Advancing ASEAN Connectivity: Harnessing Satellite Technology and Innovative Regulations to Bridge the Digital Divide

one vision
one identity
one community

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The Association of Southeast Asian Nations (ASEAN) was established on 8 August 1967. The Member States of the Association are Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste and Viet Nam.

The ASEAN Secretariat is based in Jakarta, Indonesia.

Author:
Scott Minehane and Simon Molloy, Windsor Place Consulting

For inquiries, contact:

The ASEAN Secretariat
Community Relations Division (CRD)
70A Jalan Sisingamangaraja
Jakarta 12110
Indonesia
Phone: (+62 21) 724-3372, 726-2991
Fax: (+62 21) 739-8234, 724-3504
E-mail: public@asean.org

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ASEAN: A Community of Opportunities for All

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The illustration captures the essence of unity, innovation, and economic progression among the ASEAN countries, symbolizing their collaborative spirit and commitment to digital economy development.
The use of the map in this publication is for illustrative purposes only.

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The ASEAN Secretariat

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Lao PDR

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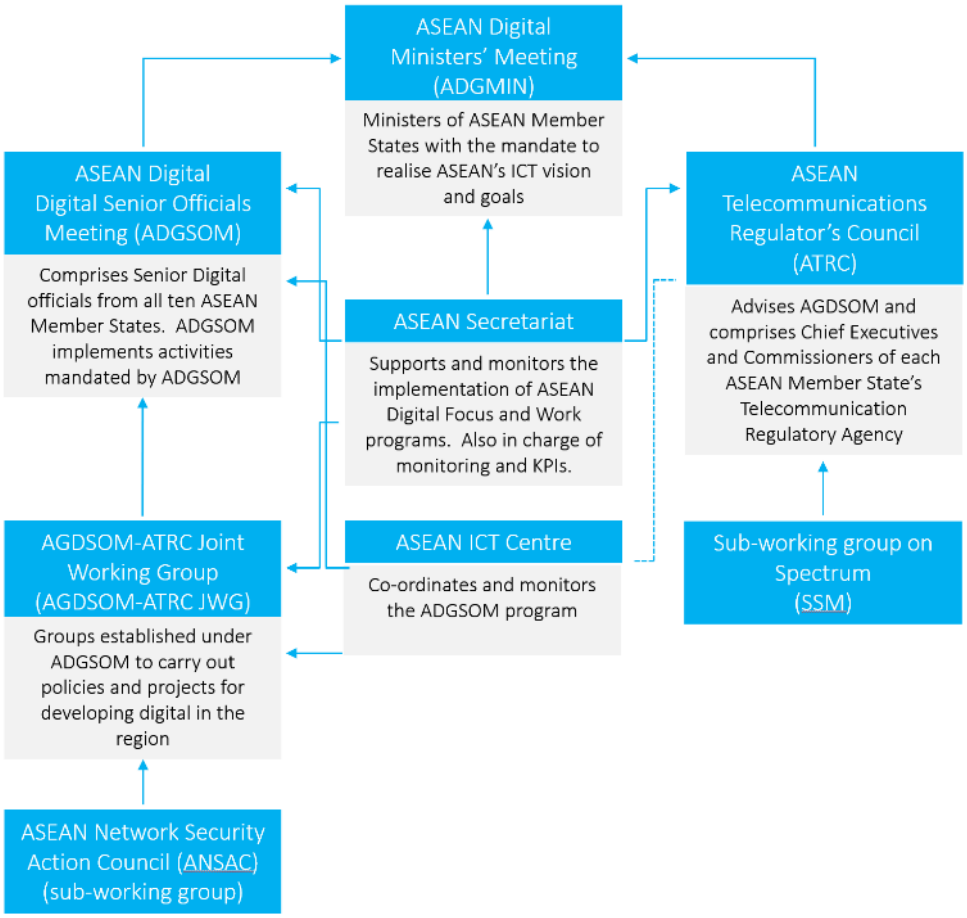
Exhibit 1: ASEAN Member States Map



1 EXECUTIVE SUMMARY

Satellite connectivity is transformative especially for ASEAN

Satellite connectivity represents a transformative opportunity for ASEAN's digital future, offering unprecedented potential to bridge the region's persistent connectivity gaps. This report examines how Low Earth Orbit (LEO) satellite technologies can benefit ASEAN connectivity while addressing the technical, economic, and regulatory challenges that must be managed to realise these benefits.

The positive impact on economic development and growth of improving connectivity are well understood and have only become more compelling as ASEAN economies mature and digital technologies become increasingly central to economic activity.

Importantly, satellite connectivity is uniquely capable of bridging the digital and connectivity divides imposed by isolation, low population densities and problematic geographies. Many ASEAN countries have significant rural populations and Indonesia and Philippines in particular have challenging archipelagic geographies.

This means that ASEAN has much to gain from moving to the forefront of satellite connectivity policy-planning in the region and in fact, the globe.

The focus of this report is on how new LEO satellite technologies can benefit ASEAN connectivity, noting that such benefits are only possible if undesirable structural effects and negative externalities (like harmful interference) are appropriately mitigated.

A new and rapidly evolving industry and business models

The advent of new satellite communications represents a fundamental shift in telecommunications economics which challenges the traditional terrestrial infrastructure paradigm. The industry is still relatively new and therefore new business models are emerging based on the synergies and complementarities between terrestrial operators, and LEO, Medium Earth Orbit (MEO) and Geostationary Equatorial Orbit (GEO) operators. The key business and partnership models identified in this report are:

- The infrastructure provider model;
- Mobile network operator partnership model;
- Integrated platform model;
- Premium consumer integration model; and
- Distributed partnership model.

Moreover, the competitive trends and strategies prevalent among satellite companies and mobile network operators (MNOs) are that, generally speaking, satellite communication services provide a ‘competitive floor’ that introduces competition for local telecommunication markets. There is also a first mover advantage at play which has seen market leaders like Starlink continue to consolidate market dominance at the expense of smaller actors and newcomers.

Breaking barriers to universal connectivity

ASEAN contains many communities located in remote areas. The costs of bringing connectivity to these communities using traditional technologies and many remain underserviced or not serviced at all.

Geography, market economics, energy supply and backhaul constraints, device affordability, and policy and spectrum bottlenecks all interact to keep high-quality telecoms and broadband out of reach for millions. Indonesia and Philippines have challenging archipelagic terrains and Lao PDR and Myanmar are mountainous, while Thailand is threaded by waterways. The cost of providing backhaul services for these communities remains an often insurmountable barrier to providing them with connectivity.

The task of assessing the current state of connectivity in remote ASEAN communities is made more challenging for two main reasons. First, there is no universal agreement about what constitutes an adequate level of connectivity and second, accurate data sets are difficult to obtain and maintain. Some tools and databases constructed by the International Telecommunication Union (ITU) nevertheless serve as useful means to at least attempt to undertake such assessments (e.g. the ICT Development Index).

Some important findings to flow from the research are that:

- there is low fixed broadband penetration in Cambodia, Indonesia, Viet Nam and Philippines and relatively low mobile subscription in Philippines;
- In Indonesia, areas of high population density show higher levels of connectivity. The differences in 5G availability also show much larger variability between low and high population density areas;

Generally speaking, services are superior in high population density areas which reflect the fact that telecommunication business models are driven by revenue per unit area.

Satellite connectivity solutions and terrestrial satellite hybrid solutions can help ASEAN Member States (AMS) overcome remote connectivity problems in new and innovative ways. With regards to the use of backhaul in remote villages, the report contains a case study on the use of Starlink as a satellite internet facility at Kampung Orang Asli Tonggang in Ulu Kinta, Malaysia. The use of backhaul yielded considerable positive benefits for the villages that led to improved economic and educational outcomes for the local population, a stronger tourism industry, and better access to emergency services in times of crisis. However, a comparison of capacity densities of terrestrial 5G and satellite Device-to-Device (D2D) shows us that D2D is unable to offer capacity densities anywhere close to terrestrial 5G networks in urban or suburban areas in ASEAN.

Central role of spectrum

Spectrum is central to the provision of satellite broadband services. Two types of spectrum are most relevant: spectrum used to provide satellite broadband services and spectrum used to provide D2D services.

The first category utilises spectrum in the Ku and Ka bands, and occasionally the E-band too. Starlink notably relies on multiple frequency bands for backhaul, although user terminals mostly utilise Ku (10.7–12.7 GHz) and Ka (17.8–19.3 GHz). Spectrum used to provide D2D services features different constellations using different approaches. These mega constellations variously utilise the bands already dedicated to mobile satellite services (MSS) or the spectrum allocated to International Mobile Telecommunications (IMT) or a combination thereof.

Both MSS and IMT spectrum have advantages and disadvantages. MSS spectrum for D2D requires sufficient bandwidth to support demanding services. MSS spectrum has been internationally harmonised, providing globally available and interference-free spectrum without the need to undertake interference management coordination.

By contrast, there is potentially a larger amount of IMT spectrum for D2D and most smartphones are already designed to utilise these frequencies. It is noted that smartphones intended for use

in D2D applications using IMT spectrum are unmodified, which means such smartphones have not been optimised for D2D use. The link budgets for connecting smartphones with satellites are very stringent, a factor that will play a significant role in the development of newer generation of handsets that can achieve appropriate link budgets when connecting to satellites. It is expected that standards-based D2D under 3GPP Non-Terrestrial Networks (NTN) using MSS spectrum will address the need for handset optimisation. Moreover, across ASEAN, low and mid band IMT band spectrum has not been sufficiently assigned in a number of AMS and cross-border coordination is required to ensure D2D use in IMT bands does not cause unacceptable interference to terrestrial communications.

Moreover, in ASEAN, there is a need for legal and licensing frameworks specifically dedicated to regulating the provision of internet services and/or backhaul connectivity through LEOs. In ASEAN, LEOs tend to be regulated in proxy through standard telecommunications license regimes or not licensed at all. The absence of bespoke rules leaves the regulatory landscape surrounding the use of LEO connectivity by MNOs all too uncertain.

Summary of key recommendations

This report thus puts forward nine key recommendations which could be adopted by AMS wishing to update existing frameworks or to implement new rules entirely. These recommendations are detailed at greater length in Section 6.

Recommendation 1: Develop LEO-specific regulations and licensing frameworks

Develop specialised regulations and licensing frameworks which address the unique technical and spectrum characteristics of LEO connectivity. Such regulations must take account of the nature of large-scale LEO constellations. Such constellations feature thousands of satellites across many orbital shells, roving faster and closer to Earth, which differ from smaller LEO constellations and more traditional satellite systems.

Recommendation 2: Create regionally unified frameworks

Regionally unified frameworks are needed to ensure interoperability across different AMS and involve licensing, spectrum use, and market access for compliance as well as operational feasibility. A unified framework would reflect ASEAN aspirations to evolve into a single market for telecommunications operators using satellites. One good example of such a unified approach is the European Union's draft "EU Space Act", which mandates specific obligations on LEO systems of 1,000 satellites or more. Spectrum regulation specific to such large-scale LEO systems must be added to the EU approach and be also considered for adoption in ASEAN.

Recommendation 3: Use licensing regimes to balance innovation with caution

This recommendation is designed to encourage flexibility and reduce uncertainties in the face of significant market and technological uncertainty. It might involve, say, the use of trial permits and regulatory frameworks which support innovation while mitigating irreversible externalities of large-scale LEOs and maintaining a degree of precaution in testing out the real-life application of LEO connectivity.

Recommendation 4: Optimise licensing duration and renewal

This, again, is designed to facilitate greater future flexibility as technologies (all technologies, not just satellite-based). Taking into account, for example, a lifespan of five to seven years of LEOs, the preliminary state of current competition and technologies there are strong arguments to support shorter licensing periods of large-scale LEOs of 1,000 satellites or more, compared to terrestrial mobile services.

Recommendation 5: Harmonise spectrum allocations and rules

There is utility in AMS having harmonised spectrum allocations for MSS and for similar rules to apply at the AMS level in relation to the use of IMT assignments for D2D services. This will facilitate faster rollout, device compatibility and lower costs.

Recommendation 6: Mandate Universal Outdoor Coverage in ASEAN

Akin to the approach followed in Australia, ASEAN should adopt a universal service obligation of a requirement of universal outdoor coverage be adopted in AMS that is not technology-specific by 2030, linked to universal smartphone adoption across ASEAN bringing unprecedented continuous connectivity coverage to the whole of the ASEAN region.

Recommendation 7: Require shared LEO gateways

There should be flexibility in ASEAN to allow shared LEO gateways within AMS regulatory regimes especially given developments in gateway technologies.

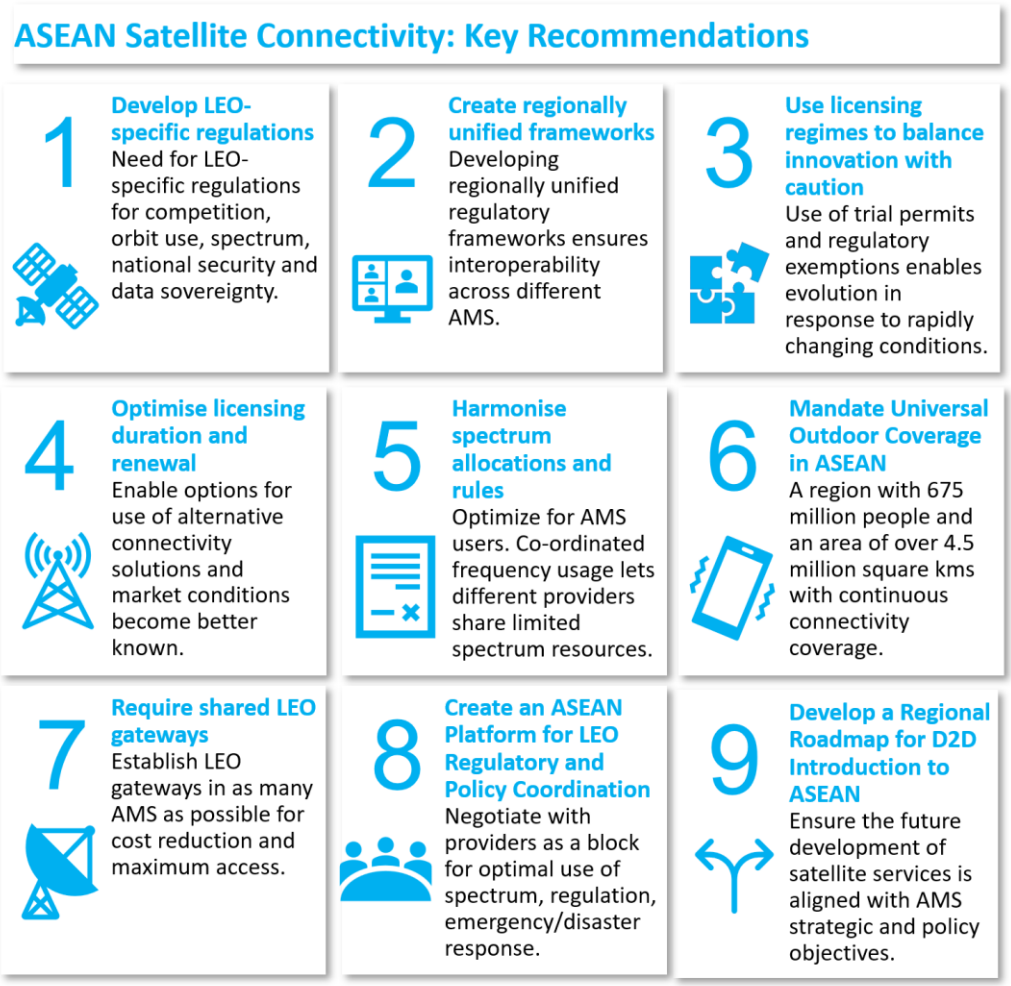
Recommendation 8: Create an ASEAN Platform for LEO Satellite Regulatory and Policy Coordination

ASEAN should utilise its existing working group mechanisms to deliberate on emerging regulatory and technical matters pertaining to LEO satellite systems, with a focus on mitigating negative externalities posed by mega constellations.

Recommendation 9: Develop a Regional Roadmap for D2D Introduction to ASEAN

Recognising the rapid advancement of satellite-based D2D technologies and their potential to enhance connectivity resilience, disaster preparedness, and digital inclusion, ASEAN may also consider developing a regional roadmap for the introduction of D2D services.

Exhibit 2: Key recommendations



Source: Windsor Place Consulting, 2025

2 The economics of the new satellite communications revolution

2.1 Why satellites?

Technological change in the global telecommunications industry is incessant and, compared to most other industries, rapid. Nonetheless, this change is also epochal—there are periods where combinations of technological change, market maturity and broader global economic disruption all combine to deliver sustained periods of extremely rapid evolution in communications. These evolutionary jumps in communications make significant differences to the economic trajectories of the countries that experience them.

An example of an earlier epochal communications leap is the rapid rollout of 3G wireless connectivity in South and South-east Asia beginning in the early 2000s and then 4G/LTE in the 2010's. To the surprise of many observers, developing countries around the region were able to 'leapfrog' into a new era of advanced connectivity, by passing the slow expensive rollout of analogue landline telephony infrastructure.

The world now finds itself at the beginning of another revolutionary communications epoch: the new satellite communications revolution.

Satellites have been a part of the communications landscape for over seven decades. On December 18, 1958, a recorded Christmas message from President Dwight Eisenhower was broadcast from the Signal Communication by Orbiting Relay Equipment (SCORE)satellite. This was followed by AT&T's Telstar in 1962[1], which achieved the first live transatlantic television broadcast, and the deployment of Early Bird (Intelsat I) in 1965, the first commercial geostationary communications satellite that provided continuous coverage between North America and Europe.

One of the distinguishing features of the new satellite communications revolution is that, instead of satellites most commonly connecting with commercial or government terrestrial sites, direct satellite links are now in the hands of end consumers. These links take the form of small affordable consumer satellite terminals and, increasingly, standard smartphones and other user equipment.

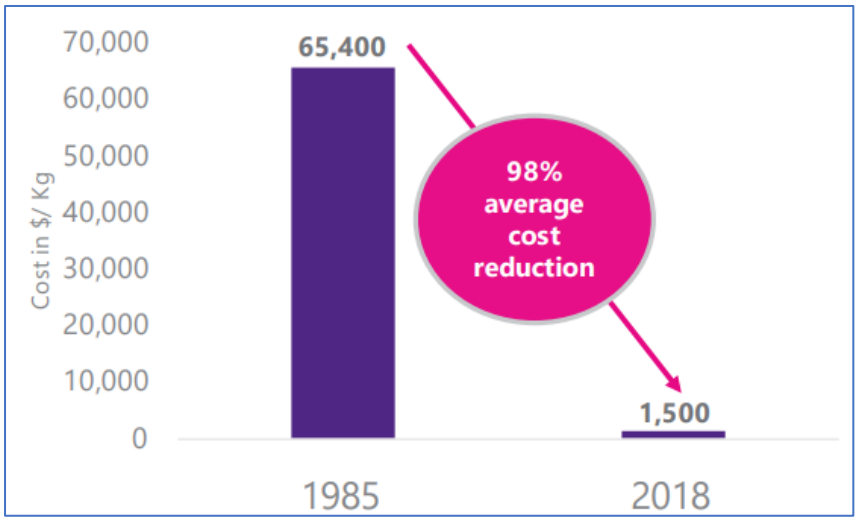
At the same time technical improvements and heightened levels of competition in the satellite launch industry are making it much cheaper to put satellites into orbit (see Exhibit 3). The most famous is currently Space X.[2] Space X projections suggest 2018's payload cost will fall to USD78–USD94 per kg with partial reusability (2025–2026), potentially reaching USD10–USD20 per kg by 2027–2040, a 580–5,450x reduction from the costs per kg of the Shuttle.[3]

1 Telstar Opened Era of Global Satellite Television, https://www.nasa.gov/history/telstar-opened-era-of-global-satellite-television/

2 And SpaceX with it's close links to Starlink is a key factor in the company's lead in the satellite broadband market.

3 Grok, LLM conversation, 15 September 2025

Exhibit 3: Payload cost to low earth orbit in 1984 and 2018



Source: Plum Consulting

New satellite platforms target mainly three main markets: (i) direct to consumer/household broadband services, (ii) provisioning of wireless backhaul services to mobile operators and (iii) increasingly consumer Direct to Device (D2D) services.[4] There are several other important niche markets such as defence, public safety, maritime, aviation and government. These, however, have less direct relationships to existing consumer markets traditionally served by terrestrial communications systems and these markets a somewhat better established than these newer consumer markets. It should also be noted that consumers have for many years been serviced by satellite for broadband services but these tend to have limited capacity, higher cost, lower speeds and often have relatively high levels of latency being in geostationary orbits.

The primary driver of current levels of interest and investment in satellites is the potential of new applications in consumer and business communications markets. The actual and potential growth of these markets is attaching substantial investment to Low Earth Orbit (LEO), and Multi-Orbit hybrid infrastructure. Geo-stationary Earth orbit (GEO) and other satellite operators are also introducing innovations in GEO satellite technology and commercial offerings, for example, deploying next-generation Ultra-High Throughput Satellites (UHTS) and small form-factor user terminals based on phased-array antenna designs. Various mergers and/or acquisitions have been completed or are underway including Eutelsat's merger with Oneweb (2023),[5] Viasat's acquisition of Inmarsat (2023),[6] SES's acquisition of Intelsat (2025),[7] and SES' merger with Lynk Global and Omnispace.[8]

With technological change and market opportunities in a state of flux, new business models are emerging based on synergies and complementarities between terrestrial operators, and LEO, medium Earth Orbit (MEO) and GEO operators (See Section 2.4) In particular, the 300–700 km portion of LEO orbital region is facing overconsumption by large-scale constellations, which is seen as overcrowding of orbits and spectrum by many, as it represents a compromise between the atmospheric drag effect and latency effects. Exhibit 4 shows the key characteristics of each type of satellite.[9]

4 D2D is also known variously as Non-terrestrial networks (NTNs), Direct to Cell (D2C)
5 Refer to https://www.reuters.com/markets/deals/eutelsat-oneweb-complete-merger-become-eutelsat-group-2023-09-28/
6 Refer to https://investors.viasat.com/news-releases/news-release-details/viasat-completes-acquisition-inmarsat
7 Refer to https://www.capacitymedia.com/article/ses-acquisition-intelsat
8 Refer to https://www.telecomtv.com/content/access-evolution/what-s-up-with-lynk-global-omnispace-exa-at-t-54137/
9 The *Economics of Satellite Broadband: a primer*, Karim Bensassi-Nour, Plum Consulting, 21/06/2024, https://plumconsulting.co.uk/the-economics-ofsatellite-broadband-a-primer/

Exhibit 4: Key features of GEO, MEO and LEO satellites

Type	Altitude (km)	No. of Satellites in Orbit	Typical Missions	Spectrum	Latency	Use Cases	Lifespan (years)
GEO	~36,000	575	Communications (83%), Earth Observation (8%)	L, C, Ku, Ka, Q/V and X bands	~500ms	Continuous coverage with a minimum number of satellites over a fixed area (telecom, broadcasting, defence, weather forecasting). Ultra-High throughput broadband applications not affected by latency.	15-24
MEO	2—36,000	142	Navigation (84%), Communications (15%)	L-Band and Ka band	~100ms	Wider coverage than LEO, lower latency than GEO, GPS navigation systems	7—10
LEO	<2,000	>8,000	Communications (64%), Earth Observation (24%)	L, S, C, Ku, Ka, Q/V and X bands	~20—50ms	Smaller coverage footprint necessitating denser constellations; internet connectivity, low-latency comms, remote sensing and Earth observation	5—7

Source: Bank of America Global Research, Congressional Budget Office, IDC, 2025 as amended by WPC

These developments are leading to another characteristic that is distinctive to this new phase of satellite communication development: increasing competitiveness. While Starlink is clearly an early leader in direct to consumer/household broadband services, new providers are developing rapidly. Alternatives to Starlink's end-to-end business model are appearing including Amazon's Kuiper. Service offerings will proliferate, prices will fall—provided there is healthy competition through many LEO providers and now just two—and capacity and quality will improve especially if the current bottleneck on launch services addressed, and devices are supported. Currently the frequency of satellite launches is higher than at any time in history.[10]

Another characteristic of these developments is the unprecedented volume of satellite launches into the prime 300–700 km region of the LEO orbit by a limited number of players, which is leading to the depletion of critical orbit-spectrum resources necessary to sustain competition and entry of newcomers. This issue impacts new and smaller LEO satellite players including any from ASEAN that may be pushed out of the satellite market through an inability to secure access to orbit-spectrum resources. A recent parliamentary report by the UK Government[11] has warned about the increase production and risk of radio-interference: "*The growth in the number of satellites in space requires increasingly careful management of spectrum, as spectrum is a finite resource—if too many satellites use the same frequencies, their signals can interfere with one another".*[12]

While Starlink is clearly the largest first-mover LEO mega constellation in direct to consumer/household broadband services, other LEO constellations are developing rapidly. For example, Amazon's Kuiper's LEO mega constellation is positioning itself to follow the steps of Starlink to secure a large portion of orbit-spectrum resources in order to move towards

10 Refer to https://ourworldindata.org/grapher/yearly-number-of-objects-launched-into-outer-space

11 Refer to: https://committees.parliament.uk/committee/773/uk-engagement-with-space-committee/news/210034/government-needs-to-take-action-if-uk-is-to-be-a-winner-in-new-race-for-space/

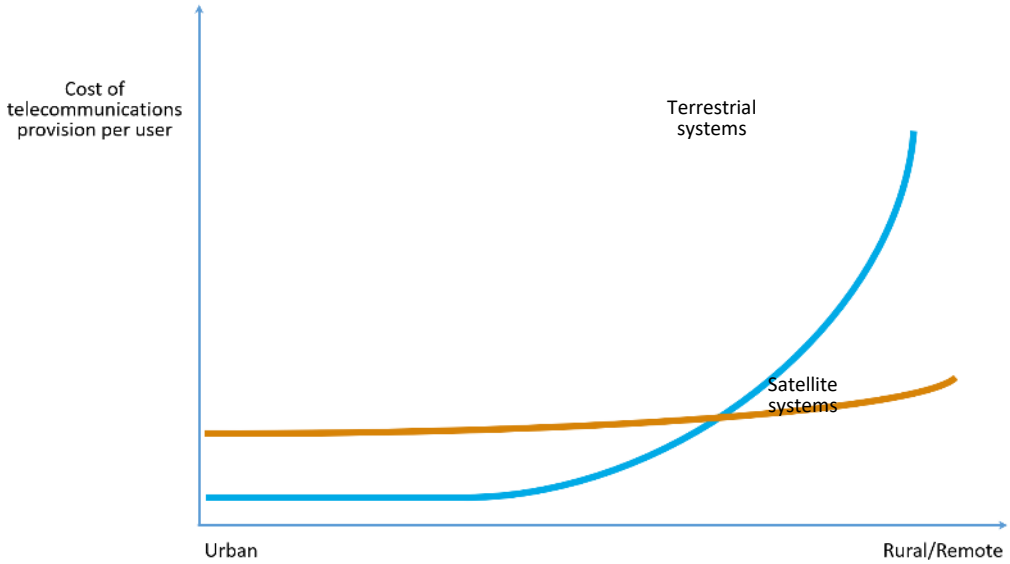
12 Ibid, page 101

a "two-player LEO market."[13] In this evolving context, it becomes challenging to ascertain that a healthy and competitive satellite broadband market will be able to proliferate. Such a market structure is likely to affect consumer prices, making them stagnant and dependent on a two-player market. Prices would be unlikely to fall, and capacity and quality would be impacted by a lack of innovation, subsequently reducing market choices. The current bottleneck and near monopoly of launch services would exacerbate this. It is noted that the frequency of satellite launches is higher than at any time in history, and that launch capability is largely in the hands of a single market player.[14]

Notwithstanding the significant and ongoing role of satellites in expanding broadband access for internet use at sea and air, enormous investment in 5G and fibre optic infrastructure continues. Likewise, terrestrial 5G operators are increasingly partnering with satellite operators to achieve complementary services to terrestrial 5G, for example, through Non-Terrestrial Networks (NTN). Many billions of dollars have been spent on mobile or wireless broadband services and corresponding cloud and data infrastructure. Given these enormous investments in terrestrial capabilities, why is the potential of a new era of satellite communications attracting so much attention and investment?

The potential for new satellite communications, especially utilising LEOs can be summed up in a single conceptual diagram (Exhibit 5). The cost of telecommunications, based on capital and operations costs, per user for terrestrial systems increases with remoteness from main urban services and its rate of increase becomes exponential in the most remote or high-cost locations. The cost per user of satellite systems, in contrast, increases very little with remoteness. The satellite curve is not, however, horizontal. Remote locations are more likely to be outside electricity grids and therefore have higher energy and overall costs.

Exhibit 5: Terrestrial and satellite communications cost characteristics



Source: Windsor Place Consulting

Providing communications for remote communities has been an important and persistent problem for decades. The relative disadvantage of remote communities has increased over time as connectivity has become more important for both individual and business end users. Today,

13 Refer to: https://www.satellitetoday.com/connectivity/2025/08/01/amazon-ceo-tells-investors-there-will-be-2-players-in-leo/

14 Refer to https://ourworldindata.org/grapher/yearly-number-of-objects-launched-into-outer-space

connectivity is the doorway to social inclusion, economic empowerment and improving living standards.

But the economic impacts of satellite connectivity are not restricted only to remote communities. In a real sense an inherently global communication solutions goes some way to driving improved global service standards in communications including in ASEAN. If domestic or terrestrial services are inadequate, expensive or unreliable, consumers—at least those who can afford them—will adopt satellite services where they are available. In this way, satellite communications services can provide a 'competitive floor' that introduces additional competition disciplines to local communications markets.

For these reasons, it is no surprise that Starlink has reached its maximum capacity in a string of urban centres in developing economies where the lack of IMT spectrum, poorly assigned IMT spectrum, the lack of mandatory quality of services (QoS), a dearth of optical fibre competition and the lack of quality fixed broadband especially has meant that domestic provided broadband services are poor or far from exemplar. Starlink has targeted urban areas in Europe and Africa first, an indication that perhaps the service remains too expensive for 'unconnected' regions.[15]

In ASEAN as of November 2025, in the Philippines on the island of Luzon from Angeles to Batangas City to Lucena including the Manila National Capital Region (NCR) and large parts of Mindanao including Zamboanga City are currently sold out on Starlink[16] and previously West Java including Jabodetabekpunjur (i.e. Greater Jakarta) was also sold out until additional satellite capacity was made available by Starlink.[17] Such trend has also shown that LEO constellations may not be a solution for broadband at scale,[18] as reports have emerged about reduced performance due to oversubscription.[19]

Multi-Orbit satellite communications systems will arguably increasingly provide a more balanced solution in comparison to LEO constellations. This is simply because bandwidth economics benefit Multi-Orbit systems by combining Ultra-High-Throughput (UHTS) GEO satellite beams, which cover extensive geographical areas, with MEO/LEO low-latency beams serving applications sensitive to latency in a targeted manner across small geographical areas. While adequate for some applications, some LEO satellite performance may not meet specific demands as from a capacity comparison, LEO satellites can currently support less than 10 Mbps/km^2, while 4G/5G services can support 100–1000 Mbps/km^2 while FTTH can support more than 1000 Mbps/km^2.[20]

Whatever the current specific applications, there is little doubt that new applications will arise for satellite communications systems that are not obvious at this stage, mirroring the experience of large general use systems such as mobile telephony, wireless broadband and the Internet itself.

2.2 Possible risks to existing GEO and emerging multi-orbit systems

It is important to highlight that the proliferation of LEO constellations, specifically large-scale deployments, is not without risk to AMS. Radio frequency emissions are not perfect. LEO constellation emissions must be carefully coordinated and must meet agreed radio interference

15 See for example, Starlink reaching capacity in the United Kingdom based on London connections, 2025. Available at https://www.thinkbroadband.com/news/10635-starlink-capacity-available-again-in-south-east

16 Refer to https://www.starlink.com/au/map

17 Even in developed markets like Australia, rapid growth in Perth and the South East Queensland saw such services sold out for a time.

18 Refer to: https://communitynetworks.org/content/new-research-starlink-unlikely-meet-bead-speed-needs-scale

19 Refer to: https://africa.businessinsider.com/local/markets/starlink-hits-capacity-in-nigerias-largest-cities-raising-questions-about-musks/xzngf7d

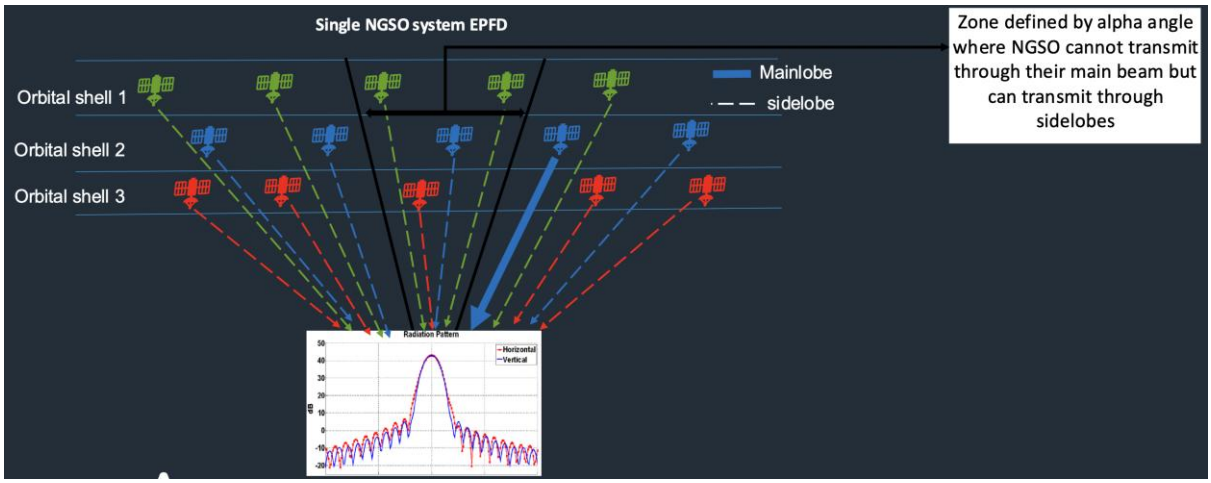
20 Refer to https://www.telefonica.com/en/communication-room/blog/direct-device-satellite-service-complement-mobile-networks/

limits[21] studied and validated by the ITU.[22] LEO mega-constellations are inherently prone to produce higher amounts of radio interference, not only due to their unprecedented scale, but also because radio interference occurs in both single-satellite source scenarios, as well as in aggregate scenarios (interference produced by numerous satellites in aggregation from a single or several mega-constellations). These scenarios are worsened when considering the production of millions of sidelobes produced by LEO constellations. Hence, there is an urgent need for interference limits' enforcement (through national licensing and penalties) and for accurate interference estimation (ie detailed modelling). Rules and regulations that well-manage interference allow for innovation, for many LEO systems to co-exist with each other, and with GEO/ Multi-Orbit networks.

In this capacity, the ITU has adopted rules to ensure that designated spectrum bands can be used by satellite operators for different services and at different orbital locations and altitudes.[23] More specifically, the ITU has developed limits on the ability of LEO systems to cause unacceptable interference into GSO networks
by adopting what are known as Equivalent Power Flux Density (EPFD) limits.[24]

The EPFD limits establish the amount of interference that a given GSO network must tolerate from any given Non-Geostationary Orbit (NGSO) system, as well as from all NGSO systems in summation. This is depicted in Exhibit 6.

Exhibit 6: EPFD is created by all visible NGSO satellites, not just one or two



Source: Viasat, 2025[25]

The EPFD limits are codified in Article 22 of the ITU's Radio Regulations.[26] EPFD limits facilitate the ability of NGSO systems to coexist with each other and to use the same frequencies as GSO networks while safeguarding GSO operations. These limits have been effective in achieving their objectives for decades and facilitating the deployment of both GSO networks and NGSO systems successfully.[27] NGSO operators must certify to regulators (such as the U.S. Federal

21 Refer to: https://www.ses.com/blog/understanding-epfd-limits-why-they-foster-innovation-and-harmonious-operations-space

22 These interference limits agreed by the ITU are known as EPFD limits (Equivalent Power Flux Density) and are prescribed in Article 22 of the ITU Radio Regulations. LEO systems (also known as NGSO, Non-Geostationary). According to Article 22, NGSO LEO systems must meet EPFD masks to limit their interference levels into GSO/GEO systems.

23 Refer to ITU *Radio Regulations*, 2024, https://www.itu.int/hub/publication/r-reg-rr-2024/

24 Equivalent power-flux density (EPFD) is sum of the power flux-densities produced by all transmitting stations of an NGSO system at a GSO receiver taking into account pointing of a GSO network receiving antenna with respect to NGSO source of interference (Off -axis discrimination).

25 Cristian Gomez, Viasat, *NGSO regulatory session, APT SATRC – Spectrum*, Goa, India, January 2025, page 9

26 *ITU Radio Regulations*, 2024.

27 Refer to Nandan Patel and Jonas Eneberg, *Response to Amazon 'Draft Technical Basis' for Diluting the Article 22 EPFD Interference Protection Criteria,* Viasat, October 26, 2023,

Communications Commission) that their NGSO systems will meet the EPFD limits and protect GSO networks from unacceptable interference.[28]

Nevertheless, globally some large-scale LEO interests are now proposing to change the ITU EPFD limits, and in the view of many satellite experts, degrade the interference protections that safeguard current, planned and future, GSO networks. Should such attempts be successful, material interference will be caused to GSO satellite services with adverse ramifications for critical satellite communications services across ASEAN. These ramifications include degradation of the services provided by both GSO broadcasting satellites and communications satellites used for defence, enterprise, aviation, maritime and government. All AMS have extensive coverage needs (including those with archipelagos, mining projects, remote communities etc where GSO services are deployed) are likely to be the AMS most affected. Given the sensitivity of satellite services to harmful interference affecting their tightly-engineered link budgets, particularly in situations of heavy rain, the interference protections granted by the current ITU EPFD limits are critical to mitigate degradation of critical satellite services and ASEAN's own GSO/ Multi-Orbit satellite investments.

In this report however, in a manner consistent with *ASEAN DIGITAL MASTERPLAN 2025* (ADM2025) especially Desired Outcome 8 of a digitally inclusive society in ASEAN, the focus of the report is how new LEO satellite technologies including direct satellite connectivity for consumers and villages, mobile backhaul by satellite and LEO connectivity offer ASEAN members an opportunity to significantly reduce the digital divide at significantly lower cost than has previously been possible. It is noted that WRC-23 categorically rejected the proposals made by LEO mega constellations to include an agenda item for WRC-27 to consider the degradation of EPFD limits. Details about the ongoing ITU studies related to the urgent need to accurately assess the spectral and interference footprint of LEO systems, especially LEO mega constellations, will be a key focus of WRC-27.

This report highlights these evolving issues in a manner that is consistent with *ASEAN DIGITAL MASTERPLAN 2025* (ADM2025) especially Desired Outcome 8 of a digitally inclusive society in ASEAN. The focus of this report is on how new LEO satellite technologies can benefit ASEAN connectivity, noting that such benefits are only possible if undesirable structural effects and negative externalities arising from large-scale LEO constellations are mitigated. It is expected that satellite applications, including direct satellite connectivity for consumers and villages, mobile backhaul by satellite and Supplemental Coverage by Satellite (SCS) offer ASEAN members an opportunity to improve connectivity. WRC-27 decisions will strengthen ASEAN's objectives, and therefore this report has noted some of the pressure points ASEAN Member States (AMS) will be challenged with on important spectrum matters concerning satellite connectivity. Some of these spectrum matters also touch on AMS' ability to preserve their sovereign rights to access satellite orbits and spectrum resources, as articulated in the ITU constitution. ITU has dedicated a resources page[29] on matters related to space sustainability, which is useful for AMS to consider in their national master plans and in the *ASEAN Digital Masterplan 2030* (ADM2030).

2.3 The economics of satellite communications

The emergence of new satellite communications, generally represents a fundamental shift in telecommunications economics which challenges the traditional terrestrial infrastructure paradigm and creates new opportunities for global connectivity, particularly for underserviced communities. However, LEO constellations maybe replicating market scaling strategies that benefit first-movers, to the detriment of newcomers including any ASEAN based competitors.

[28] Brattle Group, *Unacceptable Interference: Economic Analysis Does Not Support Degrading Protections for GSO Networks*, 27 October 2023

[29] Refer to: https://www.itu.int/space-sustainability/

The traditional telecommunications economic model relies on massive up-front capital investments in fibre networks, towers, and switching equipment that require decades to amortise. This model assumes that the high upfront costs will enable relatively low marginal costs for large numbers of users.

This model may lead to the creation of natural monopolies—especially in relation to fixed network infrastructure—which generates the need for the complex *ex ante* regulatory interventions (e.g. interconnection, infrastructure sharing, etc.) which are so characteristic of the telecommunications sector. This model is in many aspects quite similar to the scaling model of large-scale LEO constellations that seek to capture market share rapidly.

Satellite systems also require substantial upfront investments in satellite production and deployment but then provide coverage to vast geographic areas simultaneously. These investments, however, in contrast to the local reach of terrestrial systems, enable services—subject to licensing—to be provided to global markets. While this is an impressive technical capability, whether service can actually be offered in a particular nation depends on *inter alia* spectrum availability, licensing and device. affordability. For this reason, much of the discussion in this report focuses on these issues.

2.3.1 Trade-offs between Satellite and Terrestrial Systems

The economic trade-offs between satellite and terrestrial communications systems reflect fundamental differences in physics, geography, and service requirements. Satellite systems excel in providing coverage to remote and underserved areas where terrestrial infrastructure deployment is prohibitively expensive.

Satellite systems, however, face inherent limitations that affect their competitiveness with terrestrial services in densely populated areas. Satellites can have higher latency (more so for GEO than LEO systems) than terrestrial transmission systems, though this disadvantage diminishes with distance. Propagation in free space is 50% faster than in fibre optical cables, giving satellites an advantage over terrestrial fibre after exceeding a distance that accounts for the altitude of the satellite. For a constellation such as Starlink at a median orbit of 550 km, this breakeven distance is around 2,700 km.[30]

The capacity constraints of satellite systems create another significant trade-off. While terrestrial fibre networks can be upgraded incrementally to handle increased demand, satellite capacity is fixed until new satellites are launched (except to the extent that remote software upgrades increase capacity). This creates different bandwidth economic dynamics where terrestrial systems may have lower marginal costs for high-bandwidth applications, while satellite systems, particularly Multi-Orbit, provide better bandwidth economics for coverage extension and mobility applications across land, sea and air.

LEO constellations also face significant lifecycle challenges that affect long-term economics. The short lifespan of LEO satellites necessitates continuous replacement cycles, typically every 4 to 5 years, creating ongoing capital requirements—as well as capital-intensive launch capability—that terrestrial and GSO infrastructure avoids. Furthermore, the equipment harmonization—under the auspices of the ITU, 3GPP[31] and regional bodies such as ETSI[32]—which has characterised the telecommunications sector is still to be fully adopted in relation to satellite user equipment but this is rapidly being addressed by the 3GPP in Rel.17 (which incorporated NTN systems for satellites using MSS spectrum) and beyond.

30 Latency in LEO Satellites vs. Terrestrial Fiber, https://frankrayal.com/2021/07/07/latency-in-leo-satellites-vs-terrestrial-fiber/

31 Refer to https://www.3gpp.org

32 Refer to https://www.etsi.org

2.3.2 Complementary Relationships and Synergies

Rather than purely competitive relationships, satellite and terrestrial communications systems demonstrate significant complementary characteristics that create synergistic opportunities.

The most significant synergy emerges in backhaul applications, where satellites provide connectivity for remote terrestrial infrastructure. This hybrid model allows terrestrial networks to extend their reach economically by using satellite connectivity to connect remote cell towers, fiber distribution points, and other infrastructure elements. The economic benefit is substantial, eliminating the need for expensive terrestrial backhaul connections across difficult terrain or long distances or where terrestrial infrastructure is at risk from war, theft or other forms of disruption. Such technologies are ideal to help provide services across the archipelagos of Southeast Asia.

For such reasons, mobile network operators may increasingly view satellites as complementary wholesale infrastructure rather than competitive threats. Satellite connectivity provides seamless coverage extension for terrestrial networks, enabling national operators to offer continuous service delivery across geographic boundaries that encompass remote regions enabling them to expand contiguous markets. Providing services in such regions is often unprofitable for operators and, in many cases, only made possible via universal service funding. This integration creates new revenue opportunities for both satellite and terrestrial operators while improving service quality for end users.

Enterprise applications represent another area of strong complementarity. Satellites provide redundancy and backup connectivity for critical business operations, (e.g. in relation to mining, agriculture, railways or other transport corridors) while terrestrial fixed and mobile networks handle primary high-bandwidth applications. This dual-connectivity approach commands premium pricing while reducing business risk for enterprise customers and enables higher levels of standardised technology deployments across multiple geographies. Further, opportunities also exist for enterprises and utilities in relation to Internet of Things (IoT) and drones, remote sensing and other narrow-band services which can be delivered by satellite.

2.3.3 Market dynamics and competitive evolution

The economic dynamics of satellite communications markets differ substantially from traditional telecommunications markets. While high fixed costs and significant economies of scale could create conditions for a degree of natural monopoly, the interest in this sector means that there is an increased likelihood that an oligopolistic market structure will emerge in the short to medium terms in the satellite broadband sector as certain large-scale LEO constellations (specifically those systems with over 1,000 satellites) are being deployed. These include but are not limited to Starlink/Starlink D2D, AST Spacemobile, Amazon's Kuiper, and China's Guowang and Qianfan (Thousand Sails).[33]

If such market structure were to emerge, they would mimic, to some extent, the previous evolution of telecommunications markets from landline services only to the modern fixed fibre plus mobile/cellular offerings. This evolution increased competition in communications markets but not to the extent ongoing regulation was not required. The addition of consumer-scale LEO broadband services to global telephony and broadband markets may drive further competition in across communications markets generally. Having said that, recent studies of the real cost of LEO satellite connectivity in developing markets including in selected AMS found that Starlink's pricing strategy appears to be more than merely cost-based and that in adapting to local market conditions its role as a truly inclusive connectivity solution may be limited.[34] See Exhibit 7 below.

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33 Refer to https://www.starlink.com, https://www.starlink.com/business/direct-to-cell , https://ast-science.com , https://www.aboutamazon.com/what-we-do/devices-services/project-kuiper

34 Karim Bensassi-Nour, *Plum Insight: The (Real) Price of Satellite Connectivity: A Global Analysis of Starlink's affordability*, November 2024

Exhibit 7: Starlink's pricing strategy and affordability

In 2024, Plum Consulting undertook a quantitative analysis of Starlink's global pricing strategy in nominal terms and adjusted for Purchasing Power Parity.[35] The study compared Starlink fees globally, which consist of a one-time hardware fee and monthly subscription fee for residential, business, and mobile connectivity. It appears from the study's findings that Starlink's pricing strategy is adapted to local market conditions rather than being merely cost-based. Moreover, while developing and low-income countries often access lower prices these do not tend to be affordable, thus limiting Starlink's role as a truly inclusive LEO satellite service.

The results suggest that Starlink varies its global pricing strategy according to regional income levels and demand for broadband connectivity in rural/underserved areas with limited terrestrial options. Although in the case of Europe, this strategy appears to have been adapted to competitive local market conditions which already feature affordable coverage options.

When Starlink prices are adjusted for Purchasing Power Parity (PPP), an even more differentiated affordability landscape becomes apparent across the globe, shaped by local cost of living conditions and the relative financial burden placed on consumers. Importantly, Starlink's prices fall outside the affordable range in most countries, which includes in ASEAN such as in the Philippines and Malaysia.

Figure 1: Top five most and least expensive countries for Starlink (USD, Spot[4])

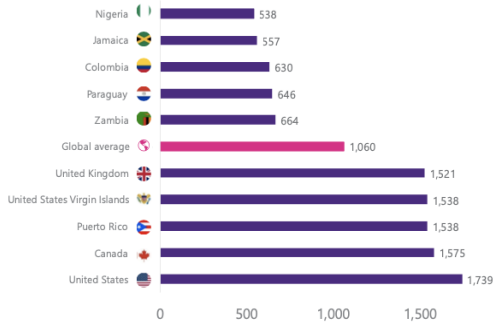
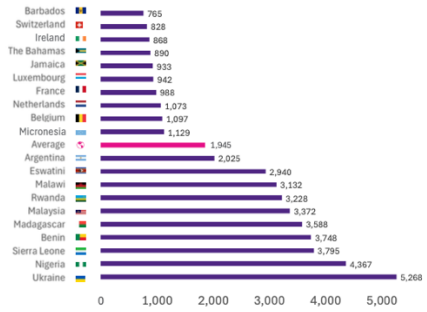


Figure 2: Top ten most and least expensive countries for Starlink (USD, PPP)



Source: Starlink, Plum Analysis, The World Bank[36]

Implications

Starlink's financial burden on ASEAN countries indicates that despite its technical and customer base-enhancing potential, high prices constrict its role as an inclusive connectivity provider. Policymakers are thus urged to be cautious in their adoption of LEO satellite services like Starlink to expand nationwide connectivity. While these are useful supplementary options, building a national, resilient broadband infrastructure better safeguards connectivity interests.

More broadly, the study's findings question whether satellite solutions can ever serve as the primary tool for bridging the digital divide and whether they ought to best be thought of as a premium option accessible to only the smaller segments of a given population. The promise of satellite connectivity may thus come with more drawbacks than previously considered.

LEO constellation designs vary widely with the evolving mix of services to deliver. No single LEO architecture is ideal, Instead, different architectures—from Walker delta and star to tiered, multi-orbit, and ad-hoc configurations—cater to various operational needs. In all cases, satellite operation remains a complex endeavor.[37]

35 Plum Insight. *The (Real) Price of Satellite Connectivity: A Global Analysis of Starlink's affordability.* November 2024.

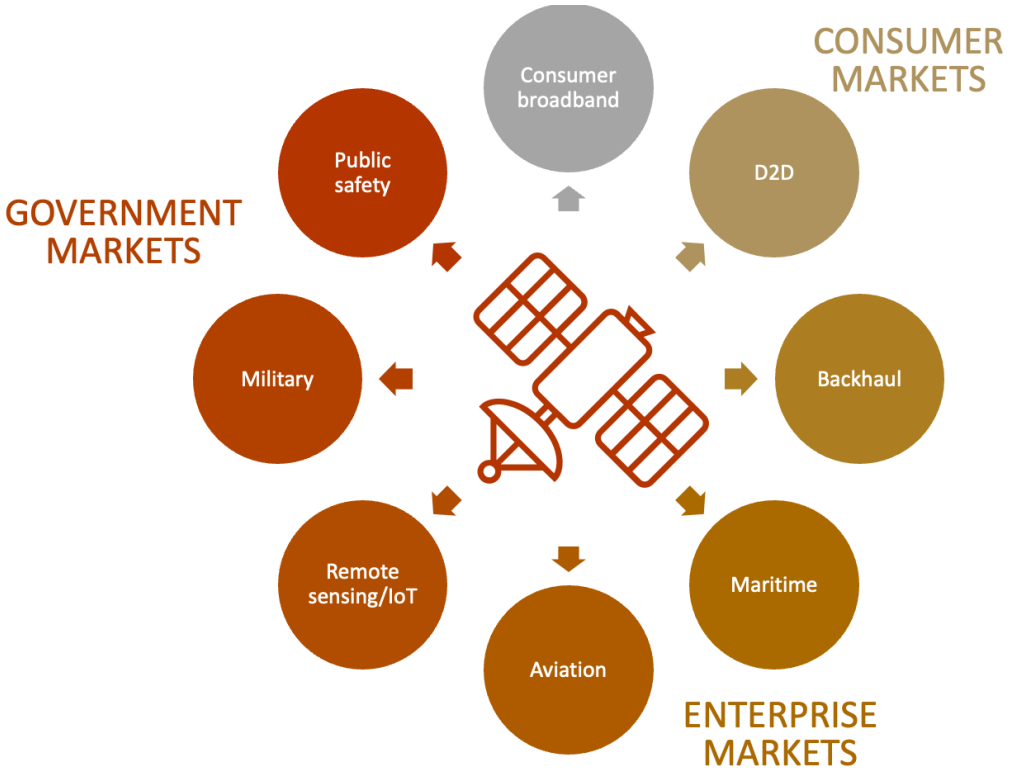
36 Ibid, pages 1-2.

37 Refer to https://www.itu.int/hub/2025/02/space-connect-the-rise-of-leo-satellite-constellations/

Much of the evolution of communications competition will depend on interactions between various communications markets. As mentioned earlier, originally, the markets for satellite services were enterprise and government. As newer satellite systems emerge, consumer markets are of increasing significance. Exhibit 8 illustrates the major markets for satellite communications services of various types.

The extent to which competition and the quality of service offerings improve over time will also depend on the evolution of business models in the sector. This includes enterprise providers pivoting towards consumers and new collaborations between satellite providers and terrestrial operators to name two business model innovations.

Exhibit 8: Terrestrial and satellite communications cost characteristics



Source: Windsor Place Consulting, September 2025

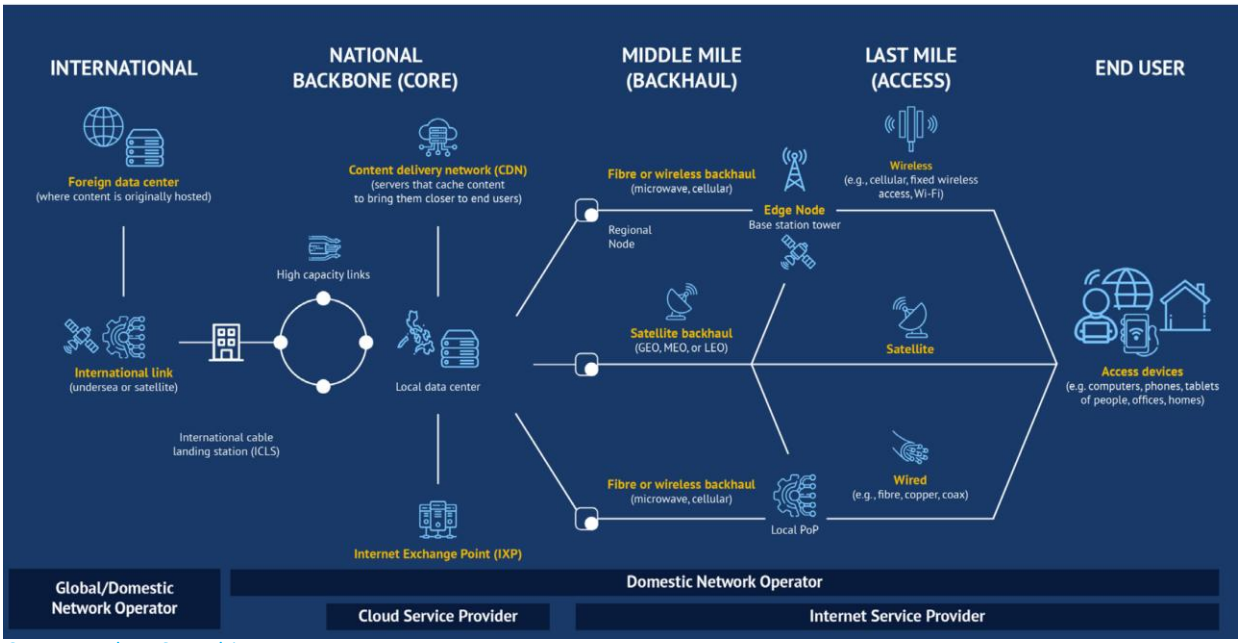
Technological advances will continue to improve the economic viability of satellite systems. Being able to address consumer demand for high-bandwidth applications, such as video streaming and communications will further drive the competitiveness of satellite relative to terrestrial services.

The integration of LEO systems with emerging technologies such as 5G and future 6G services, edge computing, and IoT applications creates new economic opportunities that extend beyond traditional communications services. However, Direct-to-Cell (D2C), or Direct-to-Device, (D2D) LEO satellite constellations which were approved in the USA that use IMT (mobile spectrum) arguably do not have a clear future path due to the lack of an internationally harmonised approach to satellites using mobile terrestrial spectrum (and related radio interference issues).

The economic transformation brought by new satellite technologies represents a paradigm shift comparable to the transition from circuit-switched to packet-switched networks or the move from analog to digital communications. Success in this market requires not only technical capabilities but also understanding of the complex economic relationships between satellite systems, terrestrial infrastructure, and evolving consumer and enterprise demands.

As the satellite communications market—especially in relation to LEOs matures, the economic relationships between satellite and terrestrial systems will likely evolve toward greater integration and specialisation, with each technology optimised for its comparative advantages while working together to provide comprehensive global connectivity solutions. This evolution will reshape telecommunications economics fundamentally, creating new opportunities for innovation, competition, and value creation across the entire communications ecosystem. Exhibit 9 provides an overview of contemporary telecommunications infrastructure illustrating the points at which satellite capabilities play competitive and complementary roles to terrestrial communications systems.

Exhibit 9: Broadband infrastructure value chain, technologies, and reach



Source: Plum Consulting

With that said, LEO connectivity does not automatically guarantee a significant improvement in performance outcomes, as highlighted by a recent assessment by OpenSignal of Starlink's performance in the Indonesian market, summarised below. These findings were important insofar as they deviated from the positive results found in Canada. Thus, despite the messaging of satellite connectivity's often claiming to being the superior offering, other alternatives such as Fixed Wireless Access (FWA) may well remain important where the features of a local context require it.

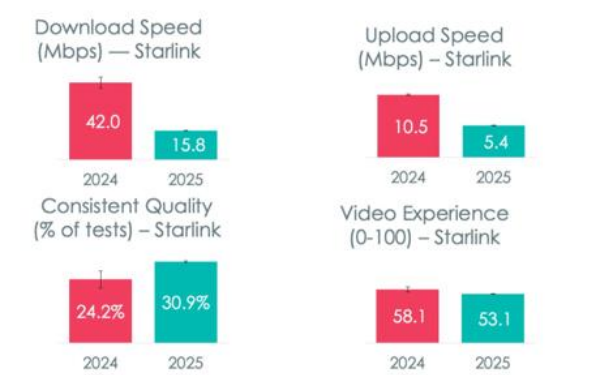
Exhibit 10: Starlink offers complementary connectivity in Indonesia

Having entered the Indonesian market in May 2024, Starlink's promise of better connectivity has not translated into straightforwardly superior outcomes. The company's performance and comparison with alternatives, such as FWA technology which is already part of the country's national digital strategy, has shed light on the beneficial scope offered by satellite connectivity.

A 2025 study by Opensignal[38] found that despite positive results in Canada when compared to FWA, the results in Indonesia were not as promising. Congestion cut up to two-thirds of Starlink's downloads and almost a half of its uploads speed within 12 months of launching. Furthermore, FWA outperformed Starlink on most metrics including Upload Speed, Consistent Quality and Video Experience—although Starlink led the race in terms of Download Speed.

38 See https://www.opensignal.com/2025/10/08/starlink-in-indonesia-one-year-on/id

Congestion took place due to demand surging too quickly, leading to Starlink freezing new sign-ups for its services in July 2025.[39] The resumption of services saw new customers having to pay elevated 'demand surge fees' (IDR 8 – 9.4 million, equivalent to $490–$574 depending on the gateway) which cost three times the average monthly wage in Indonesia.[40] With that said, Consistent Quality in Indonesia improved from 24.2% to 30.9% over the same 12-month period due to low latency and infrastructure upgrades.



[41]

Comparison with FWA

In comparing Starlink with FWA, both technologies offered different benefits which highlight their complementary roles. Starlink was found to deliver slightly faster download speeds compared to FWA, however, FWA led on all other metrics particularly Consistent Quality, where FWA achieved a score nearly 50% higher than Starlink's.

Given Indonesia's archipelagic terrain, Starlink is especially beneficial for extending connectivity to remote regions like However, FWA provided more reliable internet, while Starlink struggled with a weaker Consistent Quality score in rural zones especially.

In urban areas, Starlink users had access to download speeds nearly 25 Mbps faster than FWA. Towns and suburbs exhibited similar results between Starlink and FWA. Rural areas also saw faster speeds made available to Starlink users when compared to FWA. With that said, FWA continued to score higher on Consistent Quality across rural, urban and suburban areas while Starlink was weakest in stability in rural zones.

Moving forward

Opensignal concludes that Starlink's future success will depend on expanding capacity to meet surging demand, stabilising performance to guarantee a consistent user experience and positioning itself as a complementary technology alongside FWA and fiber rather than as its direct competitor. Starlink offers the ability to fill in critical connectivity gaps previously unserved by terrestrial solutions, rather than offering a uniform replacement for FWA or other alternatives.

2.4 Key satellite companies

The satellite communications industry is experiencing strong growth, with the global satellite communication market size projected to grow from USD16.9 billion in 2024 to USD33.2 billion by 2029 at a compound annual growth rate of 14.5%.[42] This expansion is driven by a range of factors including technological innovations in satellite design, falling satellite launch costs and the achievement of some critical mass in consumer markets leading to greater consumer awareness and service availability. The industry is experiencing an increased expansion due to innovations

39 See https://www.techinasia.com/news/starlink-stops-accepting-users-indonesia
40 See https://www.bps.go.id/en/statistics-table/2/MTUyMSMy/rata-rata-upah-gaji.html
41 https://www.opensignal.com/2025/10/08/starlink-in-indonesia-one-year-on/id
42 Top Companies in Satellite Communication - Intelsat (US) and Viasat Inc, (US), Markets and Markets, https://www.marketsandmarkets.com/ResearchInsight/satellite-communication-market.asp

in GEO and non-GEO technologies, including LEO systems, particularly on Ultra-High Throughput (UHT) GEO satellites, lower-latency LEO systems and small consumer terminals being developed by both GEO and LEO systems.

Two key categories of services emerge from our analysis of the LEO satellite connectivity market. Firstly, there are the companies that offer backhaul and broadband services equivalent to current terrestrial offerings. Secondly, there are those companies which offer D2D services that enable direct interaction between satellites and end-users such as smartphones; these services do not depend on terrestrial networks and exhibit different spectrum needs.

2.4.1 Backhaul/satellite broadband services

First movers in the satellite backhaul and broadband markets are shaping the future of broadband connectivity by increasing access to services in underserved and rural/remote regions as well as leveraging LEO and Multi-Orbit technology to offer broadband services. Some examples include SpaceX's Starlink, Eutelsat and Europe's SES. Their dominance stems from large-scale infrastructure investments, partnerships with telecom operators and the delivery of scalable, reliable broadband solutions. However, the growth of China's Guowang, Honghu-3 and Qianfan companies signal the arrival of promising new market players in this market.

2.4.1.1 First movers/current market leaders

SpaceX/Starlink dominates the modern satellite landscape. As of October 2025, the constellation consists of over 9,000 mass-produced small satellites in low Earth orbit that communicate with proprietary ground transceivers.[43] Starlink has approval for up to 42,000 satellites and continues aggressive expansion, fundamentally reshaping the industry through its proprietary low-cost, high-volume approach. Certain game-changing tools, like the operation of a reusable launch vehicle, has allowed Starlink to remain ahead of its competitors and maintain its dominance over the launch of rockets into space.[44] Starlink is currently the leading satellite communication player with the largest mega constellation and largest customer base in the world. In August 2025, it announced that it had more than 7.1 million customers globally in 150 countries, territories and many other markets.[45]

Amazon's Project Kuiper (now rebranded as Amazon Leo) represents the most significant upcoming mega constellation in addition to Starlink, with plans for over 3,200 satellites with over 150 currently deployed (October 2025).[46] Its first mission launched in April 2025, with plans to undertake 80 more missions.[47] Amazon Leo is expected to begin offering services to five countries by early 2026.[48] It is anticipated that continuous coverage in 26 countries will be achieved by Q1 2026, full global coverage in 54 countries by 2027. In 2028, there are plans to launch gen-2 constellation and another 3,200 satellites, with coverage expanded to 100 countries.

Though still in development, Amazon Leo's vertical integration of launch capability (Blue Origin) and terrestrial infrastructure provided by Amazon Web Services (AWS) is signalling a structural positioning in the market that coincides with Starlink's vertical integration strategy to rapidly capture a majority market share. Though still in development, Amazon's vast resources and existing cloud infrastructure could position it as a potential contender to Starlink in the satellite internet market offering.

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43 Refer to https://www.space.com/starlink-satellite-train-how-to-see-and-track-it

44 Ibid

45 Refer to https://x.com/Starlink/status/1960867340951937239; https://idemest.com/reports/starlink-country-data-tracker/#:~:text=Key%20Highlights:,region%2C%20and%20other%20key%20markets.

46 Kuiper mission updates: 150+ satellites in orbit following sixth successful launch. Available at https://www.aboutamazon.com/news/innovation-at-amazon/project-kuiper-satellite-rocket-launch-progress-updates

47 Ibid

48 Bloomberg. Amazon Expects Kuiper to Serve Five Countries by Early 2026. September 2025. Available at https://www.bloomberg.com/news/articles/2025-09-15/amazon-expects-kuiper-satellites-to-serve-five-countries-by-2026?embedded-checkout=true

Eutelsat OneWeb represents the merged entity combining Europe's Eutelsat with the LEO constellation OneWeb, creating a powerful hybrid operator offering both geostationary and low Earth orbit services. This merger currently positions them as the second-largest LEO constellation in the world. As such they are a material competitor to Starlink in global broadband coverage albeit that its constellation of around 650 LEO satellites is less than a tenth of the size of Starlink.[49]

The company provides telephone and data services to users worldwide, via portable terminals that communicate with ground stations through geostationary satellites. It also offers enterprise communication and integration, digitalisation, aviation safety, inflight connectivity, and maritime safety services.

SES is one of Europe's largest satellite operators, providing both traditional geostationary and next-generation medium Earth orbit (MEO) services. The company focuses on enterprise, mobility, and broadcast markets, competing directly with other established players through its O3b constellation and traditional fleet. In July 2025 SES completed its acquisition of Intelsat, a major traditional satellite operator, particularly strong in aviation connectivity. Intelsat operates primarily in geostationary orbit and serves enterprise and government customers globally, operating in 80 different countries.[50] The combined company operates a satellite network including approximately 90 geostationary, nearly 30 medium earth orbit satellites, strategic access to low earth orbit satellites, and an extensive ground network.[51] This enhanced scale and financial profile will allow SES to invest annually in emerging segments as well as new technologies.[52]

2.4.1.2 Potential new LEO players

Some satellite networks are emerging in China, however, such networks do not have a vertical integration capability that matches Starlink or Kuiper due to their lack of current scales and reusable rockets. Furthermore, China-based LEO constellations begun launching much later than Starlink, which currently occupies most of the LEO orbits and is currently consuming the largest share of the available spectrum.

Guowang (Guo Wang/Xingwang) is a potential market player, being one of China's most ambitious satellite constellation projects which is aiming to establish a comprehensive communications network through its "National Network". The company plans to deploy approximately 13,000 LEO satellites and a near-term target is to have 4 00 satellites in orbit by 2027.[53]

As of April 2025, the programme had launched 14 experimental series satellites and 57 operational satellites in both GEO and LEO configurations.[54] This dual-orbit approach allows for comprehensive coverage and redundancy in communications services. In October 2025, the company launched its twelfth group of broadband satellites.[55]

The project is a state-backed initiative designed to provide comprehensive satellite communications, navigation, and monitoring capabilities. The business model focuses primarily

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49 https://blog.apnic.net/2025/09/10/measuring-the-oneweb-satellite-network/

50 SES. *About us.* https://www.ses.com/about-us#:~:text=SES%20is%20a%20leading%20global,space%20to%20make%20a%20difference.&text=With%20an%20integrated%20multi%2Dorbit,future%20of%20space%2Denabled%20communications.

51 SES Completes Acquisition of Intelsat, Creating Global Multi-Orbit Connectivity Powerhouse, https://www.ses.com/press-release/ses-completes-acquisition-intelsat-creating-global-multi-orbit-connectivity

52 TechAfricaNews. SES Unveils New Brand Following Merger with Intelsat, Marking Bold Step in Satellite Industry. Available at https://techafricanews.com/2025/09/15/ses-unveils-new-brand-following-merger-with-intelsat-marking-bold-step-in-satellite-industry/

53 Space News. *China sends 10th group of Guowang broadband satellites with Long March 8A launch.* August 2025. Available at https://spacenews.com/china-sends-10th-group-of-guowang-broadband-satellites-into-orbit-with-long-march-8a-launch/

54 https://en.wikipedia.org/wiki/Guowang

55 Space.com. *China launches internet satellites on 600th mission of Long March rocket.* October 2025. Available at https://www.space.com/space-exploration/launches-spacecraft/china-launches-internet-satellites-on-600th-mission-of-long-march-rocket-video

on providing strategic communications infrastructure for China, with potential commercial applications for broadband internet services.

Guowang's planning targets are closely aligned with China's national strategic objectives in space. The constellation aims to provide coverage for military communications, civilian internet services, and emergency communications capabilities. The project benefits from substantial state funding and integration with China's broader space programme objectives.

Honghu-3 is a joint venture between LandSpace, a prominent Chinese launch company, and Hongqing Technology, a satellite manufacturer founded in 2017. LandSpace holds a 48% stake in Hongqing Technology, creating an integrated approach to satellite deployment and launch services.[56]

The constellation is currently in its early development phase, having filed with the ITU in May 2024. As of 2025, the constellation has approximately 30 satellites in orbit, representing the initial deployment phase of what will become a much larger network[57].

Honghu-3's planning targets are ambitious, envisioning up to 10,000 satellites deployed across 160 different orbital planes in low Earth orbit at approximately 600 kilometers altitude. This multi-plane configuration will create a unified network capable of providing satellite communication, navigation, and monitoring services across diverse applications.

The business model leverages the vertical integration between LandSpace's launch capabilities and Hongqing Technology's satellite manufacturing expertise. This integrated approach reduces costs and improves deployment efficiency compared to companies relying on external launch services. LandSpace's development of reusable launch vehicles, similar to SpaceX's approach, supports cost-effective satellite deployment for the Honghu-3 constellation.

Qianfan (G60 Starlink) operated by Shanghai Spacecom Satellite Technology (SSST), Qianfan represents China's most direct competitor to SpaceX's Starlink constellation. Also known as the G60 constellation, this project has garnered significant attention and funding as China's flagship commercial satellite internet initiative.

The constellation's current deployment phase is the most advanced among Chinese mega-constellations. As of August 2024, Qianfan has successfully launched its first batch of satellites and continues regular deployment missions. The constellation achieved 72 satellite launches in 2024, falling short of the planned 108 due to launch capacity constraints, but demonstrating steady progress toward operational capability. As of October 2025, Qinfan resumed the build-up of its infrastructure with a batch of 18 satellites launched following a six-month delay.[58]

Qianfan's ambitious planning targets include deploying more than 600 satellites by the end of 2025, with expansion to over 14,000 satellites providing global broadband internet coverage by 2030.[59] This timeline represents an aggressive deployment schedule designed to establish market presence quickly. The first phase constellation, called SpaceSails, will consist of 1,296 satellites, with regional service provided by 648 satellites by late 2025 and global service achieved with an additional 648 satellites by 2027.

The business model centers on commercial satellite internet services, directly competing with established players like Starlink. SSST secured approximately USD943 million in funding in early

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56 China's mega-constellations mega-article, https://www.china-in-space.com/p/chinas-mega-constellations-mega-article

57 China's LEO Megaconstellations: Closing the Gap in the Global Space Race, https://frankrayal.com/2025/05/19/chinas-leo-megaconstellations-closing-the-gap-in-the-global-space-race/

58 CircleID. *Chinese LEO Satellite Internet Update: Guowang, Qianfan, and Honghu-3.* https://circleid.com/posts/chinese-leo-satellite-internet-update-guowang-qianfan-and-honghu-3

59 CNN World, China launches satellites to rival SpaceX's Starlink in boost for its space ambitions, https://edition.cnn.com/2024/08/09/china/china-satellite-qianfan-g60-starlink-intl-hnk/index.html

2024, [60] representing the largest Chinese satellite funding round to date. This substantial investment reflects confidence in the commercial viability of satellite internet services and supports the company's rapid deployment plans.

Qianfan benefits from Shanghai's *Action Plan to Promote Commercial Aerospace Development (2023-2025)*[61], which provides policy support and infrastructure development. The constellation is designed to serve both civilian broadband internet customers and potentially military communications applications, creating a dual-use business model that enhances revenue potential and strategic value.

2.4.1.3 Other established satellite players

Viasat Inc. operates as a provider of Multi-Orbit high-speed satellite broadband solutions and secure networking systems that covers military and commercial markets. It operates through three segments, namely satellite services, commercial networks, and government systems. Viasat competes in the domestic and SME broadband sector as well as defense sectors, government and enterprise offering integrated solutions combining satellite and terrestrial networks.[62] Viasat is also deploying NTN D2D systems in partnership with terrestrial mobile operators. In October 2025, it announced it would be investing $2 billion to add capacity with the stated purpose of rivalling Starlink's operations.[63]

Iridium maintains a unique position with its complete global coverage constellation, particularly serving IoT, maritime, and remote communication needs where other networks cannot reach. Iridium currently operates 66 active LEOs.[64]

2.4.2 Direct-to-device (D2D)

The D2D satellite market is experiencing expanding mobile connectivity by enabling smartphones and IoT devices to connect directly to satellites without specialised terminals. While the market is currently evolving, several new players (in particular AST SpaceMobile, Starlink, Viasat and Lynx) are expected to compete in it and drive ambitious rollouts in this space. Such key players have made use of early deployments, telecom partnerships but have different approaches to spectrum use and network design. Starlink uses large-scale LEO satellite constellations in order to bolster their position in the market and fill the available LEO orbits. New constellations in China, like Geespace, are also expected to enter the market and alter the competitive landscape however, securing comparable access to spectrum and orbits will be challenging in the global market. Other D2D players are also at risk of being pushed to a residual market position due to spectrum-orbit lock in by vertically integrated first movers like Starlink.

In September 2025, the GSA released an update on Non-Terrestrial 5G Networks and Satellite Connectivity.[65] The GSA found that as of August 2025, 12 MNOs have launched satellite- to-mobile services[66] and 24 MNOs are evaluating, testing, trialling or licensed to do so

60 Space News, but China launches fourth batch of Thousand Sails megaconstellation satellites, https://spacenews.com/china-launches-fourth-batch-of-thousand-sails-megaconstellation-satellites/#:~:text=THe%2018%20flat%20panel%20satellites,Shanghai%20Engineering%20Center%20for%20Microsatellites.

61 NTN's New Power Player: Is China Aiming to Take the Lead in Space-Based Connectivity?, https://interactive.satellitetoday.com/via/september-2025/ntns-new-power-player-is-china-aiming-to-take-the-lead-in-space-based-connectivity

62 List of Top Satellite Communication Companies in the World, https://www.imarcgroup.com/satellite-communication-companies

63 Bloomberg. Viasat Fights Back Against Musk's Starlink with New Satellite. https://www.bloomberg.com/news/newsletters/2025-10-08/viasat-fights-back-against-musk-s-starlink-with-new-satellite?embedded-checkout=true

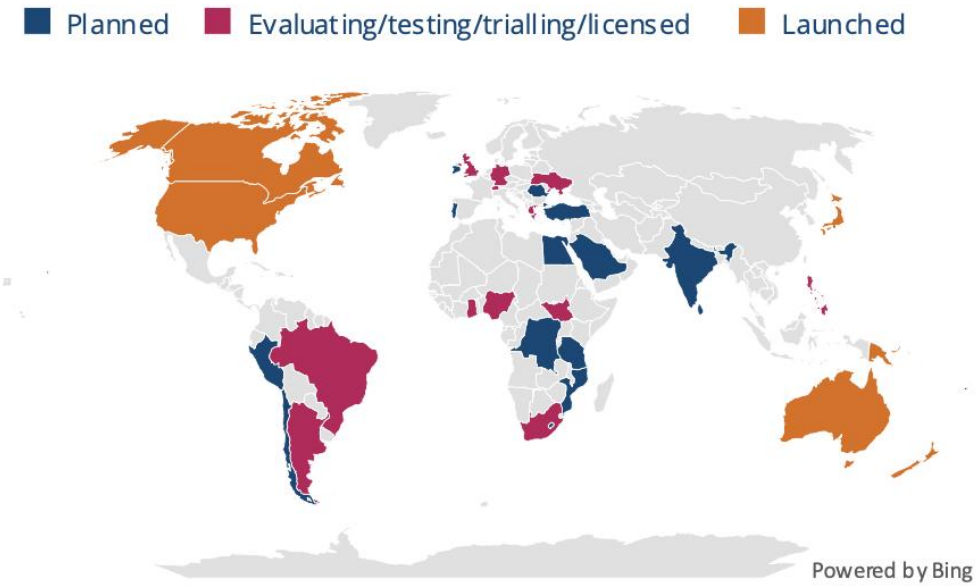
64 PCMag. *Iridium: Space X-EchoStar Spectrum Deal Will Be 'Disruptive'*, Force a Pivot. October 2025. https://au.pcmag.com/wireless-carriers/113848/iridium-spacex-echostar-spectrum-deal-will-be-disruptive-force-a-pivot

65 GSA, Non-Terrestrial 5G Networks and Satellite Connectivity, September 2025. Available at www.gsacom.com

66 Specifically MNOs in the Pacific Islands, United States, New Zealand, Japan (KDDI), Australia (KDDI), Canada (Rogers Wireless) have all launched services.

including ASEAN MNOs (e.g. Philippines). This fast-growing activity is summarised by the GSA in Exhibit 11 below.

Exhibit 11: Countries and territories with satellite-to-cellphone partnerships, by status



Source: GSA, September 2025

2.4.2.1 First-movers/current market leaders in the D2D market

SpaceX/Starlink is leading the global race to provide commercial D2D services using IMT terrestrial spectrum, which has a curtailed market growth due to the risks of interference caused by this approach. It has positioned itself in the market through various partnerships with existing mobile carriers. Due to this limitations, in September 2025, SpaceX also acquired 50 MHz of MSS spectrum and mobile satellite service licenses from EchoStar Corp,[67] a USD17 billion transition which will grant the company access to Mobile Satellite Spectrum (MSS) that could support Starlink's evolution from a satellite internet provider into a full-fledged MNO.[68] This deal will also enable Starlink to expand to a global 5G business.[69] Through integrating EchoStar's spectrum, Starlink can enhance its direct-to-cell capabilities and offer connectivity without the need for ground-based towers in unconnected regions and bypassing national telecommunications infrastructure. SpaceX is reportedly also working with partners to embed chips into smartphones, which could support a Starlink D2D service facilitated by the wireless spectrum obtained from EchoStar.[70] Looking ahead, it is anticipated that Starlink's commercial D2D services could be rolled out as early as late 2025 or during 2026, although this depends on overcoming technical and regulatory hurdles.[71]

The partnership Viasat-Skylo is a world's leading NTN operator in terms of geographic coverage and is currently routing satellite SOS messages to consumers needing emergency services. The

67 This comprises 2x 20 MHz of AWS-4 spectrum and 2 x 5 MHz of PCS-H spectrum in the United States plus MSS spectrum in the European Union (the latter until 2027).

68 Webpronews. *Elon Musk's Ambitious Leap into Mobile Networks.* September 2025. Available at https://www.webpronews.com/spacex-acquires-17b-spectrum-to-launch-starlink-mobile-carrier/

69 Reuters. *SpaceX buys wireless spectrum from Echostar in $17 billion deal.* September 2025. Available at https://www.reuters.com/business/media-telecom/spacex-buys-wireless-spectrum-echostar-17-billion-deal-2025-09-08/

70 MobileWorldLive. *SpaceX in talks with chip vendors for D2D service*. Available at https://www.mobileworldlive.com/starlink/spacex-in-talks-with-chip-vendors-for-d2d-service/

71 Webpronews. See above.

partnership has signaled it may soon offer satellite-powered voice calls on smartphones.[72] It will achieve this using MSS spectrum, which is free of interference and makes it the ideal choice for D2D deployment albeit limited in MHz terms. Hence, it overcomes the issue of radio-interference that emerges when using IMT spectrum for satellite use. The company has developed a narrowband IoT non-terrestrial network technology stack, based on 3GPP Release 17 cellular communications standards which enable devices to seamlessly switch between terrestrial mobile networks and existing satellites. The company recently made significant advancements by completing an over-the-air voice call over narrowband satellite network, paving the way for the deployment of a voice calling feature on its network.[73]

Skylo's approach to D2D focuses on utilising existing, globally allocated MSS frequency bands already in place to allow for commercially available services. This approach is one of partnership with MNOs and device manufacturers, therefore leveraging existing MSS spectrum and the device ecosystem, while avoiding waiting for additional regulatory approval.

AST Space Mobile is a satellite operator that is building the world's first cellular broadband network in space to operate directly with standard devices, designed for both commercial and government applications.[74] The company makes use of large satellites equivalent to terrestrial cell towers from space to provide coverage and has partnered with major MNOs to roll out its connectivity services. It is purpose built for D2D services in partnership with MNOs.

In August 2025, AST mobile entered into an agreement to acquire spectrum rights in the 1980-2010 MHz and 2170-220 MHz bands for LEO use.[75] While the company had previously suffered financial losses, the acquisition of spectrum and a substantial increase in capital have resolved financial woes, signalling a more optimistic pathway ahead towards commercial deployment.[76] AST had previously acquired a 45 MHz block of L-Band spectrum from Ligado.[77] As such while Starlink is the furthest ahead on satellites launched, ASTS is well-positioned with MNO exposure and able to offer cellular satellite connectivity without relying on partners like AT&T or Verizon.

Nonetheless, Verizon and AST SpaceMobile have earmarked 2026 for the launch of commercial D2D services, leveraging Verizon's 850 MHz of low-band spectrum and both companies' terrestrial and satellite infrastructure.[78] A newly formed partnership between Saudi Arabia's stc and AST SpaceMobile has similarly designated the fourth quarter of 2026 for the launch of D2D services across Saudi Arabia and select markets in the Middle East and Africa.[79]

Lynk Global is an emerging D2D player which is continuously expanding its direct-to-smartphone satellite network. The company has launched multiple small-sized satellites, providing intermittent texting and low-bandwidth services for unmodified smartphones, through partnerships with telecommunication operators in several countries, in the Pacific islands especially. Lynk plans to deploy 5,000 satellites in total and to achieve global, continuous service

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72 PCMag. *Cellular Starlink Rival Skylo Teases Satellite Voice Calling for Phones.* August 2025. https://au.pcmag.com/networking/112806/cellular-starlink-rival-skylo-teases-satellite-voice-calling-for-phones

73 However, currently only newer devices like the Google Pixel 9 and Samsung Galaxy S25 series work with its service. Refer to https://www.androidauthority.com/verizon-satellites-sms-and-voice-services-3524111/

74 AST SpaceMobile. Company Snapshot. Available at https://ast-science.com/company/

75 AST SpaceMobile agrees to acquire Global S-Band spectrum priority rights held under the ITU. August, 2025. Available at https://www.telecomtv.com/content/access-evolution/ast-spacemobile-agrees-to-acquire-global-s-band-spectrum-priority-rights-held-under-the-itu-53590/

76 The Motley Fool. AST SpaceMobile: A High-Risk, High Reward Play on the Future of Connectivity. June 2025. Available at https://www.fool.com/investing/2025/06/15/ast-spacemobile-a-high-risk-high-reward-play-on-th/#:~:text=AST%20SpaceMobile%20is%20pioneering%20a,this%20high%2Dprofile%20space%20stock.

77 PCMag. AST SpaceMobile Acquires Radio Spectrum for Cellular Satellite Service. January 2025. Available at https://au.pcmag.com/networking/109119/ast-spacemobile-acquires-radio-spectrum-for-cellular-satellite-service

78 MobileWorldLive. *Verizon, AST SpaceMobile target 2026 D2D launch.* October 2025. Available at https://www.mobileworldlive.com/network-tech/verizon-ast-spacemobile-target-2026-d2d-launch/

79 Developing Telecoms. https://developingtelecoms.com/telecom-technology/satellite-communications-networks/19271-ast-spacemobile-and-stc-team-to-develop-d2d-satellite-services.html

by 2027. In October 2025, Lynk announced its plans to merge with Omnispace to upgrade its D2D services, using coordinated S-Band spectrum rather than just relying on mobile cellular partnerships.[80]

Already a leading provider, Lynk intends on scaling its network through its partnership with SES, leveraging its orbits for backhaul and delaying data traffic while providing additional D2D services in return. Lynk and SES' partnership will likely extend to spectrum use and distribution channels across mobile network operators and governments. By achieving capital efficiency, Lynk aims to be a strong competitor to Starlink's deployed capital infrastructure.

Globalstar and Apple have set up a D2D partnership to offer an integrated hardware-and-service model.[81] Under a funding agreement set up between both players, Globalstar has committed to allocating most of its network capacity to Apple to expand the iPhone's communication services. This move built on a previous agreement focused on emerging messaging from remote areas.[82] However, recent reports that Globalstar is considering selling itself off is are raising speculations that Apple might turn to SpaceX instead.[83]

A summary of the key LEO satellite providers is contained in Exhibit 12 below with their current MNO agreements.

Exhibit 12: Summary of key LEO satellite providers

Info	Starlink	AST SpaceMobile	Skylo	Lynk Global
Satellites in orbit	9,000	6	8 (owned by Viasat, Ligado Networks, TerreStar)	10 + 120 (SES)
Full constellation	42,000	45-60		5,000
Subscribers	7 million*	0		Over 7 billion + 363 million (SES)
Satellite dimensions	approx. 1,200 sq. ft.	approx. 2,400 sq. ft.		0.15 x 1 x 1 m; 0.15 x 1.5 x 1.5 m - 6 m x 3 m x 2 m; 7 m x 3.3 m ; 7 m x 5.4 m x 2.7 m (SES)
MNO relationships	4	~50	17	Over 50
Total MNO subscribers	~166 million	>2,000 million	Up to 1 billion	
Spectrum bands (USA only)	50 MHz of AWS-4 and H-Block spectrum	45 MHz of mid-band with plans on using L-Band and 3GPP technology	Shared with Echostar, Ligado, and Inmarsat	60 MHz of S-band spectrum
D2D capability	No, not all devices – only compatible with certain 4G/LTE phones[84]	Yes, tested to be compatible with all current device technology	Not all devices, only specific handsets	Yes, compatible with handsets

80 https://spacenews.com/lynk-global-and-omnispace-to-merge-in-race-for-direct-to-device-satellite-spectrum/
81 https://telcomagazine.com/news/d2d-satellite-telcos-join-viasat-globalstar-push
82 https://developingtelecoms.com/telecom-business/telecom-investment-mergers/17565-apple-buys-into-globalstar-to-boost-coverage.html
83 https://au.pcmag.com/wireless-carriers/113848/iridium-spacex-echostar-spectrum-deal-will-be-disruptive-force-a-pivot
84 According to the T-Mobile (USA) website, over 60 handsets. See https://www.t-mobile.com/coverage/satellite-phone-service

Info	Starlink	AST SpaceMobile	Skylo	Lynk Global
Technology deployed	Full-text service with T-Mobile, data and voice to follow	Tested data, text, voice	SOS text, tested voice	SOS text, two-way messaging
Upcoming catalysts	(1) Further spectrum/deployment announcements post EchoStar announcement (2) Data and IoT service offering (2025) (3) Voice service to be enabled 'soon'	(1) First Block 2 Bluebird launch (2) Continuous manufacturing cadence of satellites (>40 satellites) (3) Intermittent service (YE25) (4) Full continuous global service (YE26)	(1) Roll out of voice calls using NB-NTN (2) Satellite text and voice on smartwatches	(1) Intends to launch voice and mobile broadband services (2) Lynk plans to merge with Omnispace and SES to upgrade D2D services. The merger is expected to close late 2025 or early 2026.

Source: Bank of America Global Research, company reports with WPC modifications and additions. Note *Starlink subscribers include broadband subscribers and recent Starlink announcements propose entirely new satellites for D2C services to be launched in approximately 2 years.

Exhibit 13: MNO – with their subscriber numbers with announced D2D deals (in millions)

AST Space Mobile		Starlink		Skylo		Lynk	
Vodafone (Worldwide)	523.4	T-Mobile (United States)	119.7	Verizon	146.1	Turkcell (Turkey)	37.5
Telefonica (S. America & Europe)	309.1	KDDI (Japan)	64.23	Deutsche Telekom	69.8	Unitel (Mongolia)	1.6
Orange (Africa & Europe)	244.5	Rogers (Canada)	10.9	Telefónica	386.2	ALIV (Bahamas)	1.3
Claro (S. America)	231.9	Optus (Australia)	10.2	KPN	44	Telecel (CAR)	0.9
MTN (Africa & Asia)	212.3	Entel (Chile/Peru)	4.8	Others		PNCC (Palau Islands)	0.8
Telkomsel Indonesia (Indonesia)	159.7	One (New Zealand)	2.6			Bmobile (Solomon Islands)	0.5
Etisalat (Africa & Asia)	150.4	Salt (Switzerland)	1.58			Telikom (PNG)	0.4
Verizon (N. America)	144.8	Telstra (Australia)	28.3			PLDT (Philippines)	3.53
AT&T (N. America)	138.1	Rogers (Canada)	12.2			TPG Telecom (Australia)	5.52
Oordedoo Hutch (Africa & Asia)	109.0	One NZ (New Zealand)	3				
Globe Telecom (Philippines)	86.7	Kyivstar (Ukraine)	24.4				
Smart Comm. (Philippines)	66.3	Virgin Media O2 (United Kingdom)	45.8				
TIM Brazil (Brazil)	61.2						
XL Axiata (Indonesia)	57.5						
Tigo (S. America)	46.7						

AST Space Mobile		Starlink		Skylo		Lynk	
Smartfren (Indonesia)	35.5						
Safaricom (Africa)	34.6						
STC KSA (Middle East)	30.3						
Telstra (Australia)	23.4						
Telecom Argentina (S. America)	23.1						
Africacell (Africa)	18.5						
Zain (Middle East)	12.7						
Maxis (Malaysia)	12.1						
NOW (Malaysia)	12.0						
Bell Canada (Canada)	10.2						
Liberty Latin America (S. America)	8.0						
FirstNet (United States)	6.1						
Rakuten (Japan)	6.1						
Pelephone (Israel)	2.6						
YES (YTL Comm.)	2.1						
UTCL (Uganda)	1.8						
Somtel (Somalia)	1.5						
LTC Mobile (Liberia)	1.0						
Muni (Africa)	0.3						
Smile (Africa)	0.3						
Salam (Middle East)	?						
Total	**2780.9**		**214.2**		**602.1**		**43.0**

Source: Nomadbets, and amendments and additions by WPC, November 2025

2.4.2.2 Possible new players

Geespace (Geely Constellation) represents a unique approach in China's satellite landscape. Developed by Zhejiang Geely Holding Group, the automotive conglomerate headquartered in Hangzhou, this entry into satellite services reflects the growing convergence between transportation and space technologies.

In 2022, Geespace launched nine satellites, which is the first of 64 phase-one satellites which reached its completion late September 2025, capable of serving 120 million users worldwide.[85] The second phase of 168 satellites will then be launched, bringing the constellation up to 240.[86]

The current state of Geespace deployment focuses on developing low-orbit satellites with centimeter-level accuracy capabilities. The constellation emphasises precision navigation and positioning services, leveraging Geely's automotive expertise to create synergies between ground-based transportation and space-based services.

Geespace's planning targets center on supporting high-speed data transmission, precise navigation, artificial intelligence remote sensing, and cloud computing services. The constellation

85 Geely. https://www.geely.com/en/news/2025/geely-constellation-sixth-launch-deployment-64-satellites-orbit
86 NewSpace Index, https://www.newspace.im/constellations/geely

aims to provide specialised services for automotive applications, including autonomous vehicle navigation, connected car services, and transportation logistics optimisation.

Amazon's Project Kuiper's (now Amazon Leo) D2D offering is currently in development.[87] Project Kuiper is reportedly aiming to begin offering commercial D2D services in five major markets across North America and Europe by early 2026.[88]

Tiantong is a geostationary satellite system which is operated by China Telecom to provide D2D services, with services available in Hong Kong and Lao PDR as well.[89]

Viasat and Space42 have announced the formation of a joint venture known as **Equatys**, which will adopt a towerco model to offer wholesale direct-do-device connectivity to third party service providers. Equatys is planning a sovereignty friendly approach to D2D and aims to launch commercial D2D services within three years of the announcement made in September 2025.[90]

2.4.2.3 Satellite IoT players

It should be noted at the outset that narrowband IoT is provided in sub-1 GHz bands[91] and S-band (same as D2D). It should be noted that in Australia, ACMA has reserved 2x5 MHz in the S-Band for D2D although such an amount may not be needed. Instead, there is potential for shared access.[92]

Sateliot is a nascent D2D company which is developing a LEO nanosatellite constellation to offer 3GPP Release 17 standards-based 5G NB-IoT non-terrestrial network connectivity services to MNOs and mobile virtual network operators (MVNOs).

Omnispace is an emerging D2D company which has been testing direct-to-smartphone LEO plans in partnership with large telecommunication players in Africa and the Middle East. Omnispace operates an NGSO constellation with both MEO and LEOs to provide connectivity to customers outside of terrestrial cell tower coverage. Omnispace intends on offering MSS D2D services which target Enterprise IoT, travellers, and emergency services in accordance with 3GPP Release standards and beyond. Omnispace recently announced its intention to merge with Lynk Global, as explained above.

2.5 Satellite-based business and partnership models

There is no dominant business model yet for the new era of satellite communications rather, several models coexist at this stage.[93]

2.5.1 Infrastructure provider model

This business model sees the Satellite Operator provide a wholesale service, and the MNO provide a retail service to its end users. For example, the MNO includes access to D2D to customers on its premium tariffs or as a 'bolt on' extra.[94]

87 Refer to https://www.lightreading.com/satellite/amazon-d2d-offerings-are-in-development-

88 https://www.telecomtv.com/content/access-evolution/d2d-in-focus-as-satellite-connectivity-moves-from-niche-to-mainstream-53873/

89 https://spacenews.com/china-promotes-direct-to-device-satellite-services-with-new-guidelines-and-licensing/

90 Telecom TV. *Viasat, Space 42 prep D2D joint venture*. September 2025. https://www.telecomtv.com/content/access-evolution/viasat-space42-prep-d2d-joint-venture-53847/

91 See RCR Wireless. *Europe clears path for satellite LoRaWAN in 862–870MHz band*. July 2025. https://www.rcrwireless.com/20250730/internet-of-things/europe-statellite-lorawan

92 See CST in Saudi Arabia**,** assigned entire 2x30 MHz but required license holder to coordinate use with narrowband IoT satellite operators in the upper 2x5 MHz**.**

93 Julia Criado, *Spanish Government*, D2D Policy Forum: Realising the Vision – Can Direct-to-Device Connectivity, 1 July 2025

94 Ofcom, Consultation: Enabling Satellite Direct to Device services in Mobile Spectrum, 2025, page 7

This enables the Satellite Operator to focus on the development of their satellite constellations and avoid the need to create a consumer-facing brand and operations.

2.5.2 Mobile network operator partnership model

This model relies on alliances formed between satellite operators and mobile carriers, characterised by exclusive arrangements and shared revenue streams.

AST SpaceMobile has adopted a model focused exclusively on B2B relationships with existing MNOs, avoiding direct consumer relations in favour of wholesale arrangements. It uses larger powerful satellites to provide coverage that is equivalent to terrestrial cell towers from space. Their larger are more complex and costly than typical LEO satellites but fewer satellites are needed overall to achieve global coverage.

This model relies on exclusive partnerships with MNOs in different geographic regions. This should enable AST SpaceMobile to build its customer base rapidly allowing it to more quickly recover their significant development and deployment costs.

The use of capacity leasing agreements (often regarding minimum revenue guarantees or long-term contracts with predictable revenue/costs) with MNOs enable low revenue volatility and provide capacity certainty for MNOs.

Consumers can maintain existing service plans and relationships with their MNOs operators, with satellite connectivity appearing as automatic extended coverage or as an add-on extra with individual partner carriers determining their own pricing strategies.

2.5.3 Integrated platform model

Under this model companies attempt to control the entire value chain from satellite infrastructure to direct consumer relationships.

One example is Starlink, which has established itself as the dominant force in the consumer and small business satellite services market in Australia and New Zealand. Its success has been built on a vertically integrated, direct-to-market model that has rapidly achieved significant scale.[95]

The company's strategy is to sell directly to consumers and businesses through the SpaceX Starlink website. This approach bypasses the traditional telecommunications reseller channel in its core broadband product, arming SpaceX with control over pricing, branding, and the customer relationship.[96]

Starlink has also deployed a second constellation for what it refers to as Direct to Cell (D2C) services. It is hoping that existing infrastructure and MNO relationships gives a competitive head start ahead of other D2D competitors that are still developing technical solutions or deploying constellations. In November 2024, after extensive testing, SpaceX was granted FCC approval for Starlink Direct to Cell commercial service within the United States, a key regulatory milestone to provide satellite-to-mobile connectivity.[97] For example, its D2C in the United States through partnering with T-Mobile means that users can keep smartphones and gain access to satellite connectivity in areas not covered by terrestrial networks—satellite connectivity appears as a seamless extension of the terrestrial network.

The Starlink model represents vertical integration across space and telecommunications value chain; maintains control over satellite manufacturing, through Space X launch services, constellation operations, and ground infrastructure. The result is optimisation of costs and

95 Venture Insights, *EXPLAINER: The ANZ LEOSat market takes shape*, July 2025, page 3
96 *Ibid*
97 Refer to https://www.starlink.com/public-files/DIRECT_TO_CELL_SERVICE_FEB_25.pdf

deployment schedules while maintaining quality control enabling the ability to pivot services and adjust pricing strategies based on market conditions

It should be noted that SMS traffic on Starlink D2C bypasses the MNO core and uses a custom Starlink-operated backend that uses a carrier-integrated messaging layer (via vendors like Syniverse) to connect to the MNO's Short Message Service Center (SMSC) . This workaround requires custom APIs, custom routing paths and other arrangements for identity and billing.[98]

Starlink's architecture is IP-based rather than cellular, which changes how voice or data capabilities are. Voice is delivered over IP (VoIP) rather than VoLTE. Data packets are sent over a generic IP tunnel and not integrated with the phone number. Similarly, 'mobile' data would land at a Starlink gateway as non-prioritised IP traffic which lacks traditional cellular controls like throttling, QoS classes or charging rules. In this way, a Starlink mobile data service would act more like a mobile hotspot than integrated mobile broadband.[99]

2.5.4 Premium consumer integration model – Apple and Globalstar

The focus of the business model is on premium consumer experiences. Consumer experience is important for encouraging D2D adoption.

The design principle is 'native integration', where satellite messaging works seamlessly through the phone's default SMS and apps, ensures familiarity and ease of use. In contrast, OTT models that rely on third-party apps create friction and limit everyday usage for this reason, a built-in and app-free functionality will more likely succeed.[100] On 15 September 2025, Apple issued a support note highlighting that even if your MNO network offers satellite features, you can still use Apple satellite features on iPhone 14 or later in select regions when you are outside of traditional cellular and Wi-Fi coverage and that MNO-provided satellite features can be switched off on your iPhone.[101]

This model integrates satellite communications as a differentiating feature rather than a comprehensive solution with the service provided at no additional cost to consumers. This is difficult for competitors to match without significant resources.

2.5.5 Distributed partnership model

This model relies on numerous smaller, strategic partnerships with broad range of MNOs worldwide and avoids pursuing exclusive arrangements with major carriers.

Satellites appear as standard cell towers to terrestrial devices, requiring minimal changes to existing network infrastructure. The satellite operator provides coverage extension that works with existing devices and plans without requiring user intervention/awareness—this creates no disruption to customer relationships.

As has reported UK's regulator Ofcom, where voice services are offered using D2D networks, consumer experience may vary depending on the business model agreed between the Satellite Operator and the MNO. A consumer may have a seamless experience of switching between the MNO's terrestrial network and the satellite, but in other models the satellite connectivity could be offered as a distinct service, more akin to the international roaming consumers are familiar with when they travel abroad.[102]

98 Analysys Mason, *MNOs and OEMs need to adopt satellite D2D now*, June 2025, page 13
99 *Ibid*
100 *Op cit,* page 6
101 Refer to https://support.apple.com/en-us/122339
102 Ofcom, *Consultation: Enabling Satellite Direct to Device services in Mobile Spectrum*, 2025, page 6

2.6 Satellite companies and MNOs: competitive strategies

Satellites offer MNOs opportunities to strengthen their consumer offerings. Satellite companies can enable MNOs to enhance their service offerings to residents in remote locations with improved broadband and direct to handset services.

Satellite operators can also offer MNO customers continuity of services when customers are travelling, especially in remote locations. They can enable broadband services in locations where previously none were available.

Furthermore, satellite operators can offer enterprise backhaul services to MNOs in situations where terrestrial backhaul is underdeveloped our cannot be developed because of local geographical and/or political conditions. The ability to offer backhaul during natural disasters is also an important capability.

Having said, Space X/Starlink have announced a satellite D2D service offering which is arguably positioning itself as being in an optimal bargaining position relative to other MNOs. This has seen a pivot in its spectrum strategy from using IMT spectrum (obtained by partnering with MNOs) to using its own spectrum portfolio. It will also be seeking to acquire access to MSS spectrum in the Asia-Pacific region including ASEAN. See Exhibit 14.

Exhibit 14: Summary of Space X/Starlink's new 15,000 D2D mega constellation

SpaceX has announced plans to launch as many as 15,000 next-generation satellites to upgrade its cellular Starlink service.[103] Since 2020, SpaceX has launched more than 8,000 Starlink satellites, with approximately 600 launched since January 2024 for the company's direct-to-cell (D2C) network.[104] The proposed additional satellites will utilise the radio spectrum that SpaceX is acquiring from BoostMobile's parent company, EchoStar, in a USD17 billion deal.[105]

Currently, the company's cellular Starlink system is utilising T-Mobile's IMT spectrum (2 x 5 MHz of the n25 band) . Through the deal, SpaceX will gain exclusive use of EchoStar's spectrum.[106] SpaceX estimates that by using the new spectrum with the next-generation D2C satellites, there would be a 20-fold increase in the throughput, as well as a 100-fold capacity increase, compared to the generation currently in orbit.[107] The current, and older, satellites are unable to make 'full use' of the spectrum.[108]

The deal also means that SpaceX does not have to rely on third-party mobile carriers to use their radio spectrum. Instead, it argues that it will have its own spectrum "portfolio", giving it stronger negotiating powers against MNOs.[109]

Importantly, as part of the deal, EchoStar will cancel its plan to build a competitor to the Starlink service. Instead, BoostMobile will gain access to the cellular Starlink system.[110] It also makes it more difficult for competitors to move forward, as they cannot compete with SpaceX's speed in bringing new satellites to market.[111]

103 https://au.pcmag.com/networking/113189/spacex-eyes-15000-more-satellites-for-cellular-starlink-hints-at-carrier-plans
104 https://www.reuters.com/business/media-telecom/spacex-buys-wireless-spectrum-echostar-17-billion-deal-2025-09-08/
105 https://au.pcmag.com/networking/113189/spacex-eyes-15000-more-satellites-for-cellular-starlink-hints-at-carrier-plans
106 https://au.pcmag.com/networking/112974/spacex-strikes-spectrum-deal-with-echostar-to-supercharge-cellular-starlink
107 Ibid
108 https://www.theregister.com/2025/09/09/spacex_echostar_spectrum_deal/; https://www.space.com/space-exploration/satellites/spacex-buys-usd17-billion-worth-of-satellite-spectrum-to-beef-up-starlink-broadband-service?
109 Refer to https://www.linkedin.com/posts/activity-7370792468256206849-9YoD/
110 https://au.pcmag.com/networking/112974/spacex-strikes-spectrum-deal-with-echostar-to-supercharge-cellular-starlink
111 https://tmfassociates.com/blog/2025/09/08/spacex-disrupts-everyones-plans-again/

In the filing to FCC requesting for additional satellites, Space X stated that the satellite system "will consist of a constellation of low and very low-Earth-orbit satellites that will leverage SpaceX's existing ground equipment as well as add new equipment that aims to optimise performance for consumers".[112]

Exhibit 15: SpaceX's Proposed Frequency Bands for Direct-To-Cellular Satellite Communications

Type of Link and Transmission Direction	Frequency Ranges
G Block SCS Uplink	1910 – 1915 MHz
G Block SCS Downlink	1990 – 1995 MHz
H-Block SCS Uplink	1915 – 1920 MHz
H-Block SCS Downlink	1995 – 2000 MHz
2 GHz MSS Uplink	2000 – 2025 MHz
2 GHz MSS Downlink	2180 – 2200 MHz
International SCS	1429 – 2690 MHz
International L-Band MSS Uplink	1668 – 1675 MHz 1626.5 – 1660.5 MHz
International L-Band MSS Downlink	1518 – 1525 MHz 1525 – 1559 MHz
International Extended L-Band MSS Uplink	1610 – 1626.5 MHz
International Extended L-Band MSS Downlink	2483.5 – 2500 MHz
International 2 GHz MSS Uplink	1980 – 2025 MHz
International 2 GHz MSS Downlink	2170 – 2200 MHz
Satellite to Gateway Earth Station	17.3 – 17.8 GHz

Source: SpaceX / FCC

However, other analysts have commented that the terrestrial network does not appear to be SpaceX's priority, while others, including AT&T CEO John Stankey, are skeptical as to whether the amount of spectrum acquired would allow SpaceX to offer a competitive service from space, particularly in highly dense areas in cities.[113] Musk himself has tempered expectations, remarking that current smartphone chipsets do not support the EchoStar radio frequencies, noting that the required modifications to smartphones and other devices would probably take two years.[114]

112 https://au.pcmag.com/networking/113189/spacex-eyes-15000-more-satellites-for-cellular-starlink-hints-at-carrier-plans

113 https://au.pcmag.com/wireless-carriers/113023/elon-musk-mulls-making-starlink-a-global-carrier-after-echostar-deal

114 https://au.pcmag.com/wireless-carriers/113023/elon-musk-mulls-making-starlink-a-global-carrier-after-echostar-deal

3 The state of ASEAN remote connectivity

3.1 The ASEAN remote connectivity challenge

As illustrated in Exhibit 5, the cost of providing connectivity to remote users increases very rapidly with increasing remoteness. Satellite communications, in effect, sidesteps this relationship between cost and remoteness.

Remote communities across ASEAN face a stubborn, multi-layered connectivity challenge. Geography, market economics, energy and backhaul constraints, device affordability, and policy and spectrum bottlenecks all interact to keep high-quality telecoms and broadband out of reach for millions. While the region has made meaningful progress expanding 4G and 5G and laying new subsea and terrestrial fiber, the last mile to sparsely populated communities remains the most expensive and complex. Policymakers increasingly frame connectivity as a foundation for inclusion, resilience, and growth; yet turning that ambition into reliable, affordable service in remote places requires different approaches from urban network expansion.

Indonesia and the Philippines alone encompass thousands of inhabited islands; Lao PDR and Myanmar are mountainous; rural Cambodia and large parts of Viet Nam and Thailand are threaded by rivers, wetlands, and jungle. In such terrain, the civil works to build towers, string microwave relays, or trench fiber escalate in cost, timelines, and risk.

Remoteness also correlated with low ARPU: small, lower income rural populations generate less traffic, so operators struggle to earn a return on capital-intensive builds without some mix of subsidies, shared infrastructure, or innovative architectures. ASEAN leaders have repeatedly put connectivity and resilience on the regional agenda precisely because these structural realities keep development uneven if left to market forces alone.[115]

Backhaul is the source of much of the cost of providing remote connectivity. A remote LTE cell is only as fast as the link that carries traffic from the tower to the core network. In many ASEAN rural areas, microwave chains hop over mountains or across island channels; during monsoon seasons, weather can degrade propagation. Fiber backhaul is ideal but prohibitively expensive where rights-of-way are difficult[116] or environmental permitting is sensitive. Governments have responded by funding backbone segments that private carriers can lease. In the Philippines, for example, the Luzon Bypass Infrastructure Project—a long fiber corridor—pairs with broader "Broadband ng Masa" efforts to lower wholesale costs and enable last-mile builds to more remote areas. This model (publicly supported backbone plus open access) helps make rural cell sites economical by cutting the single biggest cost driver after power.[117]

Electricity supply is a perennial constraint on remote connectivity. Towers off the main grid rely on diesel or hybrid solar systems; fuel logistics and battery maintenance are challenging in jungles

115 ASEAN Annual Report – *Enhancing Connectivity and Resilience*, December 2024 https://asean.org/serial/annual-report-2024-enhancing-connectivity-and-resilience/

116 For a variety of reasons including customary law and usufruct land rights which make gaining the approval of affected parties difficult. See ITU, *Digital Infrastructure Policy and Regulation in the Asia-Pacific Region,* September 2019, page 40*ff* and Appendix A.

117 ibid

and archipelagos. Intermittent power degrades quality of experience and raises operating expenditures, which then push retail prices higher.[118] Electricity companies may have strict provisioning rules.[119] Innovations here include smarter power management, lithium battery deployments with remote monitoring, and community microgrids that co-serve telecom equipment and local households. For remote clinics and schools, pairing connectivity with dependable energy can multiply social returns, but it requires coordination across ministries—not just ICT regulators.

The economics of the last mile have historically been addressed through Universal Service Funds (USFs) and similar mechanisms. But performance varies widely. Well-designed USFs set clear, technology-neutral targets, disburse funds competitively, and enforce build-and-operate milestones. Poorly designed ones accumulate fees without transparent, timely use, or they fund duplicative infrastructure. In Asia and the Pacific, evidence suggests USF design and administration significantly influence fixed-broadband reach and adoption, especially where market incentives are weak. For ASEAN's remoter areas, reforming USFs toward open-access backhaul, infrastructure sharing, and outcome-based subsidies can stretch each dollar further.[120]

3.2 Current state of ASEAN remote connectivity

Assessing the current state of connectivity in remote ASEAN communities is challenging for two main reasons. First, there is no universal agreement about what constitutes an adequate level of connectivity and second, accurate data sets are difficult to obtain and maintain.

The ITU has developed the concept of 'universal and meaningful connectivity' (UMC).

> *UMC is defined as enabling everyone to enjoy a safe, enriching and productive online experience at an affordable cost. UMC does not imply that everyone must be connected all the time but describes a situation where everyone can access the Internet optimally and affordably whenever and wherever they need.*[121]

The ITU's the ICT Development Index (IDI) has played an important role in providing a global perspective on levels of national connectivity since 2009. The annual publication of the IDI was discontinued between 2017 and 2023. Since 2023 it has again been published annually.

Although indexes do have limitations because they do not present raw data, they nonetheless are useful for international comparisons. Exhibit 16 illustrates the structure of the ICT development index.

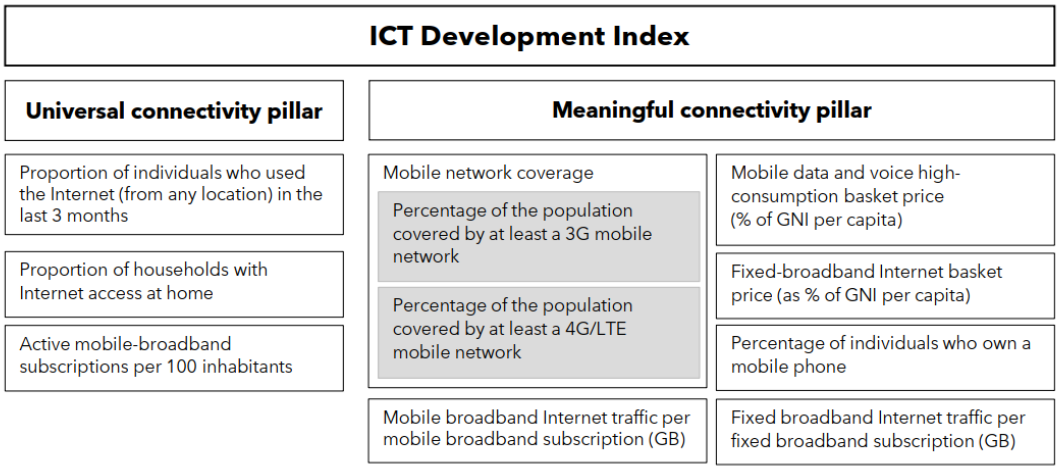
118 ASEAN Framework on Logistic for Digital Economy Supply Chain for Rural Area, https://asean.org/wp-content/uploads/2024/04/ID_Final-Report_ASEAN-Framework-on-Logistic-for-Digital-Economy-Supply-Chain-for-Rural-Area.pdf?utm_source=chatgpt.com

119 For example, in Cambodia the Electricity company requires the land owner to guarantee payment even when the service is connected to a specific location for an MNO. This maybe diminish enthusiasm on the part of the land owner to allow his or her land to be used for towers or other telecommunications infrastructure.

120 UNESCAP, The Impact of Universal Service Funds on Fixed-Broadband Deployment and Internet Adoption *in Asia and the Pacific*, https://www.unescap.org/sites/default/files/Universal%20Access%20and%20Service%20Funds.pdf

121 ITU, The ICT Development Index 2025. Available at www.itu.int

Exhibit 16: Structure of the ICT Development Index



Source: ITU, The ICT Development Index

Exhibit 17 shows the IDI index scores for ASEAN countries in 2025. The IDI scores reflect levels of economic development in AMSs as do the connectivity scores. The values for percentage of population covered by at least 3G or 4G show relatively high values for all countries. Based on these data it would appear that the problem of remote connectivity has largely been solved in ASEAN countries. However, since there are obviously still communities where connectivity is still minimal, additional more detailed data are required to examine remote connectivity in more detail.

Exhibit 17: ITU IDI for ASEAN countries

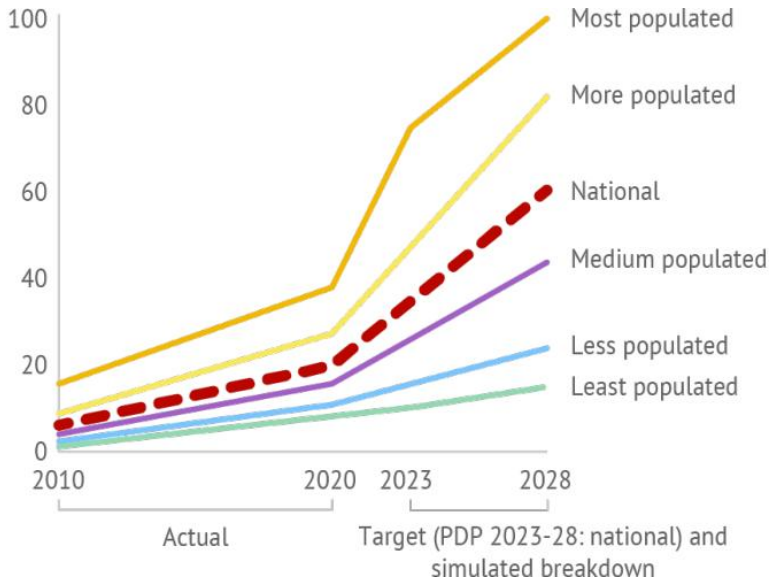
	IDI Score and change		Connectivity score		Coverage	
AMS	IDI 2025	% change since 2024	Universal	Meaningful	% pop covered by at least 3G	% pop covered by at least 4G
Brunei Darussalam	93.6	-2%	93.1	94.1	99.1	99.0
Cambodia	77.4	7%	71.4	83.3	93.1	93.1
Indonesia	84.7	2%	81.2	88.2	99.0	99.0
Lao PDR	69.7	7%	63.6	75.9	85.0	76.0
Malaysia	95.3	0%	95.3	95.2	97.1	97.1
Myanmar	32.4	1%	15.9	48.8	95.4	94.4
Philippines	78.0	5%	69.8	86.3	98.5	95.5
Singapore	97.7	0%	99.7	95.7	100.0	100.0
Thailand	91.9	1%	90.6	93.2	99.0	99.0
Viet Nam	86.0	1%	80.3	91.6	99.9	99.9

Source: ITU, The ICT Development Index

Exhibit 18 shows more detailed data for the Philippines with broadband penetration by population density. These data from The World Bank[122] data show large gaps between broadband penetration between high (100%) and low (10 to 20%) population density areas.

122 World Bank, *Better Internet for all Filipinos,: Reforms Promoting Competition and Increasing Investment for Broadband Infrastructure*, January 2024, Available at https://openknowledge.worldbank.org/entities/publication/81fa48e6-866b-49bc-8f0d-27c86dee5f68

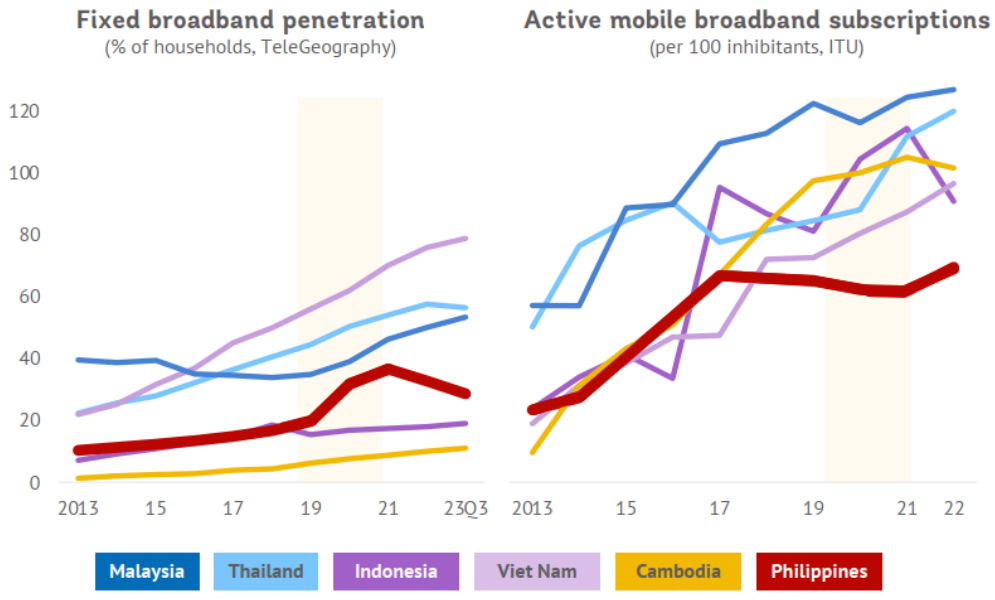
Exhibit 18: Broadband penetration, per population quintile by municipal population density



Source: The World Bank

Exhibit 19 shows trends in fixed broadband penetration and mobile subscriptions in ASEAN, indicating poor fixed broadband penetration in Cambodia, Indonesia, Viet Nam and Philippines and relatively low mobile subscription in Philippines.

Exhibit 19: Broadband access trends across ASEAN



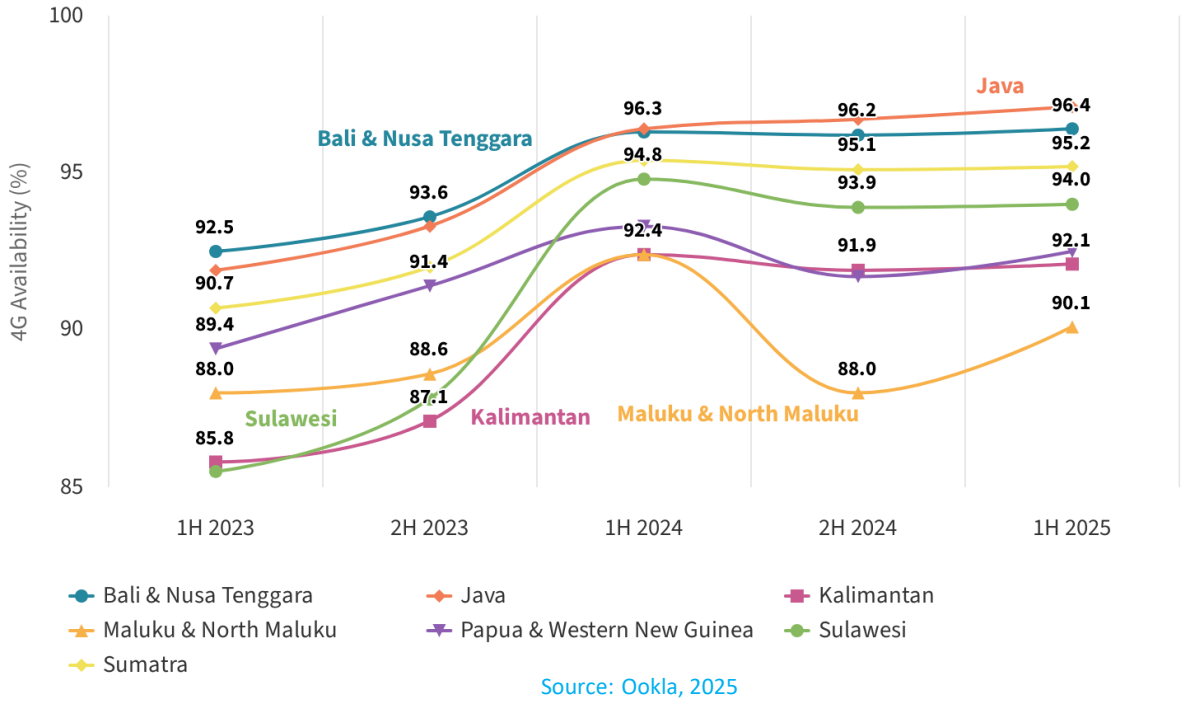
Source: The World Bank

Other sources of more detailed sub-national data include Okla[123]. Exhibit 20 and

123 Ookla, Affandy Johan, *Indonesia's digital divide narrows with mobile network performance gains,* August 12, 2025, https://www.ookla.com/articles/indonesia-connectivity-divide-1h2025

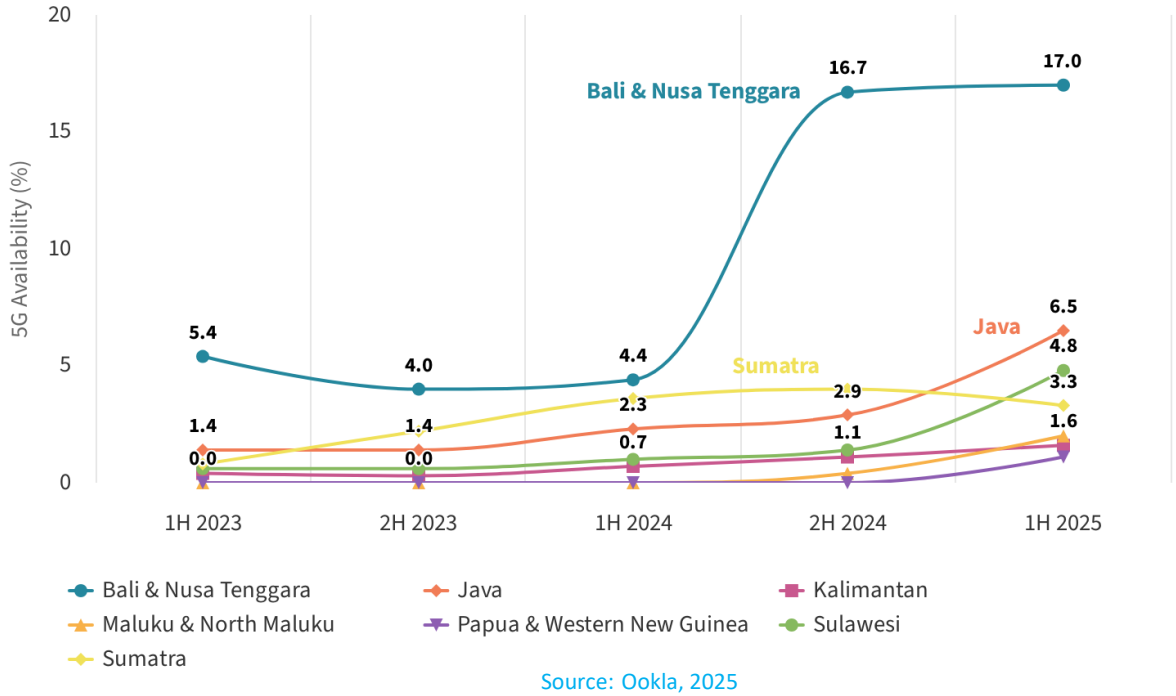
Exhibit 21 show data for major Indonesian islands. Similarly to Philippines, areas of high population density, for example, Java, show higher levels of connectivity.
The differences in 5G availability show much larger variability between low and high population density areas.

Exhibit 20: 4G availability (%) trend across Indonesia's major islands (1H 2023 and 1H 2025)



Source: Ookla, 2025

Exhibit 21: 5G availability (%) trend across Indonesia's major islands (1H 2023 and 1H 2025)

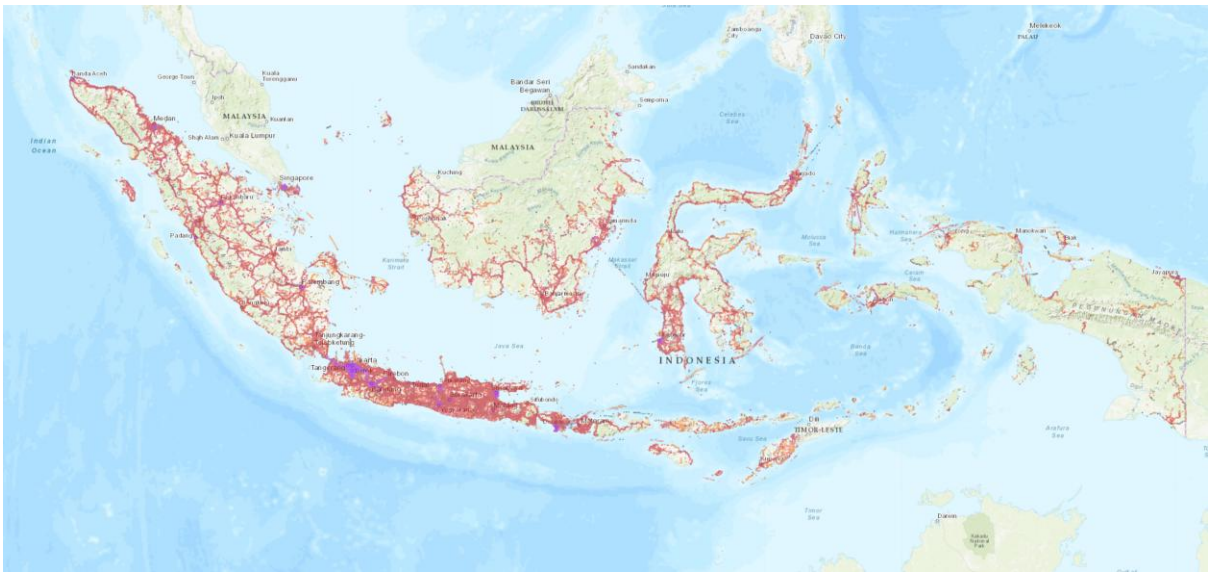


Source: Ookla, 2025

It is of course no surprise that services are superior in high population density areas—telecommunications business models are driven by revenue per unit area. But these more detailed data indicate the remote access is still a policy challenge for low population density areas in ASEAN.

This conclusion is also supported by coverage maps, for example, those from nperf.[124] Exhibit 22 shows that significant areas of Kalimantan and Sulawesi have no wireless access.

Exhibit 22: Telkomsel's 3G / 4G / 5G coverage map in Indonesia)



Source: nperf

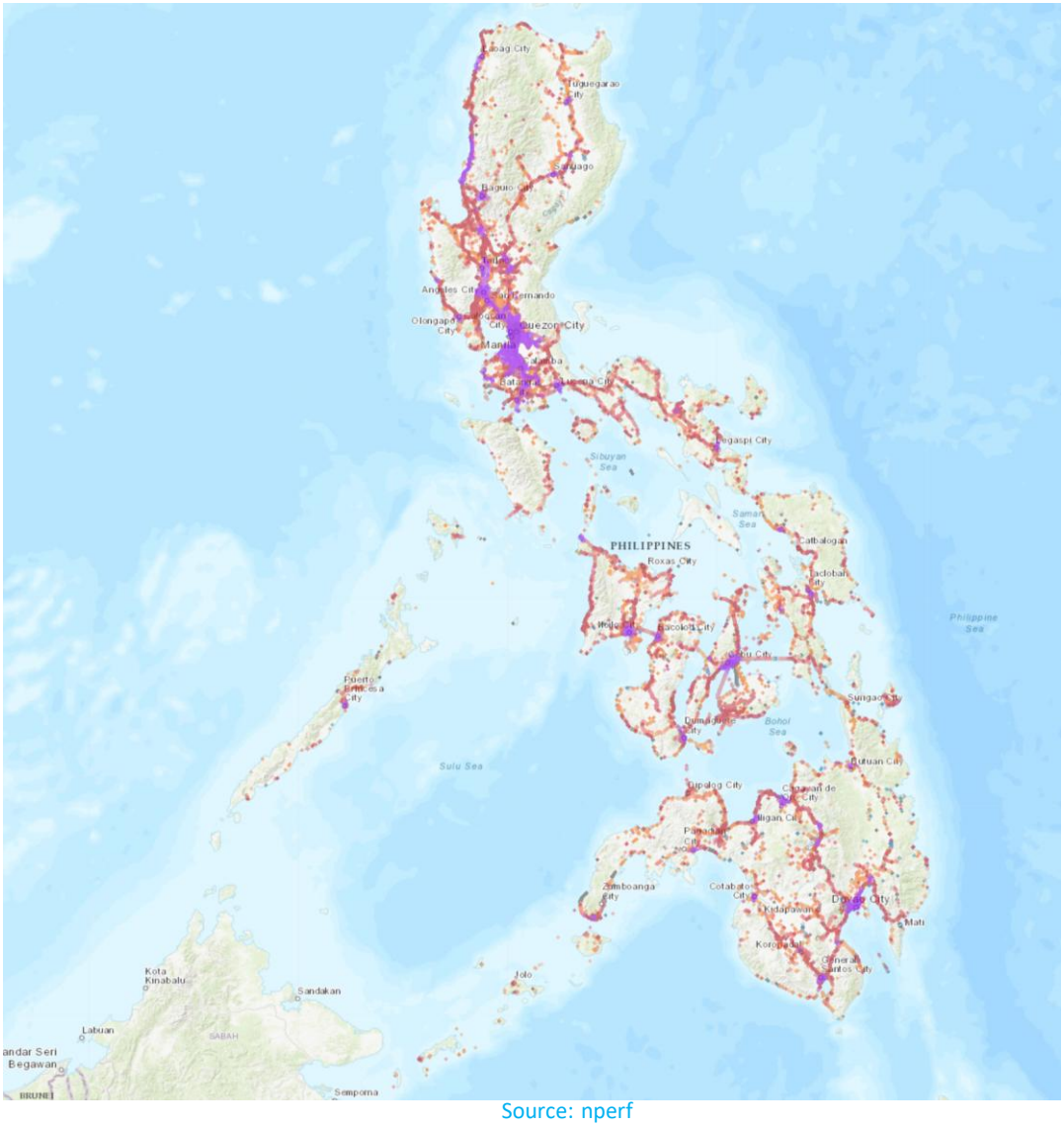
Similarly, Exhibit 23 shows that wireless coverage is far from complete in Philippines. It is worth emphasising that, given the archipelagic nature of these two nations, the problem of bringing connectivity to remote islands is even greater than would be the case in countries with large contiguous land masses.

Given these more detailed data, it is clear that addressing remote connectivity requires a range of responses depending on the specific circumstances faced by remote communities throughout ASEAN.

It is clear that the expanding connectivity options provided by new satellite systems and vendors enable now solutions for connecting underserviced communities and regions. Satellite systems come with a different set of advantages, disadvantages and tradeoffs compared with terrestrial systems. The relationship between satellite and terrestrial systems is complex. They have both a competitive and complementary relationship to one another. It may be that mixed solutions that draw on the relative strengths of satellite and terrestrial solutions offer the best way forward to address the problem of remote connectivity in ASEAN.

124 nperf, https://www.nperf.com/en/

Exhibit 23: Globe Mobile's 3G / 4G / 5G coverage map in Philippines



Source: nperf

3.3 Satellite use cases for remote connectivity

Satellite connectivity solutions and terrestrial satellite hybrid solutions can help ASEAN nations overcome remote connectivity problems in new and innovative ways. Connecting the remaining 360 million people globally could unlock USD59 billion in GDP, according to September 2025 estimates.[125]

Connectivity is important for remote communities for the same reasons it is important in urban areas. To participate in an increasingly digital economy and society, reliable affordable connectivity is a prerequisite. To some degree, digital connectivity is more important to remote communities because their access to services and information is more limited than for urban communities. To give one of many examples, online education can enable children to get access to learning where no schools are available.

The concept of the digital divide is deeply embedded in discussion about telecommunications policy. Broadly speaking, differences in access to telecommunications technology can arise for

[125] Peng Zhao, GSOA. *Unlocking Rural Potential.* September 2025, Kuala Lumpur.

several reasons: differences in income, differences in skills and differences in geographic coverage.

Differences in geographic coverage are particularly significant in ASEAN because the isolation of particular communities can have negative consequences in terms of economic, social and political inclusion and participation.

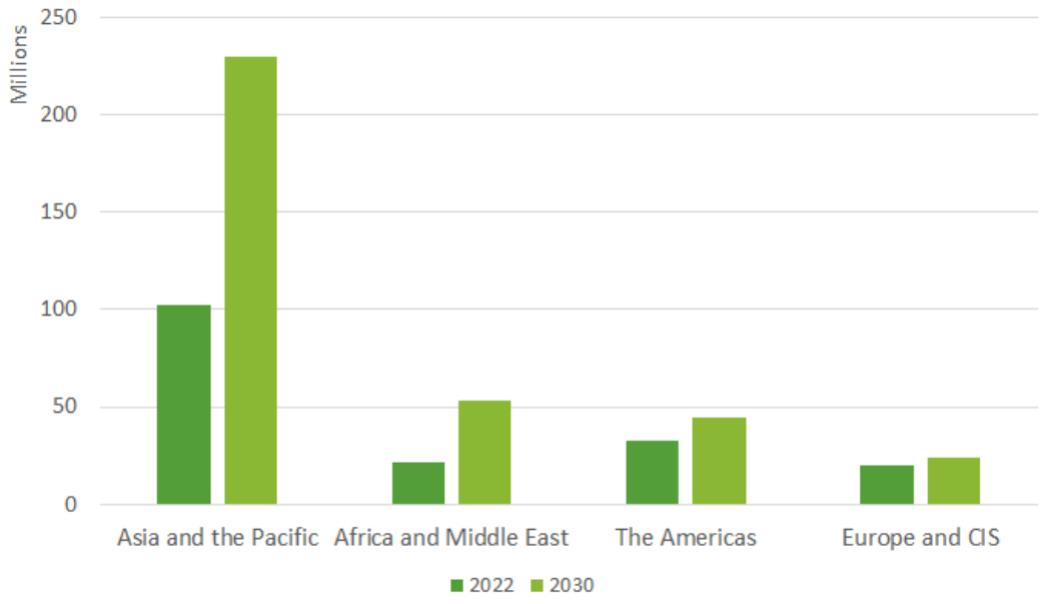
For communities that face particularly intractable problems getting connected to terrestrial networks, satellite connectivity solutions are particularly attractive. This is especially the case in situations where there are more factors such as Island communities that are distant from existing terrestrial networks.

As pointed out in a 2023 study:

> *Unlike rolling out fibre or other ground infrastructure, satellite broadband deployment can be straightforward and cost-effective. It can also be tailored to a variety of users' needs. This means that even a rural village, an isolated hospital or an entire network of schools can be served in an economically efficient manner.* [126]

Exhibit 24 from the same study shows current (2022) and estimated (2030) number of users of satellite communications systems by major regions. This indicates that the vast majority of new satellite communications uses in the world over the next five years from Asia and the Pacific. The relatively rapid expected adoption in Asia and the Pacific and Africa and the Middle East is likely driven by the fact that terrestrial networks are less developed with less complete coverage in these regions and in the Americas and Europe.

Exhibit 24: Satcom broadband users, in 2022 and 2030, by region

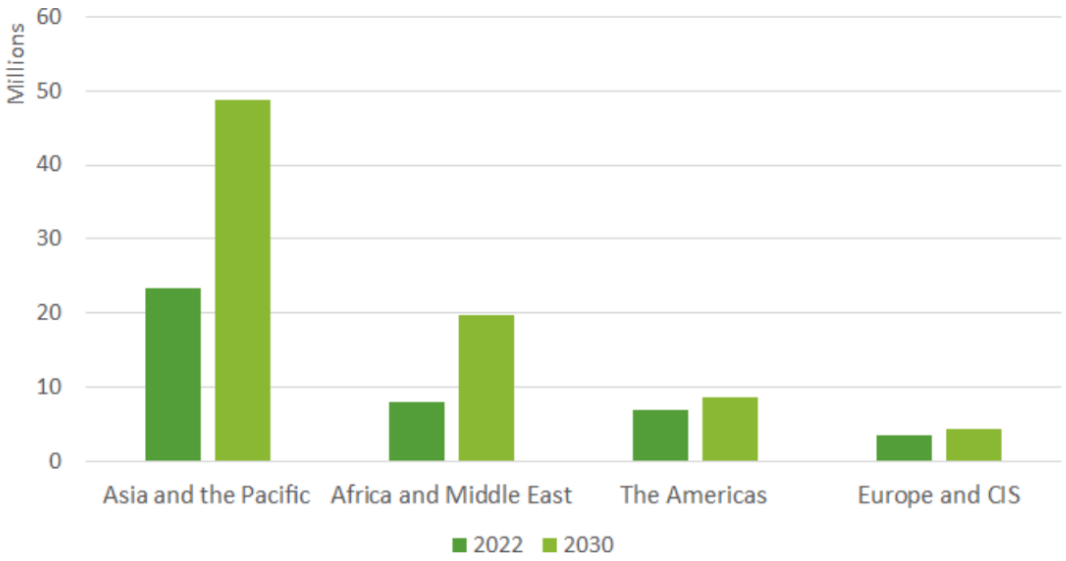


Source: Valdani Vicari & Associates

Similarly, the estimated increase in the addressable market for satellite based tele-education is dominated by Asia Pacific.

126 Valdani Vicari & Associates and LS Telecom, *The Socio-Economic Value of Satellite Communications,* March 2023

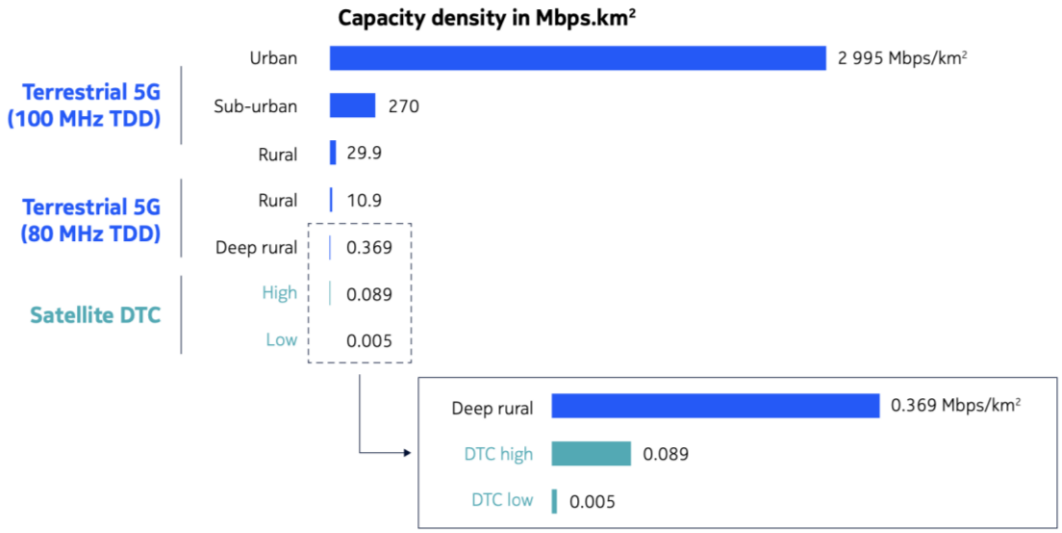
Exhibit 25: Satcom broadband users, in 2022 and 2030, by region



Source: Valdani Vicari & Associates

In all of these use case scenarios it is important to emphasis that a comparison of the capacity densities of terrestrial 5G and satellite D2D shows that D2D will not be able to offer capacity densities anywhere close to terrestrial 5G networks in urban or suburban areas of ASEAN. Thus, although the LEO satellite phased array technology formidably bridges a very challenging space- to-Earth link, D2D capacity densities are limited due to the large satellite cell size and limited spectrum resources. A comparative analysis undertaken by Nokia[127] is shown in Exhibit 26.

Exhibit 26: Comparison of capacity densities of 5G versus D2D



Source: Nokia, 2025. Notre DTC is Direct to Cell.

Nokia concludes its analysis that notwithstanding the limitation greater than 10 Mbps single-user data rates demonstrate significant progress in the field, making D2D suitable for extending coverage to areas that lack terrestrial coverage today.[128]

127 Werner Coomans, Harri Holma, Jeroen Wigard, Mads Lauridsen and Theodoros Spathopoulos, Nokia, *Satellite communication benchmarking with terrestrial 5G networks: White paper*, September 2025, page 20

128 *Ibid.*

3.4 Satellite use backhaul case study: Malaysia

In August 2023, after the issuance of licenses to Starlink Internet Services Malaysia Sdn Bhd a month earlier, the Malaysian Government has implemented the installation and use of Starlink as a satellite internet facility at Kampung Orang Asli (KOA) Tonggang in Perak and KOA Kemensah in Selangor which are part of 40 approved sites under Starlink Proof of Concept (PoC) to study on the feasibility of Starlink to provide broadband services in underserved areas. Different setup environments were used, including institutions of higher learning, schools, community halls, rural villages, KOAs, and other government facilities. Additionally, under a separate private initiative, EDOTCO, in collaboration with Zeta IOS, implemented the same solution at KOA Sungai Kelit in Pahang.

In Tonggang, Kemensah and Sungai Kelit, prior to the installations, the village residents had practically no access to the internet. [129] This development provides a real-life example of the use of LEO connectivity as a backhaul solution, with its positive impact on the villages day-to-day life illustrating the gains to be made from using LEO satellite technology as a means of enabling reliable connectivity. Starlink connectivity, very quickly brought significant benefits to the villages. Since gaining access to the internet, the villages experienced a significant increase in the sale of their various local products, underscoring their participation in the digital economy.

There is a small, beautiful camping resort area with a small river nearby KOA Tonggang, which was not known to the public at all. One of the residents there installed a CCTV showing live crystal-clear water flowing in the small river and broadcast the video over the internet. Immediately after, the camping resort was fully booked every weekend. Starlink internet service made it possible for the village to promote its tourist sites and attract more visitors.[130]

The people of KOA Kemensah, for example, managed to reach out to city dwellers through TikTok and Facebook to advertise their bamboo products. The bamboo products are very popular during local festivals as they are used to prepare the local Malay delicacy called “Lemang”. Sales of bamboo and other forest produce shot up significantly since the implementation of the above.

KOA Sungai Kelit is a high land, and the location is perfect for growing exotic and rare vegetables. Since the farmers can now communicate with the outsiders, they can now immediately advertise their local produce. Restaurant owners and city dwellers came scrambling to reach out to the farmers there directly, bypassing wholesalers and intermediaries.

Stable internet access created online learning and teaching opportunities for children in these rural areas.[131] Furthermore, Starlink connectivity offerings made it easier for village leaders to contact agencies for help during emergencies.[132]

On the last mile access, 2.4 GHz WiFi with sectoral antennas was used to ensure sufficient coverage in the rural villages. In comparison to 5 GHz WiFi, 2.4 GHz WiFi penetrates better into trees, wooden houses/walls, and other vegetation objects, while sectoral antennas increase the radial coverage distance of the WiFi access point. The objective was to ensure that they could get access to the internet inside the convenience of their houses.

In particular, the use of Starlink connectivity for backhaul and WiFi for access in these villages resulted in:

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129 Prime Minister’s Office of Malaysia, Kampung Orang Asli Tonggang to Get Starlink Internet – PM Anwar, August 2023. Available at https://www.pmo.gov.my/en/news-en/kampung-orang-asli-tonggang-to-get-starlink-internet-pm-anwar/

130 Bernama, Starlink Assists Kampung Sungai Tonggang Orang Asli Promote Ecotourism, August 2024. Available at https://www.bernama.com/en/news.php?id=2331556

131 Daily Express, Pensiangan village first location in Sabah to get Starlink, September 2023. Available at https://www.dailyexpress.com.my/news/219773/pensiangan-village-first-location-in-sabah-to-get-starlink-/

132 Weekly Echo. October 2023.

- QoS of 10 Mbps to define the coverage.
- An average monthly data consumption of 5 TB.
- Various Wi-Fi hotspot service packages on offer, ranging from 1 GB to 40 GB, and from a day to one month.
- A total power consumption of 128 Watts (both Starlink terminal and three sets of WiFi APs), paving the way for the entire system to be powered entirely by solar energy.[133]

The use of Starlink was initially conceived as a temporary solution and formed part of a broader agenda to improve infrastructure in the area.[134] The longer-term solution was to construct new telecommunications towers that would provide wide, fast, and stable internet coverage.[135]

Subsequently, in May 2024, the Malaysian Communications and Multimedia Commission undertook a PoC of Starlink as an alternative to optical fibre for connecting the base station tower in Kampung Orang Asli Kerling in Selangor. This decision was made on the basis of the challenges of installing fibre optic cables in the village, such as the long distance between each tower and the fibre point node, which would require crossing over various allotments of private land.[136] The PoC involved the bonding of two Starlink satellites to provide sufficient bandwidth to operate a mobile base station.

The PoC has enabled the offering of connectivity services from three major mobile providers, these being CelcomDigi, Maxis and U Mobile.[137]

133 ZETAIOS, Low Earth orbit (LEO) Satellite System, 2024

134 Prime Minister's Office of Malaysia, Kampung Orang Asli Tonggang to Get Starlink Internet – PM Anwar, August 2023. Available at https://www.pmo.gov.my/en/news-en/kampung-orang-asli-tonggang-to-get-starlink-internet-pm-anwar/

135 Weekly Echo. October 2023.

136 New Straits Times. Kampung Orang Asli Kerling first site for Starlink POC in Malaysia. May, 2024. Available at https://www.nst.com.my/news/nation/2024/05/1048498/kampung-orang-asli-kerling-first-site-starlink-poc-malaysia

137 Benama, MCMC improves facilities for Kampung Orang Asli Kerling Residents. May 2024. Available at https://www.bernama.com/en/news.php?id=2294109

4 Spectrum related to satellite broadband

Radio frequency spectrum related to satellite broadband services which are the subject of this report can be divided into two major elements, namely (i) the spectrum used to provide satellite broadband services and (ii) the spectrum used to provide D2D services. These are explored below.

4.1 Spectrum used to provide satellite broadband services

Common to many satellite services the spectrum used to provide satellite broadband services is primarily in the Ku-band (i.e. 12–18 GHz) and the Ka-band (i.e. 17.3–31 GHz). Other bands such as the E-Band are also utilised.

Specifically in the case of Starlink it relies on multiple frequency bands to deliver internet from space. The system primarily operates in Ku-band (10.7–12.7 GHz), Ka-band (17.8–19.3 GHz), and E-band (71–76 GHz / 81–86 GHz) for backhaul, but user terminals mostly utilise Ku (10.7–12.7 GHz) and Ka (17.8–19.3 GHz). It should be noted that about 70% of traffic runs on Ku-band for reliability, while Ka-band carries 30% of high-speed data. The phased-array antenna switches frequencies in real-time (every few milliseconds) to avoid congestion with the aim of, improving average speed consistency by 20–30%. This is because lower frequencies (i.e. Ku) penetrates obstacles better, while higher frequencies (i.e. Ka/E) delivers more bandwidth but needs clear line of sight. Starlink's frequency allocation is dynamic—satellites adjust frequency usage based on real-time demand.[138]

Similarly, in accordance with the ITU regulations requirements, Eutelsat OneWeb has priority rights to operate the Ku- and Ka-band spectrum; this brings over 6 GHz of the spectrum into use. Amazon's Kuiper System is designed to rely on Ku (18 GHz) band to downlink information to receiving customer terminals in the space-to-Earth direction, and Ka band (27.5 GHz–30 GHz) in the Earth-to-space direction.[139]

Where AMS regulators are looking to extend assignments for IMT and microwave services into the Ku and Ka bands care should be taken not to adverse impacts on fixed satellite services (FSS) and hence satellite broadband services. We note that in accordance with the decision taken at the WRC-23, the WRC-27 IMT bands under IMT consideration include 14.8 to 15.35 GHz band.

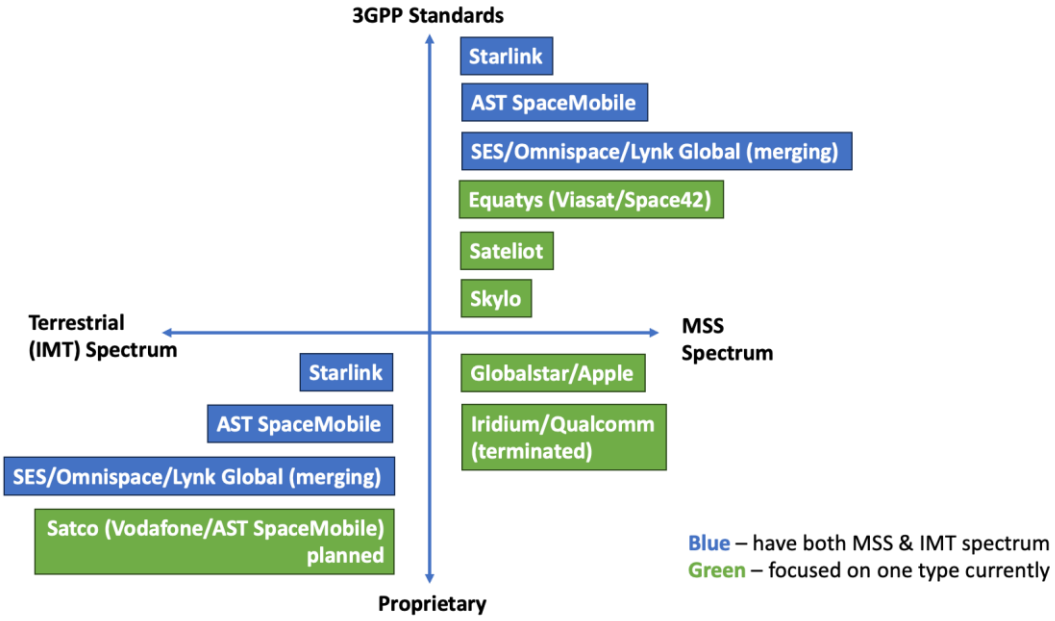
4.2 Spectrum used to provide D2D services

In relation to D2D services, the key questions include what spectrum band is optimal, how much spectrum will be required and whether such spectrum can be shared with other services? Different constellations currently have different approaches to delivering D2D. They variously can use the bands that are already dedicated to mobile satellite services (MSS) or the spectrum allocated to International Mobile Telecommunications (IMT) or a combination thereof. Exhibit 27 categorises the various satellite D2D network providers, according to their spectrum access and

138 Refer to https://www.dolphmicrowave.com/default/what-is-the-default-ghz-for-starlink/
139 Refer to http://www.trai.gov.in/sites/default/files/2025-07/Amazon_Kuiper_03072025_0.pdf

standardisation strategy as at June. 2025; however recently Starlink has also acquired MSS spectrum.

Exhibit 27: Categorisation of various satellite D2D network providers, according to their spectrum access and standardisation strategy



Source: Analysys Mason, MNOs and OEMs need to adopt satellite D2D now, June 2025 updated by WPC, 2025. Note SatCo would also be a candidate for access to the EU 2.0 GHz MSS band in 2027.

Both approaches have their advantages and disadvantages and these are explored below.

4.2.1 Use of MSS spectrum for D2D

For proponents of MSS the key question is whether there will be sufficient bandwidth to support more demanding services, such as voice calls, multimedia messaging and mapping. At this point of time only a relatively small amount of spectrum has been harmonised internationally for MSS and smartphones need to be adapted to use it.[140]

Another option is to re-open the 2 GHz MSS bands—1980–2010 MHz (uplink) and 2170–2200 MHz (downlink). In Europe, licenses held by Viasat and Echostar expire in May 2027. Vodafone/AST SpaceMobile, Skylo, Deutsche Telekom, EchoStar, Globalstar, Inmarsat (Viasat), Omnispace and Space X have all suggested this spectrum could be used for D2D services. Post the acquisition of EchoStar's 2 GHz MSS spectrum in the USA by SpaceX as described in Exhibit 27 above they most certainly wish to use this spectrum for D2D services.

It should be noted that 3GPP Release 17 improves the 5G architecture to support Non-Terrestrial Networks (NTNs) for coverage extension, IoT, disaster communications, global roaming, and broadcasting. Release 18 identifies three MSS frequency bands under 6 GHz for 5G NR and NB-IoT to enable satellite connectivity, as defined by the ITU table of frequency allocations. Release 19 is considering additional MSS frequency bands. Exhibit 28 below summarises the MSS bands in 3GPP FR1-NTN 38.104.

140 There are various attempts in Asia to increase it – for example, see the Japanese MCI proposal of 1 September 2025 in relation to 2 x 3 MHz of the 700 MHz band. Refer to https://www.soumu.go.jp/main_content/001028374.pdf

Exhibit 28: NTN satellite bands in 3GPP FR1-NTN (Rel 19 Jun 2025)

NTN satellite operating band	Uplink (UL) operating band Satellite Access Node receive / UE transmit FUL, low – FUL, high	Downlink (DL) operating band Satellite Access Node transmit / UE receive FDL, low – FDL, high	Duplex mode
n256	1980-2010 MHz	2170-2200 MHz	FDD
n255	1626.5-1660.5 MHz	1525-1559 MHz	FDD
n254	1610-1626.5 MHz	2483.5-2500 MHz	FDD
n252	2000-2020 MHz	2180-2200 MHz FDD	FDD

Source: MSSA, Spectrum Management Considerations for D2D Services, White Paper, August 2025, page 11 and https://www.sqimway.com/nr_band.php

4.2.2 Use of IMT spectrum for D2D

In contrast to MSS, there is potentially a larger amount of IMT spectrum and most smartphones are already designed to use these frequencies. However, across ASEAN, there remains significant low and mid band IMT band spectrum not assigned in a number of AMS.[141] Excluding the 1.5 GHz band, the Philippines has assigned the most IMT spectrum with nearly 90 percent of all harmonised IMT spectrum being assigned. Next is Malaysia with approximately second (80%), and Lao PDR and Singapore (~70%) . While the largest increase over 2024/2025 has been Viet Nam, it has assigned 60%, while Thailand has only assigned 53%, Cambodia 45% and Indonesia only 40%. Myanmar and Brunei Darussalam have assigned only 36%, although it can be argued that Brunei Darussalam i need not assign as much IMT spectrum as AMS with much larger populations. In such circumstances, additional care should be taken by AMS with a low total IMT assignments as additional usage/sharing and/or harmful interference may arise from the use of IMT spectrum from D2D services.

It should be noted that Agenda Item 1.13 of the World Radiocommunications Conference 2027 (WRC-27) studies on possible allocations to the MSS in the frequency range between 694/698 MHz and 2.7 GHz, taking into account the IMT frequency arrangements addressed in the most recent version of Recommendation ITU-R M.1036.[142]

Exhibit 29: Low and Mid-band IMT spectrum assignments in AMS

	3GPP Band	Target MHz	BN	KH	ID	LA	MY	MM	PH	SG	TH	VN
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	68.4	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	120	120	120	120	120	120
2300 MHz	**n40**	**90**	0	44	90	90	90	20	90	40	70	0
2600 MHz	**n7/38/41**	**190**	0	120	0	140	180	40	185	165	190	100
3500 MHz	**n77/78**	**400**	100	300	0	100	200	0	300	200	0	200
		1130	**410**	**825.6**	**452**	**778.4**	**910**	**406.9**	**1005**	**805**	**600**	**680**
			36%	**73%**	**40%**	**69%**	**81%**	**36%**	**89%**	**71%**	**53%**	**60%**

Source: GSMA, ASEAN IMT Spectrum Harmonisation Report, January 2026 forthcoming

Non-conforming use

Perhaps more importantly, the use D2D in IMT bands in the ITU Radio Regulations (RR) is currently a non-conforming use of spectrum due to the absence of a regulatory framework that allows for

141 Note the GSMA's *Vision 2040 Spectrum for the future of mobile connectivity* released in November 2025 details the overall challenge. In assessing the total mid-band IMT spectrum needs in 2035–2040 for Southeast Asia, the GSMA estimates that there are high spectrum requirements in the region, with a weighted average between 1.9 GHz and 2.8 GHz, and spectrum needs for the highest-demand populations between 2.3 GHz and 3.8 GHz. Available at https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2025/11/Vision-2040-Future-Spectrum-Needs.pdf

142 Refer to https://www.itu.int/rec/R-REC-M.1036/en

satellite use of bands allocated to IMT services.[143] Domestic regulation in AMS may need to consider the impacts on emergency uses, quality of service and service level agreements when using IMT spectrum for satellite use in a non-conforming manner, like in the United States. [144]

Need for agreements with MNOs

We concur with the recent GSMA view[145] that industry regulators in AMS should not grant separate spectrum licences to D2D operators for the same frequencies and geographical areas as existing terrestrial IMT spectrum licences. If this was done it would have the effect of significantly undermining regulatory certainty currently supporting MNO investment in mobile terrestrial infrastructure and the provisioning of services for billions of ASEAN consumers. It may also result in harmful interference which any single MNO in ASEAN would struggle to address. In the case of IMT spectrum which is already licensed in ASEAN, often through expensive spectrum auctioning then there would likely be ever more uncertainty and potential litigation/arbitration. Therefore, access to already licensed MNO spectrum for D2D services should be sub-ordinate to the MNO licence rights, not from any separate licence from the regulator.

Given the above the MNO spectrum holder must provide consent to the satellite operator via a lease agreement or similar commercial transaction for the use of any such spectrum. The D2D satellite entity will need satellite authorisations to operate their constellations but its rights of use of terrestrial MNO spectrum licences— especially in relation to IMT spectrum should derive from the rights of the MNO. To properly function, extensive coordination will be required by national authorities as satellite beams are quite large and there remains a risk of overlap with terrestrial coverage despite being solely pointed at underserved regions.

Having said the above, if an ASEAN regulator whishes to assign the usage of MSS spectrum usable for D2D within its geographical area, then such uses fit well within administrative licensing which is accessible to parties who have coordinated MSS use at ITU level. Conditions could attach to such rights including making available access for universal services, etc. As highlighted by Nokia "*Usage of those satellite spectrum bands is shared and allocated based on the condition that the new satellite service cannot impact the operation of existing satellite systems in the same spectrum. In FSS, interference impact is quantified before a license is granted and typically leverages mechanisms like antenna directivity (providing angular separation) and proper coordination with existing constellations*."[146]

Addressing national borders

In ASEAN like in many parts of the world, D2D in IMT bands could be materially hindered by the need to reduce power transmit levels within tens of kilometres of a national border to protect terrestrial networks using IMT spectrum on the other side of the border. Furthermore, as satellite beams are fairly large, the utility of D2D in IMT bands risks being reduced. In the ASEAN context unless there is harmonisation of the approach this will have implications with key land/water borders between Singapore, Malaysia and Indonesia (eg including but not limited to the Johor Strait and Strait of Malacca), Thailand and Lao PDR (along the Mekong River), Cambodia and Viet Nam (along the Mộc Bài–Bavet Border), Cambodia and Thailand border and Malaysia and Thailand border. MSS spectrum is not affected by such issues, as it is globally harmonised.

4.3 IoT spectrum

The strategic use of spectrum is seen as a key factor in defining market opportunities and limitations for satellite IoT. Spectrum availability shapes where and how satellite IoT services can operate. For one thing, the technicalities of spectrum licensing, such as whether operators hold

143 This is the view of a number of countries and international organisations including GSOA.

144 Refer to Appendix B of this report.

145 GSMA, *Spectrum for D2D: The use of satellite to supplement mobile coverage* September 2025. Available at https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2025/09/Spectrum-for-D2D-Public-Policy-Paper-v2.pdf

146 Nokia, *Satellite communication benchmarking with terrestrial 5G networks: White paper*, September 2025, page 9

international rights or local/shared allocations, determine the geographic deployment of satellite links.[147] Such services, are we understand underdeveloped in ASEAN. Furthermore, given the limited amount of MSS spectrum available for D2D, spectrum sharing may be preferred over setting spectrum aside for IoT on an exclusive basis.

Operators with MSS spectrum have consistent and reliable access to spectrum rights, whereas operators that rely on leased or shared capacity do not, thus facing higher costs and regulatory risks. Moreover, the different allocations of spectrum between regions across the globe complicates the manufacturing and deployment of IoT devices.[148] ASEAN Regulators may therefore better off when adopting a service and technology-neutral framework to support IoT.[149]

Importantly, satellite IoT differs from traditional IoT connectivity in terms of its spectrum needs and licensing configurations.[150] Satellite IoT can operate on various spectrum bands and does not require specific licensing per se. However, it is desirable to run satellite IoT on dedicated spectrum as to minimize interference with other users.[151] EchoStar has run its satellite IoT network using S-band spectrum.[152]

4.4 Public safety

Satellite connectivity can offer a critical backup in the event of a natural disaster or other crisis leading to terrestrial communication systems failing. Thus, satellite connectivity can rapidly re-establish communication for emergency response services and those located in affected areas.[153]

4.5 Spectrum recommendations

At the global level it is clear that spectrum for D2D services will be a major topic of deliberations at the World Radiocommunications Conference 2027 (WRC-27) where it is likely that additional spectrum will be made available for NTN services.

As such to the extent possible, similar to current efforts to harmonise IMT spectrum allocations across the whole of ASEAN,[154] there is utility in AMS having harmonised spectrum allocations for MSS and for similar rules to apply at the AMS level in relation to the use of IMT assignments for D2D services.[155] Co-ordinated frequency usage lets different constellations share the same limited spectrum resource.[156] Such an approach should result in smartphones and other devices being consistent and harmonised across the region (and hence available on a more affordable basis). It should also minimise the need for border exclusion zones and similar to avoid harmful interference.

147 IoT-now. Satellite IoT: Rethinking market segmentation.
148 IoT-now. Satellite IoT: Rethinking market segmentation.
149 Spectrum for the Internet of Things. GSMA Public Policy Position. August 2016. Available at https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2018/12/Spectrum-IOT-Position-Paper.pdf
150 EchostarMobile. A complete guide to satellite IoT. Available at https://echostarmobile.com/blog/a-complete-guide-to-satellite-iot/
151 Ibid
152 Echostarmobile. Why S-band satellite services are crucial for resilient connectivity. Available at https://echostarmobile.com/blog/why-s-band-satellite-services-are-crucial-for-resilient-connectivity/
153 Dr Norilmi Amilia Ismail, Universiti Sains Malaysia, From Orbits to Innovation: Fundamentals and Frontiers of Satellite Communication. September 2025, Kuala Lumpur.
154 Refer to the ASEAN GSMA IMT Harmonisation Report, to be submitted to the ADGMIN in January 2026.
155 It is noted that it may not be possible in relation to L-Band given the assignment of this band in selected ASEAN markets but it should be possible for other MSS bands.
156 ITU. *WRS-22; Regulation of satellites in Earth's orbit*. 2023. Available at https://www.itu.int/hub/2023/01/satellite-regulation-leo-geo-wrs/

5 Regulatory and legal review

5.1 ASEAN regulatory overview

In ASEAN, there is a lack of legal frameworks specifically dedicated to regulating the provision of internet services and/or backhaul connectivity through low-earth orbit satellites (LEOs). A review that summarises these various developments, both present and future, can be found at Appendix A. In Appendix B we provide summaries of the applicable regimes in selected other markets including Australia, China, European Union, United Kingdom, and the United States.

Given the above, LEOs tend to be regulated in proxy through standard telecommunications license regimes or not licensed at all. For instance, in Brunei Darussalam, there is no unique legislation that governs the use of LEOs for the purpose of providing connectivity in the country. Satellite operators are instead obliged to obtain a more generic Service Provider for the Telecommunications Industry Licence (SeTi) as well as an Infrastructure Provider for the Telecommunications Industry Licence (InTi) if they also happen to own premises that enable telecommunication services to be offered to third parties. Generic licensing for LEO presents deficiencies, as it does not address significant structural issues and negative externalities posed by large-scale LEO systems.

With that said, multiple countries have pointed to future regulatory developments in this area. Thailand is one country which is expected to announce a comprehensive legislative regime for LEOs while Singapore is reviewing the regulatory frameworks applicable for D2D services. Meanwhile, Brunei Darussalam's regulator is currently undertaking a review of its telecommunications licensing regime which could lead to the development of licenses applicable to LEOs directly. International best practice applicable to LEO systems does not yet exist and must be developed by ASEAN. Global developments in this area were reported across the board by AMS to be crucial factors in shaping their own policies on the matter.

Some AMS are also considering licensing D2D services. Lao PDR's Ministry of Technology and Communications, for instance, is in the process of developing an applicable regulatory framework which will focus on technical and regulatory compliance issues. This includes, *inter alia*, satellite network coordination, land rights, preservation of sovereignty and earth stations. Other parts of the world are acting fast to regulate D2D services with the goal of maximizing being a first mover in this space, and thus to position oneself as global leaders in connectivity and digital innovation. The example of Bahrain can be found in Exhibit 30.

Exhibit 30: Bahrain's Satellite-to-Mobile Service

In October 2025, Bahrain's Telecommunications Regulatory Authority (TRA) announced a public consultation regarding the authorisation of Satellite Direct-to-Device (D2D) services in the Kingdom of Bahrain.[157] The proposal seeks to enable standard mobile phones to connect directly to satellites in areas that are not reached by terrestrial networks. As remarked by the General Director of TRA, the adoption of D2D has been motivated by concerns that span safety, economic

157 See https://tra.org.bh/en/article/tra-bahrain-launches-consultation-on-direct-to-device-satellite-services-to-further-enhance-mobile-coverage

opportunity, national resilience as well as capitalising on technological advancements.[158]

The proposed licensing system would see MNOs partner with global satellite operators to provide connectivity services, with the model focusing on enabling
a standard mobile handset to automatically switch to a satellite network for low latency SMS, low-speed data and eventually, voice services. The end outcome is for any user to have uninterrupted access to essential communication services.[159]

Bahrain has been seeking to position itself as a global leader in connectivity and digital innovation.[160] While the country has already achieved full 4G and 5G coverage, the addition of D2D is expected to be 'transformative' insofar as it would benefit those working at sea and during potential network disruptions.[161]

The consultation awaits input from licensees, industry stakeholders and the public.[162]

At the time of writing, there were no Quality-of-Service (QoS) obligations unique to satellite connectivity services to be found in AMS' regulatory and legal frameworks. This is not to say that satellite license-holders are generally free from obligations imposed by regulators. Lao PDR reported that any future LEO connectivity provider would be required to meet QoS set out in Ministerial Decisions that set out technical and performance benchmarks for all licensed telecommunications service providers. Similarly, Indonesia's Kominfo imposes a 5-year long service commitment on all types of telecommunications services operators—which includes satellite providers— that obtain an Internet Service Provider Licence. The commitment obliges operators to meet minimum service area coverage requirements. Spectrum licensing for LEO systems is a significant area of pending work globally.

While the development of specific frameworks is still in progress in ASEAN, the efforts undertaken by various AMS to license Starlink may provide useful pointers for how ongoing and future regulatory developments are to advance in this area. In Viet Nam, for instance, the Government has granted regulatory clearance to Starlink to operate on a trial basis until 2030 and provide fixed and mobile service satellite services across the country, with a limit set on the number of subscribers for this duration of time. In the Philippines, the regulator NTC has approved the registration of Starlink as a value-added service provider, mandating the local construction and operation of broadband facilities.

Despite these regulatory approaches only applying to a single satellite provider, they signal a desire on part of governments throughout ASEAN to be willing to engage with emerging satellite technology companies on flexible terms, making space for innovation and entrepreneurship to grow while putting regulatory limits in place which reflect sovereignty considerations against the novelty and lack of complete information around the somewhat unpredictable impact these new technologies will have and continue to have in future on connectivity options.

158 https://techafricanews.com/2025/10/10/bahrain-to-pioneer-satellite-to-mobile-service-ensuring-seamless-national-coverage/
159 Ibid
160 https://tra.org.bh/en/article/tra-bahrain-launches-consultation-on-direct-to-device-satellite-services-to-further-enhance-mobile-coverage
161 https://www.zawya.com/en/business/technology-and-telecom/bahrains-tra-launches-public-consultation-on-satellite-connectivity-proposal-qw1fx2uj
162 Ibid

Exhibit 31: Current LEO Regulatory overview of ASEAN members

	BN	KH	ID	LA	MY	MM	PH	SG	TH	VN
LEO licensing regime?	No specific	No specific	No specific	No specific	No specific	No specific	No specific	No	Yes	Yes
Other telecom licences available?	Yes		Yes	Yes, but not in place	Yes	Yes	Yes	Yes		
D2D/SCS/NTN licenses?	No	No	No	No	Not yet	No	Yes for NTN	No	No	Yes for NTN
Future planning	Reg-ulatory review			Reg-ulatory review			Subject to new KP Act Spectrum Managem ent Policy Framewor k	Develop-ing reg-ulations	Reg-ulatory review	
USO	General USO	Not yet	5-year service commit-ment	Not known	General USO and con-tribution	General USO and con-tribution	No USO	General	Con-tribution	General
QoS	No	Not yet	General QoS	General QoS	General	General	General	No	No	General
Backhaul connectivity?	No	No	Yes	No	Yes	Yes	Yes	Yes	Not yet	Yes

6 Conclusion and recommendations

This report to ASEAN has sought to present an in-depth analysis of modern satellite communications in the ASEAN region, focusing on LEO connectivity especially and its application to consumer broadband services, backhaul and direct-to-device (D2D). LEO connectivity is important insofar as it offers an inclusive and cost-effective connectivity solution for remote and rural communities and provides an alternative for consumers whose domestic or terrestrial options are too expensive, unreliable,
or otherwise inadequate.

We approached the issue of LEO connectivity from multiple perspectives. First, we explored the economics of new satellite communications, looking at the market dynamics and acceleration of competition within this sector. We built on this analysis by evaluating the spectrum needs created by the use of this technology, seeking to optimise the use of this scarce resource from both a policy and a commercial point of view. We also developed a legal and regulatory overview of existing LEO connectivity regulations as the precursor to formulating our own key regulatory recommendations in this space.

6.1 The key issues for regulators in ASEAN

While there is no dominant business and partnership model in the LEO connectivity industry, satellite operators and MNO have been acting fast to set up partnerships and other kinds of initiatives to strengthen their consumer offerings and grow their satellite infrastructure, all of which aims to outcompete rival companies in a burgeoning industry where first mover advantages pay off in terms of market capture. In the case of Starlink for instance, the acquisition of its own spectrum portfolio from EchoStar has undeniably provided the company with a competitive edge over other market actors at least in the USA market.

Given the significant level of market activity and the pace of technological change, it is clear that LEO connectivity is in need of sound regulatory frameworks. These frameworks are essential to enabling the efficient use of resources and the protection of the public interest. AMS regulators nonetheless face several connectivity challenges given the region's differing geographic landscapes, market economics, energy supplies, backhaul constraints, handset devices, policies, spectrum holdings and so on. The core challenge lies in developing regulations which enable a connectivity landscape that is truly inclusive, resilient, and capable of encouraging competition and economic growth.

In regard to ***spectrum considerations***, we found that AMS regulators should take care not to adversely impact fixed satellite services (and hence satellite broadband services too) in the process of making spectrum assignments for IMT and microwave. In the case of D2D, the key issue concerned how much spectrum would be required to provide D2D services, national sovereignty, what spectrum band would be optimal, in what quantity, and whether it should be shared with other services.

Some key spectrum considerations emerged from our analysis:

- ***MSS spectrum*–**which involves only relatively small amounts of spectrum harmonised internationally, contingent on there being sufficient bandwidth. The allocation of additional resources such MSS spectrum will be a key issue for discussion at WRC-27;
- ***IMT spectrum***–features a larger amount of IMT spectrum and greater compatibility with smartphones already circulating the market. With that said, total quantum of assigned low and mid band IMT band spectrum in number of AMS is low in world terms. Importantly, AMS may very well have to modify domestic regulations to accommodate D2D in IMT service bands given the use of D2D in IMT bands is currently a non-conforming use of spectrum based on the Radio Regulations. Moreover, AMS should not grant separate spectrum licences to D2D operators for the same frequencies and geographical areas as existing terrestrial spectrum licences. Instead, a consent-based system is the preferred approach.
- ***IoT spectrum***–spectrum licensing rights can optimise the operation of satellite IoT services and strongly benefit from implementing service and technology-neutral frameworks.

We also undertook ***a regulatory and legal review*** of existing mechanisms in place that regulate the use of LEOs by MNOs as a connectivity solution. We found that in ASEAN, there is a lack of legal frameworks specifically dedicated to regulating the provision of internet services and/or backhaul connectivity through LEOs tend to be regulated in proxy through standard telecommunications license regimes or not licensed at all. Spectrum licensing of LEO systems is a pending area of work, with particular attention to large-scale LEO systems, given structural and radio interference risks.

With that said, multiple AMS have pointed to future regulatory developments in this area, with several reviews of existing telecommunications regimes being undertaken by regulators at the time of writing. It is recommended that ASEAN utilise its existing working group mechanisms to deliberate on emerging regulatory and technical matters pertaining to LEO satellite systems going forward. Developing a best practice and attention to global developments should be also crucial factors in shaping ASEAN policies on the matter. Finally, given the rapid developments in this area and the sovereignty issues involved, an ASEAN Regional Space Framework like we see in Europe and in some AMS should be considered for ASEAN.

6.2 Regulatory recommendations

As ASEAN progresses further along the pathway of updating regulatory frameworks to accommodate the emergence of satellite connectivity including LEOs, a range of actions can be taken by policymakers and industry regulators to optimise this technology option. This paper has formulated several key recommendations to this effect, with a focus on highlighting best regulatory practice and principles both globally and in the context of AMS.

Recommendation 1: Develop LEO-specific regulations and licensing frameworks

The rise of LEO connectivity and LEO mega constellations is changing the world's constellation architecture, from one with few, geostationary satellites with a broad view of Earth to one with many non-geostationary satellites roving faster, closer to Earth. These differences warrant specialised regulatory intervention from governments regarding the launch of satellites and for countries to receive satellite services.[163] Regulations need to be flexible enough to allow for communications from numerous moving satellite instead of a single fixed one.[164]

Viet Nam provides a model example of sufficiently specialised regulatory intervention. As of March 2025, Viet Nam has set up a separate licensing framework for LEO satellite communications services with specific requirements to safeguard national security and data

163 ITU. Space Connect; Updating Regulations for LEO satellite services, March 2025. Available at https://www.itu.int/hub/2025/03/space-connect-updating-regulations-for-leo-satellite-services/

164 Ibid

sovereignty, as well as adopted a pilot mechanism for controlled investment and business operations in satellite telecommunication networks. This framework exists in addition to a general licencing regime which regulates the provision of telecommunication services, satellite orbit use, and the use of radio frequencies by satellite internet providers. The Viet Namese model thus carves out both generic and specific regulations to suit the distinct evolutions of satellite technologies which now include LEO satellites.

With that said, the implementation of LEO-specific regulations takes place within the context of outdated spectrum fee regimes which may restrict the benefits to be gained from such regulatory developments. For instance, charging per terminal for fixed terminals or VSATs remains standard practice. However, companies like Starlink have tended to pass on terminal costs onto customers, increasing the cost of services. AMS spectrum fee regimes may therefore require updating, for instance by charging on the basis of a percentage of revenues, reflecting the cost of service and adoption. Similarly, certain AMS have bandwidth-based fees which discourage the use of broader channels, reducing the effectiveness of sharing infrastructure.

Recommendation 2: Create regionally unified frameworks

Developing regionally unified regulatory frameworks ensures interoperability across different ASEAN Member States. LEOs operate across the borders of different countries and thus require consistent regulations regarding licensing, spectrum use and market access for compliance and operational feasibility to be achieved. This approach is akin to the European Union (EU), where building on the EU's Open Skies directive, policymakers have developed unified legislation. The ITU has praised this decision for ensuring certainty to operators regarding technical and regulatory parameters.[165] Another example of such a unified approach is the European Union's draft "EU Space Act", which mandates specific obligations on LEO systems of 1,000 satellites or more. Spectrum regulation specific to such large-scale LEO systems must be added to the EU approach and be also considered for adoption in ASEAN.

Ideally, a unified regulatory framework would reflect ASEAN's moves towards regional integration as a single market for telecommunications operators using satellites. Additionally, consistent regulations improve the certainty and predictability of the regulatory frameworks, which is attractive to the range of operators, investors and stakeholders invested in LEO regulations.

Recommendation 3: Use licensing regimes to balance innovation with caution

The use of trial permits and regulatory exemptions is a practical means of operationalising regulatory frameworks which balance innovation with a degree of caution. As LEO satellite services are a relatively new technology with unpredictable impacts from both a technical and market perspective, perhaps by establishing regulatory sandboxes can optimise the transition to its increased use. In Viet Nam for instance, Starlink has been authorised by the Vietnamese Government to provide fixed and mobile satellite services until 2030, with the number of subscribers fixed to 600,000 for this duration of time. This approach will allow the Government to pre-empt the impacts of a more widely integrated LEO connectivity market.

Such consumer-facing licensing regimes should from a technology neutrality perspective also require LEO providers to subject to similar rules as fixed and terrestrial wireless competitors including in relation to inter alia interception capability, any content curation/take down rules, emergency services, universal service contribution rules, etc. Thus, it is preferable for policymakers to adopt inclusive, solution-based approaches rather than mandate specific technologies.[166] One option would be to encourage the creation of public-private partnerships with sustainable business models to stimulate investment in this area.[167] For example, Malaysia has signalled that in future, it will be looking to implement public-private partnerships under the

165 Ibid
166 Peng Zhao, GSOA. September 2025, Kuala Lumpur
167 Peng Zhao, GSOA. September 2025, Kuala Lumpur.

auspice of its 'New Space' programme.[168] This recommendation is designed to encourage flexibility and reduce uncertainties in the face of significant market and technological uncertainty. It might involve, say, the use of trial permits and regulatory frameworks which support innovation while mitigating irreversible externalities of large-scale LEOs and maintaining a degree of precaution in testing out the real-life application of LEO connectivity.

Recommendation 4: Optimise licensing duration and renewal

In particular, it should be noted that LEO have a service life of say five to seven years with very LEOs perhaps having an even shorter life. In such circumstances, there is considerable requirement for replacement LEO satellites to be financed, built and then launched. This results in substantial annual capital expenditure just to retain what was in place before. While costs are shared globally, even the share apportioned to ASEAN/AMS may be substantial and will be ongoing. As such it may be commercially sensible for AMS – especially in relation to BTS backhaul to only utilise LEO satellites for a finite period of time and concurrently build out fibre backhaul. As such there are good arguments for the licensing duration and renewal to be for shorter periods of time than terrestrial services for large-scale LEO constellations of 1,000 satellites or more.

Recommendation 5: Harmonise spectrum allocations and rules

To the extent possible, similar to current efforts to harmonise IMT spectrum allocations across the whole of ASEAN, there is utility in AMS having harmonised spectrum allocations for MSS and for similar rules to apply at the AMS level in relation to the use of IMT assignments for D2D services.[169] Co-ordinated frequency usage lets different constellations share the same limited spectrum resource.[170] Such an approach should result in smartphones and other devices being consistent and harmonised across the region (and hence available on a more affordable basis). It should also minimise the need for border exclusion zones and similar to avoid harmful interference.

Recommendation 6: Mandate Universal Outdoor Coverage in ASEAN

Similar to the approach which is now being taken in other markets (e.g. see Exhibit 32 below in relation to Australia), it is recommended that a universal service obligation of a requirement of universal outdoor coverage be adopted in AMS that is not technology-specific by 2030. This would result in universal outdoor coverage across ASEAN; which is the third most populous region globally. This would result in a region with a population of over 675 million (as of 2025), or 8.5 percent of the world's population and an area of over 4.5 million square kilometres having coverage.

Such coverage especially if linked to universal smartphone adoption across ASEAN would further position smartphones as the primary platform for accessing government and financial services across ASEAN. To realise this objective, policymakers must prioritise improving smartphone accessibility, particularly for lower-income groups.[171]

Exhibit 32: Universal outdoor mobile coverage in Australia

In February 2025, Australia's Federal Government announced a new Universal Outdoor Mobile Obligation which would require mobile carriers to provide access to mobile voice and SMS in almost all of Australia, ensuring that up to 5 million square kilometres including 37,000 on regional roads are connected. The policy would require Australian telecommunications operators to partner with a satellite provider to ensure the provision of basic voice calls and

168 Ministry of Science, Technology and Innovation Malaysian Space Agency. *Malaysia's Journey in Remote Sensing Satellites Applications.* September 2025, Kuala Lumpur.

169 It is noted that it may not be possible in relation to L-Band given the assignment of this band in selected ASEAN markets but it should be possible for other MSS bands.

170 ITU. *WRS-22; Regulation of satellites in Earth's orbit*. 2023. Available at https://www.itu.int/hub/2023/01/satellite-regulation-leo-geo-wrs/

171 See ASEAN, *Understanding the digital drivers of inbound investment in ASEAN's manufacturing and services industries,* December 2024, page 56. Available at https://asean.org/wp-content/uploads/2025/03/WPC_ASEAN_Investment_Manufacturing_Services_finalrev_9Jan2025.pdf

SMS are available in most of the country.[172] For instance, in January 2025, major player Telstra announced a 'partnership' with Starlink aiming to bring D2D services to their customers using LEO satellites. Optus made a similar announcement in July 2023.[173]

The use of Low Earth Orbit Satellites (LEOSats) and Direct to Device (D2D) technology will support mobile carriers in meeting these new coverage obligations.[174] D2D messaging is expected to be integrated as a modernised and expanded voice Universal Service Obligation.[175] Currently, only broadband internet via the NBN, landline and telephone access are included in the universal service obligations.[176]

These technologies are expected to fill the existing coverage gap in the provision of telecommunication services for remote areas where it is too cost-prohibited to roll out fixed networks or mobile towers, and will offer a better quality standard of service compared to geostationary satellites such as the National Broadband Network's (NBN) Sky Muster satellites.[177]

The government is currently in the process of consulting with industry on the proposed legislation, as part of its efforts modernise long-standing universal services framework. However, it has already identified three policy objectives:

- the expansion of Triple Zero access for Australians all across the country;
- the expansion of outdoor voice and SMS coverage into existing mobile blackspots; and
- improving the availability of mobile signals during disasters and power outages.[178]

With the Government expected to introduce legislation in 2025 that will expand the universal services framework, the implementation of outdoor SMS and voice is expected to take place by late 2027.

Recommendation 7: Require shared LEO gateways

Subject to specific AMS law, consideration should be given for the sharing of LEO gateways by AMS. Given cost considerations and the willingness of the LEO provider to establish a gateway in each and every AMS, smaller AMS may wish to share a gateway in an ASEAN neighbour. It is understood that gateway stations have essentially two functions: (1) providing a RF link to/from a satellite by landing the traffic ("Teleport Gateway"), and (2) routing the data to the terrestrial core network ("Data Gateway"). While traditionally these two functions were performed at the same gateway station location, advancements in satellite system design and data technology have transformed Data Gateway functionality, these operations can now be performed at a Point of Presence (PoP) or Point of Interconnect (PoI). If this can be shown in any AMS regulator review then any lawful intercept and internet content regulation could be achieved by access functionality of Data Gateway, rather than the Teleport Gateway.[179]

172 ABC. *Voice and SMS services to be included in universal service obligation under Labor election pledge.* February 2025. Available at: https://www.abc.net.au/news/2025-02-25/labor-pledges-expansion-of-voice-and-sms-coverage/104976030

173 Bird & Bird. A new frontier of connectivity: regulating direct-to-device services in Australia. March 2025.

174 Department of Infrastructure, Transport, Regional Development, Communications and the Arts. *Universal Outdoor Mobile Obligation to improve outdoor mobile coverage across Australia.* February 2025. Available at: https://www.infrastructure.gov.au/department/media/news/universal-outdoor-mobile-obligation-improve-outdoor-mobile-coverage-across-australia

175 Ministry for Communications. *Albanese Labor Government building Australia's mobile future. Media release*, February 2025. Available at: https://minister.infrastructure.gov.au/rowland/media-release/albanese-labor-government-building-australias-mobile-future

176 ABC. *Voice and SMS services to be included in universal service obligation under Labor election pledge.* February 2025. Available at: https://www.abc.net.au/news/2025-02-25/labor-pledges-expansion-of-voice-and-sms-coverage/104976030

177 The Guardian. *Black spots, satellites and Elon: new technology could fill Australia's mobile gaps but can it be relied on?* March 2025. Available at: https://www.theguardian.com/australia-news/2025/mar/02/universal-outdoor-mobile-obligation-coverage-satellite-technology-elon-musk-starlink

178 ibid

179 GSOA, *Rethinking Local Gateways: A Satellite Industry Perspective*, August 2024, page 2

Given the above, it is advised that this requirement be a flexible one and avoid being mandatory. LEO gateways need certain specific coordinates which in some cases, cannot be located too close to one another.

It is also recommended that the regulatory regime in each AMS should be flexible enough to accommodate and benefit from advances in technology that could, for instance, provide the respective AMS national authorities access to data from gateway earth stations outside the country. Such advances can ensure service providers remain compliant with national security, data privacy protection, as well as information security obligations without imposing a requirement to install costly and redundant local technical facilities in a country.[180]

Recommendation 8: Create an ASEAN platform for LEO satellite regulatory and policy coordination

It is recommended that ASEAN utilise its existing working group mechanisms to deliberate on emerging regulatory and technical matters pertaining to LEO satellite systems. These working groups could serve as a formal platform for engagement and negotiation between ASEAN with satellite service providers to address issues such as beam capacity constraints, which often lead to service congestion. Through this integrated approach, AMS would be able to jointly identify and implement mitigation measures and strengthen regional collaboration on LEO satellite deployment and harmonised regulatory approach. Further, it could include provide for disaster and emergency services planning and related issues.[181] Finally, given the rapid developments in this area and the sovereignty issues involved a regional Space Act or Guideline, like we see in Europe and in some AMS should be considered for ASEAN.

Furthermore, the same platform could be leveraged to develop harmonised technical specifications for satellite terminals and user devices. Establishing common standards across ASEAN would facilitate economies of scale, reduce production costs, and promote interoperability among systems deployed by different operators. This initiative with a focus on mitigating negative externalities posed by mega constellations would contribute to lowering the overall cost of satellite connectivity solutions, particularly for fixed terminals and satellite-enabled mobile devices thereby advancing ASEAN's objective of bridging the digital divide and strengthening regional digital connectivity.[182]

Recommendation 9: Develop a regional roadmap for D2D introduction to ASEAN

Recognising the rapid advancement of satellite-based D2D technologies and their potential to enhance connectivity resilience, disaster preparedness, and digital inclusion, ASEAN may also consider developing a regional roadmap for the introduction of D2D services taking into account possible adverse impacts of mega constellations on competition, orbit layers, etc . This could be included as one of the action items in the ADM2030.

Such a roadmap would provide a common strategic guidance for Member States, while allowing each country to implement the framework in line with its own national licensing and requlatory requirements. This ensures that regional alignment complements, but does not supersede, national policy and spectrum management priorities.

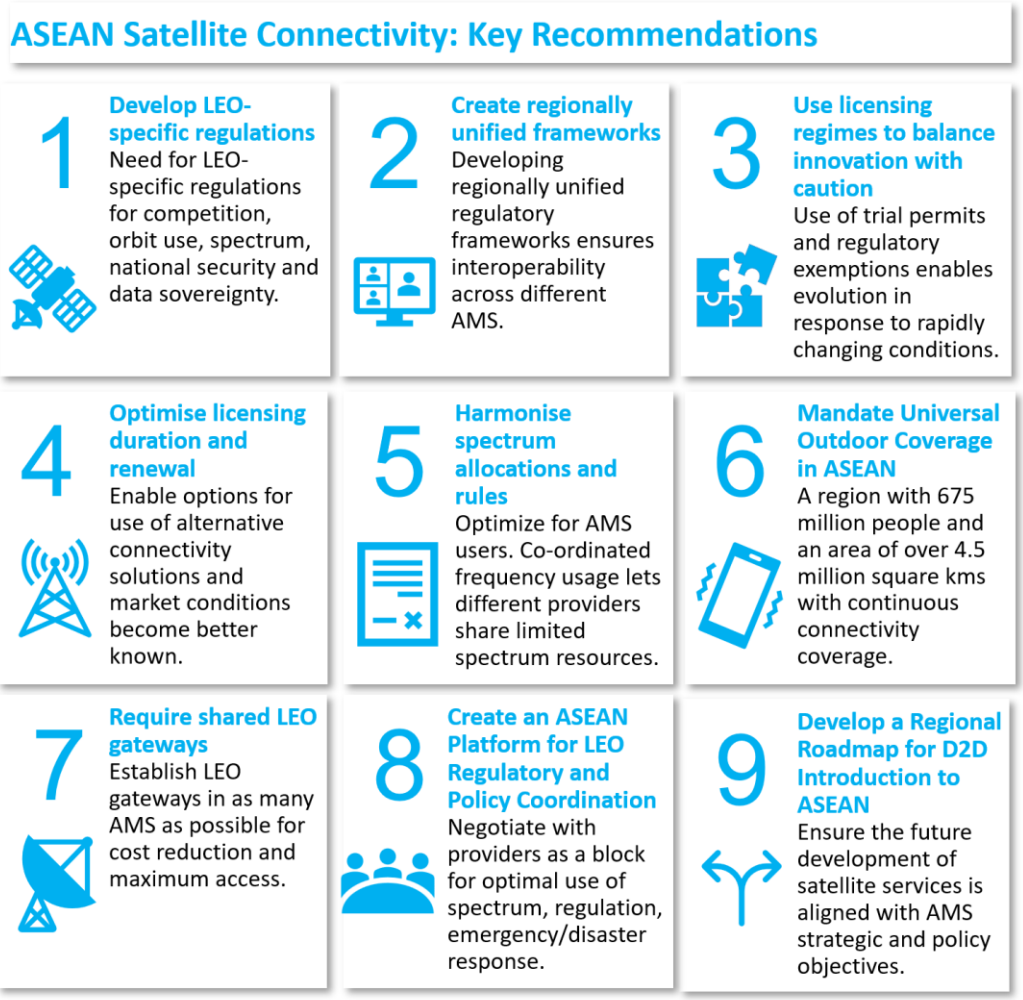
180 Ibid

181 Refer to FirstNet's deployment of direct-to-device (D2D) satellite connectivity for first responders in the USA with AST SpaceMobile. Refer to https://www.datacenterdynamics.com/en/news/ast-spacemobile-firstnet-push-ahead-with-plans-for-d2d-sat-service-for-first-responders/

182 This could involve SIRIM of Malaysia and other similar standards bodies in ASEAN.

Exhibit 33 provides a graphical representation of the key recommendations.

Exhibit 33: Key recommendations



Source: Windsor Place Consulting, 2025

7 Appendix A - Regulatory and legal review

This appendix consists in a review of the legal and regulatory developments in ASEAN that govern space connectivity, especially the use of LEOs to provide connectivity services whether they be commercial in nature, backhaul or direct-to-device (D2D). The review summarises research undertaken by WPC, augmented by questionnaire responses received from AMS.

This appendix summarises key features from the frameworks that govern the use of LEOs for providing connectivity as a consumer product, for backhaul and for D2D.

7.1 Brunei Darussalam

7.1.1 LEO laws and regulations

There is no unique legislation purporting to regulate the use of LEOs in Brunei Darussalam for the purpose of providing internet services and/or backhaul connectivity and/or D2D. Brunei Darussalam's regulator AITI is currently undertaking a holistic review of its telecommunications licensing regime, signalling that future developments may lie on the horizon regarding the introduction of a specific licence for satellite communications services.

7.1.2 General laws and regulations

Operators are required to obtain a Service Provider for the Telecommunications Industry Licence (SeTi), which may also require the acquisition of an Infrastructure Provider for the Telecommunications Industry Licence (InTi) if the provider also happens to be an infrastructure owner.

- A SeTi license allows an operator to lease telecommunication facilities from an InTi Licensee to provide telecommunication services to third parties; resell the services of an InTi Licensee such as telecommunication system, network facilities and equipment or resell the services of a SeTi Licensee, or any other operator as determined by the Authority to provide telecommunication services to third parties.

- An InTi Licence allows an operator to deploy any form of telecommunication infrastructure inside and outside of his own premise to enable telecommunication services to be offered to third parties. Telecommunication infrastructure includes any telecommunication system, network facilities and equipment such as satellite gateways that offer voice, data and leased circuit services.

Standard licence terms and conditions apply to holders of InTi or SeTi Licences. If designated a Public Telecommunication Licensee, the licensee must fulfil three universal service obligations: availability, accessibility, and affordability. There is no contribution requirement set for this designated category of licensees. While there are no QoS conditions placed on satellite connectivity services, Brunei Darussalamis said to be monitoring global developments and best practice on D2D QoS.

7.2 Kingdom of Cambodia

7.2.1 LEO laws and regulations

Cambodia does not currently license LEO connectivity services, although the development of a licensing regime for satellite services is being considered by the Government. Cambodia has not yet issued D2D, SCS and NTN licences.

7.2.2 General laws and regulations

Satellite communication policies and laws are still being developed in Cambodia.[183]

7.3 Indonesia

7.3.1 LEO laws and regulations

NGSOs in Indonesia must protect and not causing harmful interference to Indonesian GSO satellites/terrestrial radio stations.[184]

NTN D2D may be integrated into the Ministry of Communications and Digital Affairs (MCDA)'s Strategic Plan for 2025-2029—which seeks to accelerate the provision of inclusive, high quality and affordable broadband connectivity in the country.[185]

7.3.2 General laws and regulations

The relevant frameworks are:

- Telecommunication Service Operation License;
- Telecommunication Network Operation Licence;
- Radio Spectrum Frequency License regarding Bandwidth, Radio Station, Class;
- Satellite Landing Rights, requiring approval from MCI if a foreign satellite is used to provide VSAT services; and
- Ministerial Regulation No. 3/2025.

Indonesia has regulatory frameworks in place to regulate satellite providers operating in the telecommunications sector. To provide satellite internet services, an applicant must obtain a Telecommunications Operations Licence, Telecommunications Service Operations Licence, and Radio Frequency Spectrum Licence. Satellites must be registered with the Space Agency and satellite launches are managed by the Indonesian government.[186]

In 2018, the Government passed Regulation of Minister of Communications and Informatics of the Republic of Indonesia Number 7. National operational permits for Business-to-Consumer (B2C) or retail services must also be obtained by providers.

An official permit is required to run an internet service provider service in Indonesia, called an Internet Service Provider licence (ISP) which is obtained from the Ministry of Communication and Information Technology (Kominfo). The Kominfo released the *Regulation on Telecommunications Service Operations* in 2019. ISPs must obtain a Business Identification Number—an official government identification issued to business entities.

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183 See http://m.en.freshnewsasia.com/index.php/en/localnews/59689-2025-04-30-09-50-58.html

184 Ministry of Communications and Digital Affairs Republic of Indonesia. *Indonesia Satellite Regulatory Frameworks.* September 2025, Kuala Lumpur.

185 Ministry of Communications and Digital Affairs Republic of Indonesia. *Trends in Satellite Technology – NTN D2D.* September 2025, Kuala Lumpur.

186 *Ibid*, 191; see also *Regulation on Electronically Integrated Business Licensing Service in the Field of Communication and Informatics, 2018* (Reg. No. 7/2018) art. 15 and art. 16

A 5-year-long service commitment is imposed on telecommunications service operators that obtain an ISP licence. Within the first year of operation, operators must provide a minimum of service area coverage within 1 municipality/regency. There must also be a minimum of a total of service capacity available in accordance with the classification of municipalities/regencies committed in letter. Upwards from the second year, the number of municipalities/regencies to the regional coverage may be added and/or service capacity may be increased.[187]

Moreover, there are no USO specific to satellite providers, however, general obligations would apply. Telecommunications Law No.36 of 1999 requires every telecommunications network operator and/or communications service operator to provide a contribution to universal services in the form of telecommunications facilities and infrastructure and/or other compensation.

There are no specific quality of service standards for satellite providers, however, all telecommunications service operators are by law required to guarantee 'good quality' telecommunications services.[188]

Ministerial Regulation No.3/2025 commenced in March 2025, and seeks to balance the need to increase satellite capacity while ensuring national interests are protected. The regulation simplifies the licensing of satellite services, encourages collaboration and partnerships between Indonesian and global satellite players to provide satellite connectivity in Indonesia, and require in-country facilities to support local data protection and control.[189]

In October 2025, the Ministry of Communication and Digital (Kemkomdigi) opened a public consultation on the regulations and policies related to the implementation of Non-Terrestrial Network Direct-to-Device (NTN-D2D) Technology in Indonesia. The consultation seeks to better understand the views, data and best practices surrounding the use of NTN-D2D technology a solution for equitable access to national digital connectivity, given the technology's potential in expanding coverage beyond terrestrial networks' reach.[190]

Kemkomdigi has also invited public participation in its consultation on the Potential Implementation of NTN-D2D and Air-to-Ground (A2G) Technology in the 2 GHz frequency band, viewed as a potential strategic solution to expanding the reach of digital services in remote areas, borders, waterways and air routes in Indonesia.[191] Both consultations closed early November 2025.

7.3.3 Licensing of Starlink

In April 2024, Starlink applied for an ISP business permit for its Starlink satellite unit.[192]

Starlink had already received a permit to operate in Indonesia as a satellite internet provider using low-Earth orbit satellites, in the form of a business license for Very Small Aperture Terminal (VSAT) closed fixed networks.[193] A VSAT business licence provides for satellite landing rights to be

187 Regulation of Minister of Communications and Informatics of the Republic of Indonesia Number 7 of 2018

188 Article 15, Regulation of the Government of the Republic of Indonesia Number 52 of 2000

189 Ministry of Communications and Digital Affairs Republic of Indonesia. *Indonesia Satellite Regulatory Frameworks.* September 2025, Kuala Lumpur.

190 Komdigi. To Accelerate Equality of Digital Connectivity to 3T Regions, Komdigi Opens Public Consultation on NTN-D2D Technology Study. October 2025. Available at https://www.komdigi.go.id/berita/siaran-pers/detail/percepat-pemerataan-konektivitas-digital-hingga-ke-daerah-3t-komdigi-buka-konsultasi-publik-kajian-teknologi-ntn-d2d

191 Komdigi. Addressing Connectivity Challenges on Land and Air, Komdigi Opens Public Consultation on NTN-D2D and Air-to-Ground (A2G) Technology Studies in the 2 GHz band. October 2025. Available at https://www.komdigi.go.id/berita/siaran-pers/detail/jawab-tantangan-konektivitas-di-darat-dan-udara-komdigi-buka-konsultasi-publik-kajian-teknologi-ntn-d2d-dan-air-to-ground-a2g-di-pita-2-ghz

192 Light Reading, Starlink applies for an ISP license in Indonesia' April 2024. Available at https://www.lightreading.com/satellite/starlink-applies-for-an-isp-license-in-indonesia

193 The Jakarta Post. Elon Musk's Starlink granted licences to operate in Indonesia. May 2024. Available at: https://www.thejakartapost.com/business/2024/05/09/elon-musks-starlink-granted-licences-to-operate-in-indonesia.html

granted to a telecommunications network operator/service operator, which includes an internet service provider.[194]

7.4 Lao PDR

7.4.1 LEO laws and regulations

The Ministry of Technology and Communications has not yet issued licenses for commercial LEO connectivity services. Any future licences authorising the provision of commercial LEO connectivity services would be regulated by the Decree on Satellite Communication No. 471/PM, dated 27 December 2019.

Licenses for D2D, SCS and NTN have not been introduced, with the Ministry of Technology and Communications still in the process of developing an applicable regulatory framework. The framework will likely focus on technical and regulatory compliance, covering issues such as satellite networks coordination, landing rights, frequency licensing, telecommunications licensing, earth station licensing, Joint venture agreement with the government of the Lao PDR, install the hub station in Lao PDR and connect to Laos Internet Center and user equipment type approval.

Any future LEO connectivity provider would be required to meet the QoS requirements stipulated in Ministerial Decision No. 2329/MPT, dated 17 December 2020, which sets out the technical parameters, performance benchmarks, and service quality obligations that licensed telecommunications service providers must comply with (e.g., standards for network availability, latency, throughput, fault repair).

7.4.2 General laws and regulations

In 2019, Lao PDR's Government issued the Decree On Satellite Communications. The Decree holds that '*Legal entities or organisations properly established in Lao PDR for the purpose of establishing or purchasing satellites to provide services on behalf of Lao PDR'* must register with the Ministry of Post and Telecommunications.[195] Satellite communications businesses must also apply for a permit from Ministry of Post and Telecommunications to conduct satellite communications activities.[196]

7.5 Malaysia

7.5.1 LEO laws and regulations

There is no dedicated licensing regime that is specifically designed for LEO satellite service provisioning in Malaysia. Under the current framework, service providers offering satellite-based services are required to obtain the appropriate licences under the *Communications and Multimedia Act 1998* (CMA), in this instance, typically the Network Facilities Provider (NFP) and/or Network Service Provider (NSP) licences, depending on the nature of the service offering. This general licensing framework applies uniformly across all types of satellite systems, whether GEO, MEO, or LEO, and such general framework also governs other categories of satellite operations.

7.5.2 General laws and regulations

Malaysia has regulatory frameworks in place that generally govern satellite connectivity service provisioning. The relevant laws and regulations in Malaysia are:[197]

194 Regulation of Minister of Communications and Informatics of the Republic of Indonesia Number 7 of 2018, sections 4-5

195 Article 21, *Decree On Satellite Communications* (2019)

196 Article 40, *Decree On Satellite Communications* (2019)

197 See also https://apnic.foundation/wp-content/uploads/2024/02/Malaysia-Satellite-Internet-Access-Guide-ILRC.pdf

- Malaysian Communications and Multimedia Commission Act 1998;
- Communications and Multimedia Act 1998 (CMA);
- Malaysian Space Board Act 2022;
- Communications and Multimedia (Spectrum) Regulations 2000;
- Communications and Multimedia (Licensing) Regulations 2000;and
- Communications and Multimedia (Technical Standards) Regulations 2000.

Pursuant to section 126 of the CMA, a Network Facility Provider and/or Network Service Provider licences are required before any party intends to undertake the provisioning of satellite service, while an Application Service Provider licence is required to provide satellite broadband or Internet access services to the end user. Under the CMA, there are two (2) types of licences, namely, individual and class. Individual licence requires high degree of regulatory control for a specified person to conduct a specified activity and may include special licence conditions, while class licence is designed to promote industry growth and development with easy market access. In providing satellite service, a Network Facilities Provider licensee is the owner or provider of network facilities such as satellite earth stations, satellite hubs, satellite control station or space station and a Network Service Provider licensee will provide network services which enable connectivity or transport between different networks including but not limited to bandwidth services, space services and gateway services. Meanwhile, an applications service provider licensee will provide retail services to be delivered to the end-users.

Any licence application must be submitted to MCMC in line with the provisions of section 27 of the CMA for individual licence and section 45 of the CMA for class licence. While the applications are submitted to MCMC, the grant of an individual licence is done by the Minister in charge of communications and multimedia who acts on recommendation of the MCMC.

Regarding the duration, regulation 11 of the Licensing Regulations stipulates that the validity of an individual licence is within 5 to 10 years in accordance with the duration of the individual licence granted by the Minister, while the registration of class licence is valid for 1 year from the registration date in accordance with regulation 25 of the Licensing Regulations.

Malaysia's *Space Board Act 2022* requires, among other things, that licensees obtain a launch permit to launch a space object into space and to register a space object which has been launched into the earth's orbit or beyond with the Space Regulator.[198] Section 17 of the Space Board Act requires that a license (launch permit) be obtained to launch a satellite from within Malaysia.

The use of spectrum for the provisioning of satellite service in Malaysia must be consistent with the Spectrum Plan,[199] which provides details of information on spectrum allocation and relevant conditions and requirements for its usage in Malaysia. In line with the Malaysia's spectrum allocation chart[200], the C, L, S, X, Ku, Ka and Q/V/E bands are among the primary bands considered to provide satellite internet access, without being exclusive to such use.

In addition, the Commission may issue an assignment which confers rights for the use the spectrum at a specified frequency or in any specified frequency band(s) pursuant to sections 164 and 169 of the CMA. These may be in the form of an Apparatus Assignment,[201] which authorises individual spectrum use, or a Class Assignment,[202] which allows unlicensed usage under specified conditions.

198 Skrine Lawyers '*2021: A (Congested) Space Odyssey?*' 2021. Available at https://www.skrine.com/insights/alerts/august-2021/2021-a-congested-space-odyssey

199 Malaysia Spectrum Plan: https://mcmc.gov.my/skmmgovmy/media/General/MCMC-Spectrum-Plan-2022.pdf

200 Malaysia's Spectrum allocation Chart: https://mcmc.gov.my/skmmgovmy/media/General/pdf2/Malaysian-Spectrum-Chart-2022.pdf

201 https://mcmc.gov.my/en/spectrum/assignment-of-spectrum/apparatus-assignment

202 https://mcmc.gov.my/en/spectrum/assignment-of-spectrum/class-assignment

In addition, all communications equipment, including satellite gateways and user terminals, must be certified and shall bear the MCMC certification label in accordance with the Communications and Multimedia (Technical Standards) Regulations 2000.

Malaysia provides a facilitative trial mechanism for interested applicants, including license seekers, to conduct trial, experimental, or demonstration activities prior to commercial launch. A license is not required, provided that such activities comply with the MCMC Trial, Experiment and Demonstration (TED) guidelines. The trial period may extend up to 12 months, fostering innovation and enhancing regulatory preparedness for new satellite technologies and services.

Section 34 of the Space Board Act makes provision for the renewal of such licences.
The launch permit's duration is stipulated in the licence as per section 26 of the *Space Board Act*, and the licence may be renewed under Section 28. An apparatus assignment is valid for a maximum period of five years.[203] A register of all holders
of individual licences is provided on MCMC's website. The broadband satellite operators include SpeedCast, Satellite NOC, Measat Satellite Systems, ASN Satellites, Privasat, etc.[204]

There are general USO and a contribution requirement that apply to telecommunications service providers, which would also apply to satellite services.[205]

Only general QoS apply, which exist as set benchmarks for wireless broadband performance e.g. minimum download speeds.[206] Where QoS are found to be breached by a telecommunications provider, fines of RM500,000 are payable under section 105(5) of the CMA.

7.5.3 Licensing of Starlink

Starlink received a 10-year licence to operate as a Network Facilities Provider (NFP) and Network Service Provider (NSP) in accordance with the CMA based on its submitted ownership status. As a holder of such licences, Starlink is permitted by the MCMC to set up space stations, earth stations, satellite hubs and satellite control stations, to provide bandwidth services and space services. Starlink was exempted from foreign ownership requirements. [207]

7.6 Myanmar

LEO laws and regulations

Telecommunications legislation provides for the licensing and operations of LEO satellite services. Article 13 of the *Telecommunications Law* requires a Telecommunications License Equipment License be obtained for import, export, possession, and use of LEO satellite services. Unauthorised use is prohibited under Section 67 of the Law.

LEO service providers are covered by general regulatory frameworks which require obtaining an Applications Service Licenses (AS) for the provision of satellite services if this is done on a re-sale basis and without owning or operating telecommunications facilities e.g., earth stations, international gateways. The use of such facilities would alternative require obtaining a Network Facility Service (Individual) Licence NFS-I.

Additionally, where the licensee intends on setting up an International Gateway Services, authorization must be obtained pursuant to Article 8 of the Telecommunications Law. A service

203 *Communications and Multimedia Act 1998*, Section 168
204 See https://apnic.foundation/wp-content/uploads/2024/02/Malaysia-Satellite-Internet-Access-Guide-ILRC.pdf
205 See *The Communications and Multimedia (Universal Service Provision) (Amendment) Regulations 2003*
206 Minimum LTE download speeds were mandated in 2024, see GSMA. Towards better mobile quality in Asia-Pacific. January 2025. Available at https://www.gsma.com/about-us/regions/asia-pacific/wp-content/uploads/2025/01/BetterMobileQoS_APAC_R_Web.pdf
207 Malaysia Now. MCMC grants Starlink 10-year licence despite being 100% foreign owned, says report. July 2023. Available at: https://www.malaysianow.com/news/2023/07/25/mcmc-grants-starlink-10-year-licence-despite-being-100-foreign-owned-says-report

provider who has already received an AS licence may also be required to obtain the relevant spectrum authorisation.

Administrative fees and charges are imposed on LEO connectivity licensees that total 2% of annual revenue.

7.6.1 General laws and regulations

Under Section 5 of the Telecommunications Law 2013 and Section 52 (c) of Spectrum Rules 2013, an operator must apply to the respective Government department for a business license in order to lawfully establish and operate a telecommunications service business. The rule also applies to international satellite operators wishing to provide satellite communications services to end users.[208]

A Network Facility Service (Individual) licence must be obtained to lawfully construct and operate satellite earth station facilities. Meanwhile, a Network Service (NS) licence must be obtained to provide satellite uplink/downlink connectivity services without possessing satellite earth station facilities. Both types of licences permit the provision of telecommunications services, but access to spectrum can be granted by a Network Facility Service (Individual) license if the applicant states that they intended to apply for scarce resources. The actual right to use spectrum in these cases is not guaranteed, but flows from the provisions of the Telecom Law and Spectrum Rules.

Per section 13 of the Telecommunications Law and section 33(a) of the Licensing Rules, a licence must be obtained to lawfully acquire and use satellite communication devices and equipment.[209]

Additionally, licences are subject to quality of service standards set by the Post and Telecommunications Department regarding e.g. minimum bandwidth speeds.[210]

7.7 Philippines

7.7.1 LEO laws and regulations

From our review there are no specific laws and regulations.

7.7.2 General laws and regulations

The frameworks relevant to satellite connectivity providers in the Philippines are:

- Implementing Rules and Regulations on the National Policy for Expanding Internet Services through Inclusive Access to Satellite Services (DICT Circular No. 02 s 2021);
- Philippines Space Act (Republic Act No. 11363) 2019;
- Executive Order No. 467, as amended by Executive Order No.127 2021; and
- Konektadong Pinoy Act 2025.

In 2019, the Republic Act No. 11363 or "Philippine Space Act"[211] established the Philippine Space Agency and tasks the agency with developing a national Philippine Space Development and Utilisation Policy ("Philippine Space Policy").

On 28 September 2021, the Department of Information and Communications Technology ("DICT") released Department Circular No. 02 ("D.O. No. 2") which provided implementing rules and

208 Nation Thailand. *Myanmar to act against unlicensed use of satellite, radar, and radio equipment. November 2023.* See https://www.nationthailand.com/world/asean/40033165

209 Posts and Telecommunications Department. Regulatory Notification: satellite internet services and communication device licensing 2023; see also https://www.myanmaritv.com/news/regulatory-notification-satellite-internet-services-and-communication-device-licensing

210 VDB Loi. Telecommunications, *Media and Technology Myanmar update.* 2017. Available at https://www.vdb-loi.com/wp-content/uploads/2020/04/Telecommunications-Media-and-Technology-Myanmar-Update-2017.pdf

211 Available at https://philsa.gov.ph/philippine-space-act/

regulations on national policy for expanding the provision of internet services through satellites and identifies the objective of providing universal access to connectivity.[212]

Providers must obtain a satellite service provider and operator (SSPO) license, which allows the operator to provide satellite access and backhaul solutions to MNOs, telecommunication carriers and internet service providers e.g. as with Intelsat.[213] SSPO Licence allows for cellular network to expand beyond current terrestrial limits.

Satellite systems providers or operators ("SSPOs") are required to obtain an accreditation evidenced by the SSPO Accreditation Certificate, which shall be valid for five (5) years, subject to renewal. All internet service providers and all Value-Added Service Providers ("VAS") duly registered with the National Telecommunications Commission ("NTC"), are allowed to directly access all satellite systems duly accredited, for purposes of offering or providing internet services. So can enfranchised telecommunications entities/public telecommunications entities duly authorised by the NTC.

In accordance with Executive Order No. 467, as amended by Executive Order No. 127, the aforementioned entities can have direct access to all satellite systems, can build and operate broadband facilities to offer internet services, as well as perform any and all acts as may be necessary or incidental to any or all of the foregoing activities.[214]

The Konektadong Pinoy Act's draft IRR require the NTC to develop and release performance standards for all Data Transmission Industry Participants (DITPs), a legal category which includes SSPOs.[215] The standards will take into account quality of service parameters such as speed, packet loss, jitter, latency and the benchmarks will be adjusted to the satellite systems in question and whether these are low earth orbits.[216]

The IRR furthermore creates a regulatory pathway for direct access to satellite systems, whereby duly registered DITPs can deploy satellite technology and use associated spectrum in broadband networks with fewer hurdles than before.[217]

7.7.3 Licensing of Starlink

In 2022, the NTC approved the registration of Starlink as a value-added service (VAS) provider, permitting direct access to satellite systems and the construction and operation of broadband facilities.[218] In 2023, the Philippines exempted Starlink's equipment from having to obtain radio station licensing. Starlink User Terminals were thus re-classified by the NTC as customer premise equipment and therefore not subject to radio station licensing.[219]

The NTC has nonetheless required Starlink to file an application for the modification of its type acceptance certificates with the NTC's Equipment Standards Division. NTC also required Starlink to obtain permits from the Commission's regulation Branch, National Capital Region office and Radio Spectrum Planning Division.[220]

As a value-added service, Starlink had to register with the NTC and in turn, and in turn, received a renewable Certificate of Registration valid for up to five years.

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212 See https://www.ocamposuralvo.com/2021/10/13/dict-releases-irr-on-the-national-policy-for-expanding-the-provision-of-internet-services-in-the-philippines/

213 See https://www.intelsat.com/newsroom/intelsat-named-first-foreign-geo-satellite-operator-licensed-to-sell-operate-in-the-philippines/

214 Ibid

215 See Draft Konektadong Pinoy Implementing Rules and Regulations, section 4(i)

216 See Draft Konekatdong Pinoy IRR, section 10 (a)

217 See Konektadong Pinoy IRR, section 15 (b)

218 Republic of the Philippines News Agency. *NTC OKs registration of Elon Musk's Starlink*. May 2022. Available at: https://www.pna.gov.ph/articles/1175290

219 Manila Standard. *NTC exempts Starlink from radio licensing process*. February 2023. Available at: https://manilastandard.net/?p=314301628

220 *Ibid*

A VAS provider must comply with service performance standards, certain memorandum circulars, and other applicable standards prescribed by the Commission.[221] The rates of value-added services are deregulated.[222]

As of 2025, the Filipino Senate adopted a resolution urging the NTC to grant Starlink Internet Service Services Philippines provisional authority to operate.[223] The resolution responded to a circular issued by the Department of Information and Communications Technology (DICT) issued in 2021 which sets out an accreditation framework for satellite service providers and/or operators to encourage them to establish, own, maintain, and operate satellite ground stations within the country. Starlink being wholly foreign owned, it has required change from the Philippines's existing legal and regulatory regimes.[224]

7.8 Singapore

7.8.1 LEO laws and regulations

In Singapore, LEO systems are licensed through the country's telecommunications regulatory framework rather than a bespoke regime.

Existing licensing frameworks do not impose specific universal service obligations on LEO connectivity service providers, although general requirements apply as detailed in the next section. Additionally, no service quality or QoS conditions apply to providers. LEO connectivity services are nonetheless subject to the general telecommunications licensing fee structure based on annual revenue.

LEO and GEO connectivity services are in use in Singapore for various applications, including backhaul and coverage in maritime areas where terrestrial networks cannot operate. Given Singapore's extensive terrestrial connectivity infrastructure, LEO service adoption is driven by specific use cases rather than broad connectivity gaps. Satellite services are thus viewed as complementary to terrestrial networks.

7.8.2 General laws and regulations

Singapore regulates satellite communications through its telecommunications framework. The relevant frameworks are;

- Telecommunications Act 1999 (The Telecoms Act);[225]
- *Telecommunications (Radio-communication) Regulations;*[226] and
- Guidelines issued by regulator IMDA e.g. e.g. Satellite Communication Station Licence Application Guidelines and *Guidelines for Singapore-Related Space Activities* May 2024.

The Telecommunications Act is the primary legislation governing the telecoms industry in Singapore, it does not make a distinction between fixed, mobile and satellite services as such the Infocomm Media Development Authority (IMDA) has adopted a technology neutral approach in regulating the industry.[227]

Satellite Communications Stations (portable satellite communication terminal, very small aperture terminal, earth station, tracking, telemetry and command (TT&C) earth station) must

221 Memorandum Circular 02-05-2008, s 8(b)
222 Memorandum Circular 02-05-2008, s 9
223 Senate Joint Resolution No. 3
224 Inquirer.Net. *Elon Musk's Starlink PH gets boost from House*. January 2025. Available at: https://newsinfo.inquirer.net/2029588/elon-musks-starlink-ph-gets-boost-from-house
225 See https://www.imda.gov.sg/regulations-and-licensing-listing/telecommunications-act-1999
226 See See https://sso.agc.gov.sg/SL/TA1999-RG5?DocDate=20020930
227 Lexology. Telecoms and Media Singapore. 2023. Available at https://www.drewnapier.com/DrewNapier/media/DrewNapier/2023-Telecoms-and-Media-Singapore.pdf

obtain a Satellite Communication Station Licence.[228] In doing so, licensees must seek the IMDA's approval for access to any space segment and shall comply with the relevant rules, regulations and procedures imposed by satellite operators for station access, booking and fees.[229]

Following Regulation 52 of the *Telecommunications (Radio-communication) Regulations*, IMDA may grant a license to enable the licensee to transmit, receive or transmit and receive messages by means of satellite communication for such purposes as may be authorised by the IMDA. This includes through making use of Earth stations. To provide telecommunication services, an entity must either obtain a Facilities-Based Operations (FBO) licence if there is telecommunication infrastructure to be deployed (e.g. fibre networks, satellite gateways). A Services-Based Operations (SBO) licence would be required if an entity intends to lease telecommunication network elements (i.e., such as transmission capacity and switching services) from any FBO licensed by IMDA so as to provide their own telecommunication services.

IMDA may also vary, modify, suspend and cancel any of the terms of a licence in accordance with the relevant Act and Regulations. A licence is not transferable unless with prior written approval from IMDA,[230] and is valid for one year and renewed annually.[231]

Licensees may only use the radio frequencies or bands approved by IMDA for use. Further, a licensee must not without the written approval of the IMDA use any satellite communication equipment in respect of which the licence has been issued. IMDA is empowered to withdraw frequencies from or allocate different frequencies in place of a licence without providing reasons.[232]

Obligations can also be imposed on licence-holders. Regulation 53 of the *Telecommunications (Radio-communication) Regulations* empowers the IMDA to impose obligations on licensees and Regulation 54 allows for IMDA to exempt a licensee from complying with international regulations and conventions, but otherwise requires all other licensees to comply. Unless a licensee is exempted by IMDA, a licensee shall at all times comply with the provisions of the International Telecommunication Convention and all regulations/recommendations annexed thereto. However, generally-speaking, universal service obligations (USOs) are applied by the IMDA to public telecommunications licensees only if this is required by the conditions of their licence. An annual fee will be levied by IMDA from license-holders based on revenue.

The *Telecommunications (Radio-communication) Regulations* furthermore contain general licensing requirements. Regulation 19 requires that a station or network may be possessed, established, installed, maintained, provided, or operated if authorised by a licence. A licence shall be subject to such conditions, restrictions and limitations as determined by IMDA.

Quality of Service standards are set by the IMDA and require operators to submit periodic reports of their service quality. Current QoS standards have not specifically addressed satellite communication services, but rather, mobile and broadband services more broadly.[233]

The Office of Space Technology and Industry (OSTIn) also issued the *Guidelines for Singapore-Related Space Activities* in May 2024 which impose requirements for launching satellites into space on registered/funded entities.[234]

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228 Telecommunications (Radio-communication) Regulations, Regulation 53(a)

229 *Telecommunications (Radio-communication) Regulations*, Regulation 53(c)

230 IMDA. *Satellite Communication Station Licence Application Guidelines*. Available at: https://www.imda.gov.sg/-/media/imda/files/regulation-licensing-and-consultations/licensing/licenses/guidesatecomm.pdf

231 IMDA. *Satellite Communication Station Licence*. Available at: https://iris.imda.gov.sg/application/satellite-communication-station-licence

232 IMDA. *Satellite Communication Station Licence Application Guidelines*. Available at: https://www.imda.gov.sg/-/media/imda/files/regulation-licensing-and-consultations/licensing/licenses/guidesatecomm.pdf

233 IMDA. *Quality of Service*. See https://www.imda.gov.sg/regulations-and-licensing-listing/dealer-and-equipment-registration-framework/compliance-to-imda-standards/quality-of-service

234 See https://www.space.gov.sg/files/2024_05_Guidelines_for_Singapore_related_Space_Activities.pdf

7.9 Thailand

7.9.1 LEO laws and regulations

The following legal frameworks and licensing schemes have been put in place by the NBTC to regulate LEO connectivity services:

- Notification of the National Broadcasting and Telecommunications Commission on criteria and procedures to license foreign satellite to provide domestic services;[235]
- Notification of the National Broadcasting and Telecommunications Commission Re: Criteria and Procedure for Granting Telecommunications Business License;[236]
- Spectrum Licenses to import, install and use Gateway licenses;
- Licenses to import, install and use radiocommunication equipment;
- Type approval for user terminal.

The NBTC has licensed LEO connectivity services in Thailand's market, having granted two Landing Rights licenses at the time of writing. The first was granted to the National Telecommunications Public Company in partnership with OneWeb to provide internet broadband and satellite capacity. The second was provided to TC BROADCASTING COMPANY LIMITED in partnership with Globalstar for tracking purposes.

The NBTC is yet to license D2D, SCS and NTN. The licensing of D2D services may nonetheless take place towards the end of 2026.[237] The Office of the NBTC is currently conducting a study on D2D and LEO/GEO connectivity services, market, and opportunity in Thailand to develop guidelines in this field.

7.9.2 General laws and regulations

Licensing terms for existing arrangements include universal service obligations, requiring operators to provide a contribution of 2.5% of gross revenue. Additionally, licensees must pay an annual fee of 0.25–1.5% of gross revenue.

Furthermore, while there are no formalised QoS conditions for LEO connectivity, Landing Rights applicants are required by the NBTC to provide QoS as part of their application.

7.10 Viet Nam

7.10.1 LEO laws and regulations

On 23 March 2025, Prime Ministerial Decision No. 659/QD-TTg was adopted, authorising a pilot programme for LEO satellite telecommunications services. The Decision requires the establishment of a domestic ground gateway to route satellite traffic through local infrastructure, ensuring compliance with national security and data sovereignty. The pilot programme will include fixed and mobile satellite services with a cap of 600,000 subscribers and at all times must comply with national defence and security requirements.[238]

As of June 2025, the National Assembly Resolution No. 193/2025/NQ-QH15 established a pilot mechanism for controlled investment and business operations in satellite telecommunications

235 Available at https://www.nbtc.go.th/satellite/Annouce/46857.aspx?lang=th-TH

236 Available at https://telecom-license.nbtc.go.th/getattachment/Information/Criteria-and-procedure/C-Pfortelelicense/Criteriaprocedurefortelelicense.pdf.aspx

237 Bangkok Post. August 2025. Available at https://www.bangkokpost.com/business/general/3093757/satellite-to-phone-service-to-be-available-in-thailand-next-year#ufabpz35vpqhz61avcv2bs40wbva5tido

238 Digital Policy Alert. Vietnam: *Prime Ministerial Decision authorising a pilot program for low- orbit satellite telecommunications services by Space X was adopted* (Decision No.659/QD-TTg). 2025. See https://digitalpolicyalert.org/event/28661-prime-ministerial-decision-no659qd-ttg-authorising-a-pilot-program-for-low-earth-orbit-satellite-telecommunications-services-including-operational-license-requirement-was-adopted-by-the-government

networks using low Earth orbit technology, based on the principle of ensuring national defence and security.

Under this new regime, the Ministry of Science and Technology is responsible for issuing, modifying and revoking business licences for LEO satellite-based telecommunications providers.[239] Licenses may be revoked for non-compliance, including breaches of security or operational conditions.[240] The Ministry of National Defense and the Ministry of Public Security overseas security measures to regulate and monitor these activities.[241]

Viet Nam's advancing legal framework has enabled SpaceX's Starlink to receive an initial pilot license, with Amazon's Kuiper aiming to launch services as well as of late August 2025.[242]

7.10.2 General laws and regulations

The applicable legislation in Viet Nam is:

- Law on Telecommunications (No. 41/2009/QH12) (Law on Telecommunications)
- Law on Radio Frequency (No. 42/2009/QH12) as amended by Law on Radio Frequency Amendment No. 09/2022/QH15 (Law on Radio Frequency)
- Decree No. 72/2013/ND-CP on management, provision and use of internet services and online information (Decree No. 72/2013/ND-CP)
- Decree No. 25/2011/ND-CP detailing and guiding the implementation of a number of articles of the Telecommunications Law (Decree No. 25/2011/NDCP)

Generally-speaking, if an applicant is wanting to establish telecommunications networks alongside the provision of telecommunications services, a License for the Commercial Provision with fifteen years of validity must be obtained (Article 34 of the Law on Telecommunications 2009).[243] To use radio frequencies, satellite internet providers must acquire satellite orbit and frequency licenses (Article 16 of the Law on Radio Frequency).[244]

A telecommunications license and a frequency and satellite orbit use license is required to use, operate, or otherwise control satellites for internet access. Under Articles 8 and 9 of Decree No. 25/2011/ND-CP, satellite fixed and mobile telecommunication networks are classified telecommunication networks, while internet access services are classified as telecommunication services.

Article 36 of the Law on Telecommunications requires that certain conditions be met before a telecommunication license can be granted to a provider. These include:

- Having a business registration certificate or a certificate of investment in a telecommunications service;
- Having adequate financial capacity, staff strength, and competence for the business.

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239 Vietnamnet Global. *Can Vietnam's LEO satellite initiative transform its digital landscape?* February 2025. Available at: https://vietnamnet.vn/en/can-vietnam-s-leo-satellite-initiative-transform-its-digital-landscape-2373660.html

240 Decision No.659/QD-TTg; see also Digital Policy Alert. Available at: https://digitalpolicyalert.org/event/28661-prime-ministerial-decision-no659qd-ttg-authorising-a-pilot-program-for-low-earth-orbit-satellite-telecommunications-services-including-operational-license-requirement-was-adopted-by-the-government

241 Vietnamnet Global. *Can Vietnam's LEO satellite initiative transform its digital landscape?* February 2025. Available at: https://vietnamnet.vn/en/can-vietnam-s-leo-satellite-initiative-transform-its-digital-landscape-2373660.html

242 RASP. *Amazon Getting Ready for Launching Kuiper in Vietnam*. August 28, 2025. Available at https://www.rentasatphone.com.au/blog/amazon-getting-ready-for-launching-kuiper-in-vietnam#:~:text=Amazon's%20LEO%20constellation%20is%20engineered,e%2Dcommerce%20for%20remote%20communities.&text=Amazon's%20Project%20Kuiper%20is%20expected,cost%2Deffective%20service%20availability%20nationwide.

243 Matin Pedram and Eugenia Georgiades, '*The Role of Regulatory Frameworks in Balancing Between National Security and Competition in LEO Satellite Market*' (2024) *Bond University Australia*, 194

244 Ibid, 194

- Having a feasible technical and business plan.
- Having in place appropriate measures to safeguard the telecommunications infrastructure and information security.

Article 21 of the Law on Radio Frequency stipulates additional requirements that need to be met regarding resourcing, planning, and respect for international law.

A licence to provide telecommunications services is valid for up to ten years,[245] it can be renewed.[246] A frequency and satellite orbit use license is valid for up to 20 years,[247] and can also be renewed.[248]

Viet Nam does not have a standalone national law regulating the launch, use and operation of satellites, though it is a signatory to the Treaty on Principles Governing States' Activities in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies 1967, and the Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space 1968. These are two out of the five main international treaties on outer space.

The Law on Telecommunications 2009 requiring all licensed telecommunication providers meet certain service quality standards. Standards are issued by the Ministry of Science and Technology but have not specifically address satellite services.[249]

7.10.3 Licensing of Starlink

In August 2025, Starlink was licensed for trial operations in Viet Nam, following the finalisation of the location of the company's first two ground stations located at FPT's data centre in Tan Thuan (formerly District 7) and at the Saigon Hi-Tech Park in Ho Chi Minh City.[250] Starlink's telecommunications service license was conditional on satisfying legal and investment requirements obliging the company to establish a local entity and to fulfil its investment registration with the Ministry of Finance.[251] The company will remain a wholly foreign-owned enterprise, and has collaborated with the Ministry of Finance to develop procedures to establish such an entity in Viet Nam.[252]

In July 2025, Prime Minister's Decision No. 659/QD-TTg was issued which allows for the controlled pilot deployment of satellite-based telecommunications using LEO technology. Under the pilot plan, Starlink has committed to investing around USD 1.4 billion worth of orders with Vietnamese companies for the production of Starlink terminal devices, designed to boost local employment opportunities.[253]

Starlink will run as a pilot programme for a maximum of five years from the date it was granted a telecom service license.[254] The company has been authorised by the Vietnamese Government to provide a fixed and mobile service satellite services across the country.[255] The period of the trial

245 Article 34 of the *Law on Telecommunications*
246 Article 38 of the *Law on Telecommunications*
247 Article 21 of the *Law on Radio Frequency*
248 Article 22 of the *Law on Radio Frequency*
249 Russin & Vechhi. *Telecommunications in Vietnam. 2022*. Available at https://www.russinvecchi.com.vn/wp-content/uploads/2022/08/telecommunications-in-vietnam_august-2024-cbk.pdf
250 Voice of Vietnam. SpaceX reveals locations for first two Starlink ground stations in Vietnam. August 2025. Available at https://english.vov.vn/en/society/spacex-reveals-locations-for-first-two-starlink-ground-stations-in-vietnam-post1223985.vov
251 Voice of Vietnam, August 2025.
252 Voice of Vietnam, August 2025.
253 Voice of Vietnam, August 2025.
254 See Decision No. 659
255 Nova News. *Vietnam Government Announces Trial Period for Starlink Services Until 2030.* March 2025. Available at: https://www.agenzianova.com/en/news/Vietnamese-government-announces-trial-period-for-Starlink-services-until-2030/

has been earmarked to last until the end of 2030 and limits the number of subscribers at 600,000 for this duration of time.[256]

[256] Reuters. *Vietnam to allow SpaceX's Starlink satellite internet service*. March 2025. Available at: https://www.reuters.com/technology/space/vietnam-issues-decision-allow-spacexs-starlink-satellite-internet-service-2025-03-26/

8 Appendix B – Foreign country exemplars

8.1 Australia's regulation of LEO satellites

8.1.1 Background

The Australian Communications and Media Authority (ACMA) is Australia's principal statutory body for the regulation of satellite communications and radio frequency spectrum. Space-based radiocommunications systems may not be operated in Australia without obtaining a licence from the ACMA.

8.1.2 Licensing

Under the *Radiocommunications Act 1992*, there are three primary classes of licences.

- **Spectrum Licences** are licences that entitle a holder to the exclusive use of a portion of spectrum (subject to any licensing conditions).
- **Apparatus Licences** permit the use of specific transmitters and receivers. Apparatus licences are more restrictive than spectrum licences, as they only grant permission to use specific radiofrequencies from specific location(s).
- **Class Licences** are a generalist legal instrument that authorise entire classes of transmitters or receivers. Class licences generally cover low risk equipment that can be assessed as complying with international or Australian technical standards. Class licences are more limited than apparatus and spectrum licences. [257]

At a high level, there are two options for the licensing of space and Earth systems in Australia:

- Option 1 – Operators obtain apparatus licenses for each of their Earth stations individually: an Earth license for the uplink and an Earth receive license for the downlink. Under this approach, a license is not required for the space stations aboard a satellite; and
- Option 2 – A combination of apparatus and class licenses in certain bands specified in the Radiocommunications (Communication with Space Object) Class License 2015 (Space Objects Class License). This requires operators to obtain a license for the space stations aboard a satellite with a space license for the downlink and a space receive license for the uplink. Earth stations in the network are then automatically authorised collectively under the Space Objects Class License.[258]
    - This approach is commonly adopted where satellite systems have numerous or ubiquitous Earth stations because it provides a means to license a number of Earth

[257] APO. Available at https://apo.org.au/sites/default/files/resource-files/2022-07/apo-nid318785.pdf

[258] Norton Rose Fulbright. Available at https://www.nortonrosefulbright.com/en/knowledge/publications/f0a97b4e/global-outer-space-guide-australia

stations without the need to obtain a license for every Earth station in a satellite system. [259]

Spectrum for IMT satellite direct-to-mobile services is mainly authorised Australia-wide for use by MNOs under spectrum licences. Mobile phones used in an IMT satellite direct-to-mobile service can be operated under the current spectrum licensing framework, subject to the phone complying with all applicable licence conditions, without the need for explicit approval from the ACMA.[260]

Additionally, the *Telecommunications Act 1997* regulates the use of telecommunications assets and infrastructure within Australia.

- Section 41 of the Act requires satellite operators to receive a carrier licence by ACMA to operate a spectrum 'network unit' such as a satellite.
- Sections 45 to 51 outline licence exemptions for Defence, intelligence agencies and certain industries, and gives the Minister discretionary authority to allow exemptions for individuals or organisations.
- Section 10 outlines the *Telecommunications Act 1997's* application to the Australian mainland and its external territories, and s 65 outlines the application of the Act regarding foreign satellite service operators seeking to operate in Australia.

8.1.3 D2D regulations

A foreign satellite operator must apply to the Australian Communications and Media Authority (ACMA) to be listed in the Foreign Space Objects Determination for its satellite system to lawfully operate in Australian spectrum bands. However, since the frequency bands contemplated for IMT are currently not within the scope of the Foreign Space Objects determination for licencing purposes,[261] D2D service providers do not need to apply.

Instead, D2D services operate under spectrum licences granted by the Australian government, usually following an auction process after consultation with ACMA and ACCC. Spectrum licences allow MNOs to operate their services within a demarcated geographical area and within a specified frequency band, with the intended purpose of avoiding interference with other services. D2D services may also be subject to additional obligations as telecommunications carriers or carriage service providers under the *Telecommunications Act 1997.*[262]

In September 2024, ACMA released a regulatory guide for D2D services.[263] The guide identifies two types of satellite direct-to-mobile services: MSS satellite direct-to-mobile services and IMT satellite direct-to-mobile services.

- For MSS, operating under this type of service can take place within the normal licensing process used for mobile phone phones and no additional license is necessary. The mobile earth station functionality is included in the mobile phone, however, this does mean that new adapted handsets are required to make use of this kind of technology.
- For IMT satellite services, these services intend to operate in frequency bands allocated for IMT services, meaning that they have been licensed to MNOs under spectrum licences

259 Norton Rose Fulbright. Available at https://www.nortonrosefulbright.com/en/knowledge/publications/f0a97b4e/global-outer-space-guide-australia

260 ACMA Regulatory Guide 2024. Available at https://www.acma.gov.au/sites/default/files/2025-05/Regulatory%20guide_Operation%20of%20an%20IMT%20satellite%20direct-to-mobile%20service_0.pdf

261 ACMA. *Update to Foreign Space objects Determination*. October 2019. Available at: https://www.acma.gov.au/consultations/2022-02/update-foreign-space-objects-determination-consultation-032022

262 Bird & Bird. *A new frontier of connectivity: regulating direct-to-device services in Australia*. March 2025.

263 ACMA. *Operation of an IMT satellite direct-to-mobile service – Regulatory guide.* September 2024. Available at: https://www.acma.gov.au/sites/default/files/2024-09/Regulatory%20guide_Operation%20of%20an%20IMT%20satellite%20direct-to-mobile%20service.pdf

and the bands are not planned for MSS. Theses technical and regulatory conditions require operators to either lease out or reach an agreement with satellite operators around the use of spectrum. By contrast to MSS, a standard mobile phone does not require additional satellite communications capability in order to access IMT satellite direct-to-mobile service.

8.1.4 Spectrum licensing framework

Spectrum licences, being technology-neutral and flexible in nature, authorise the emissions from a mobile phone that reach a space station on-board a satellite provided emissions remain within the parameters of a licence's conditions; and similarly authorises the transmissions from a space station that reach a mobile phone. No authorisation of a space station is required to provide an IMT satellite direct-to-mobile service.

ACMA expects spectrum licensees and their partner satellite operators to undertake their own due diligence in managing coexistence with other spectrum uses and users.

The potential frequency bands for use by IMT satellite direct-to-mobile services can be found in the following table:

Band	Spectrum licence area	Apparatus licence area
700 MHz	Australia-wide (ASMG area)	PTS licensed in outside areas*
800 MHz	Australia-wide (ASMG area)	PTS licensed in outside areas
850/900 MHz	Australia-wide (ASMG area)	PTS licensed in outside areas
1800 MHz	Metro and regional areas	Remote areas
2 GHz	Metro (entire band) Regional areas (upper 2x20 MHz)	Regional (lower 2x40 MHz) Remote areas (entire band)
2.5 GHz	Australia-wide (ASMG area)	No licences issued

** Outside areas: Australian territorial waters and offshore areas outside the ASMG boundary.*

Source: ACMA[264]

8.2 China's regulation of satellite communications

In August 2025, China's Ministry of Industry and Information Technology issued its "*Guiding Opinions on Optimising Business Access to Promote the Development of the Satellite Communications Industry*".[265]

The guidelines consist of 19 points in seven key areas relating to market opening, application expansion, industrial ecosystem development, resource optimisation, regulatory oversight, and possible international collaboration.[266]

The guidelines support the development of direct-to-satellite services, the application of direct satellite connection for mobile phones and other terminal devices, encourage partnerships between operators and satellite companies, and expand market access for private enterprises. In addition, they encourage the expansion of the use of satellite services across various industries such as agriculture and transportation, in emergency communications, remote and rural areas, as

264 ibid
265 Refer to https://www.gov.cn/zhengce/zhengceku/202508/content_7038032.htm
266 Refer to https://www.china-in-space.com/p/china-to-have-10-million-satellite

well as its cross-integration with next-generation information technologies such as artificial intelligence and 5G/6G.[267]

The guidelines also support the development of an open, collaborative and mutually beneficial industrial ecosystem, the optimisation of resources, and the strengthening of the management system and regulations for satellite communication. They also outline China's intention to "actively participate" in the work of international and regional organisations, including the International Telecommunications Union (ITU) and the Third Generation Partnership Project (3GPP).[268]

Under the guidelines, China seeks to "fully unleash" the development potential of its satellite communications industry. By 2030, new business models such as direct satellite connection for mobile phones are to be applied widely, and the number of satellite communication users will exceed 10 million.[269]

After issuing the guidelines, officials told *People's Daily* (the official newspaper of the Central Committee of the Chinese Communist Party) that the upcoming 15th Five-Year Plan period (2026-2030) is critical for the development of China's satellite communications industry. They emphasised a phased implementation approach, with different roles assigned to different enterprise types: state-owned satellite companies will focus on Low-Earth-Orbit internet development, telecommunications operators will focus on direct satellite services for consumer devices, and private companies will focus on other emerging applications, possibly those beyond Low-Earth-orbit.[270]

In April 2025, seven government departments issued a notice, "*Regulations on the Management of Terminal Equipment Directly Connected to Satellite Services",* establishing the legal and technical groundwork for satellite connectivity.[271]

China is also deploying Low-Earth-Orbit (LEO) satellite constellations. Major projects include the *Guowang* low-Earth-orbit mega-constellation (13,000 satellites), the *Qianfan* constellation (15,000 satellites) and the *Honghu-3* constellation (10,000 satellites).[272]

In September 2025, the Ministry granted a licence to China Unicom, one of the three major telecommunication operators, to operate satellite mobile services. China Telecom is already licenced and operating direct-to-device (D2D) services through the *Tiantong* satellite system. China Mobile is reported to have applied for a licence.[273]

8.3 European Union's regulation of LEO satellites

The European Union's CEPT, the body bringing together the administrations of 46 European countries, has been reviewing how to manage the technical and regulatory issues affecting D2D satellite connectivity. The objective is to agree on a common view across these countries on authorisations for satellite-based services.[274]

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267 Refer to https://www.gov.cn/zhengce/zhengceku/202508/content_7038032.htm

268 Refer to https://www.gov.cn/zhengce/zhengceku/202508/content_7038032.htm

269 Refer to https://www.gov.cn/zhengce/zhengceku/202508/content_7038032.htm; https://english.news.cn/20250827/f7c7a8c4f61042809f29f705a8f36149/c.html

270 Refer to https://www.china-in-space.com/p/china-to-have-10-million-satellite; https://mp.weixin.qq.com/s/r2kXvfPXNDMry7pko3Bt6g

271 Refer to https://spacenews.com/china-issues-regulatory-framework-to-support-direct-to-device-satellite-services/

272 Refer to https://interactive.satellitetoday.com/via/september-2025/ntns-new-power-player-is-china-aiming-to-take-the-lead-in-space-based-connectivity

273 Refer to https://spacenews.com/china-promotes-direct-to-device-satellite-services-with-new-guidelines-and-licensing/

274 Fieldfisher. *Satellite enabled mobile services – European and UK regulation*. April 2025, available at https://www.fieldfisher.com/en/insights/satellite-enabled-mobile-services-european-and-uk-regulation

A public consultation was finalised in February 2025.[275] A final report and roadmap are expected to be released by CEPT by February 2026. The report will address the regulatory and technical features, which include mitigation, for the national authorisation of satellite based D2C communications.[276]

The European Commission furthermore intends to grant a study mandate to CEPT for the purpose of establishing future European harmonised technical conditions by 2027/2028. Harmonised technical conditions would be included in the licences of mobile operators providing D2D services in partnership with D2D satellite operators, the preferred approach of Member States, and would see mobile operators free up part of their licensed spectrum for D2D use.[277]

In June 2025, the European Commission proposed the EU Space Act, which will introduce a harmonised framework for space activities in the EU to replace the existing fragmented regulatory landscape with 13 countries following different approaches. A harmonised framework seeks to improve the safety, resilience, and sustainability of the space sector by implementing new rules for tracking space objects and limiting new debris, integrating tailored cybersecurity requirements to strengthen the protection of European space infrastructure, and putting in place measures to mitigate the environmental impact from space activities.[278] Competition concerns also underlie the development of the Act.[279] The framework will apply to any space operator whose activities affect the EU market.[280]

U.S. and non-EU operators will be required to obtain a license or registration and to appoint a legal representative if they provide space-based data or services within the territory of the EU. Exemptions may be available where third party regulatory frameworks are substantially aligned with EU requirements, in the interest of international cooperation and streamlined market access.

Additionally, between late May and June 2025, the European Commission initiated a targeted consultation that sought to obtain stakeholder views on the future of the EU's 2 GHz Mobile Satellite Services (MSS) band after May 2027. The European Commission has since published a report,[281] summarising the different views surrounding what types of services should be provided in future using the band, MSS band segmentation options given the maximum of 2 x 15 MHz per single applicant, spectrum sharing and efficiency, renewal rights of use and a review of the selection criteria for the previous MSS Decision (Decision 626/2008/EC).

Four MSS band segmentation options were proposed by the Commission:

- Option A: Operator 1 = 2x15 MHz - Operator 2 = 2x15 MHz
- Option B: Operator 1 = 2x10 MHz - Operator 2 = 2x10 MHz - Operator 3 = 2x10 MHz
- Option C: Operator 1 = 2x15 MHz - Operator 2 = 2x10 MHz - Operator 3 = 2x5 MHz
- Option D: Operator 1 = 2x15 MHz - Operator 2 = 2x10 MHz – Shared pool = 2x5 MHz

275 European Commission. *DRAFT Opinion on the EU-level policy approach to satellite Direct-to-Device connectivity and related Single Market issues*, February 2025. Available at https://radio-spectrum-policy-group.ec.europa.eu/document/download/7c6039f4-0e01-402c-9b78-638d800ce965_en?filename=RSPG25-008final-Draft_Opinion_on_D2D_and_Access_to_EU_Market-for_PC.pdf

276 European Communications Office. *CEPT activities on satellite D2D.* May 2025. Available at https://cept.org/files/2118/Miia%20Mustonen%20-%20CEPT%20activities%20on%20satellite%20D2D.pdf

277 ANFR. *Direct to Device; mobile coverage everywhere coming soon?* July 2025. Available at https://www.anfr.fr/en/anfr/news/all-news/detail-of-the-news/direct-to-device-mobile-coverage-everywhere-coming-soon

278 EU Commission Press Release. EU Space Act: enhancing market access and space safety. June 2025. Available at https://commission.europa.eu/news-and-media/news/eu-space-act-enhancing-market-access-and-space-safety-2025-06-25_en

279 European Parliament Directorate-General for Parliamentary Research Services. EU Space Act. September 2025. Available at https://epthinktank.eu/2025/09/22/eu-space-act-eu-legislation-in-progress/

280 Defence Industry and Space. *EU Space Act.* June 2025. Available at https://defence-industry-space.ec.europa.eu/eu-space-act_en

281 European Commission, *Mobile Satellite Services consultation – Factual summary*, November 2025. Available at https://digital-strategy.ec.europa.eu/en/library/summary-report-targeted-consultation-mobile-satellite-services

Most respondents expressed a preference for Option A, with Option D also favoured especially by satellite IoT providers or users.[282]

8.4 United Kingdom regulation of D2Ds and LEOs

Ofcom, the United Kingdom's telecommunications regulator, licenses NGSOs with the stated purpose of mitigating interference and competition issues between satellite operators.[283]

Operators can obtain:

- a *Satellite (non-geostationary earth station)* licence which authorises NGSO gateway earth stations, large hubs that connect a satellite network to the internet;
- Operators can also obtain a *Satellite (earth station network)* for NGSO use. These licences authorise the use of NGSO user terminals (e.g. dish ad equipment installed on particular premises) which must be held by any satellite operator wishing to deliver services in the UK.

Both licences are used to authorise gateway earth stations and user terminals that relay traffic via NGSO satellites orbiting the Earth, satellite systems which can provide direct-to-consumer broadband services, broadband services to businesses, telecom operators and governments, Internet of Things services for enterprises operating in extreme environments, delivering broadband services to aircraft and providing backhaul to mobile base station sites or to trains.[284]

An NGSO Network Licence is held by someone who has control over the whole satellite network, which includes associated user terminals and gateway earth stations. This would usually be the satellite operator. The licensee has the ability to negotiate and agree to coexistence arrangements with other licence holders, so they are able to comply with the conditions in the licence. Existing holders of a GSO licence must re-apply for an NGSO licence, the two are not interchangeable.[285]

There are restrictions on the licenses in terms of where they can be used. Restrictions apply in the vicinity of airports and MoD sites, due to the high intensity radio emissions that earth stations produce.[286]

A Satellite (non-geostationary earth station) license-holder is able to transmit through parts of the Ku band and Ka band. A Satellite (earth station network) licence holder can operate in different frequency ranges.

In 2021, Ofcom introduced new licence conditions on NGSO, which required technical cooperation between licensees, enabling Ofcom where require to manage local cases of interference, requiring gateways to only operate with an NGSO satellite system authorised under a network license, and requiring gateways to commence and maintain transmission within 12 months.[287]

Satellite users are furthermore subject to general regulatory obligations, imposed by the Telecommunications (Security) Act 2021 which seeks to ensure telecommunications providers

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282 Ibid

283 Ofcom. *Non-geostationary satellite earth stations (Licensing guidance*) September 2023. Available at https://www.ofcom.org.uk/siteassets/resources/documents/manage-your-licence/satellite-earth-stations/guidance/ngso-guidance.pdf?v=327285 p.1

284 Ibid

285 Ibid page 3

286 Ibid page 4

287 Ofcom. *Non-geostationary satellite systems – Licensing updates*. December 2021. Available at: https://www.ofcom.org.uk/siteassets/resources/documents/consultations/category-2-6-weeks/222439-non-geostationary-satellite-systems/associated-documents/statement-ngso-licensing.pdf?v=327294

comply with security and network resilience rules. Providers are obliged to take appropriate and proportionate measures to identify and reduce the risks of security compromises taking place.[288]

In September 2025, Ofcom announced a new consultation aimed at improving the existing licensing process for NGSO systems that offer broadband from satellites using LEOs (and MEOs).[289] Ofcom is concerned with improving existing frameworks to speed up decision-making timeframes and reduce the coordination and administrative burden on satellite operators. For instance, the regulator has proposed to no longer routinely consult on applications for NGSO gateway licenses.[290]

8.5 United States of America SCS regulations

8.5.1 Overview of Supplemental Coverage from Space Framework

In 2024, the Federal Communications Commission (FCC) released new rules designed to progress towards a single network future that will seek to utilise hybrid satellite-terrestrial networks to fill coverage gaps and reach ubiquitous connectivity directly to consumer handsets using spectrum previously allocated only to terrestrial service.[291] The FCC has anticipated that supplemental coverage from space will enable consumers in areas not covered by terrestrial networks to be connected using their existing devices via satellite-based communications, paving the way for a 'single network future'.

For these reasons, in March 2024, the FCC adopted a licensing framework that authorises satellite operators to partner with terrestrial wireless providers to develop hybrid satellite-terrestrial networks intended to provide ubiquitous network connectivity.

Referred to as the 'Supplemental Coverage from Space' regime, it became effective in May 2024 and enables satellite operators to serve as a gap-filler in the networks of the wireless providers they partner with, using satellite capability combined with spectrum previously exclusively allocated to terrestrial service.

The new regime authorises communications from satellites networks to mobile devices in the following spectrum bands:

- 600 MHz (614–652 MHz and 663–698 MHz)
- 700 MHz (698–769 MHz, 775–799 MHz, and 805–806 MHz)
- 800 MHz (824–849 MHz and 869–894 MHz)

The FCC has said it will consider expanding the list of eligible bands as the market for satellite mobile services develops. The list of SCS-eligible bands also reflects two notable changes from the rules the FCC proposed last year. It excludes frequencies in the Wireless Communications Service (WCS) band (2305–2320 MHz and 2345–2360 MHz) due to interference risks and includes the 758–769 MHz and 788–799 MHz bands allocated for public safety use.[292]

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288 Ofcom. *Statement: General policy on ensuring compliance with security duties.* 2022. Available at https://www.ofcom.org.uk/spectrum/space-and-satellites/wider-regulatory-obligations

289 Ofcom. *NGSO licensing review. Proposals for revising and improving our NGSO licensing process.* 16 September 2025. Available at https://www.ofcom.org.uk/siteassets/resources/documents/consultations/category-3-4-weeks/consultation-proposals-for-revising-and-improving-our-ngso-licensing-process/main-documents/consultation-proposals-for-revising-and-improving-our-ngso-licensing-process.pdf?v=402900

290 Ibid, page 3

291 FCC. *Report and Order and Further Notice of Proposed Rulemaking.* March, 2024. Available at: https://docs.fcc.gov/public/attachments/FCC-24-28A1_Rcd.pdf

292 Covington & Burling LLP. *FCC''s Supplemental Coverage from Space' Rules take effect May 30; New Licensing Framework Expands Satellite-to-Smartphone Coverage.* Available at https://www.lexology.com/library/detail.aspx?g=23f099ee-455a-46c7-8595-29ba19c39c23

The new rules authorise services in the aforementioned frequencies only on a 'secondary' basis, meaning that operations in these bands may not cause harmful interference to and may not claim interference protection from any service operating on a 'primary' basis in the same frequencies.

8.5.2 Licensing process

The FCC's new rules establish threshold eligibility requirements and licensing procedures for satellite operators in order to commence operations under the regime. The framework requires that satellite operators satisfy license and eligibility conditions across (1) terrestrial spectrum access (through spectrum leasing), (2) satellite transmissions to U.S. points of communication and (3) terrestrial device operations.

(1) A threshold requirement for eligibility is that a satellite operator must have one or more spectrum lease notifications or applications on file with the FCC for each of the terrestrial providers with which it plans to partner with in order to provide SCS service;

(2) Authorisation to operate a specific satellite or satellite constellation is required, as governed by Part 25 of the FCC's rules which govern commercial and satellite operations;

(3) The new SCS rules separately authorise the terrestrial devices with which satellite operators will communicate using satellite communication services (*e.g.* smart phones, Internet of Things (IoT) devices, etc.) through a "license by rule" regime.

In regards to emergency services, the FCC rules do not extend 911 obligations to SCS-authorised satellite operators, however certain 911 call requirements will apply to terrestrial wireless providers that use SCS arrangements to extend their coverage areas.

Windsor Place Consulting Pty Ltd (WPC) is internationally recognised as an outstanding provider of advice to the information industries. The firm, established in 2000, works extensively in telecommunications, media, and information technology, both in the development of commercial strategies for the private sector and the formulation of national policy and legislative settings for public sector clients. WPC's team members have a long association with these industries, having been actively involved through various stages of market liberalisation, from the introduction of competition in Australia in the 1990's to the drafting and implementation of modern convergence legislation in a range of countries especially in Asia, Africa and the Pacific.

WPC has undertaken projects in each and every ASEAN Member States more than 20 years including engagements for Governments, regulators, licensed operators, investors and international organisations such as the International Telecommunications Union (ITU), the World Bank, ASEAN, USAid, Asia-Pacific Telecommunity (APT) on range of issues including legislation, spectrum, broadband policy, interconnection, tariff regulation and training.

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