a new wave of digital transformation and a fresh business opportunity for the mobile ecosystem. Private mobile networks and massive IoT can play a role in delivering productivity growth while offering one of the core business opportunities of the 5G era. However, nearly six years after the first 5G launches, private networks still represent new ground in terms of regulatory best practice.

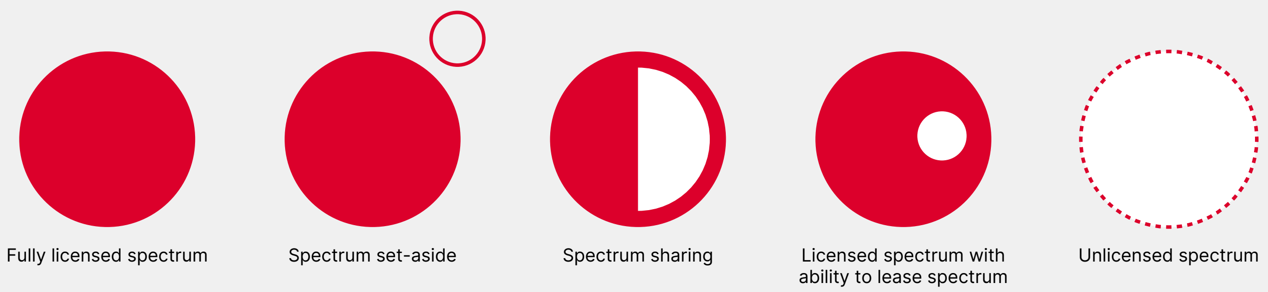
Approaches to providing connectivity for enterprise and local networks have varied, and the use of public spectrum resources must benefit businesses and consumers simultaneously. Interventionist approaches such as spectrum set-asides, particularly in core bands for public mobile, should be avoided in favour of licensing mechanisms that ensure all needs – public mobile or enterprise users – are met equally.

5.4.1 Approaches to enterprise spectrum

Generally, regulators have taken different approaches to meet the interest in private mobile networks, which typically fall into one of the categories outlined in Figure 38. For most enterprises, the default option for 5G solutions is public MNOs and their end-to-end solutions, including access to shared public infrastructure and managed spectrum. Conversely, unlicensed spectrum might be an option but susceptibility to congestion and interference means such solutions are not suitable for mission-critical applications that require guaranteed quality of service.

Figure 38

Approaches to providing spectrum for private networks for industry users



Source: GSMA

Depending on the local availability of mobile services and particular conditions, such as industrial locations, some enterprises have connectivity needs that may not be universally served by public mobile networks. This can spur interest in custom, private mobile networks. Such private 5G-based connectivity generates additional demand for radio spectrum. Policymakers therefore need to consider these needs and options for enabling access to spectrum for enterprises. The typical spectrum access options for private enterprise networks are:

- **Set-asides:** Setting spectrum aside for industrial use, permitting its local use on the basis of applications from enterprises.
- **Spectrum sharing:** Creating shared spectrum bands, enabling several users to access spectrum simultaneously under a set of priority-of-access rules, including support for private mobile networks.
- **Licence obligations:** Stipulating licence conditions for public MNOs, requiring them to deploy private networks or lease spectrum to enterprises.

A GSMA study found that each option offers certain advantages and disadvantages.[74] First, set-asides carry significant risks to the economy. Industry users will require spectrum to be made available within the relevant geographical area, with certainty of access and tenure and free from interference. Set-asides do not outperform alternative approaches, such as appropriately designed licence conditions. However, the economic cost for MNOs created by set-asides can be enormous. Set-asides also prevent MNOs from accessing potentially valuable spectrum assets, leading to poorer mobile network speeds and capacity. They can also create spectrum scarcity, which can raise prices in auctions, as observed in the German 3.5 GHz auction.[75]

Second, spectrum-sharing frameworks are complex and carry some risks and drawbacks. Concerns around certainty of access and tenure, as well as potential interference issues with other users, limit the potential benefits of sharing for industry users.

Sharing frameworks can have a significant negative impact on MNOs. In the United States, it is estimated that restrictions based on the three-tier priority sharing framework, as known as Citizen Broadband Radio Services (CBRS), created an economic cost in excess of $20 billion.[76]

Third, well-designed licence conditions for mobile are least intrusive and stimulate cooperation. Catering for private networks through licence conditions reflects the general trend that most networks are created in cooperation between MNOs and industry users. This approach draws on the knowledge and experience of MNOs in deploying wireless networks. Finland is one such example where MNOs with 3.5 GHz spectrum are required to provide private network services on request or to sub-licence their spectrum to other entities.[77] When such frameworks are designed well, MNOs gain access to valuable spectrum assets while providing market-driven incentives for cooperation that are in the interest of all market players.

5.4.2 Evidence and lessons from international examples

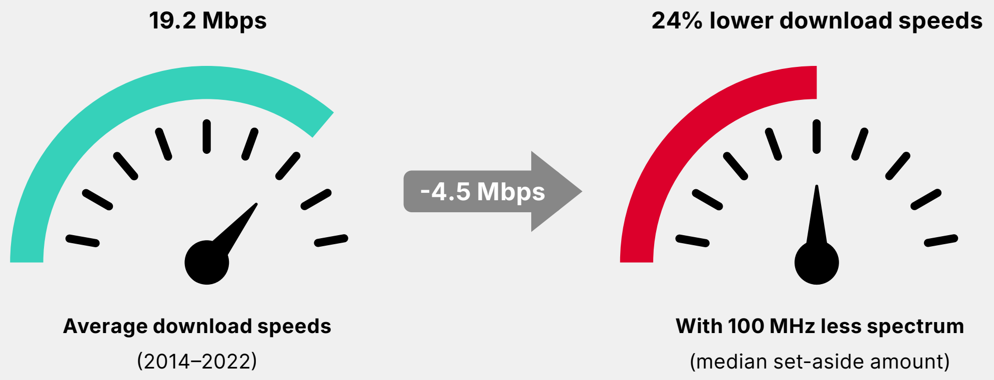
Private networks have been growing equally in countries without set-asides, where more spectrum can be used for consumer or other connectivity requirements, as they are in countries that have limited spectrum through a set-aside or sharing regime. Evidence from a sample of more than 50 countries from 2018 to 2022 shows no statistically significant impact of spectrum set-asides on the number of private network customer launches.[78]

Instead, limiting spectrum supply to public mobile lowers quality of service and raises network costs. A typical set-aside amount (100 MHz) could negatively impact download speeds for public networks, as shown in Figure 39. The opportunity cost is an undesirable consequence of set-asides and should not be overlooked, given the common objectives of regulators and policymakers to maximise the economic value of spectrum as a public resource. This is especially relevant in the ASEAN context where mid-band spectrum supply for 5G remains relatively low compared to leading markets in APAC and elsewhere.

74 GSMA. (June 2023). The Impact of Spectrum Set-Asides on 5G.
75 GSMA. (July 2025). The Impact of Spectrum Set-Asides on 5G – Germany.
76 GSMA. (July 2025). The Impact of Spectrum Set-Asides on 5G – United States of America.
77 GSMA. (July 2025). The Impact of Spectrum Set-Asides on 5G – Finland.
78 GSMA. (May 2024). The Impact of Spectrum Set-Asides on Private and Public Mobile Networks.

Figure 39

Impact of a 100 MHz difference in IMT spectrum on public network speeds



Source: GSMA

Given the uncertain benefits but clear cost of set-asides, policymakers should carefully consider all the alternative options for making spectrum available to enterprises. This also generally applies to other industry verticals that may seek access to IMT spectrum, for example, public safety and emergency services and railways (see Appendices E and F for a separate discussion on these topics).

Unlike auction-based assignments for public networks, set-asides are not subject to a test of the economic efficiency of spectrum. The spectrum in set-aside bands is frequently assigned on a non-competitive basis to select entities, often excluding public MNOs.

Offering set-aside spectrum at reduced or no cost leads to distorted incentives in the market for digital solutions and infrastructure. Pricing spectrum differently based on whether it is used by public or private networks can impact the relative cost of each solution type. As the cost saving is passed on to prospective users, the use of private networks is effectively subsidised. This can put public mobile network-based solutions at a disadvantage where they otherwise would have been the optimal choice.

Alternative frameworks, such as licence requirements to offer private networks, preserve market incentives. Network operators that compete for access to spectrum on an equal footing have an incentive to put it to the use that generates the most economic value, whether this means leasing spectrum to enterprises, offering private network services or using spectrum to enhance public network services and features (network slicing).

Well-designed licence conditions for MNOs are therefore the least intrusive mechanism for delivering private mobile networks and supporting the digitalisation of industry.

GSMA Head Office
One Angel Lane
London, U.K.
EC4R 3AB
United Kingdom