Extending Broadband Connectivity in Southeast Asia

OECD

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Foreword

This report was drafted by Inmaculada Cava Ferreruela, Lauren Crean and Hokuto Nakagawa, based on statistical analyses from Frédéric Bourassa from the OECD Secretariat. It was prepared under the supervision of Verena Weber, Head of the Communication Infrastructures and Services Policy Unit within the Digital Economy Policy Division (DEP) and the overall leadership of Jerry Sheehan, Director of Science, Technology and Innovation (STI), Jens Lundsgaard, Deputy Director of STI, and Audrey Plonk, Head of DEP. Andreia Furtado assisted with communication efforts. Editorial and formatting work was undertaken by Mark Foss and Meral Gedik. Thanks go to Robert Dawson, Alexia Gonzalez Fanfalone, Seongtak Oh and Alice Weber for their contributions to the publication.

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The engagement by officials and experts from the five countries included in the study (Cambodia, Indonesia, Singapore, Thailand and Viet Nam) was essential to this report. The OECD wishes to thank the Ministry of Post and Telecommunications (MPTC) and the Office of Council of Ministers (OCM) of Cambodia; the Ministry of Communications and Informatics (MCI) of Indonesia; the Infocomm Media Development Authority (IMDA) of Singapore; the Ministry of Digital Economy and Society (MDES), the Office of the National Digital Economy and Society Commission (ONDE) and the Office of the National Broadcasting and Telecommunications Commission (NBTC) of Thailand; and the Authority of Telecommunications (VNTA), a department of the Ministry of Information and Communications (MIC) of Viet Nam. The institutional support of these organisations and their staff was invaluable as they provided essential inputs to inform the report, assisted to organise meetings with relevant stakeholders, and contributed valuable comments on the draft of this publication.

In particular, we would like to thank MPTC Secretary of State Sok Puthyvuth, OCM Secretary of State Kang Chandararot, MPTC Under Secretary of State Sun Rapid and Kiyoung Lee, Head of Cambodia-Korea Digital Government Co-operation Center, MPTC (Cambodia). We would also like to thank Director Tran Tuan Anh, Director Nguyen Tien Son, Director Luong Pham Nam Hoang, Director Nguyen Anh Cuong and officials Nguyen Tuan Vinh, Pham Manh Ha, Vu Huy Cuong and Nguyen Minh Ngoc from the VNTA (Viet Nam). We would also like to thank Pathomdanai Ponjan and Thitikorn Sakhamula for their indispensable assistance throughout the project, especially during the OECD's mission to Bangkok, Thailand in 2022. This publication was made possible by the financial contribution of the Ministry of Foreign Affairs of Korea.

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Executive summary

Broadband connectivity is not just the backbone of modern economies but also a critical enabler of vibrant societies. In the rich mosaic of Southeast Asia (SEA), characterised by diverse geography, demographics, and socio-economic dynamics, robust broadband connectivity transcends a mere technological necessity and emerges as an imperative for SEA's sustained prosperity amid multifaceted challenges. As many countries in the region transition from middle to high-income status, high-quality broadband connectivity has become a pivotal enabler of this transformation. It fuels innovation, streamlines the exchange of goods and services, and drives economic growth.

The region's vulnerability to climate-related disasters underscores the crucial need for resilient infrastructures, while demographic shifts towards an ageing population demand innovative solutions and enhanced connectivity for all. Persisting urban-rural divides pose challenges to ensuring all citizens have access to reliable connectivity.

Recognising these evolving challenges, this report seeks to support policymakers in SEA by providing tailored policy recommendations to promote high-quality broadband services in the region. These recommendations leverage the OECD Council Recommendation on Broadband Connectivity, covering key issues such as market developments, competition, investment, innovation, digital divides, and the environmental impact of networks.

The report shows the substantial transformation of SEA’s broadband landscape in the last decade, reaching 769 million subscriptions in 2022, a tenfold increase from 2010. Mobile broadband subscriptions constitute over 92% of total subscriptions, indicating a dynamic mobile broadband market with an average annual growth rate of 25% from 2010-22. However, the landscape is far from uniform, with significant disparities among countries. Mobile subscriptions range from 56.4 subscriptions per 100 inhabitants in the Lao People’s Democratic Republic (Lao PDR) to 169.6 in Singapore. Fixed broadband subscriptions are highest in Singapore (27.4 per 100 inhabitants) and Viet Nam (21.7), but significantly lower in countries like Cambodia, Lao PDR and Myanmar, where rates do not exceed 3 per 100 inhabitants.

Coverage of 3G and 4G networks reaches over 90% of the population in most SEA countries, with six deploying 5G networks by 2022. Fibre-to-the-Home is the dominant fixed broadband technology in the region. Fibre makes up over half of fixed broadband subscriptions in all SEA countries, ranging from 50.75% in Myanmar to 99.75% in Singapore as of 2021. Singapore is SEA’s international connectivity hub with the largest installed capacity in the region and is one of the world's leading submarine cable hubs.

Market structures and competitive intensity vary across SEA, with mobile communication markets generally falling within “moderately concentrated” to “highly concentrated” classifications. Recent mergers and acquisitions, such as the 2023 True-Dtac merger in Thailand and the 2022 Indosat Ooredoo-Hutchison merger in Indonesia, have reshaped the market landscape. Government involvement is notable compared to many OECD countries, with some countries having important stakes in communication operators.

Institutional frameworks for communication regulation in SEA have varying degrees of independence. Some countries have independent regulators, while others rely on ministerial bodies or statutory boards. National broadband strategies seek to foster connectivity for digital transformation, often with targeted goals to expand communication infrastructure and improve service. Overall, SEA's broadband challenges require adaptive policies and a comprehensive approach to navigate the complexities of the region's digital landscape.

Key recommendations

The report uses a methodology that draws on the principles included in the OECD Council Recommendation on Broadband Connectivity to analyse the state of broadband markets and identify areas for improvement. Countries are clustered into five groups according to predictors of broadband adoption. The report provides tailored recommendations for the representative countries of each group: Cambodia, Indonesia, Thailand, Singapore and Viet Nam. This methodology allows for recommendations that adapt to regional nuances, providing a comprehensive overview of SEA's diversity. While some recommendations may be more relevant for certain SEA countries or clusters, several overarching policy recommendations apply more broadly and are presented below.

Strengthen the independence of regulatory bodies with transparent appointment processes. Independent regulators insulated from undue influence are crucial for long-term regulatory effectiveness and market competitiveness. This is especially important to avoid potential conflicts of interest in cases where the state has ownership stakes in communication operators, such as in Viet Nam and Indonesia.

Undertake regular competition assessments. Many SEA countries could benefit from conducting regular assessments of competition in relevant communication markets. Such assessments can help identify whether there are factors that could hinder market competition and the need for regulatory measures to foster market competition.

Facilitate private sector participation. Where restrictions on private sector (foreign or national) participation exist, amending or removing such restrictions can stimulate innovation, diversify services and contribute to the long-term development of the communication sector.

Streamline administrative processes. Streamlining network construction permits, access to rights of way and public infrastructure, and improving local coordination mechanisms will significantly facilitate timely network deployment in many SEA countries.

Promote coordination of civil works and passive infrastructure sharing between networks, especially communication and electricity networks. This approach ensures cost-effective expansion and upgrading of both networks in underserved areas and can be particularly relevant in countries such as Cambodia and Indonesia.

Leverage synergies between programmes to promote the provision and adoption of connectivity services. Creating synergies between various public policy initiatives to extend coverage and programmes to promote digital literacy, local content and public access points can significantly maximise their overall impact.

Ensure transparency and data publication for network quality. Establishing a standardised framework for open, verifiable and granular data publication on subscription, coverage and quality of service would empower end-users and stimulate competition. Viet Nam's quality-of-service measurement and publication tool could inspire other regional countries.

Promote policies to enhance network resilience, including backbone, Internet exchange points and international connectivity. Applicable across SEA, these measures address challenges in disaster-prone areas and vulnerabilities, strengthening communication infrastructure for uninterrupted connectivity.

Support and promote smart and sustainable networks and encourage operators to report regularly on environmental impacts. Singapore's standard for reducing data centre energy consumption could serve as an inspiration.

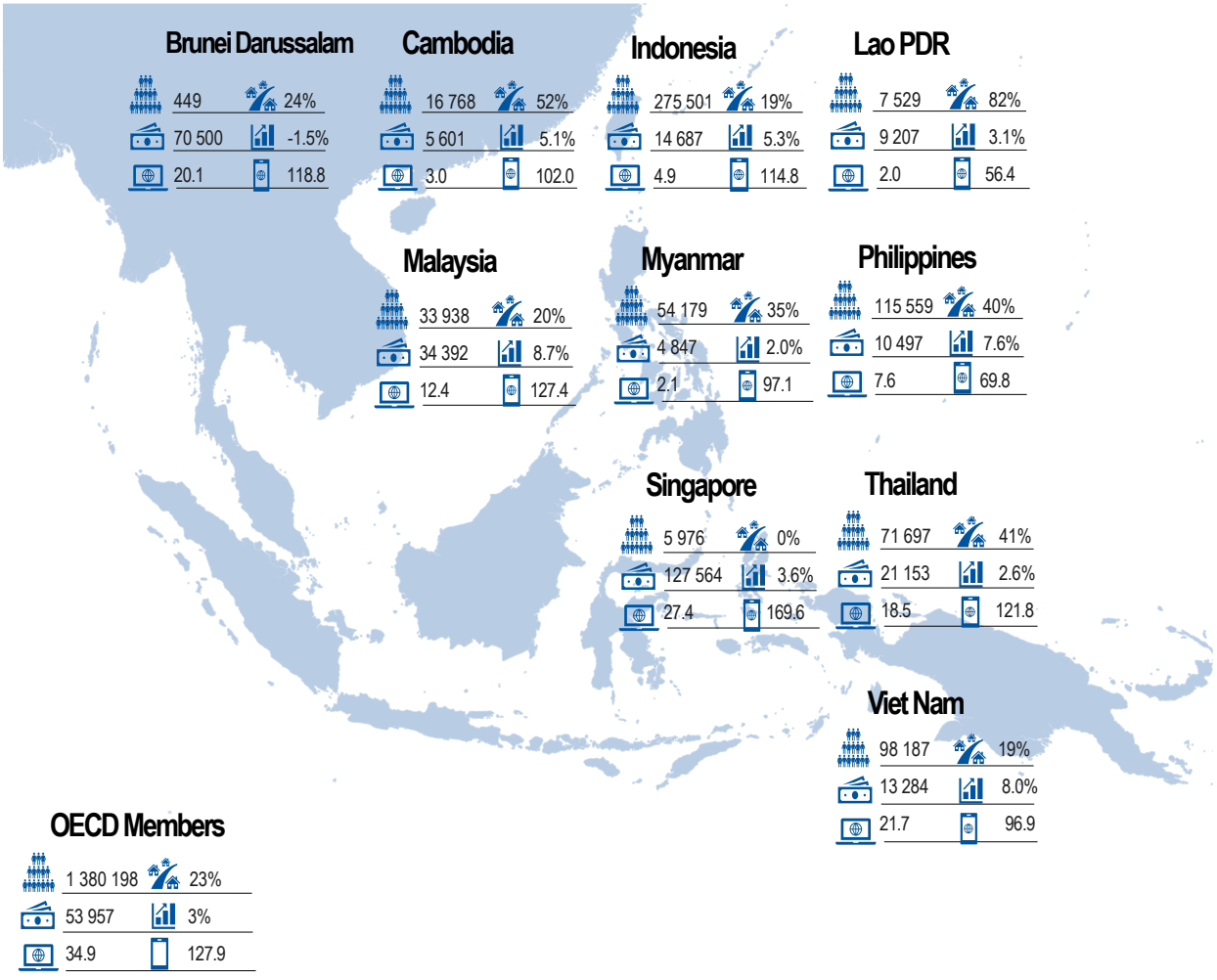
Encourage the establishment of a regular assessment procedure for broadband markets. Such a process ensures a continuous, data-driven evaluation of connectivity metrics, enabling evidence-based policy adjustments and targeted interventions. Countries like Singapore, with its comprehensive data publication, showcase the benefits of regular reviews.

1 Setting the scene for broadband policy recommendations for Southeast Asia

This chapter sets out the framework to develop recommendations to promote high-quality broadband connectivity in Southeast Asia. First, it examines the region's geographical, demographic and socio-economic conditions, which not only condition network deployment and adoption but also illustrate the future challenges and opportunities in the region for which high-quality connectivity is a key driver. Second, it analyses the connectivity situation in the region through key indicators of broadband infrastructure and services, the structure and evolution of communication markets, the institutional frameworks employed across the region, and broadband policies. Finally, the chapter describes the methodology used to develop tailored policy recommendations. This methodology builds on the OECD Council Recommendation on Broadband Connectivity. It considers regional diversity by identifying groups of similar countries and conducting a detailed analysis of one representative country from each group (Cambodia, Indonesia, Singapore, Thailand and Viet Nam).

1.1. Southeast Asia and its broadband framework conditions

Figure 1.1. Southeast Asia at a glance



Note: Population figures for the OECD reflect the total population of all 38 member countries. For the metric "percentage of the population living in rural areas", for Southeast Asian countries, rural areas are defined as grid cells of 1 square kilometre with a density below 300 inhabitants per square kilometre and other grid cells outside urban clusters or centres (European Commission, Joint Research Centre, 2015[1]). For OECD countries, rural population is the percentage of the population living in predominantly rural regions, based on the OECD classification of small regions (territorial level 3). For more information, see OECD (2018[2]), "Defining regions and functional urban areas", in *OECD Regions and Cities at a Glance 2018*, OECD Publishing, Paris. For gross domestic product per capita, current prices, the unit is purchasing power parity; international dollars per capita. For real gross domestic product (GDP) growth (percentage change), data for Myanmar relate to the 2022 fiscal year. For mobile broadband subscriptions per 100 inhabitants, data for Indonesia and Lao PDR are from 2021.
Sources: [Population] For SEA countries: UNDESA (2022[3]), *World Population Prospects: the 2022 revision*, https://population.un.org/wpp/ (accessed on 8 November 2023); For OECD: OECD (2023[4]), *OECD.Stat database, "Historical population: OECD – total (2022)"*, https://stats.oecd.org/ (accessed on 28 August 2023).
[Rural Population] For SEA countries: European Commission, Joint Research Centre (2015[1]), *Country Fact Sheets based on the Degree of Urbanisation*, *Global Human Settlement Layer (GHSL)*, https://ghsl.jrc.ec.europa.eu/CFS.php; For OECD: OECD (2023[5]), *OECD.Stat* (database), *"Regions and cities: Regional statistics: Regional demography: Demographic indicators by rural/urban typology, Country level: OECD: share of national population by typology"*, https://stats.oecd.org/ (accessed on 28 August 2023).
[GDP per capita, current prices, PPP] For SEA countries: IMF (2023[6]), *World Economic Outlook Database, April 2023,* www.imf.org/en/Publications/WEO/weo-database/2023/April (accessed on 22 June 2023); For OECD: OECD (2023[7]), *Gross domestic product (GDP)* (indicator), https://doi.org/10.1787/dc2f7aec-en (accessed on 28 August 2023).
[Real GDP growth, percentage change] For SEA countries: OECD (2023[8]), *Economic Outlook for Southeast Asia, China and India 2023: Reviving Tourism Post-Pandemic*, OECD Publishing, Paris, https://doi.org/10.1787/f677c529-en; For OECD: OECD (2023[9]), *Real GDP forecast: Total annual growth rate (OECD – Total, 2022)* (indicator), https://doi.org/10.1787/1f84150b-en (accessed on 28 August 2023).
[Fixed and mobile broadband subscriptions per 100 inhabitants] For SEA countries except Singapore: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023),* www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023); Singapore: Data provided by IMDA; For OECD: OECD (2023[11]), *Broadband Portal, December 2022 update,* www.oecd.org/sti/broadband/broadband-statistics/ (accessed on 28 August 2023).

1.1.1. Geographical and demographic conditions

Southeast Asia (SEA) is defined in this report as the ten member countries of the Association of Southeast Asian Nations (ASEAN), namely, Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (hereafter "Lao PDR"), Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.[1]

Located in the heart of the Asia-Pacific region, SEA strategically straddles the maritime passage between East Asia and the Middle East and the Mediterranean world. This location has helped define its worldview and foster the distinctive fusion of different cultures of the region, framed by the Middle East, Europe, the People's Republic of China (hereafter "China") and India.

SEA is split between mainland and island countries. Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam and Singapore at the southern tip of the Malay Peninsula constitute mainland SEA. The archipelagic countries of Indonesia and the Philippines, together with Brunei Darussalam on the island of Borneo, form island SEA. Malaysia is both mainland and island, with a western portion on the Malay Peninsula and an eastern part on the island of Borneo.

SEA falls within the warm, humid tropics, and its climate is generally monsoonal (i.e. marked by wet and dry periods), although the region has a high degree of climatic variation. Shallow seas (the Sunda Shelf, from the Gulf of Thailand to the Java Sea) and extensive waterways (the three largest systems, the Irrawaddy, Salween and Mekong rivers) have facilitated communication and trade. In so doing, they have shaped forms of settlement, as well as political and economic patterns (Britannica, 2022[12]).

SEA is one of the most at-risk regions in the world for adverse climate events such as droughts, floods, typhoons, rises in sea levels and heat waves. The effects of the climate crisis exacerbate this. Indeed, climate-related disasters affecting the region have become four times more frequent over the past 40 years, with the Philippines, Indonesia and Viet Nam among the most exposed countries (OECD, 2023[13]). Climate change could wipe out over 35% of the region's gross domestic product (GDP) by the middle of the century. It can severely impact key sectors such as agriculture, tourism and fishing along with human health and

labour productivity (Renaud, 2021[14]). Recognising these challenges, public and private infrastructure investment should prioritise climate change adaptation and mitigation (OECD, 2023[13]).

As of 2022, SEA comprised 680 million people (UNDESA, 2022[3]) spread over 4.5 million square kilometres across 20 000 islands and landmasses. This geographical setting has led to a variety of economic, social and cultural differences. The region is home to over 1 000 languages, with several hundreds of those related to ethnic minorities and all the world's major religions, along with local beliefs.[2] Demographically, the population in 2022 across SEA countries varies from 0.4 million in Brunei Darussalam to 275.5 million in Indonesia. More than 40% of the region's total population resides in Indonesia; the Philippines is the second most populous country in the region with 115.5 million people (UNDESA, 2022[3]).

Similarly, the degree of urbanisation varies greatly among SEA countries. Beyond the unique case of Singapore, with a 100% urban population, the variation ranges from Brunei Darussalam and Malaysia, with around 80% urban and 20% rural, to Cambodia and Lao PDR with over 50% rural population (2015) (European Commission, Joint Research Centre, 2015[1]).

The growth of urban areas is, however, a common trend in SEA countries, which includes an increasing number of mega-cities with more than 10 million inhabitants and their secondary cities. This growth has been unprecedented in recent years and has been coupled with more people living in slums (ASEAN, 2021[15]).[3] Estimates suggest that in 2020, one in three urban residents lived in slums in Cambodia and the Philippines, and more than one in two in Myanmar (UN-Habitat, 2020[16]). Access to basic infrastructure is often lacking in slums, which can make it challenging to access quality connectivity, especially fixed communication service.

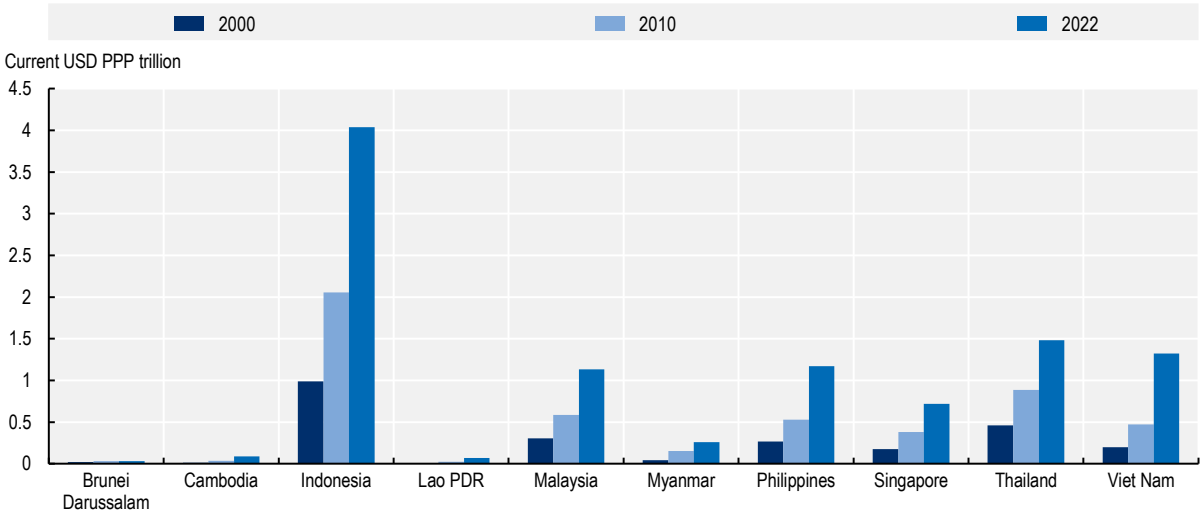
Another relevant demographic pattern observed in SEA is the rapidly ageing population, shifting the distribution towards older age groups. The speed of ageing is particularly fast in Brunei Darussalam, Singapore, Viet Nam and Thailand, which are expected to move from an ageing to an aged society in 20 years or less. Having enjoyed the benefits of a young workforce for decades, this dramatic demographic shift may strain the countries' welfare system and hamper economic growth (ESCAP, 2022[17]).

1.1.2. Socio-economic conditions

The evolution of indicators for the Sustainable Development Goals for 2016-20 shows that, overall, most socio-economic outcomes have improved in SEA (ASEAN, 2022[18]). Taking a broad view of human development, which includes not only economic growth but also health and educational attainment, all SEA countries have reached at least a medium level of development (UNDP, 2022[19]).

From an economic standpoint, SEA economies have performed well over the last two decades (2000-22). The region's total combined GDP in 2022 (USD PPP 10.3 trillion) grew more than fourfold from 2000 (USD PPP 2.5 trillion) (IMF, 2023[6]). Indonesia is the region's largest economy, accounting for 39% of GDP (in USD PPP) followed by Thailand (14%), Viet Nam (13%), the Philippines and Malaysia (11% each) and Singapore (7%), as of 2022 (IMF, 2023[6]). The group of Brunei Darussalam, Cambodia, Lao PDR and Myanmar together account for the remaining 4.4% of the region's GDP (in USD PPP, 2022) (IMF, 2023[6]) (Figure 1.2).

Figure 1.2. Gross domestic product, 2000, 2010, 2022

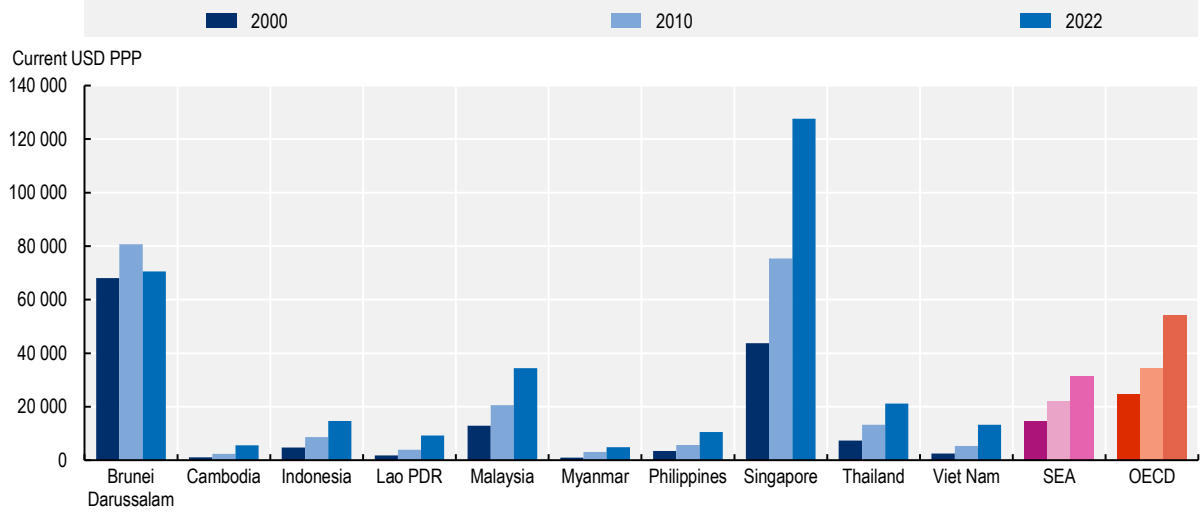


Note: 2022 data include estimates for Brunei Darussalam, Cambodia, Lao PDR, Malaysia, Myanmar and Thailand.
Source: IMF (2023[6]), *World Economic Outlook Database, April 2023*, www.imf.org/en/Publications/WEO/weo-database/2023/April (accessed on 22 June 2023).

StatLink https://stat.link/97c5p6

A similar trend was observed for the average GDP per capita for the region, which reached USD PPP 31 173 in 2022, doubling its 2000 value (USD PPP 14 672) (Figure 1.3) (IMF, 2023[6]). Cambodia and Viet Nam reported the largest growth over 2000-22, with their respective 2022 GDPs per capita (USD PPP) 5.3 times greater than in 2000 (IMF, 2023[6]). Lao PDR and Myanmar also recorded similar patterns, with 2000 GDP per capita growing by a factor of 5.0 and 4.9, respectively, to reach 2022 figures (IMF, 2023[6]). This implies some degree of economic convergence within the SEA region. Today, all SEA countries are classified as middle-income economies except for Singapore and Brunei Darussalam, which are high income (World Bank, 2023[20]).[4]

Figure 1.3. Gross domestic product per capita in 2000, 2010 and 2022



Note: 2022 data include estimates for Brunei Darussalam, Cambodia, Lao PDR, Malaysia, Myanmar, Thailand, Viet Nam and SEA.
Source: For SEA countries: IMF (2023[6]), *World Economic Outlook Database, April 2023*, www.imf.org/en/Publications/WEO/weo-database/2023/April (accessed on 22 June 2023); For OECD: OECD (2023[7]), *Gross domestic product (GDP)* (indicator), https://doi.org//10.1787/dc2f7aec-en (accessed on 28 August 2023).

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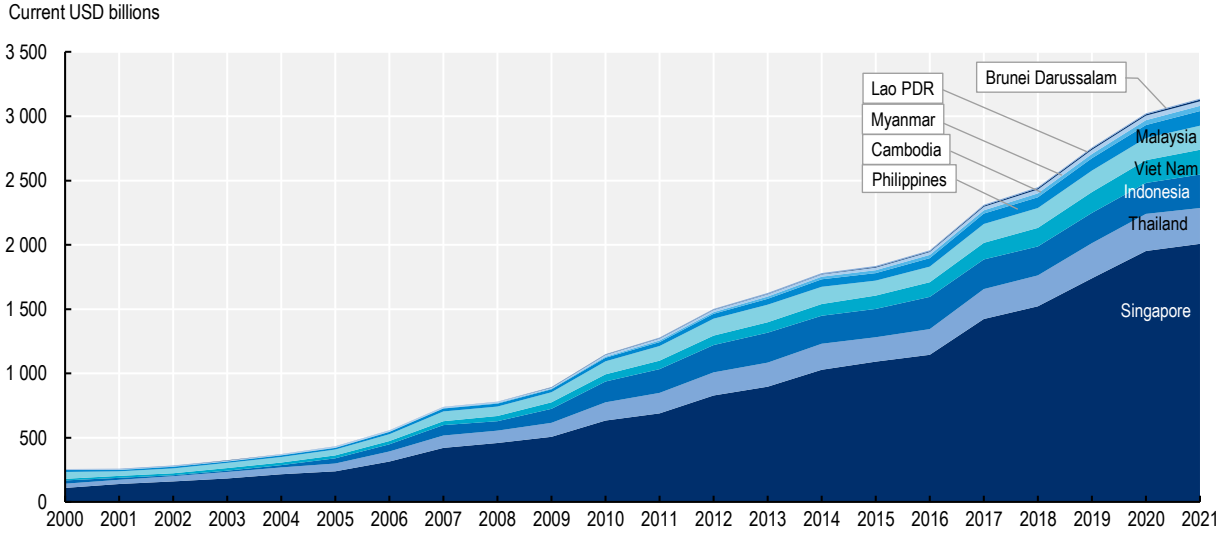
Economic trends shown in Figure 1.2 and Figure 1.3 seem likely to continue with SEA's real GDP forecasts indicating solid and steady growth. After the region set out on the path to economic recovery in 2021 and experienced strong growth in 2022, average real GDP growth was projected to increase by 4.6% in 2023, followed by a 4.8% expansion in 2024 (OECD, 2023[8]). Individual country growth rates projected for 2023 range from 2% in Myanmar to 6.4% in Viet Nam. These rates show some differences but reflect a smaller range than in 2022 (low of -1.5% in Brunei Darussalam to a high of 8.7% in Malaysia in 2022) (OECD, 2023[8]).

Despite forecasts of continued growth, the region could be negatively affected by challenges such as rising inflation, economic slowdowns in the global economy and disrupted supply chains (OECD, 2023[8]). While most Southeast Asian countries had less consumer price inflation than the OECD average of 9.2% in March 2023, consumer prices are increasing in some countries (OECD, 2023[8]). In particular, Lao PDR and Myanmar reported high consumer price inflation rates of 41.3% (December 2021) and 19.5% (July 2022) (OECD, 2023[8]). Consumer price inflation in March 2023 in other countries in the region ranged from 1.5% in Brunei Darussalam to 8.6% in the Philippines (OECD, 2023[8]).

Nevertheless, SEA's economic climate has benefitted from foreign direct investment (FDI), which it has attracted successfully as part of an export-led development strategy. For example, SEA was among the greatest recipients of FDI among emerging regions. It has also managed to maintain and even slightly increase its share of FDI at a time when emerging market economies worldwide have started to embrace a more liberal approach (OECD, 2019[21]). This openness to FDI may have benefitted the region beyond higher investment stocks through higher productivity and competitiveness (OECD, 2023[13]).

All ASEAN countries have made significant improvements to enable investment, but the pace of change has varied considerably. Some countries remain relatively restrictive to FDI, such as the Philippines and Indonesia (OECD, 2023[13]). The upward trend in FDI has continued over the last two decades (2000-21, Figure 1.4), with the annual inward stock increasing by a factor of 12 over this period. Singapore is far and away the largest recipient of FDI, with 64% of inward stock in 2021 – well ahead of the next largest recipients (Thailand with 9% and Indonesia with 8%) (UNCTAD, 2022[22]). In that same year, the countries with the lowest share of inward stock in the region were Brunei Darussalam (0.2%), Lao PDR (0.4%), Myanmar (1.2%) and Cambodia (1.3%) (UNCTAD, 2022[22]). In 2022, FDI inflows to SEA increased by 5% to USD 223 billion, the highest level ever recorded. Singapore, the largest recipient, registered another record with an increase of 8% in FDI inflows (UNCTAD, 2023[23]).

Figure 1.4. Foreign direct investment, annual inward stock, 2020-21



Source: OECD elaboration based on UNCTAD (2022[22]), *FDI/MNE database,* https://unctad.org/fdistatistics (accessed on 10 January 2023).

StatLink https://stat.link/f1iv5h

Services are the leading sector in the ASEAN economy, accounting for 50.6% of GDP in 2020, followed by manufacturing at 35.8% and agriculture at 10.5%. The services sector covers trade, government activities, communication services, transportation, finance and other economic activities that do not produce goods (ASEAN, 2021[24]). Travel, transport and other business services generally dominate the export and import of ASEAN services. Travel services dominate ASEAN exports, while transport services dominate its imports.[5] At the country level, services are the most important sector for all but one ASEAN country. The exception is Brunei Darussalam, where the manufacturing sector leads, contributing 64.2% of GDP. However, the economic structure differs between countries. The share of the service sector was highest in Singapore, reaching 74.1% of the country's total GDP, followed by the Philippines (60.7%), Thailand (59.8%) and Malaysia (54.9%). On the other hand, agriculture remains an important sector for Myanmar (22.0%), followed by Cambodia (17.3%), Lao PDR (13.9%), Viet Nam (13.6%) and Indonesia (12.4%) (ASEAN, 2021[24]).

Given SEA's strategic location, merchandise trade is particularly important for all ASEAN countries. With the exception of a drop in 2020, both merchandise exports and imports have been increasing over the past two decades, with ASEAN's total merchandise trade increasing by almost 3.5 times. Singapore was the largest exporter and importer of the region in 2020 with a share of 27.6% and 26.7%, respectively. It was followed by Viet Nam, a leap from its fifth position in 2010. China was the largest external market for ASEAN exports in 2020 with a 15.7% share, followed by the United States (15.2%), EU-27 (9.4%) and Japan (7.2%). China is also the region's most important importer with a share of 23.5%, followed by Japan (7.8%), United States and Korea with similar shares (7.7%) and EU-27 (7.6%) (ASEAN, 2021[24]).

The degree of integration of ASEAN countries into global value chains (GVCs) is relatively high by international standards. The share of GVC participation varies across countries, but regional supply chains play a key role in all ASEAN members. In 2020, in most cases, integration with other Asian countries accounted for more than half of value added through GVCs (OECD, 2022[25]). The Regional Comprehensive Economic Partnership trade agreement, signed in November 2020 between the ten ASEAN countries and China, Japan, Korea, Australia and New Zealand, is likely to strengthen regional linkages in Asia. In this context, digitalisation to facilitate trade and regional integration is seen as a strategic priority for the region (ASEAN, 2019[26]). Digitalisation could also create new opportunities for small and medium-sized enterprises by facilitating their integration into regional and global markets through GVCs and their operations into foreign markets (OECD, 2022[25]).

From a broader perspective, the region's development faces more structural challenges. Some studies find that certain SEA economies face the challenge of transitioning from a growth model based on inputs to one based on productivity, and graduating from middle-income to high-income economies. Although investment (infrastructure) will continue to be important, innovation is expected to play a central role to increase productivity (Estrada et al., 2017[27]). The combined impact of changing demographics (ageing population) and climate change in the region may hamper this transition. Issues such as investment in human capital (to compensate for the decline in the labour force) and infrastructure resilience may become more important to face these challenges. This, in turn, can help countries shift to more productivity-based growth and achieve high-income status.

Box 1.1. Southeast Asia and the OECD

For over two decades, the OECD and Southeast Asia (SEA) have enjoyed a mutually beneficial relationship. In addition to fostering policy dialogue, the relationship has disseminated good practices and mutual learning in areas such as investment, education, inclusiveness, sustainable infrastructure, good governance, access to markets and fiscal policy. The OECD SEA Regional Programme, launched in 2014, has been instrumental in strengthening OECD co-operation with this dynamic region. Its structure is designed to encourage a systematic exchange of experiences to develop common solutions to regional and global policy challenges.

Today, Indonesia is a key partner of the organisation and the Thailand Country Programme was established in 2018. All ten ASEAN countries participate in OECD committees, working groups, peer reviews and studies. The region contributes to data collection and international benchmarking exercises such as the Programme for International Student Assessment and Investment Policy Reviews. Countries adhere to a range of international standards and norms developed by the OECD.

The ASEAN-OECD Investment Programme promotes dialogue and exchange of experience between OECD countries and SEA economies on issues related to the business and investment climate. The programme achieves its objectives through regional policy dialogue, country investment policy reviews and training seminars.

In recent years, two more specific initiatives have been developed in the field of the digital economy. The 2019 OECD study “Southeast Asia Going Digital: Connecting SMEs”, for example, proposes a set of policies to encourage SME connectivity. The present, broader study recommends policies to expand and improve the quality of broadband connectivity in the region.

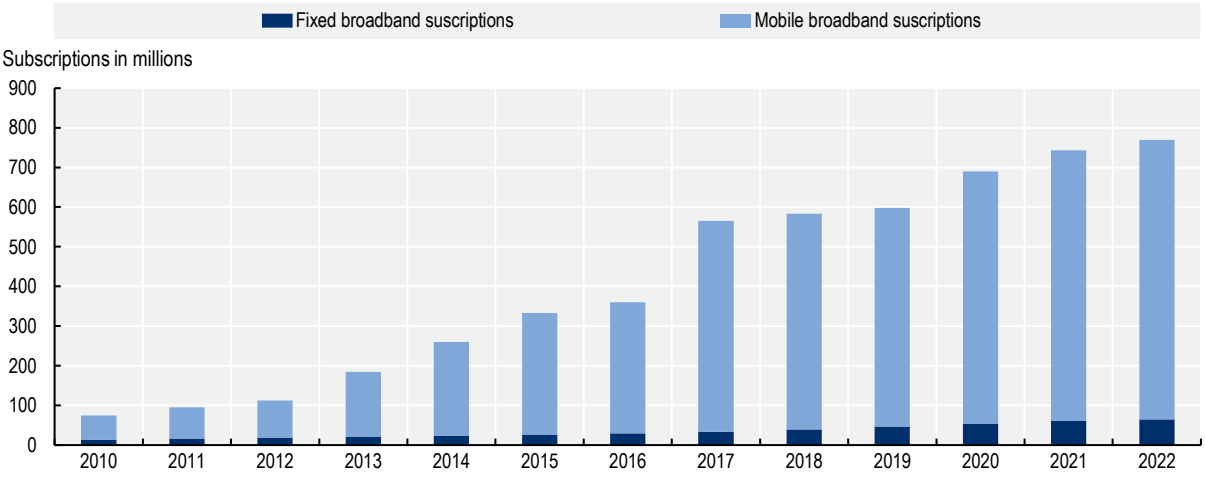
Source: (OECD, 2023[28]; OECD, 2023[29]; OECD, 2019[30]).

1.2. Broadband in Southeast Asia

1.2.1. Infrastructure and services

The SEA region has actively embraced digital technologies in recent years, leading to unprecedented growth in broadband connectivity. By 2022, the region reached 769 million broadband subscriptions, more than ten times the 74 million subscriptions in 2010 (ITU, 2023[10]). Mobile subscriptions represent over 90% of total broadband subscriptions (2022), after strong year-on-year growth rates averaging 25% (2010-22). These followed annual growth rates of 75% from 2012-13 and 61% from 2016-17 (ITU, 2023[10]). Fixed broadband subscriptions have grown more steadily over the same period (2010-22), with annual (year-on-year) growth averaging 15% over the period (ITU, 2023[10]) (Figure 1.5).

Figure 1.5. Broadband subscriptions in SEA, 2010-22



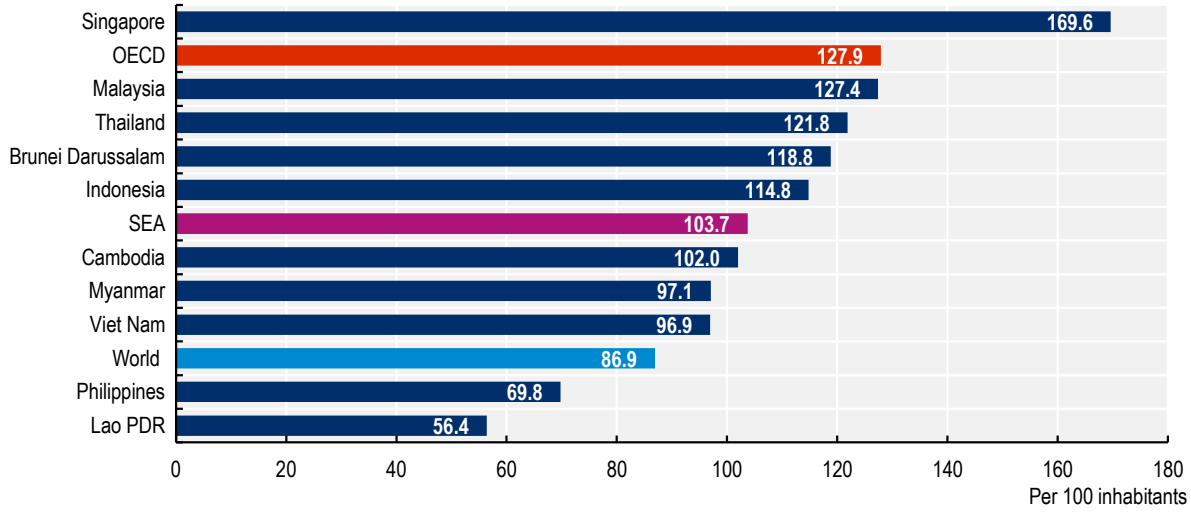
Note: 2022 total mobile broadband subscriptions data includes 2021 data for Indonesia and Lao PDR. 2022 total fixed broadband subscriptions data includes 2021 data for Lao PDR.

Source: SEA countries except Singapore: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023). Singapore: Data provided by national authorities.

StatLink https://stat.link/8gy4pf

The explosive growth of mobile connectivity in the region can also be seen in the average mobile broadband subscription rate of 103.7 subscriptions per 100 inhabitants in 2022 (Figure 1.6) (ITU, 2023[10]). There is still uneven progress in uptake of mobile broadband services. Subscription rates around the region range from Lao PDR (with 56.4 mobile broadband subscriptions per 100 inhabitants) to Singapore (with an over-subscription rate of 169.6 per 100 inhabitants) (ITU, 2023[10]). Six of the ten countries exceed 100 subscriptions per 100 inhabitants in 2022, including countries with low fixed broadband penetration like Cambodia and Indonesia (ITU, 2023[10]). This confirms the clear dominance of mobile technologies for broadband access in the region.

Figure 1.6. Mobile broadband subscriptions per 100 inhabitants, 2022



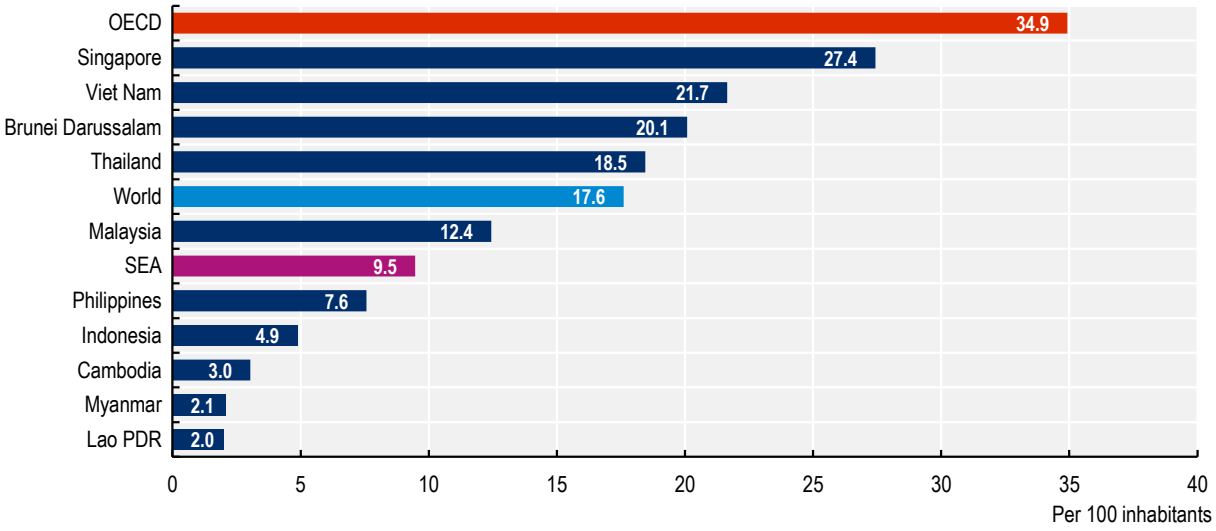
Note: Data for Indonesia and Lao PDR are for 2021.

Source: For SEA countries except Singapore: OECD elaboration based on ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023). Singapore: Data provided by national authorities. For OECD: OECD (2023[11]), *Broadband Portal, July 2023 update,* www.oecd.org/sti/broadband/broadband-statistics/ (accessed on 28 August 2023).

StatLink https://stat.link/je4tzc

The number of fixed broadband subscriptions per 100 inhabitants shows significant differences between countries (Figure 1.7). While Singapore reports 27.4 fixed broadband subscriptions per 100 inhabitants, Cambodia, Lao PDR and Myanmar do not surpass 3 subscriptions per 100 inhabitants (ITU, 2023[10]). On average, the region has a subscription rate of 9.5 subscriptions per 100 inhabitants (ITU, 2023[10]). This is significantly lower than the OECD average (34.9 subscriptions per 100 inhabitants) (OECD, 2023[11]).

Figure 1.7. Fixed broadband subscriptions per 100 inhabitants, 2022



Note: Data for Lao PDR are for 2021.
Source: For SEA countries except Singapore: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023). Singapore: Data provided by national authorities. For OECD: OECD (2023[11]), *Broadband Portal, July 2023 update*, https://www.oecd.org/sti/broadband/broadband-statistics/ (accessed on 28 August 2023).

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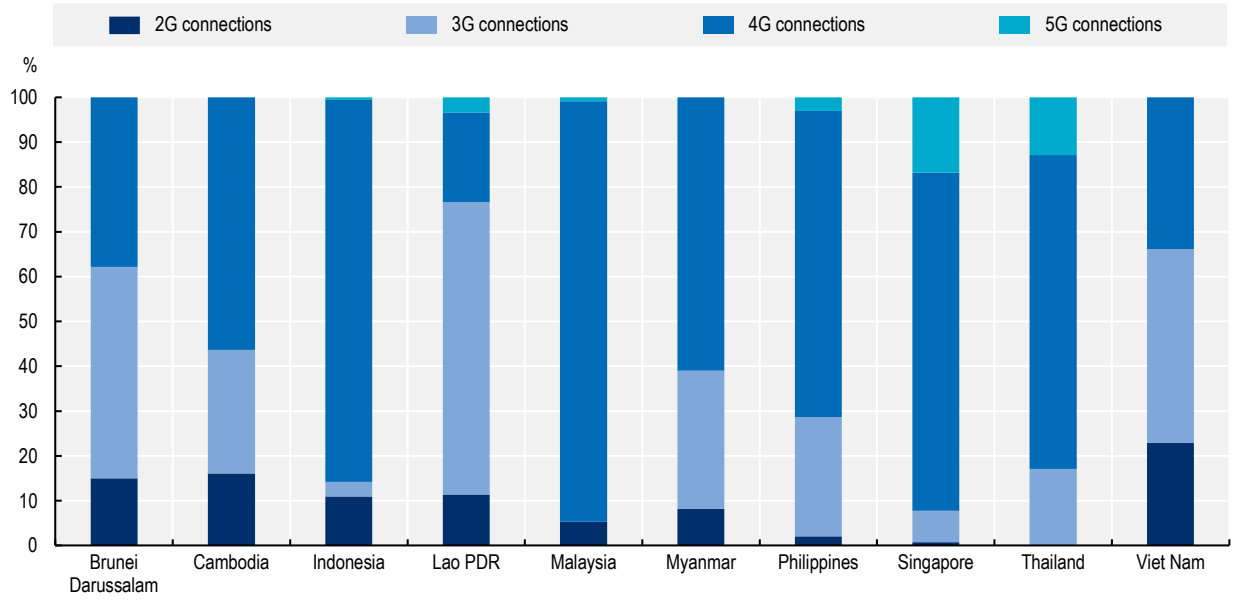
Alongside variations in broadband penetration between countries, disparities also exist within countries. Internet usage data demonstrates marked discrepancies dependent on the geographic and socio-economic circumstances of users. For countries in Southeast Asia, with the exception of Singapore and Brunei Darussalam where the entirety of the territory is urban or suburban available date shows that the proportion of individuals utilising the Internet reached 22.5 percentage points lower in rural areas compared to urban areas (ITU, 2023[10]).[6] Gender-wise, the usage of the Internet by women is generally lower compared to men in all countries (ITU, 2023[10]). With regard to age, the proportion of the population using the Internet is notably lower among older individuals, with differences reaching 61 points lower for those aged 75 and above compared to the next age group, 25-74 (ITU, 2023[10]).[7] These digital divides stem from insufficient coverage in some cases, as well as unaffordable broadband services, inadequate digital skills, gender-related biases, or perceived lack of usefulness.

In terms of network infrastructure, 3G and 4G networks cover the highest percentages of the population. All SEA countries have 3G networks with a population coverage of 90% or above, except for Malaysia, which completed the switch-off of its 3G network in 2022. 4G networks in most SEA countries covered at least 90% of the population in 2022 (GSMA Intelligence, 2023[31]). Six of the ten countries in the region had deployed 5G networks as of 2022, Indonesia, Lao PDR, Malaysia, the Philippines, Singapore and Thailand (GSMA Intelligence, 2023[31]). At the time of writing, Viet Nam had piloted 5G service in certain cities. Singapore was the leader in the region for 5G coverage in 2022, with 97%, followed closely by Thailand with 85% and the Philippines with 66% of the population covered (GSMA Intelligence, 2023[31]).

Despite the extensive coverage of high-quality mobile broadband networks, the uptake of mobile technologies varies between countries (Figure 1.8). While the percentage of 4G connections was 20% in Laos and 34% in Viet Nam, it exceeds 80% in Indonesia and Malaysia (GSMA Intelligence, 2023[31]). The adoption of 5G likewise varies across countries and is highest in Singapore, with 17% of total mobile connections, followed by Thailand with 13% (2022) (GSMA Intelligence, 2023[31]). Beyond network coverage, these differences may be explained by consumers' readiness to use the mobile Internet, which is influenced by various factors including the accessibility of a compatible mobile phone, fundamental skills, and societal factors like gender bias (GSMA, 2021[32]).

Figure 1.8. Percentage of mobile connections by technology, 2022

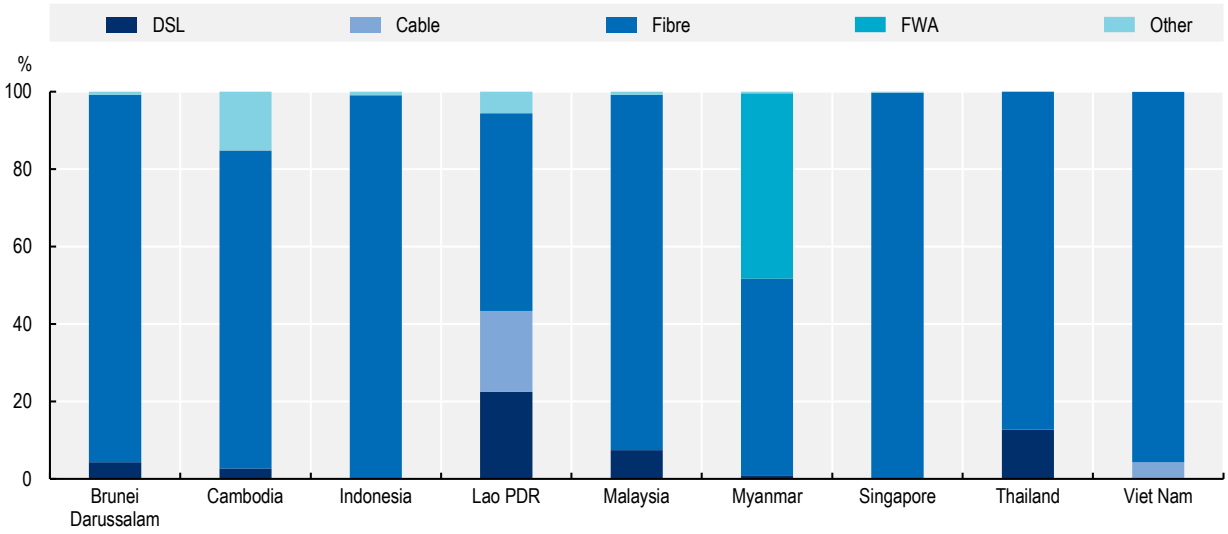


Note: A mobile connection is defined by GSMA Intelligence as "a unique SIM card (or phone number, where SIM cards are not used) that has been registered on a mobile network. Connections differ from subscribers in that a unique subscriber can have multiple connections" (GSMA, 2022[33]).
Source: GSMA Intelligence (2023[31]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/qhntda

Fibre-to-the-Home (FTTH) is the most commonly used fixed broadband technology, reaching over 80% in most countries except Lao PDR and Myanmar, which still account for over 50% of subscriptions (2021) (ITU, 2023[10]). The low subscription percentage for copper-based technologies (DSL and cable) in all countries may indicate the region's widespread access network upgrade to fibre, as well as fibre's preference for new deployments (ITU, 2023[10]).

Figure 1.9. Fixed broadband subscriptions by technology, 2021

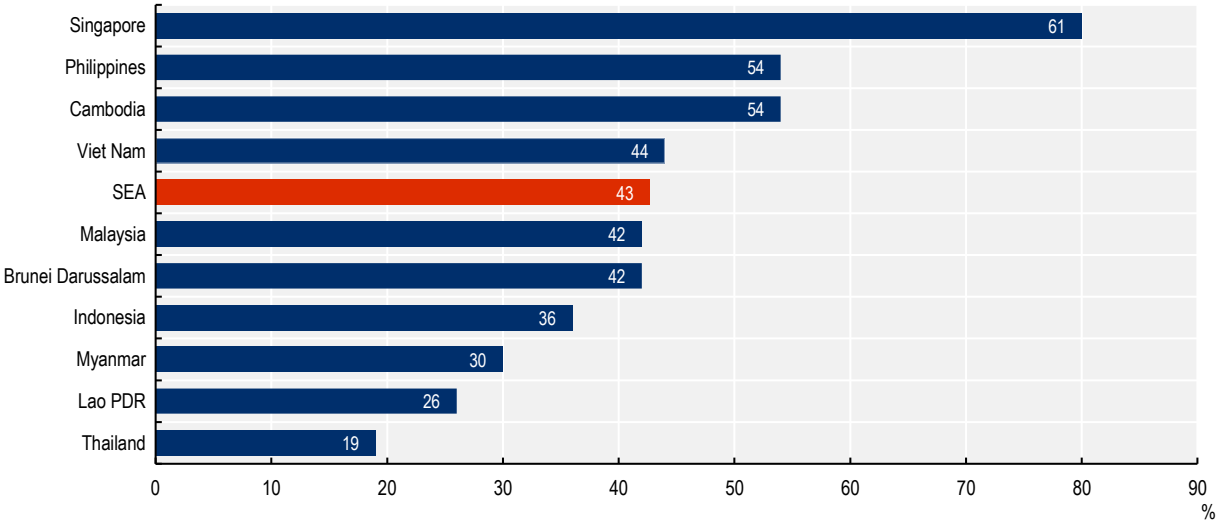


Note: Data are from 2021, except for Brunei Darussalam (2020), Lao PDR (2017), and Singapore (2022). No data available for Philippines.
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/7thiz1

For backbone networks, fibre is used for virtually all links, with microwave links used only rarely (ITU, 2023[34]). The extension of these networks varies considerably between SEA countries. In Singapore, 80% of the population is within at least 10 km of a transmission node (2020) (ITU, 2023[34]).[8] Conversely, only 19% of the population in Thailand is within this distance (2020) (ITU, 2023[34]). The SEA average is 43% of the population, which is in line with most countries (2020) (ITU, 2023[34]) (Figure 1.10). The extension of the backbone network influences the length of backhaul/middle-mile networks and the access/last mile network that needs to be built to reach the end user. This, in turn, informs the level of investment required to extend broadband coverage, especially in rural areas that are not densely populated.

Figure 1.10. Proportion of population within 10 km of a transmission node, 2020



Note: Data for SEA represent a simple average.
Source: OECD elaboration from ITU (2023[34]), *ITU Broadband Map*, https://bbmaps.itu.int/bbmaps/ (accessed on 6 March 2023).

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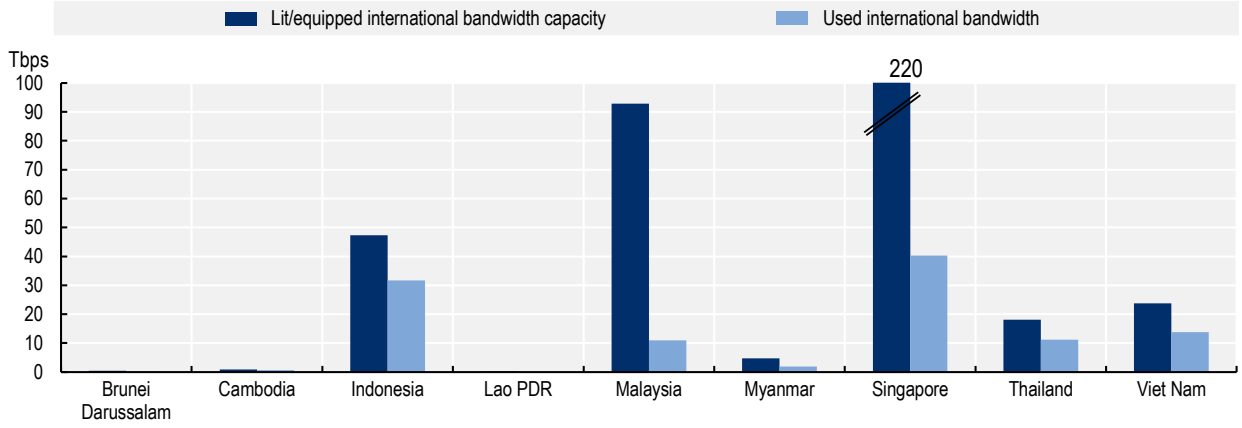
The increase in broadband users and the growth in data-intensive applications and services have led to a growing demand in SEA for connectivity to the rest of the world. Total international Internet used bandwidth in the region has seen exponential growth in the last period, reaching 111 terabits per second (Tbps) in 2022 (ITU, 2023[10]). Equipped capacity has kept pace, although distribution across countries is uneven (Figure 1.11). Singapore has by far the largest installed capacity (220 Tbps in 2022) (ITU, 2023[10]). At the same time, the country uses only 18% of its installed capacity (40 Tbps) (ITU, 2023[10]), attesting to Singapore's role as a hub for Internet traffic in the region. Malaysia holds the second highest installed capacity in the region with 93 Tbps, using only 11% of it, followed by Indonesia, which uses 67% of its installed capacity of 47 Tbps (2021) (ITU, 2023[10]).

Figure 1.11. International bandwidth in the SEA region, 2022



Notes:
1. Lit/equipped international bandwidth capacity refers to the total lit capacity of international links, namely fibre-optic cables, international radio links and satellite uplinks to orbital satellites in the end of the reference year (expressed in Mbit/s). If the traffic is asymmetric (i.e., different incoming and outgoing traffic), then the highest value out of the two should be provided. Average usage of all international links, including optical fibre cables, radio links and traffic processed by satellite ground stations and teleports to orbital satellites (expressed in Mbit/s). The average is calculated over the twelve-month period of the reference year. If the traffic is asymmetric (i.e. different incoming and outgoing traffic), then the highest value out of the two should be provided. All international links used by all types of operators, namely fixed, mobile and satellite operators should be taken into account. The combined average usage of all international links can be reported as the sum of the average usage of each link (ITU, 2020[35]).
2. Data for Lao PDR are for 2021, and used international bandwidth data for Singapore is for 2021. The Philippines is not in the graph because equipped international bandwidth capacity data is not available since 2015 and used international bandwidth since 2018.
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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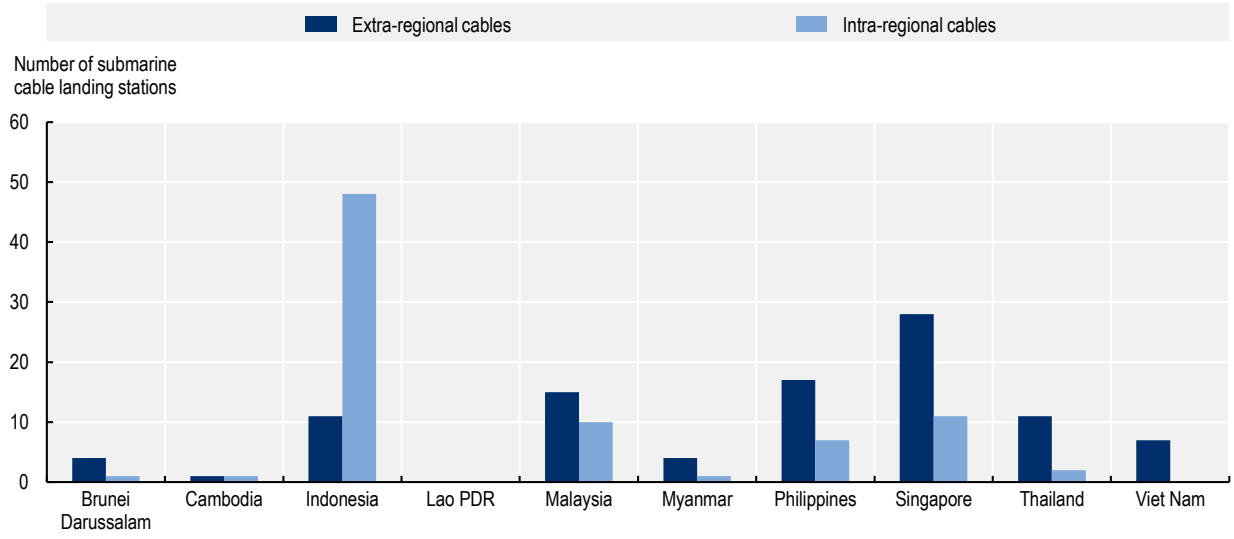
In the SEA region, as in the rest of the world, submarine cables provide the vast majority of international broadband links to meet demand. This is due, in part, to their lower failure rate compared to terrestrial cables (OECD, 2014[36]). The region has landing stations for 96 submarine cables. Most of these cables (59) are connecting SEA countries, and 37 reach other regions of the world. SeaMeWe-3 has the longest reach, connecting nine subregions (North Africa, sub-Saharan Africa, Eastern Asia, Southern Asia, Western Asia, Northern Europe, Southern Europe, Western Europe, Australia and New Zealand). This cable also has landing stations in virtually all SEA countries (except Cambodia and Lao PDR). Other notable submarine cable systems connecting the region are FLAG Europe-Asia, which connects seven subregions, and Asia Africa Europe-1 (AAE-1), PEACE Cable and SeaMeWe-4, 5, 6, which connect five or more subregions.

All SEA countries, except for landlocked Lao PDR, have submarine cable landing stations, although they vary considerably (Figure 1.12). Indonesia has the highest number of intra-regional cable landing points (48), followed by Singapore at a distant second (11) and Malaysia (ten). Singapore has the highest number of extra-regional cable landing points (28), followed by the Philippines (17) and Malaysia (15). At the other extreme, Cambodia has only two cable landing points in total (intra- and extra-regional), followed by Brunei Darussalam and Myanmar with five and Viet Nam (seven). Singapore, together with Hong Kong China, concentrates most of the points of presence of the global Internet providers in the region (OECD elaboration based on TeleGeography) (2023[37]).

Figure 1.12. Number of landing stations of submarine cables



Note: Extra-regional cables indicate the landing stations in a given country of submarine cables that connect to other regions of the world. Intra-regional cables indicate landing stations in a given country, of submarine cables confined to the SEA region. This includes cables under construction, which are expected to be ready for use in 2023-26.
Source: OECD elaboration based on TeleGeography (2023[37]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

StatLink https://stat.link/0gt54k

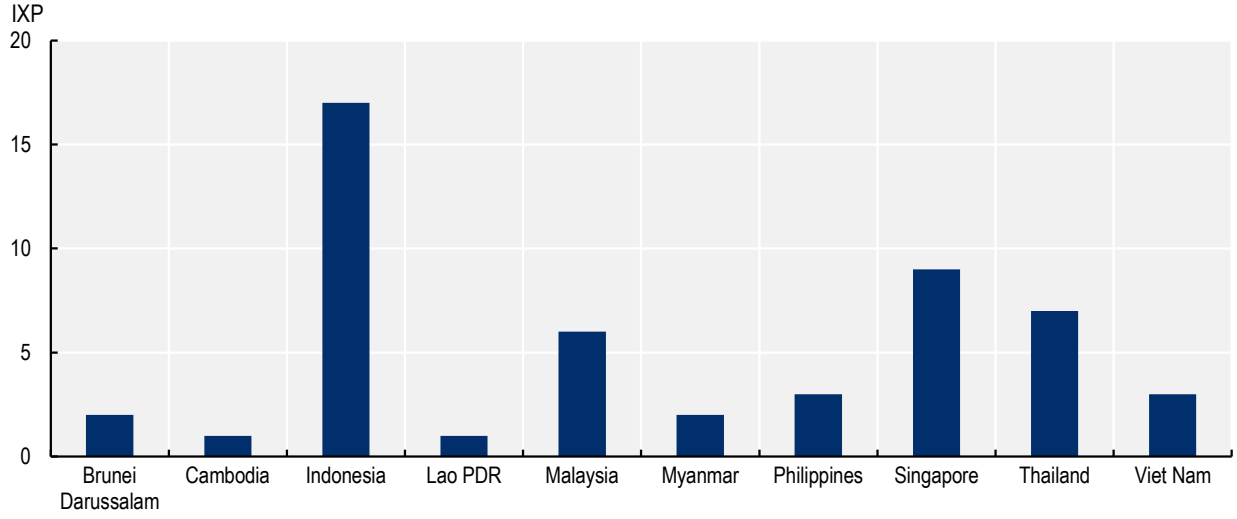
Such disparities could be reduced by building infrastructure to share the region's international connectivity capacity between countries. To this end, some initiatives propose the construction of cross-border terrestrial networks connecting national Internet Exchange Points (IXPs), in particular for Cambodia, Lao PDR, Viet Nam and Thailand (CLVT) (ESCAP, 2022[38]).[9] These links, together with the co-ordination of routing policies (BGP), would make the international connections (e.g. submarine cable landing stations) of the connected countries potentially reachable from all of them. This network topology could also improve the resilience of the region's international connectivity by providing alternative routes to international traffic. Ultimately, this could increase the quality of service to users through, for example, lower latency and higher bandwidth.

Overall, the expected growth of the digital economy in the region is sparking the interest of many market players. They are keen both to deploy new submarine cables and to create multiple avenues to connect the region. For example, the region is laying 12 new submarine cables that are expected to be put in service in 2023 and 2024. These are financed by a range of communication operators, as well as other players, such as content providers (e.g. Meta and Google). Several submarine cables came, or are expected to come, into service in 2023 to connect various SEA countries. These include the Asia Direct, Biznet Nusantara Cable System-1 (Indonesia only), India Asia Xpress, MIST, Philippines Domestic Submarine Cable Network (Philippines only) and the Singapore-Myanmar cables (TeleGeography,

2023[39]). The Apricot, Bifrost, Cambodia-Hong Kong, Echo, SEA-H2X and SEA-Japan 2 (SJC2) cables are planned for service by end of 2024 (Telegeography, 2023[40]).

The number of IXPs in SEA has increased in recent years. Indonesia has strengthened its connectivity by increasing the number of IXPs and building submarine cables for inter-island connectivity. It has the highest number of active IXPs in the region with 17. This is followed by countries with high numbers of submarine cable landing stations, namely Singapore (9 active IXPs), Thailand (7 active IXPs), and Malaysia (6 active IXPs) (Figure 1.13) (PCH, 2023[41]). Viet Nam and the Philippines follow with 3 active IXPs, then Brunei Darussalam and Myanmar (2) and Cambodia and Lao PDR with one active IXP) (PCH, 2023[41]). IXPs create shorter routes for Internet traffic exchange, allowing networks to keep traffic local and provide faster connections with low latency and at lower cost. They also improve overall network performance and resilience. In addition, by creating a central point where cloud and content companies can interconnect with service providers, IXPs are likely to have a positive impact on other elements of the ecosystem (Internet Society, 2021[42]).

Figure 1.13. Internet exchange points, 2023



Source: PCH (2023[41]), *Internet Exchange Directory*, www.pch.net/ixp/dir (accessed on 5 December 2023).

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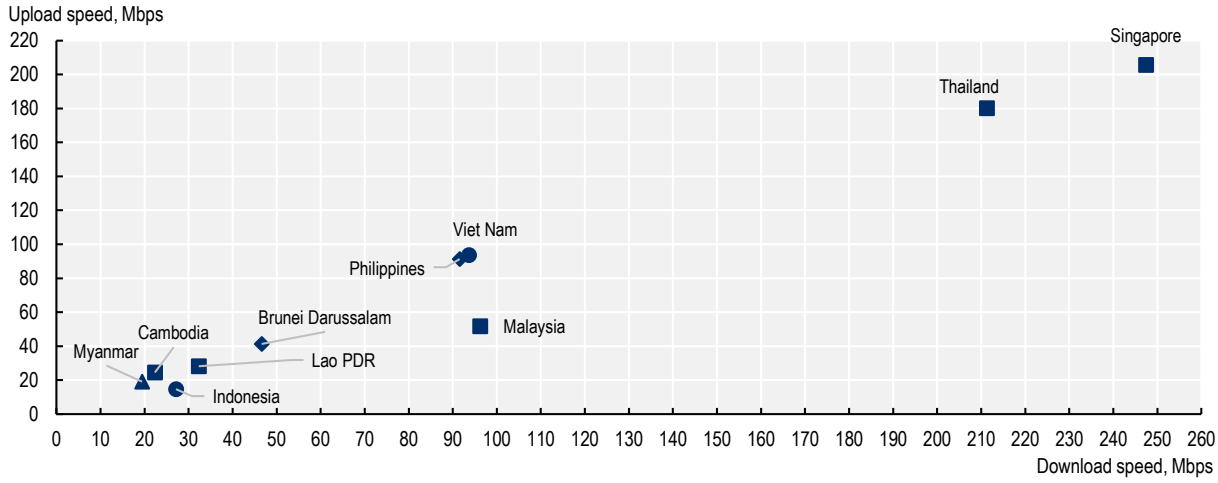
The variability of the infrastructures deployed in different SEA countries, as shown in the graphs above, translates into differences in the performance of the broadband services offered to users. The speed of fixed and mobile broadband connectivity – one aspect of performance – varies considerably across SEA countries. In terms of fixed broadband upload and download speeds, Singapore and Thailand remain at a considerable distance from other countries in the region (Figure 1.14). According to Ookla data as of July 2023, Singapore reached median fixed download speeds of 247 megabits per second (Mbps) and median upload speeds of 206 Mbps, while Thailand recorded 211 Mbps download and 180 Mbps upload (Ookla, 2023[43]) . With these speeds, Singapore earned the top spot globally for median fixed download speeds and Thailand was ranked fifth, both among the highest ranked globally (Ookla, 2023[43]). In the region, Malaysia followed with median fixed download speeds of 96 Mbps, followed by Viet Nam (94 Mbps), the Philippines (92 Mbps) and Brunei Darussalam (47 Mbps) (Ookla, 2023[43]). The remaining countries in the region have median fixed download speeds of less than 35 Mbps. Fixed broadband speeds are fairly symmetrical for all countries (i.e. similar download and upload speeds), which reflects the high share of fibre (Figure 1.14). Another aspect of quality is latency, which can be defined as the round trip time for information to travel between two devices across the network, also known as delay or ping rate.[10] Fixed broadband latency ranges from 4-8 milliseconds (ms) between SEA countries (July 2023) (Ookla, 2023[43]).

Figure 1.14. Median fixed broadband download versus upload speed, July 2023



Note:Data collected and aggregated by Ookla's Speedtest® Methodology (Ookla, 2023[44]).
Source: Ookla®, (2023[43]), *Speedtest Global Index ®,* www.speedtest.net/global-index (accessed on 22 August 2023).

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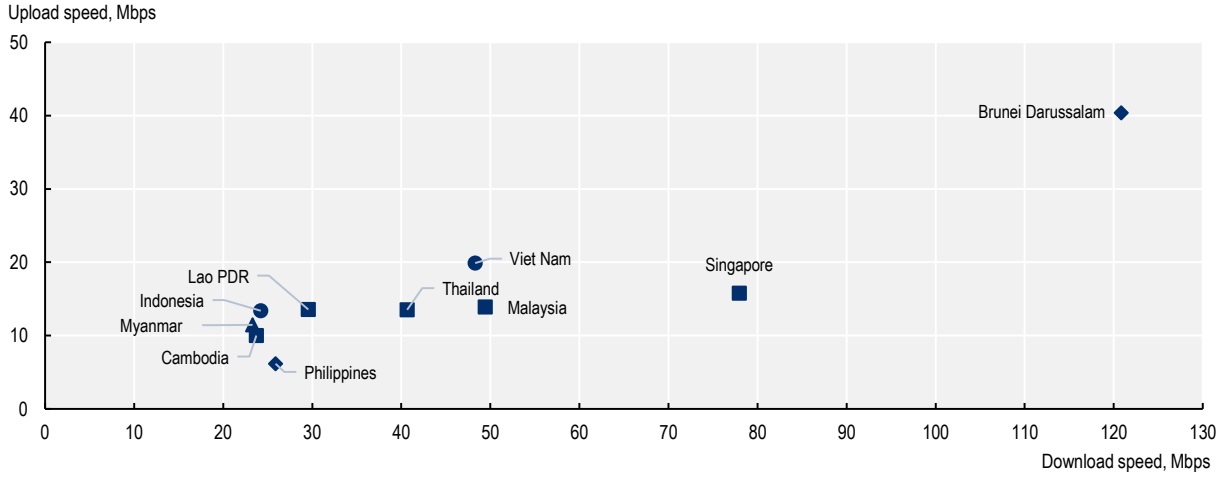
There are also clear differences between SEA countries in mobile broadband performance. In July 2023, Brunei Darussalam and Singapore stood out with median mobile download speeds considerably higher than the other countries: 121 Mbps (download)/40 Mbps (upload) and 78 Mbps (download)/16 Mbps (upload) respectively (Ookla, 2023[43]). Elsewhere in the region, download speeds ranged from 23 Mbps in Myanmar to 48 Mbps in Viet Nam and 49 Mbps in Malaysia (Ookla, 2023[43]). In all cases, mobile broadband connectivity is markedly asymmetric with download speeds between two and close to five times the upload speeds, although this is inherent to the technology and not unique to the SEA region (Figure 1.15). Mobile broadband latency is higher than fixed broadband, ranging from 15 ms in Brunei Darussalam to 27 ms in Indonesia (Ookla, 2023[43]).

Figure 1.15. Median mobile broadband download versus upload speed, July 2023



Note: Data collected and aggregated by Ookla's Speedtest® Methodology (Ookla, 2023[44]).
Source: Ookla®, (2023[43]), *Speedtest Global Index®,* www.speedtest.net/global-index (accessed on 22 August 2023).

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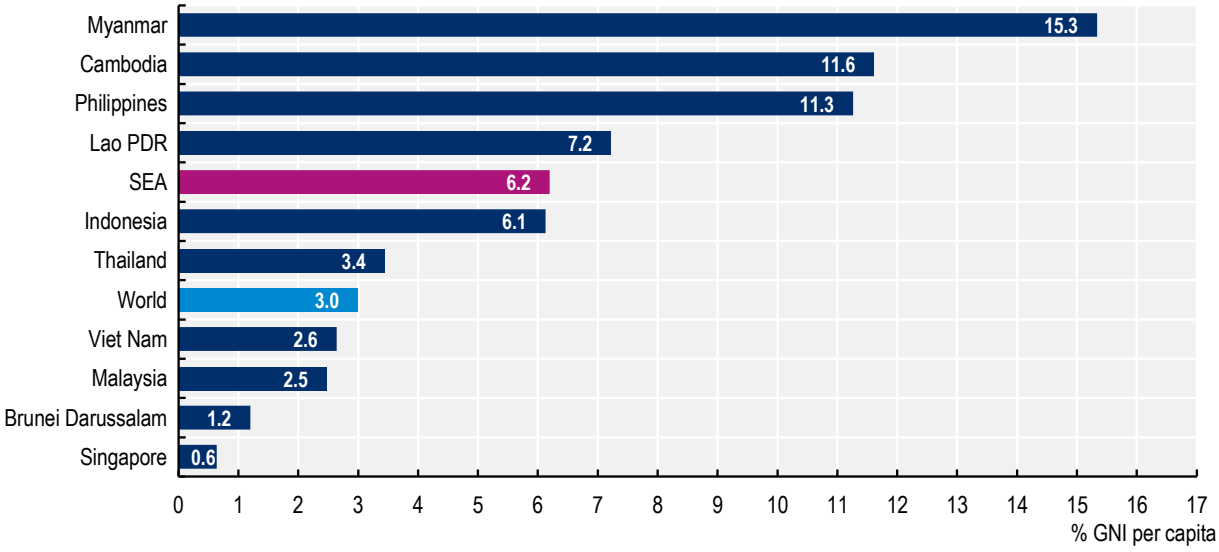
Beyond speed, the resilience of communication networks is a key element of the quality of connectivity. This is especially the case in SEA, which is vulnerable to natural hazards and expected to become even more vulnerable in the face of the climate crisis. According to the E-Resilience Monitoring Dashboard, fibre-optic cable infrastructure, understood as the backbone and middle-mile network, can strengthen "e-resilience" to overcome unexpected crises (ESCAP, 2021[45]).[11] Some operators in the region are fortifying their networks in the face of adverse weather events. In the Philippines, for example, broadband service provider PLDT (historically, the Philippine Long Distance Telephone Company) announced a plan in 2022 to lay 600 km of submarine fibre optic cable, as well as underground inland cables. This will increase the resiliency of its network, particularly in areas often hit by natural disasters (Smart Communications, 2022[46]).

The take-up of broadband services, which varies widely between countries as shown above (Figure 1.6 and Figure 1.7), depends not only on how well they perform but also on how affordable they are. In this regard, fixed broadband prices remain expensive relative to purchasing power in the region, limiting broadband's full potential to connect households. Only in Singapore and Brunei Darussalam are broadband services priced below 2% of monthly gross national income (GNI) per capita in 2022 (ITU, 2023[10]). The average for SEA countries is three times this threshold (6.2% of GNI per capita) (Figure 1.16) (ITU, 2023[10]). Mobile broadband prices are much more affordable in SEA countries, with a regional average of 1.6% of GNI per capita (Figure 1.17) (ITU, 2023[10]). Together with the greater coverage of mobile broadband networks, mobile broadband services' relative affordability can help explain its high penetration.

Figure 1.16. Fixed broadband prices, percentage GNI per capita, 2022



Notes: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2008 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. (ITU, 2020[47]). SEA data are a simple average of country values.
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed 22 on August 2023).

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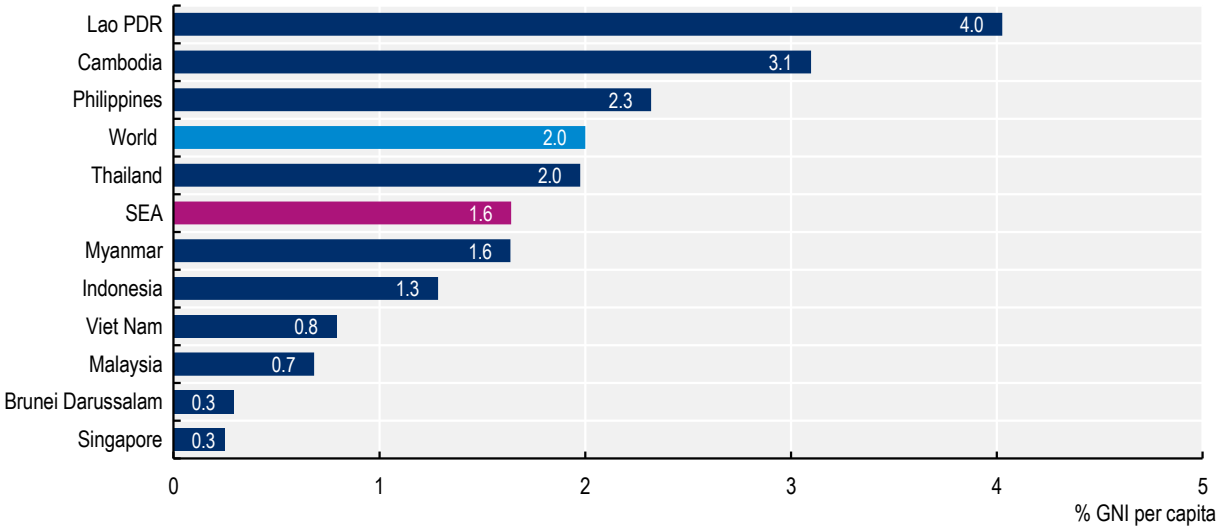
Figure 1.17. Mobile broadband prices, percentage GNI per capita, 2022



Note: The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[47]). SEA data are a simple average of country values.
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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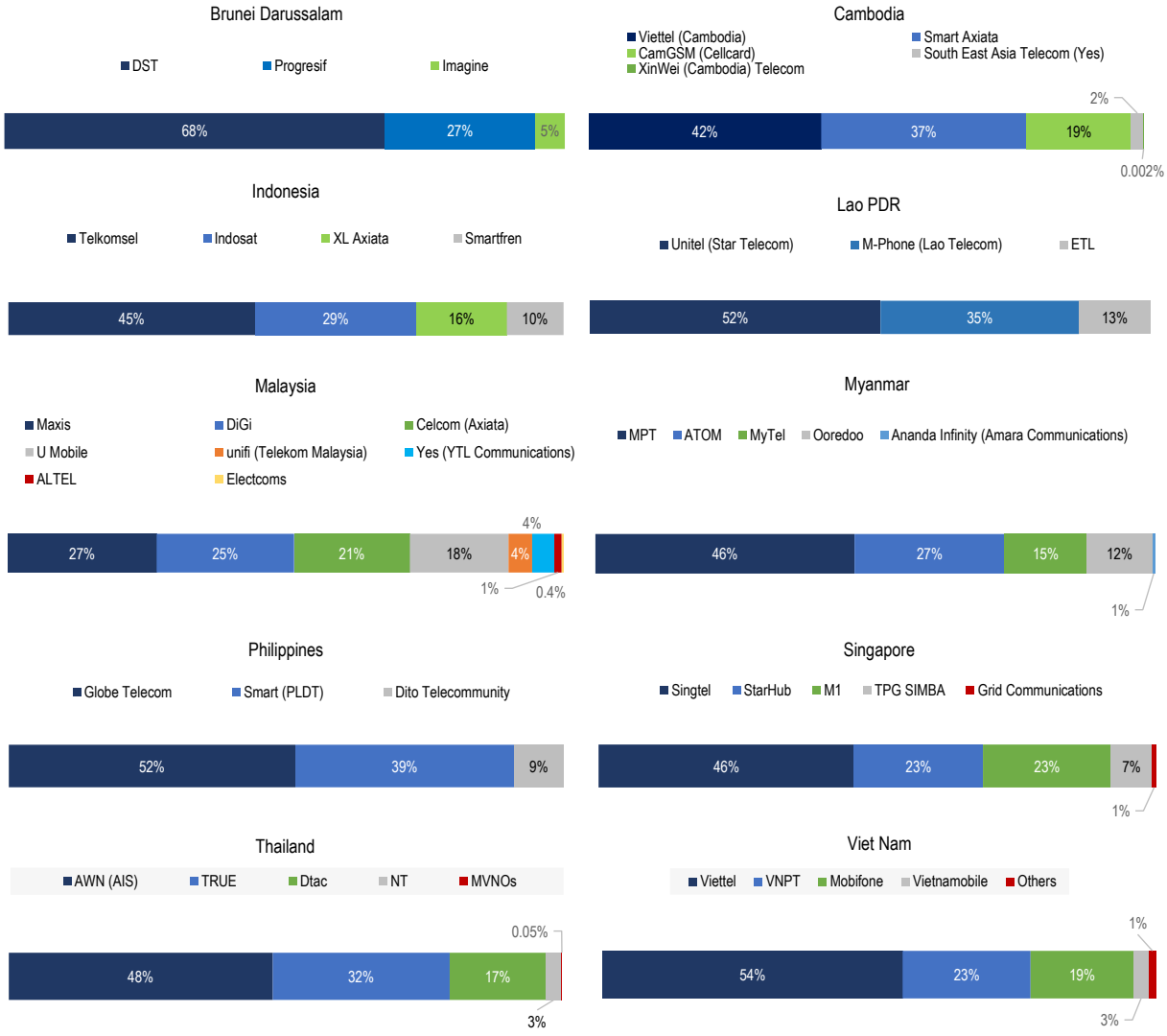
1.2.2. Market structure

Communication market structures and the level of competition among SEA markets varies considerably (see Figure 1.18). Considering available market share data for the mobile market (data unavailable for fixed market), SEA countries have at least three main mobile network operators (MNOs). Brunei Darussalam, Lao PDR and the Philippines have three MNOs; the rest have four or more, however some of these have small market shares (see Figure 1.18). In Thailand, Figure 1.18 reflects the situation prior to the 2023 merger of True and Dtac (see Table 1.1), which will change the market structure by moving from four main mobile operators to three. In addition to these main mobile operators, countries may have other smaller operators offering services, such as mobile virtual network operators (MVNOs).

The distribution of market shares also varies in the region. For example, the mobile market is more evenly split between operators in Malaysia, while Lao PDR, Philippines, and Viet Nam have operators with market shares over 50%, and in Brunei Darussalam it reaches 68% (Figure 1.18).

Figure 1.18. Mobile market shares in SEA countries



Note: Market shares for Cambodia, Thailand and Viet Nam reflect data as of Q4 2021. Together with Indonesia (Q4 2022), these four countries are based on national responses to the OECD questionnaire. Data for Cambodia and Viet Nam reflect mobile broadband subscriptions (data and voice, or data-only). Indonesia reflects the number of mobile broadband subscribers (contracting voice and data, or data-only plans) for Q4 2022. Thailand reflects total number of mobile subscribers (contracting data, voice or both) for Q4 2021. All other countries rely on GMSA Intelligence data (Q4 2022) on mobile connections, defined as "a unique SIM card (or phone number, where SIM cards are not used) that has been registered on a mobile network" (GSMA, 2022[33]). In Indonesia, "Indosat" refers to "Indosat Ooredoo Hutchison" following the 2022 merger between Indosat and 3 (CK Hutchison). Data for Thailand is prior to the True-dtac merger.

Source: [For all countries except Cambodia, Indonesia, Thailand and Viet Nam] GSMA Intelligence (2023[31]) *Database*, https://www.gsmaintelligence.com/data/ (accessed on 9 November 2023); [For Cambodia, Indonesia, Thailand and Viet Nam] OECD elaboration based on data from national sources.

When assessing the level of market competition, both the number of operators and the market power of players are important considerations. Competition is lower when the market is more concentrated in the hands of one or a few operators. The Herfindahl-Hirschman Index (HHI) is a common measure of market concentration, calculated by summing the squared market shares (represented as an integer) of all market players. An HHI can fall anywhere from 1 to 10 000. A lower HHI indicates a more competitive market. Conversely, a perfect monopoly, where one player captures all the market, would have an HHI of 10 000 (100 squared). According to guidelines from the United States Department of Justice (DoJ), unconcentrated markets are generally classified by an HHI below 1 500; moderately concentrated markets

generally have an HHI between 1 500 and 2 500; and concentrated markets are usually those with HHIs above 2 500 (US DoJ, 2010[48]).

HHIs in SEA mobile markets range from around 2 000 in Malaysia to over 5 000 in Brunei Darussalam, according to GSMA Intelligence data for Q4 2022 (GSMA Intelligence, 2023[31]). Even Malaysia would be classified as "moderately concentrated" under the DoJ guidelines. However, that guidance is not specific to communication markets, which have high entry costs and require large investments both upfront and recurrently. Unlike in other markets, the level of required investment changes the economics for companies both to enter the market and to break even to recoup their investments.

The level of competition across SEA has been dynamic in recent years as several countries in the region have had mergers in both the fixed and mobile markets. Examples of recent mergers and acquisitions include Indonesia, Malaysia, Myanmar, Singapore and Thailand (Table 1.1). The region has previously seen mergers and acquisitions such as the sale of VimpelCom Holding Laos B.V. to the Lao PDR government in 2017 (VEON Ltd., 2017[49]). However, the past few years have seen a flurry of activity towards consolidation. Of course, the impact of each merger or acquisition depends on the characteristics of each market, including the level of concentration pre- and post-merger. Given the critical role of mobile networks in many SEA countries, consolidation in the mobile market may impact overall competition significantly. Consolidation thus requires careful assessment as competition helps drive innovation, affordability and increased quality-of-service.

Table 1.1. Examples of ongoing and recently completed mergers and acquisitions in the SEA region

Year	Country	Companies involved	Market	Description
Ongoing	Thailand	Advanced Wireless Network (AIS subsidiary) and Jasmine International subsidiaries Triple T Broadband and Jasmine Broadband Internet Infrastructure	Fixed	Advanced Wireless Network announced plans to acquire 99.87% interest in Triple T Broadband and a 19% interest in Jasmine Broadband Internet Infrastructure in July 2022, but it is still pending at the time of writing.
2023	Thailand	True Internet Corporation Company Ltd (True) and Total Access Communication Public Company Ltd (dtac)	Mobile	The Thai regulator, National Broadcasting and Telecommunications Commission gave its approval for the merger, with conditions, in October 2022, and it was announced as complete in March 2023.
2022	Indonesia	Axiata Group Berhad and PT XL Axiata Tbk, and PT Link Net Tbk	Fixed	Axiata and its Indonesian subsidiary, XL Axiata, acquired 66.03% of shares of Link Net in June 2022. As of April 2023 Axiata and XL Axiata increased their shares of Link Net to 95%.
2022	Indonesia	CK Hutchison and Ooredoo Group	Mobile	Hutchison and Ooredoo Group merged to become "Indosat Ooredoo Hutchison", according to certain merger conditions.
2022	Malaysia	Digi.Com Berhad (Digi Telecommunications Sdn. Bhd.) and Celcom Axiata Berhad	Mobile	The Malaysian regulator, the Malaysian Communications and Multimedia Commission, approved the merger, with conditions.
2022	Myanmar	Ooredoo Myanmar Ltd and Nin Communications Pte. Ltd.	Mobile	Ooredoo Myanmar sold its operations in the country to Nin Communications Pte. Ltd., whose owners include Link Family Office, based in Singapore, and U Nyan Win.
2022	Myanmar	Telenor Myanmar and M1 Group	Mobile	Telenor Myanmar sold its mobile operations in the company to M1 Group and a local partner (rebranded under Atom brand).
2022	Singapore	StarHub Online Pte Ltd and MyRepublic Broadband Pte Ltd	Fixed	StarHub took a majority interest (50.1%) in MyRepublic Broadband at the time of consolidation.
2021	Thailand	CAT Telecom + TOT	Mobile/ Fixed	State-owned operators CAT Telecom and TOT merged to become one state-owned entity, National Telecom (NT).

Source: Thailand (Thai PBS World, 2023[50]; KPMG, 2022[51]; Inside Telecom, 2021[52]; Telenor Asia, 2023[53]); Indonesia (XL Axiata, 2022[54]; CK Hutchison Holdings Ltd, 2022[55]; Link Net, 2023[56]); Malaysia (Axiata Group, 2022[57]); Singapore (IMDA, 2022[58]); Myanmar (Ooredoo, 2022[59]; Zan, 2022[60]; Telenor, 2022[61]; Reuters, 2023[62]).

Unlike other SEA countries, the Philippines has moved away from consolidation. In 2019, the Philippines authorised a new mobile operator, DITO Telecommunity, to provide communication services (DITO Telecommunity, 2023[63]). This transformed the mobile market from a duopoly to a three-player market.

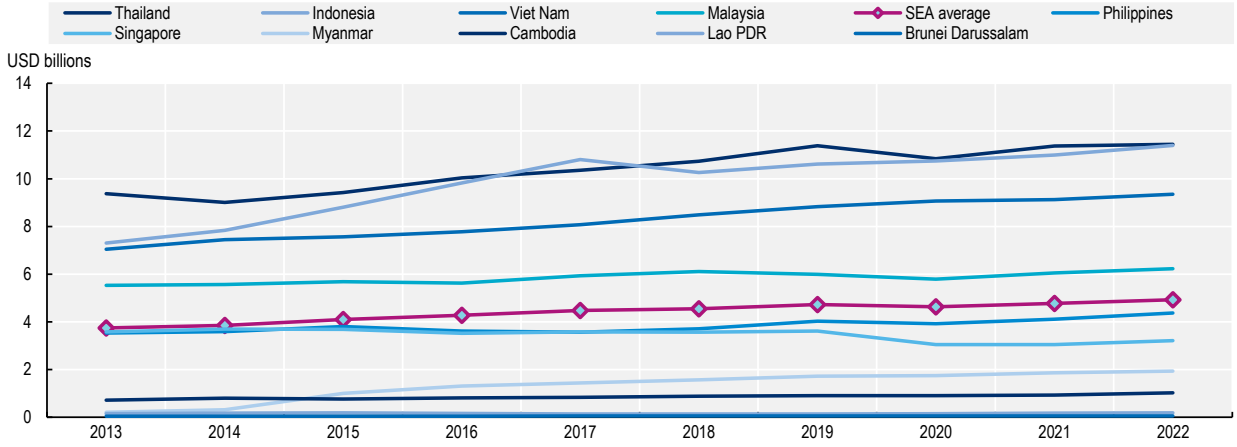
Another aspect shaping the structure of communication markets in the region is the degree of involvement of the government. Compared to many OECD countries, some SEA governments are more involved in the communication market. While many SEA countries have privately owned operators, some SEA governments have stakes in communication operators. This is the case, for example, in Brunei Darussalam, Indonesia, Thailand and Viet Nam. In Brunei Darussalam, the government owns all three communication operators through Darussalam Assets. It provides services from the Unified National Networks (UNN), which pools the assets of all three operators to create a wholesale network (UNN, 2022[64]).

In a different approach, Singapore's regulatory body, the Infocomm Media Development Authority (IMDA), led development of the "Nationwide Broadband Network" (NBN), a nationwide shared fibre-based infrastructure upon which retail operators can offer end-user services (please see Chapter 4 for further details). The government provided funding to two selected companies to support the initial roll out of the NBN's passive and active infrastructure (IMDA, 2009[65]).

In Malaysia, the Digital Nasional Berhad (DNB) is a government-owned, national wholesale network for 5G network infrastructure (DNB, 2021[66]). The DNB rollout has seen delays, with Malaysian operators criticising its price and raising concerns that it may become a government-run monopoly (Reuters, 2023[67]). In May 2023, the Malaysian Communications and Multimedia Commission (MCMC) announced that DNB will become a private entity once it had reached 80% coverage of populated areas (Developing Telecoms, 2023[68]). In July 2023, major operators in the country reportedly agreed to take shares in the DNB, although financial details of their ownership were unclear at the time of writing (Mobile World Live, 2023[69]). In addition, local news reported the government's plans to launch a second state-run network once the DNB had reached its coverage targets to counter concerns (Developing Telecoms, 2023[70]).

Over the past decade (2013-22), revenues for mobile services have steadily increased across SEA countries, in some cases dramatically. The examined revenue and investment data over this period contains nominal values converted to USD via spot rates from GSMA Intelligence data. For example, Myanmar saw an increase of 226% in mobile revenues in nominal terms from 2014-15, following liberalisation of the market (GSMA Intelligence, 2023[31]). The median percentage growth in revenues in SEA countries was around 30% over 2013-22, with Indonesia performing above the SEA median with an increase of 56% and Myanmar increasing by an astonishing 847% over the same period (Figure 1.19). Singapore is the only SEA country showing a slight decline, with an 10% decrease from 2022 mobile revenue compared to 2013. Thailand and Indonesia lead the region in terms of gross mobile revenues (nominal terms) in 2022, followed by Viet Nam and Malaysia (GSMA Intelligence, 2023[31]).

Figure 1.19. Mobile revenues in SEA countries, 2013-22

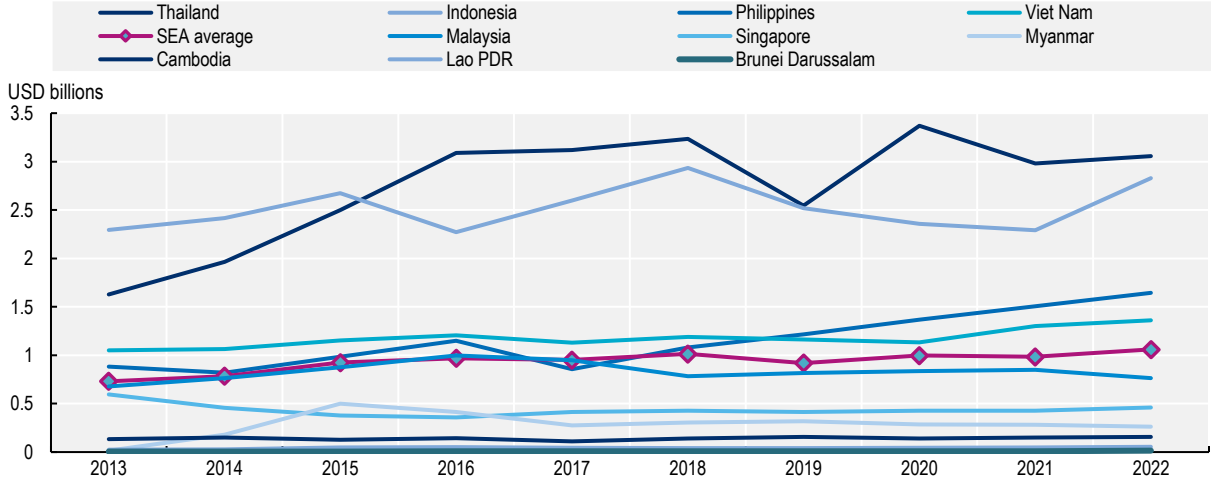


Note: The examined data contains nominal values converted to USD via spot rates from GSMA Intelligence data.
Source: GSMA Intelligence (2023[31]), *Database*, https://www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/ampr8q

Investment in mobile networks also increased over 2013-22. The median percentage growth across the region of total mobile capital expenditure (Capex) investment over 2013-22 was close to 60% (GSMA Intelligence, 2023[31]). Thailand and Indonesia, the countries with the highest revenues (Figure 1.19), also had the highest amounts of investment (in nominal terms) in 2022 (Figure 1.20). The Philippines and Viet Nam followed with the third and fourth highest rates of mobile investment in 2022 (GSMA Intelligence, 2023[31]). From a percentage growth perspective, Myanmar showed the greatest increase over the 2013-22 period (1610%) (GSMA Intelligence, 2023[31]). This is unsurprising given market entry following liberalisation, although its gross Capex numbers are ranked seventh in the region. Lao PDR and Brunei Darussalam also showed strong increases, although gross Capex numbers (nominal terms) rank them the lowest in the region. Cambodia and Malaysia were relatively stable over the period, while Singapore showed a slight decline in 2022 Capex investment compared to 2013 figures (GSMA Intelligence, 2023[31]).

Figure 1.20. Investment in mobile networks (total Capex) in SEA countries, 2013-22



Note: The examined data contains nominal values converted to USD via spot rates from GSMA Intelligence data.
Source: GSMA Intelligence (2023[31]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/s0w71k

1.3. Institutional frameworks and broadband policies in Southeast Asia

1.3.1. Institutional frameworks

The regulatory and policy frameworks across the ten SEA countries vary, although there are some commonalities. At a high level, the ministries with remit over communication services in SEA countries usually develop policies and plans related to communication services and connectivity. These may include policies to promote the digital economy or digital transformation. Regulation of the communication sector broadly can be established through legislation to be the remit of an independent body outside of the ministry ("de jure" independent regulator), or as a unit within the ministry's structure (OECD, 2021, p. 164[71]). However, de jure independence is also affected by the law's application, the institutional culture and staff behaviour, which all contribute to the level of independence of the regulator in practice ("de facto independence") (OECD, 2021[71]).

OECD recommendations for regulatory independence have relevance to SEA. Both the 2021 Broadband Recommendation on Broadband Connectivity and the 2012 Recommendation of the OECD Council on the Regulatory Policy and Governance advocate for regulatory independence and independent regulators in certain cases (OECD, 2021[72]; OECD, 2012[73]). These include where an independent regulator is needed to uphold public confidence; where governmental and private entities are subject to the same regulatory framework; and where regulatory decisions can have a significant economic impact on the regulated parties (OECD, 2012[73]). The communication sector clearly falls under this umbrella. Regulatory decisions can often have a significant impact on communication operators, including their ability to operate in the country or obtain critical spectrum resources. In addition, some operators, especially in SEA, have state ownership, which bolsters the call for independent regulators to uphold principles of competitive neutrality.

The region has both independent regulators, statutory bodies and ministerial regulators as defined by national legislation. In OECD countries, independent regulators are more common, with legislation defining 84% of communication regulators as independent (OECD, 2021[71]). Thailand provides an example of an independent sectoral regulator (Government of Thailand, 2010[74]). Cambodia established an autonomous body with remit over the communication sector (Government of Cambodia, 2015[75]). Nevertheless, the level of overall independence of the regulator in practice also depends on other aspects, such as appointment of top positions or budget allocation, which may introduce possible risks of political influence.

Myanmar is moving, in principle, towards creating an independent regulator. Article 86 of the 2013 Law on Communications requires the Myanmar government to establish an independent regulatory authority (Myanmar, 2013[76]). However, this has not happened yet, at the time of writing. In practice, the Department of Communications under the Ministry of Transportation and Communications supervises the sector (Department of Communications, Government of Myanmar, 2018[77]).

Singapore, Malaysia, the Philippines and Brunei Darussalam have varied statutory bodies to regulate the communication sector. In Singapore, the IMDA is a statutory board that regulates the communication and media sectors (Government of Singapore, 2016[78]), although it is subject to control by the Ministry of Communications and Information, its supervisory Ministry (IMDA, 2022, p. 74[79]). In Malaysia, the Malaysian Communications and Multimedia Commission (MCMC) is a "body corporate" tasked to regulate the communication and broadcasting sector (Section 4), however MCMC is responsible to the Minister of Communications and Digital (Section 18) (Malaysia, 1998[80]). In the Philippines, the National Telecommunications Commission (NTC) is defined as an "attached" agency of the Department of Information and Communications Technology (DICT), which is part of the Executive branch of government (Philippines, 2015[81]). The Authority for Info-communications Technology Industry of Brunei Darussalam is defined as a "body corporate" with the remit to regulate the communication sector, under the jurisdiction of the Ministry of Transport and Infocommunications (Brunei Darussalam, 2001[82]; MTIC, n.d.[83]).

Viet Nam, Lao PDR and Indonesia have ministerial regulators. The Viet Nam Authority of Telecommunications assists the Ministry of Information and Communications to monitor and regulate the communication sector (MIC, n.d.[84]). In Lao PDR, the regulatory authority is a body under the Ministry of Communications and Technology (World Bank, 2022[85]).[12] Indonesia had a separate regulatory body, the Indonesian Telecommunication Regulatory Body (BRTI), which worked under and was responsible to the Ministry of Communications and Informatics (MCI) (ADB, 2020[86]). However, to streamline government, MCI fully assumed the regulatory functions when BRTI was disbanded in 2020 (MCI, 2020[87]; MCI, 2020[88]). The move to disband BRTI and further centralise regulatory functions in the ministry goes against OECD best practice for the communication sector, which supports regulatory independence, as noted above.

Some SEA countries have bodies that regulate both communication and broadcasting sectors. MCMC in Malaysia, IMDA in Singapore and NBTC in Thailand are examples of converged regulators, which have both sectors under their remit. The NTC in the Philippines has a mandate to "regulate and supervise radio and television broadcast stations, cable television (CATV) and pay television", along with public telecommunications services (NTC, n.d.[89]).

1.3.2. Regional broadband strategies and plans

SEA economies have recognised the importance of connectivity, which underpins digital transformation, in achieving sustainable and inclusive growth. As a result, virtually all SEA countries have concrete plans and measures to expand and improve the quality of connectivity. In addition to these national plans, supranational initiatives for greater economic and social integration in the region prioritise connectivity improvement.

ASEAN has been adopting regional strategies to improve connectivity and accelerate technological innovation for decades. The ASEAN Digital Masterplan 2025 stresses the importance of regional connectivity and co-operation. To that end, it seeks to increase the quality and coverage of fixed and mobile broadband infrastructure (DO2) through several concrete measures:

- enabling and encouraging cross-border regional investment for network deployment
- adopting best practices for granting permits and rights of way for network deployment
- developing consistent regulation across the region, especially regarding spectrum allocation
- ensuring adequate international Internet connectivity for the region
- developing and measuring common metrics of telecommunication operators' carbon footprint
- establishing a regional centre of excellence for rural connectivity (ASEAN, 2021[90]).

The Asia-Pacific Information Superhighway (AP-IS), an initiative promoted by the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), has broader geographical scope. It aims to bridge digital divides and accelerate digital transformation by promoting digital connectivity, digital technologies and use of data in the Asia-Pacific region (ESCAP, 2022[91]). The Master Plan for the AP-IS (2019-22) (ESCAP, 2018[92]) has led, among other results, to feasibility studies and expert working group meetings to guide establishment of a common IXP. This aims to improve the efficiency of Internet traffic flow in Cambodia, Lao PDR, Myanmar and Viet Nam. The Master Plan has also inspired studies and pilot projects for the co-deployment of ICT infrastructure with energy and road transport infrastructures, and development of an ICT resilience monitoring framework (e-resilience dashboard) (ESCAP, 2021[93]; 2022[94]). The AP-IS Master Plan for 2022-26 includes connectivity as one of its three pillars. It focuses mainly on enhancing regional broadband backbone networks and infrastructure for promotion of universal access to affordable and reliable Internet (ESCAP, 2021[93]).

1.4. Developing broadband policy recommendations for the SEA region

Authorities in the region recognise the importance of broadband as a key tool for digital transformation. In recent years, they have promoted policies and regulatory changes to foster deployment and adoption of broadband technologies. However, these policies must keep pace with the evolution of communication markets and networks. As economies and societies become more digital, communication networks must also adapt in tandem to offer high speed, low latency and resilient communication services that can support emerging technologies such as artificial intelligence and extended reality. Increasingly, they must consider the environmental sustainability of these communication networks as countries grapple with the effects of climate change.

In this context, the study aims to provide tailor-made recommendations for SEA countries to support the formulation of communication policies fit for the future. To this end, the study builds on the OECD Council Recommendation on Broadband Connectivity (hereafter the "Broadband Recommendation") (OECD, 2021[72]). The Broadband Recommendation sets out overarching principles to extend connectivity and enhance the quality of broadband networks around the following pillars or targets:

I. Competition, investment and innovation in broadband development
II. Broadband network deployment and closing the digital divide
III. Quality of networks (resilience, reliability, security and high capacity)
IV. Environmental impacts of networks
V. Regular assessment of broadband markets .

On this basis, the study analyses connectivity in the region to develop tailored recommendations based on the Broadband Recommendation. On the one hand, it examines the institutional framework of communication policy, complemented by a compilation of recent plans, and policy and regulatory measures. On the other, it analyses the state of connectivity and identifies areas for improvement in light of the pillars of the Broadband Recommendation. This is a data-driven analysis based on indicators selected to measure the degree of fulfilment of the objectives of the Broadband Recommendation pillars. The resulting tailor-made recommendations address the identified areas for improvement per pillar, while considering the current institutional framework and communication policies.

The OECD has extensive experience with such in-depth country studies, as well as regional studies (OECD, 2020[95]; OECD, 2019[30]; OECD, 2017[96]; OECD/IDB, 2016[97]). However, this study has a slightly different methodology, using a cluster analysis to account for the diverse set of countries in the SEA region. The cluster analysis groups countries according to conditions that can usually predict, or are closely related to, the level of broadband penetration. According to academic literature, these characteristics include the country's economic output/wealth, population, level of human development (including longevity, education and income), degree of urbanisation, level of competition in communication markets and affordability of services (Cava-Ferreruela and Alabau-Muñoz, 2006[98]; Dwivedi and Lal, 2007[99]; Prado and Bauer, 2021[100]).

The analysis is conducted on a cluster basis, producing results for each country typology. In addition, one representative country was selected for each cluster to allow for in-depth analysis. The subsequent recommendations can be extrapolated to the other countries in the same cluster as they have a similar framework and macroeconomic conditions for broadband deployment. Overall, the study provides an overview of the region but with nuances that reflect its diversity.

The country clustering has been implemented through a statistical analysis[13] of the aforementioned conditions[14], along with fixed and mobile broadband penetration. This process has identified five clusters with the following distinctive features:

Cluster 1 comprises Cambodia, Lao PDR and Myanmar, and the selected representative country is Cambodia. The three countries all have a higher proportion of rural population than any others in the region.[15] Other shared features are low educational attainment, low fixed broadband penetration and low per capita income, all of which are among the lowest in the region.

Cluster 2 (Thailand and Malaysia) and cluster 3 (the Philippines and Indonesia) share less rurality and better development and broadband indicators than cluster 1, but they have significant differences between them. Cluster 2 countries have comparatively fewer urban areas than cluster 3 countries.[16] In addition, cluster 2 is characterised by higher income levels and higher broadband penetration, especially mobile broadband. The analysis selected Thailand as the representative country for cluster 2, and Indonesia for cluster 3.

Cluster 4 comprises Viet Nam. This country is similar to clusters 2 and 3 for most indicators. However, it has two significant distinguishing features: its high fixed broadband penetration, second only to Singapore, and its high urban cluster type of urbanisation, second only to Brunei Darussalam.[17]

Finally, cluster 5 formed by Brunei Darussalam and Singapore share complementary characteristics with cluster 1: low rurality, high education level, high per capita income and high fixed broadband penetration. However, Brunei Darussalam is mostly urban cluster-based and Singapore is urban centre-based. Given the significant commonalities, these countries were analysed as a single cluster and Singapore was chosen as the representative country.

According to the described methodology, the following chapters study each of the SEA country clusters, focusing on the chosen representative country, namely Cambodia (Chapter 3), Indonesia (Chapter 4), Singapore (Chapter 5), Thailand (Chapter 6) and Viet Nam (Chapter 7). Following an analysis of the situation of broadband connectivity in each country, each chapter includes tailored-made recommendations. These cluster studies, as well as the analysis at the regional level presented in this chapter, inform the key recommendations outlined in the executive summary.

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Notes

[1] East Timor's application for ASEAN membership is pending.

[2] Buddhism, Judaism, Christianity, Islam and Hindi are present in region, along with local religions.

[3] For this report, a slum household refers to a group of individuals living under the same roof that lack one or more of the following conditions: insecure residential status, inadequate access to safe water, inadequate access to sanitation and other infrastructure, poor structural quality of housing and overcrowding (UN-Habitat, 2003[104]).

[4] Middle-income refers to the countries classified as either "lower-middle income" or "upper-middle income" according to the World Bank classifications (World Bank, 2023[20]). The World Bank assigns the world's economies to four income groups – low, lower-middle, upper-middle and high income. For the fiscal year 2024, lower-middle income ranges from USD 1 136 to USD 4 465, upper-middle income ranges from USD 4 466 to USD 13 845, and high-income is USD 13 846 or greater (World Bank, 2023[20]). Cambodia, Lao PDR, Myanmar, the Philippines and Viet Nam are classified as lower-middle income economies, and Indonesia, Malaysia and Thailand are classified as upper-middle income economies (World Bank, 2023[20])..

[5] Financial services also contribute to ASEAN exports but are ranked as a distant fourth in importance. Meanwhile, charges for use of intellectual property make up ASEAN's imports (ASEAN, 2019[102]).

[6] Data for Indonesia in 2021 (ITU, 2023[10]). The indicator 'Individuals using the Internet' refers to the proportion of individuals having used the Internet from any location in the last three months. Access can be via a fixed or mobile network (ITU, n.a.[103]).

[7] Data for Thailand in 2021 (ITU, 2023[10]).

[8] This indicator, defined in the framework of the ITU Broadband Map (ITU, 2023[34]), refers to the percentage of population within reach of transmission networks refers to the percentage of people within physical reach of nodes on core terrestrial transmission networks. The actual catchment area, or how many people can be served by the core transmission network, is greater than the reach from nodes on the core network. This is a useful indicator of the catchment area of a core transmission network or networks, and how many people it can reach potentially.

[9] An Internet exchange point (IXP) is defined as the infrastructure for interconnecting three or more Autonomous Systems (AS). AS is a connected group of one or more IP prefixes run by one or more network operators that have a single and clearly defined routing policy (Hawkinson and Bates, 1996[101]).

[10] Latency or ping is the reaction time of connection — that is, how quickly the user device gets a response after you've sent out a request. A fast ping means a more responsive connection, especially in applications where timing is everything (like video games). Ookla® measures several types of latency. The figures referenced in the text refer to ‘minimum latency’ that measures the best case latency for the user at the time they decide to take a Speedtest®. The lowest ping value is determined across one or more pings made before the download speed test – this represents the ‘minimum latency’ (Ookla, 2023[44]).

[11] According to (ESCAP, 2021[45]), “e-resilience is defined as the ability of ICT systems to withstand and recover from and change in the face of an external shock.”

[12] Analysis relies on third part sources due to difficulties to translate key legislation and access websites of the Ministry of Communications and Technology and the regulatory authority in Lao PDR.

[13] Preliminary data analysis (discard variables with few values available, and highly correlated variables to mitigate overfitting), Principal Component Analysis (PCA), clustering analysis (K-means).

[14] Specifically, GDP per capita (IMF, 2023[6]) and total population (UNDESA, 2022[3]); the Human Development Index, educational, longevity and income dimensions (UNDP, 2022[19]); and the population and built-up area by degree of urbanisation (urban centre, urban cluster, rural) (European Commission, Joint Research Centre, 2015[1]).

[15] Rural population defined as the population that lives in rural areas. Rural area (or mostly low-density cells) is defined as grid cells of 1 square kilometre with a density below 300 inhabitants per square kilometre and other grid cells outside urban clusters or centres (European Commission, Joint Research Centre, 2015[1]).

[16] Urban centre(high-density cluster) is defined as contiguous grid cells with a density of at least 1 500 inhabitants per square kilometre. An urban centre has a population of at least 50 000 (European Commission, Joint Research Centre, 2015[1]).

[17] Urban cluster (moderate-density cluster) is defined as contiguous grid cells with a density of at least 300 inhabitants per square kilometre and has a population of at least 5 000 in the cluster (European Commission, Joint Research Centre, 2015[1]).

2 Extending broadband connectivity in Cambodia

Cambodia is located on the region's mainland, with a predominantly flat geography and a relatively high proportion of a rural population. Its economy continues to grow at pace, and the level of human development, including income, life expectancy, and education, is medium. Given that these features are shared with its regional peer countries of Lao People's Democratic Republic and Myanmar, these countries are analysed as a cluster represented by Cambodia. The chapter outlines the geographic, economic and social conditions for broadband connectivity in Cambodia. It proceeds by examining the performance and structure of the market and reviewing Cambodia's communication policy and regulatory framework, including broadband strategies and plans. It then reviews competition, investment and innovation in broadband markets; broadband deployment and digital divides; networks' resilience, reliability, security and capacity; and the country's assessment of broadband markets. It offers recommendations to improve in these areas, which could be relevant for the other countries forming this cluster.

Policy recommendations

1. Strengthen the regulatory independence of TRC by adopting measures to increase transparency in the selection process of top officials and in budgetary allocation.
2. Clarify areas of potential overlap with MPTC and TRC and consider whether TRC should receive further powers to enable it to carry out its mandate effectively.
3. Reduce regulatory uncertainty through active engagement with operators and clear communication on the timeline of regulatory changes.
4. Leverage the ongoing legislative processes to define SMP regulation and clarify the roles of TRC and the CCC on competition matters in the communication sector.
5. Undertake competition assessments once the Prakas on competition aspects comes into effect.
6. Consider fostering the wholesale market and monitoring wholesale prices.
7. Assess the impact the level of fees may have on operators' investment decisions.
8. Support investment through expedient licensing processes.
9. Apply regulation impartially and clearly communicate upcoming changes to industry.
10. Support industrial efforts to deploy 5G networks.
11. Reduce barriers to broadband deployment by streamlining access to rights of way, public infrastructure and permits for network construction.
12. Promote co-ordination of civil works and passive infrastructure sharing between different networks, especially between communication and electricity networks.
13. Promote and invest in improving digital literacy.
14. Take actions to improve the affordability of communication services and access devices.
15. Leverage synergies between programmes to promote the provision and adoption of connectivity services.
16. Publish open, verifiable, granular and reliable subscription, coverage and quality of service data.
17. Promote measures to improve the quality of communication networks.
18. Promote measures to improve the resilience of traffic exchange infrastructures and international connectivity.
19. Assess the environmental impact of investment projects in communication networks, while promoting sustainable networks.
20. Encourage communication network operators to report regularly on their environmental impacts and initiatives.
21. Regularly assess the state of connectivity to determine whether public policy initiatives are appropriate, and whether and how they should be adjusted.

Note: CCC = Cambodian Competition Commission; MPTC = Ministry of Post and Telecommunications; SMP = Significant Market Power; TRC = Telecommunication Regulator of Cambodia. These tailored recommendations build on the OECD Council's Recommendation on Broadband Connectivity (OECD, 2021[1]), which sets out overarching principles for expanding connectivity and improving the quality of broadband networks. The number of recommendations is not an appropriate basis for comparison as they depend on several factors, including the depth of contributions and feedback received from national stakeholders. In addition, recommendations do not necessarily carry the same weight or importance.

2.1. Geographic, economic and social conditions for broadband connectivity

Geographically, Cambodia is in the southern part of the Indochina Peninsula, between Viet Nam in the east and Thailand in the west. Cambodia borders Lao People's Democratic Republic (Lao PDR) to the north and has a coastline on the southwest with the Gulf of Thailand. A low-lying central plain surrounded by low mountains, the Tonle Sap (Great Lake) and the upper reaches of the Mekong River delta define Cambodia's landscape (Britannica, 2022[2]).

Cambodia has a population of 16.8 million people as of 2022 (UN DESA, 2022[3]), and its capital Phnom Penh has a population of more than 2 million people (Ministry of Plannning, 2020[4]). Other urban centres of considerable size are Ta Khmau, next to Phnom Penh in the south; Battambang in the west; Serei Seophoan in the northwest; Siem Reap known for Angkor Wat and near the Tonle Sap; Kampong Cham on the Mekong River in the southeast; and Sihanoukville on the Thailand Bay in the southwest.

Cambodia is one of the most disaster-prone countries in Southeast Asia, affected by seasonal floods and droughts. Floods from the Mekong River and Tonle Sap Lake occur repeatedly during the rainy season. They often cause major disasters, as about 80% of the country's population lives along the Mekong River (World Bank, 2021[5]). On the other hand, irregular or shorter monsoon rains often cause drought damage. In addition, sea-level rise could pose a significant threat to coastal areas already plagued by storm surges, coastal erosion and seawater intrusion. Cambodia has suffered great socio-economic losses due to these natural disasters (World Bank, 2021[5]).

Cambodia is the representative country of the cluster comprising Cambodia, Lao PDR and Myanmar. Key features of this group of countries include their predominantly rural nature. It also has relatively low educational attainment and low per capita income, both of which are among the lowest in the region (see Table 2.1). However, Cambodia, Lao PDR and Myanmar are all classified as having a "medium" level of human development, considering indicators including longevity, education and income (UNDP, 2022[6]).

With respect to gross domestic product (GDP) per capita, Cambodia was in the middle of the three with USD PPP 5 601 in 2022. Lao PDR's position was higher at USD PPP 9 207 and Myanmar's was slightly lower at USD PPP 4 847 (IMF, 2023[7]). These three countries occupy the bottom three positions among Southeast Asian countries. The 2022 populations of Cambodia, Lao PDR and Myanmar were 16.8 million, 7.5 million and 54.2 million, respectively (UN DESA, 2022[3]). They are the seventh, eighth and fifth most populous countries in Southeast Asia.

Cambodia, Lao PDR and Myanmar have similar geographic breakdowns between urban and rural areas. Around 99% of their land mass was classified as "rural", with the remainder considered urban ("urban cluster"[1] or "urban centre"[2]) (European Commission, Joint Research Centre, 2015[8]). In addition, the proportion of the population in rural areas is relatively high for the region.[3] In Cambodia, 51.6% live in rural areas, while the figures are 82.5% in Lao PDR and 34.9% in Myanmar. They are ranked second, first and fifth in the region for rural population (European Commission, Joint Research Centre, 2015[8]).

Table 2.1. Human development (2021) and degree of urbanisation (2015), Cambodia, Lao PDR and Myanmar

	Life expectancy (years, 2021)	Expected years of schooling (children, 2021)	Mean years of schooling (adults, 2021)	Gross domestic product per capita (current prices, PPP, 2022)	Population living in urban centres (%, 2015)	Population living in urban clusters (%, 2015)	Population living in rural areas (%, 2015)
Cambodia	69.6(6)	11.5(8)	5.1(10)	5 601(9)	18.3	30.1	51.6
Lao PDR	68.1(8)	10.1(10)	5.4(9)	9 207(8)	8.5	9.0	82.5
Myanmar	65.7(10)	10.9(9)	6.4(8)	4 847(10)	41.0	24.1	34.9
OECD Average	80.0	17.1	12.3	53 957	48.8 (2022 data)	28.11 (2022 data)	23.11 (2022 data)

Note: The numbers in parentheses refer to the simple ranking (i.e. no weighting) of SEA countries for each indicator. The OECD average for human development indicators is a simple average across OECD member countries. The urbanisation indicators for SEA countries refer to the population percentage in urban centres, urban clusters and rural areas, respectively. For the OECD, figures are given for the rate of the population living in predominantly urban, intermediate, and rural regions, respectively.
Source: [Human development indicators] UNDP, *Human Development Report 2021/2022: Uncertain Times, Unsettled Lives: Shaping our Future in a Transforming World*, www.undp.org/egypt/publications/human-development-report-2021-22-uncertain-times-unsettled-lives-shaping-our-future-transforming-world. [GDP per capita, SEA countries] IMF (2023[7]), *World Economic Outlook Database, April 2023*, www.imf.org/en/Publications/WEO/weo-database/2023/April (accessed on 28 June 2023). [GDP per capita, OECD] OECD , *Gross domestic product (GDP)* (indicator), https://doi.org/10.1787/dc2f7aec-en (accessed on 30 June 2023). [Urbanisation indicators for SEA] European Commission, Joint Research Centre, *Global Human Settlement Layer (GHSL)*, https://ghsl.jrc.ec.europa.eu/CFS.php. [Urbanisation indicators for OECD] OECD (2023[9]), *OECD.Stat* (database),*"Regions and cities: Regional statistics: Regional demography: Demographic indicators by rural/urban typology, Country level: OECD: share of national population by typology"*, https://stats.oecd.org/ (accessed on 28 August 2023).

Given the similarities in conditions for broadband deployment and use, recommendations for Cambodia may also be relevant for Lao PDR and Myanmar. The subsequent sections focus on Cambodia for further analysis.

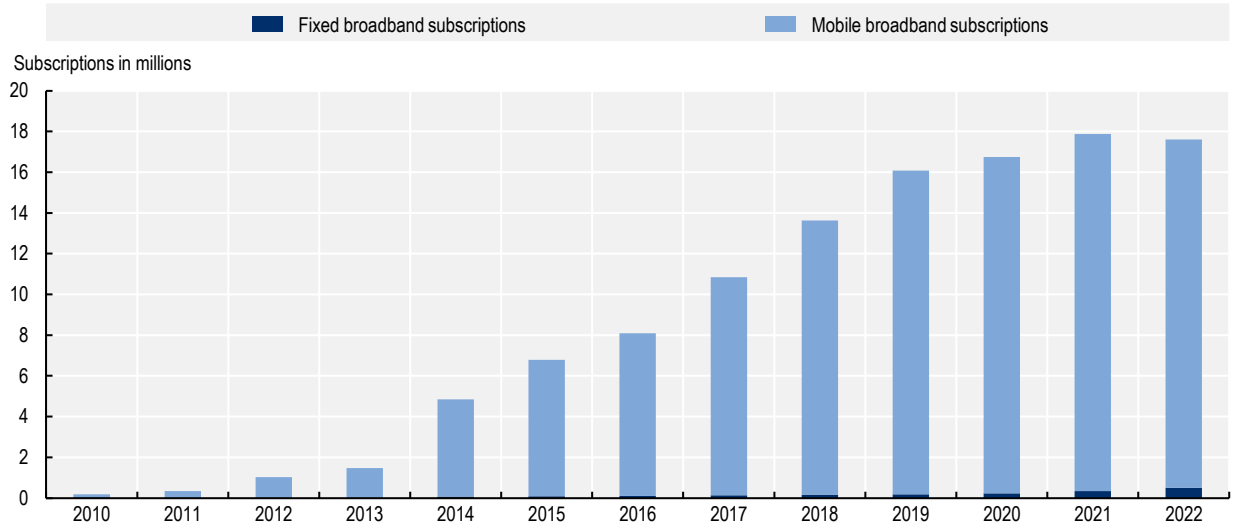
2.2. Market landscape

2.2.1. Market performance

Broadband uptake has grown dramatically in the last decade (2010-22), led by mobile broadband connectivity (Figure 2.1). The total number of broadband subscriptions soared from 185 666 in 2010 to 17.6 million in 2022, of which almost all (97%) were mobile subscriptions (ITU, 2023[10]). Mobile broadband subscriptions grew at an annual rate of 62% between 2010 and 2022; the deployment of 4G networks led to a significant increase in subscribers from 2014 (Figure 2.9) (ITU, 2023[10]). However, year-on-year growth rates have been lower in recent years, even with a slight decline in 2022 (-2.5%) (ITU, 2023[10]). In terms of penetration, the number of mobile subscriptions exceeded Cambodia's inhabitants in 2020, reaching 102.0 subscriptions per 100 inhabitants in 2022, slightly below the regional average (103.7 subscriptions) (ITU, 2023[10]).

Fixed broadband adoption is much lower, reaching only 509 830 subscribers in 2022 and growing at a slower pace. Year-on-year growth averaged 29% between 2010-22, although accelerating in 2021 and 2022 with rates of 44% and 52% respectively (ITU, 2023[10]). Cambodia has the third lowest fixed penetration rate in the region, with 3.0 subscriptions per 100 inhabitants (2022) (ITU, 2023[10]). This rate was just above Myanmar and Lao PDR, with 2.1 and 2.0 fixed broadband subscriptions per 100 inhabitants in 2022, respectively (ITU, 2023[10]).

Figure 2.1. Broadband subscriptions, 2010-22



Note: Fixed broadband subscriptions refer to fixed subscriptions to high-speed access to the public Internet (TCP/IP connection) at downstream speeds equal to, or greater than, 256 kbit/s. This includes cable modem, DSL, fibre-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. It includes fixed WiMAX and any other fixed wireless technologies. This total is measured irrespective of the method of payment. It excludes subscriptions with access to data communications (including the Internet) via mobile-cellular networks. It includes both residential subscriptions and subscriptions for organisations. Mobile broadband subscriptions (active mobile-broadband subscriptions in ITU Database) refer to the sum of active handset-based and computer-based (USB/dongles) mobile-broadband subscriptions that allow access to the Internet. It covers actual subscribers, not potential subscribers, even though the latter may have broadband-enabled handsets. Subscriptions must include a recurring subscription fee or pass a usage requirement if in the prepayment modality – users must have accessed the Internet in the last three months (ITU, 2020[11]).
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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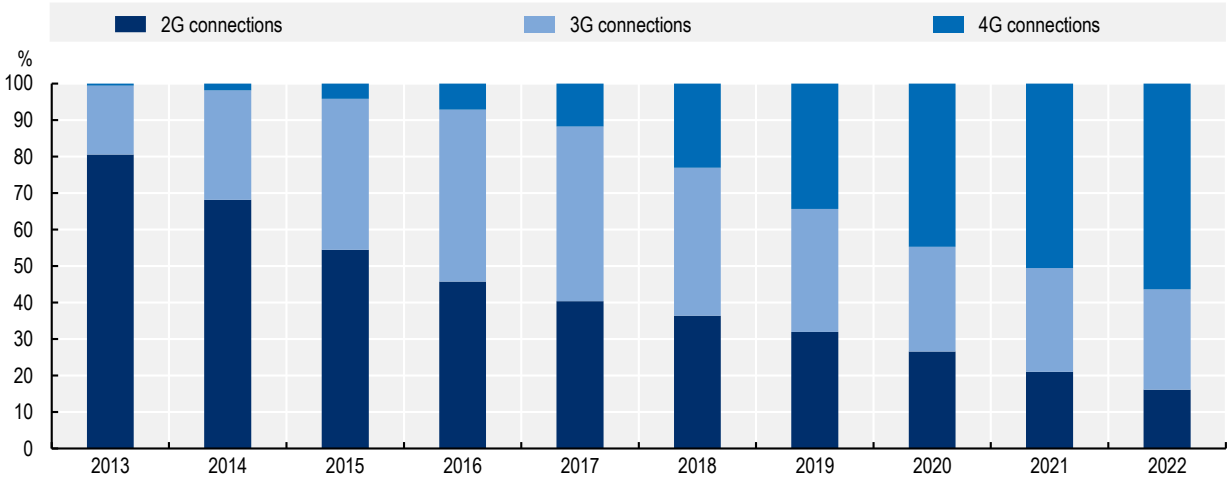
4G is the most common technology in Cambodia, accounting for 56% of mobile connections in 2022 (GSMA Intelligence, 2023[12]). It is followed by 3G with 28%, which has been in continuous decline since 2018. This decline coincides with the rollout of 4G networks, which reached 93% population coverage in that year. 2G still makes up 16% of mobile connections in the country, although it has been declining since 2013 (GSMA Intelligence, 2023[12]). Cambodia has not yet deployed 5G commercially, along with Brunei Darussalam, Myanmar and Viet Nam in the region (GSMA Intelligence, 2023[12]).

Figure 2.2. Percentage of mobile connections per technology, 2013-22



Source: GSMA Intelligence (2023[12]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

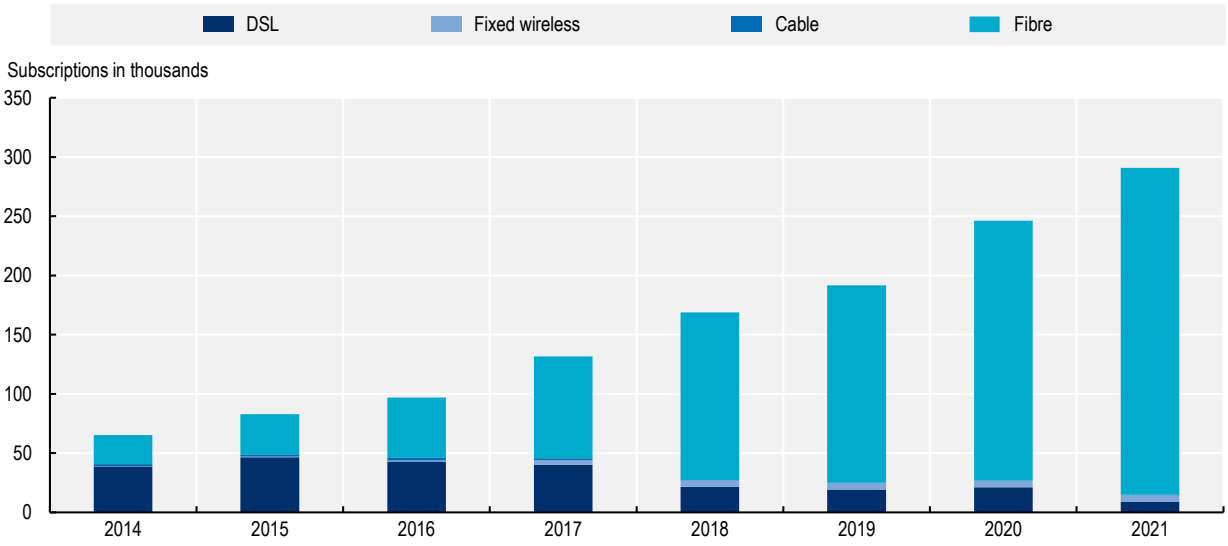
StatLink https://stat.link/2ucmiy

On the fixed side, Cambodia has seen a significant increase in the deployment and technological upgrade of its broadband networks over the last ten years, albeit from a low base. Fibre-to-the-home (FTTH) is the most widely used technology for fixed broadband in Cambodia, which overtook digital subscriber line (DSL) in terms of subscriptions in 2016. By 2021, 95% of fixed broadband subscriptions used FTTH technology, DSL reported 3% of total fixed broadband subscriptions, fixed wireless access accounted for 2%, and cable had only 0.1% (ITU, 2023[10]) (Figure 2.3).

Much of the fibre deployed is aerial fibre. This installation method is often faster and cheaper than laying fibre underground, but it has caused aesthetic and operational problems and is less resilient. This has led authorities to take steps to move to cables underground in major metropolitan areas. Operators report that FTTH networks are concentrated in densely populated areas, with much less geographic coverage compared to mobile networks. The low coverage area contributes to the low penetration rate of fixed broadband subscriptions (3 subscriptions per 100 inhabitants, 2022) (ITU, 2023[10]).

Beyond FTTH and DSL, the other technologies providing fixed access remained constant and at low levels, although fixed wireless access subscriptions increased since 2016 (ITU, 2023[10]). Interviews with operators suggest this technology has emerged to provide a fixed connectivity solution in areas where fibre is not available, mainly to business and government customers.

Figure 2.3. Fixed broadband subscriptions by technology, 2010-21



Note: Terrestrial fixed wireless broadband subscriptions for 2020 and 2021 are estimates.
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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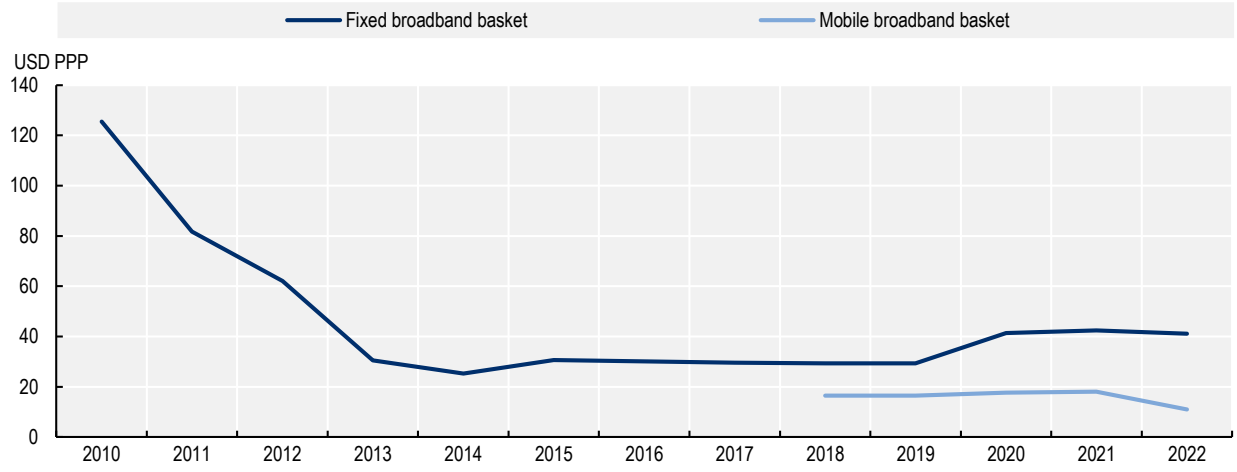
In 2022, prices for entry-level mobile communication services in Cambodia (USD PPP 11.0) were around a quarter of those for entry-level fixed services (USD PPP 41.1) (ITU, 2023[10]). This follows regional trends, with the regional average for entry-level fixed broadband services at USD PPP 51.6 compared to USD PPP 15.5 for entry-level mobile services (ITU, 2023[10]).

As Figure 2.4 shows, prices for entry-level fixed broadband services (5 GB monthly data usage) have fallen since 2010. They dropped sharply from USD PPP 125.4 in 2010 to USD PPP 25.3 in 2014 (ITU, 2023[10]). Prices were relatively stable after 2014 until 2020, when they increased to reach USD PPP 41.1 in 2022 (ITU, 2023[10]). Despite this uptick, Cambodia's prices in 2022 for entry-level fixed services (USD PPP 41.1) ranked second best in the region. They were behind Viet Nam (USD PPP 22.8) and below the regional average of USD PPP 51.6 (ITU, 2023[10]).

For entry-level mobile services (monthly data usage of a minimum of 500 MB of data, 70 voice minutes and 20 SMSs), prices over the past four years have been relatively steady (mobile pricing data prior to 2018 are unavailable). They show a slight increase from USD PPP 16.5 in 2018 to USD PPP 18.1 in 2021, followed by a decrease to USD PPP 11.0 in 2022 (Figure 2.4) (ITU, 2023[10]). In 2022, entry-level mobile prices in Cambodia were third lowest in the region after Myanmar and Viet Nam (USD PPP 5.2 and 6.8, respectively). They were also below the regional average (USD PPP 15.5) (ITU, 2023[10]). Despite these low prices (in terms of USD PPP), the affordability of fixed and mobile services may pose a barrier to adoption (see section on Digital divides below). In terms of price as a percentage of gross national income (GNI) per capita, Cambodia's prices are among the least affordable in the region. Cambodia's fixed (11.6% of GNI per capita) and mobile broadband prices (3.1%) both rank second highest in SEA in 2022 (ITU, 2023[10]) (Figure 2.12).

Figure 2.4. Prices for entry-level fixed and mobile communication services, USD PPP, 2010-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2010 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[13]). Mobile basket prices are not available from 2010 to 2017.
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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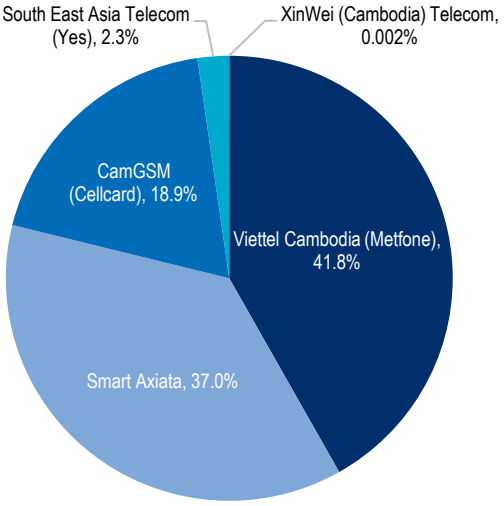
2.2.2. Market structure

Cambodia's mobile market structure has experienced vast change over the past decade. In 2012, there were eight active mobile operators, with a strong level of competition (Vong, Lee and Zo, 2012[14]). These eight operators operated in a market largely regulated through ad hoc legislation. This changed with the Law on Telecommunications (hereafter "Telecom Law"), adopted in 2015 (Vong, Lee and Zo, 2012[14]).

In 2021, five mobile operators remained, with the two largest players holding close to 80% of the market in terms of mobile broadband subscriptions (Figure 2.5). According to national authorities, Viettel Cambodia (Metfone) leads the mobile market with 41.8% of mobile broadband subscriptions as of the end of 2021, followed closely by Smart Axiata with 37% market share. CamGSM (Cellcard) is in third place with 18.9% of the market, and South East Asia Telecom (Yes) and XinWei (Cambodia) Telecom hold the remaining shares with 2.3% and 0.002%, respectively. These operators provide services mainly over their own networks. There are no mobile virtual network operators (MVNOs) present on the market, according to national authorities.

Figure 2.5. Mobile market shares based on mobile broadband subscriptions, Q4 2021



Source: OECD elaboration based on data from Cambodian authorities.

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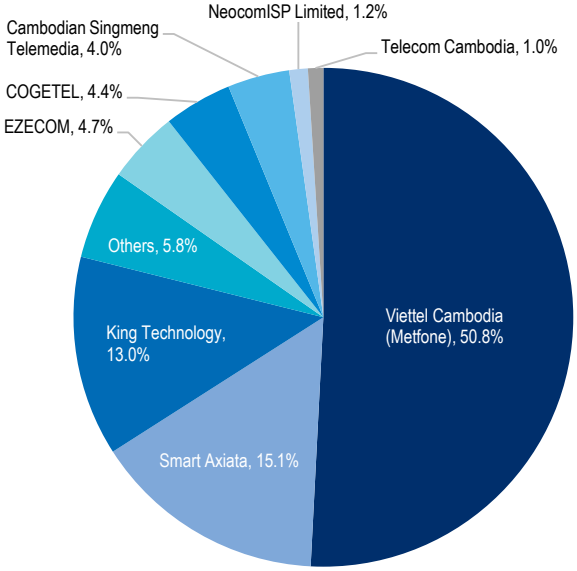
The fixed market in Cambodia, by contrast, has many operators offering services (Figure 2.6). Viettel Cambodia (Metfone) holds 50.8% of the market based on the number of fixed broadband subscriptions, according to information from national authorities. It is followed by Smart Axiata at a distant second with 15.1% of the market and King Technology in third with 13%. EZECOM, COGETEL and Cambodian Singmeng Telemedia hold 4.7%, 4.4% and 4%, respectively, while NeocomISP Ltd holds 1.2% and Telecom Cambodia holds 1%. The remaining 5.8% of the market is split between 30 Internet service providers (ISPs) that each hold less than 1% market share based on number of fixed broadband subscriptions. According to Cambodian authorities, only Telecom Cambodia owns and operates its own fixed network; all other operators provide services mainly over third-party infrastructure.

Figure 2.6. Fixed market shares based on fixed broadband subscriptions, Q4 2021



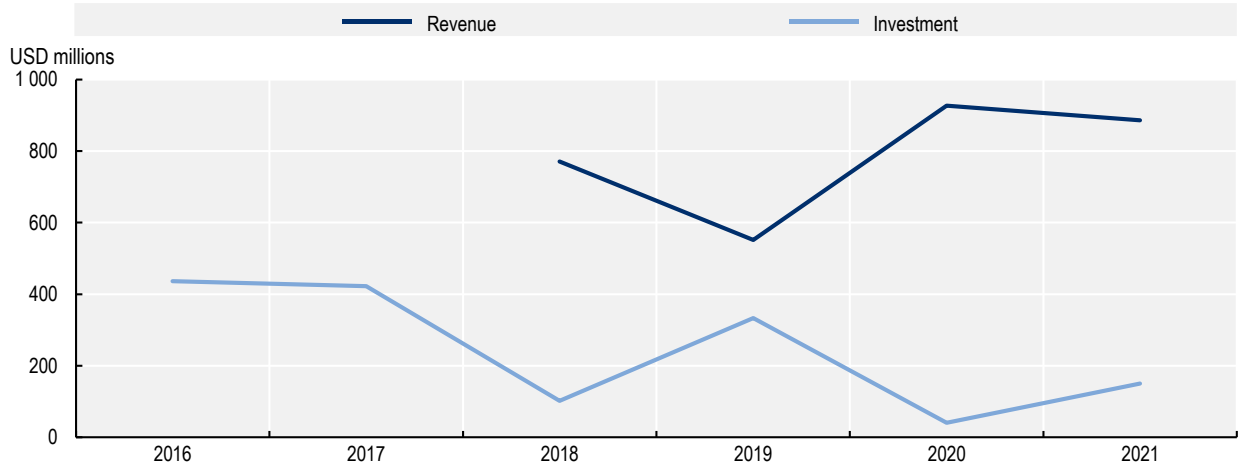
Note: "Others" includes ISPs with less than 1% market share each based on number of fixed broadband subscribers (30 ISPs make up this list).
Source: OECD elaboration based on data from Cambodian authorities.

StatLink https://stat.link/7fuwdl

There is some state ownership in the communication market. Namely, Telecom Cambodia is 100% state-owned, under the technical supervision of MPTC and the financial supervision of the Ministry of Finance and Economy (Government of Cambodia, 2005[15]). Among the largest players in both the fixed and mobile markets in terms of market shares, others have foreign state ownership. For example, Viettel Cambodia (Metfone) is part of the Viettel Group, which is under the management of the Vietnamese Ministry of Defence (MIC, 2018[16]). Smart Axiata is part of the Axiata Group Berhad, which has various stakeholders, with the largest being Khazanah Nasional Berhad (36.73%), Malaysia's sovereign wealth fund, and Permodalan Nasional Berhad (18.39%), a Malaysian wealth management company (Axiata Group Berhad, 2022[17]). CamGSM(Cellcard) is majority-owned by Royal Millicom Co., Ltd (98.5% of shares), a joint venture of two investment firms (CamGSM, 2023[18]).

In Cambodia, data on investment in the communication sector (mobile and fixed networks) show a decline from 2016-21. Investment fell from USD 436 million in 2016 to USD 150 million in 2021, a decrease of 66% over the period (Figure 2.7) (ITU, 2023[10]). By contrast, revenues for the sector increased slightly from USD 771 million in 2018 to USD 886 million in 2021, a growth rate over the four-year period of 15% (Figure 2.7) (ITU, 2023[10]). The ratio of investment to revenues across the sector for 2021 was 17% (ITU, 2023[10]).

Figure 2.7. Revenue and investment in communication services, 2016-21



Note: Revenue data before 2018 are unavailable.
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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Due to data gaps for communication investments in both fixed and mobile networks, it is difficult to compare Cambodia's figures to regional peers. However, a comparison across the region is possible for investments in mobile networks. GSMA Intelligence data show Cambodia's investment in mobile networks (Capex) at a relatively stable growth rate of 16% over the period of 2013-22, from USD 134 million in 2013 and reaching USD 155 million in 2022, in nominal terms (GSMA Intelligence, 2023[12]).

By comparison, nominal revenues of the mobile communication sector in Cambodia have steadily increased between 2013-22. During that period, revenues had a growth rate of 42%, from USD 719 million in 2013 to USD 1 billion in 2022 (GSMA Intelligence, 2023[12]).

Cambodia ranks the third lowest in the SEA region in terms of both mobile revenues and investment (Capex) in nominal terms in 2022, ahead of Brunei Darussalam and Lao PDR (GSMA Intelligence,

2023[12]). Considering its ratio of investment to revenues in 2022, Cambodia with 15% is below the regional average of 21% (GSMA Intelligence, 2023[12]). This means that Cambodian mobile operators are investing slightly less in proportion to the revenues received than the average for the region .

2.3. Communication policy and regulatory framework

2.3.1. Institutional framework

The Telecom Law, adopted in 2015, defines the responsibilities of the Ministry of Post and Telecommunications (MPTC) (Government of Cambodia, 2015[19]). MPTC formulates policies and regulations over the communication sector. It can issue ministerial decisions, known as "Prakas", related to specific issues such as licensing, interconnection, technical standards, numbering, radio frequency plans and competition. It issues Prakas as needed or upon the advice of the regulatory authority, the Telecommunication Regulator of Cambodia (TRC) (Government of Cambodia, 2015[19]). Article 7 of the Telecom Law gives MPTC broad latitude to order operators to take certain measures in "force majeure" events [unofficial translation] (Government of Cambodia, 2015[19]). MPTC also has competence over communication infrastructures and networks (Art. 24) (Government of Cambodia, 2015[19]). Further, MPTC appoints officials to monitor enforcement of the Telecom Law, although this seems to be more focused on the technical inspection of the network and equipment (Art. 70) (Government of Cambodia, 2015[19]).

The Telecom Law formally establishes TRC as an autonomous body with remit over the communication sector (Government of Cambodia, 2015[19]). TRC's duties include regulating and monitoring the communication sector, resolving disputes, enforcing relevant regulation and making recommendations to the MPTC regarding regulation and the issuance of Prakas (Government of Cambodia, 2015[19]). TRC grants licences for operation of communication networks, as well as for the use of spectrum resources. TRC can undertake several enforcement actions in case of non-compliance (Art. 78), however MPTC has the authority to issue fines (Art. 79) (Government of Cambodia, 2015[19]).

The Ministry of Economy and Finance must approve TRC's annual budget, which is described as an annex of MPTC's budget (Government of Cambodia, 2015[19]). The TRC Chairperson, who is the head of the organisation, is selected by the Minister of Post and Telecommunications and proposed to the head of the Cambodian government for appointment (Government of Cambodia, 2015[19]). The Telecom Law contains few details regarding the selection process. It only mentions the Chairperson should hold a university degree, possess "appropriate qualifications" and have at least ten years' experience in "telecommunications, information technology, law, public administration, economics, commerce" or other related fields [unofficial translation] (Government of Cambodia, 2015[19]).

The institutional framework set forth in the Telecom Law specifies that TRC has autonomy to perform regulatory functions and duties over the communication sector (Government of Cambodia, 2015[19]). However, the relationship between TRC and MPTC seems somewhat interlinked, with MPTC influence possible on TRC. First, MPTC selects the TRC Chairperson, through an opaque selection process, as the Telecom Law does not detail the steps to select an appropriate candidate (Government of Cambodia, 2015[19]). The Telecom Law only specifies broad qualifications, which may make it more difficult to ensure MPTC will select a Chairperson with the appropriate skills. This may introduce political influence in the appointment process and lead to appointment of political supporters or allies to top positions. This, in turn, could limit the amount of independence TRC holds in practice (also known as *de facto* independence). For example, the current TRC Chairperson was a former Secretary of State of MPTC, suggesting the possibility of governmental influence in the appointment process.

While some OECD countries follow a similar approach, OECD good practice recommends that such appointment processes be transparent, preferably involving an independent selection panel (OECD,

2021[20]), as opposed to the sectoral minister. This can help insulate the process from political influence and ensure candidates have the needed skills to fulfil the position.

Additionally, the Ministry of Economy and Finance approves TRC's budget. This may introduce further political influence as TRC's activities will depend on the ministry's decision. Across the OECD, only 22% of communication regulators rely on budget allocated from the government (OECD, 2021[20]). Roughly half (46%) are funded through a mix of budget from the government and fees collected from industry. The remaining third rely only on industry fees (33%) (OECD, 2021[20]). OECD good practice recommends safeguards to reduce potential governmental influence on regulatory budgets. A transparent and clearly defined process to allocate multi-annual budgets, for example, can be less susceptible to short-term political pressures (OECD, 2021[20]).

The broad powers given to MPTC under Art. 7 are further cause for concern. They allow MPTC to order operators take certain actions in "force majeure" events. This power could infringe upon TRC's regulatory mandate, depending on how often this article is used. The Telecom Law does not define "force majeure" events. Additionally, while TRC is granted certain enforcement powers, MPTC has the power to issue fines. This may impede TRC's ability to regulate the communication sector effectively. Finally, Art. 24 lists communication infrastructures and networks as being under the remit of MPTC, which may blur the lines between the jurisdictions of the two entities (Government of Cambodia, 2015[19]).

Recommendations

1. **Strengthen the regulatory independence of TRC by adopting measures to increase transparency in the selection process of top officials and in budgetary allocation**. While the Telecom Law formally establishes TRC as an autonomous body with remit over the communication sector (Government of Cambodia, 2015[19]), influence from MPTC seems possible. Selection of the TRC Chairperson by the MPTC minister may introduce political influence in the appointment process. Cambodia could consider adopting measures to increase transparency in appointments. This could include clearly defining the selection process and establishing an independent selection panel to ensure that high-level TRC staff have relevant skills and experience. Additionally, the Ministry of Economy and Finance approves TRC's budget. This may introduce further political influence as TRC's ability to carry out its mandate depends on the ministry's decision. OECD good practice recommends safeguards to reduce potential governmental influence on regulatory budgets. These include a transparent and clearly defined process to allocate multi-annual budgets, which can be less susceptible to short-term political pressures (OECD, 2021[12]).
2. **Clarify areas of potential overlap with MPTC and TRC and consider whether TRC should receive further powers to enable it to carry out its mandate effectively**. MPTC has certain powers that could overlap with TRC's mandate. For example, MPTC has broad powers to order operators to take certain actions in "force majeure" events, which could infringe upon TRC's regulatory mandate depending on how often these powers are invoked. Cases where MPTC takes action that overlap with the mandate of the TRC should be limited. TRC should clearly have the main responsibility to regulate the communication sector; Cambodia could consider revisiting legislation to clarify this where needed. Additionally, MPTC has the power to issue fines, not TRC, which may impede TRC's ability to regulate the communication sector effectively. As an autonomous body tasked to regulate the communication sector, TRC should have the necessary tools to enforce regulation when necessary. Therefore, Cambodia should consider reviewing whether any changes to legislation are needed to enable TRC to carry out its mandate effectively (e.g. giving TRC the power to issue fines).

2.3.2. Regulatory framework

The Telecom Law is the main legislation governing the communication sector. The Law covers licensing, interconnection, quality of service, Universal Service Obligation (USO), spectrum management, tariff regulation and competition (Government of Cambodia, 2015[19]). Other laws support the communication regulatory framework on certain issues, such as the Law on Competition (Government of Cambodia, 2021[21]) and the Law on Investment (Government of Cambodia, 2021[22]).

In addition to the Telecom Law, governmental sub-decrees and ministerial Prakas provide more detailed regulation on several topics. Prakas No. 208, for example, defines approval requirements for communication equipment (MPTC, 2010[23]). Prakas No. 122 (2017) specifies further information on the licensing procedure (MPTC, 2017[24]). The Prakas on quality of service establishes certain quality requirements for operators (MPTC, 2022[25]). Sub-Decree No. 197 sets out the implementation of the USO Programme (Government of Cambodia, 2020[26]). Relevant regulations will be discussed in more detail in later sections.

In addition, according to information provided by the Cambodian authorities, an amendment of the Telecom Law and new regulations (including laws, sub-decrees and Prakas) are being drafted. However, these have not been published at the time of writing. These cover a range of important topics, such as spectrum management, consumer protection and competition in the sector, among other topics. Some of these have been explicitly noted in the "Cambodia Digital Economy and Society Policy Framework 2021-2035" (DESPF), such as those related to competition, infrastructure and spectrum management. This underscores the government's high-level commitment to define such legislation (Government of Cambodia, 2021[27]). Given the breadth of topics, much of the communication regulatory framework may change once this draft legislation and regulations come into effect.

The Telecom Law defines the licensing framework. MPTC Prakas No. 122 (2017) provides further details on the "condition and procedure for granting, modifying, transferring and revoking permits, certificates or licences" [unofficial translation] (MPTC, 2017[24]). The Telecom Law stipulates that a person should apply for a licence from TRC to: i) construct and/or provide services to use communication infrastructure and networks; ii) provide communication services; or iii) other activities defined by MPTC Prakas (Government of Cambodia, 2015[19]).

Other activities require a permit from TRC, including Internet service business or the sale or repair of communication equipment, among others (Government of Cambodia, 2015[19]). Permits for Internet service business or to sell/repair communication equipment have the shortest duration (one year) (MPTC, 2017[24]). Licences to construct or provide services to use infrastructure and networks are valid for 30 years, with a possibility of review every 10 years (MPTC, 2017[24]). Licences to provide communication services are valid for 15 years, with a possibility of review every 5 years (MPTC, 2017[24]). Fees apply to obtain licences, including an application/registration fee, an initial fee and a licence fee that is a percentage of gross income for telecommunication operation licences and renewal fees (MPTC, 2017[24]).

There seems to be a potential overlap with the Internet service business permit and the licence to provide communication services. Further legal clarity regarding when an "Internet service business" permit is required would be welcome. If the Internet service business permit is required to provide fixed communication services in Cambodia, along with the licence to provide communication services, the one-year duration for a permit is short. It also would incur annual administrative costs to renew the licence. e.

If communication operators do not comply with licence conditions, TRC may take several actions, such as obliging operators to adhere to existing or additional conditions or restricting or suspending the licence (Government of Cambodia, 2015[19]). In cases of an operator's non-compliance with the law or other related regulation, TRC may suspend or dismiss its senior leadership, or limit or stop its general activities (Government of Cambodia, 2015[19]). Certain offences may be subject to fines, which are applied by MPTC (Government of Cambodia, 2015[19]).

While the legislative framework defines licensing procedures, some implementation challenges seem to exist. As of late 2022, five operators were granted "optical cable network" licences (TRC, 2022[28]). Cambodian authorities confirmed that these are Cambodia Fibre Optic Cable Network (CFOCN), Angkor Data Infrastructure, Micromax, Telcotech and Telecom Cambodia, which are licensed to deploy fibre networks. Of these five fibre licensees, Cambodian authorities reported CFOCN, Telecom Cambodia and Telcotech as actively providing wholesale services (dark fibre, backhaul network and duct) on the market. Additionally, Cambodian authorities reported that CFOCN had 17 099 km of fibre and Telecom Cambodia had 2 180 km in 2022 (information unavailable for the other licensees).

As none of the five licensees are mobile operators, this may hinder efforts to upgrade and expand mobile networks. Fibre increasingly must be deployed deeper into networks to increase broadband performance, including for mobile networks (OECD, 2022[29]). Fibre is also needed to increase backhaul capacity, especially to support 5G networks (e.g. to connect mobile base stations). Some mobile operators mentioned challenges to obtain the appropriate licences to deploy fibre, or only obtaining a licence to connect a single base station with fibre, but not a general or "blanket" licence. It requires substantial time and resources for mobile operators to apply for a licence each time they want to deploy fibre to connect a base station and cannot be considered good practice.

In addition, the application of regulations seems to be changing according to recent local news reports. After years of no or relatively lenient enforcement measures, MPTC and TRC are now taking aggressive actions against operators not in compliance. This includes imposing fines and revoking licences. In October 2020, MPTC revoked or suspended the licences of 17 communication operators, mostly licensed as ISPs, although some provide Voice-over-Internet Protocol (VoIP) services (MPTC, 2020[30]). MPTC determined the operators were inactive, had no employees, failed to pay fees or meet other licence obligations, or submit required technical documentation (MPTC, 2020[30]).

Fibre installation, which has largely been above-ground in Cambodia, is another area where regulation has not been strict. However, according to local news sources, authorities have begun warning operators they need appropriate licences to install and maintain fibre. More drastically, authorities are cutting down overhead fibre lines to clean up installations (Turton, 2022[31]).

Enforcing regulations is a key role of any communication regulator. However, both the draft amendments in the communication sector, as well as the abrupt changes in the application and enforcement of the regulation, may introduce uncertainty for operators.

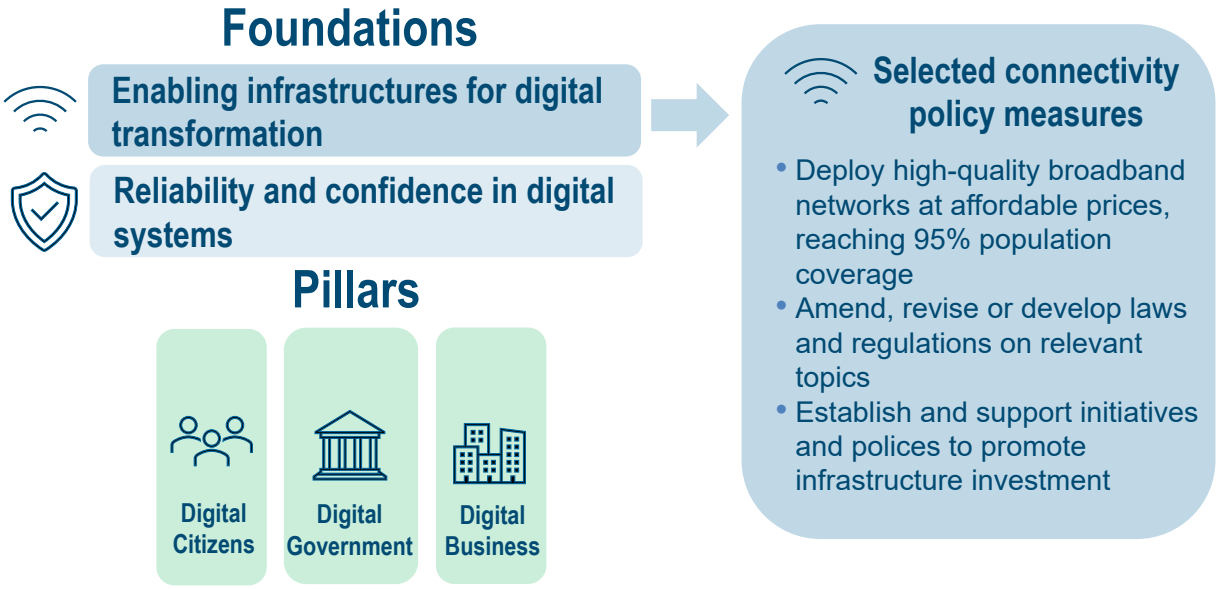
Recommendations

3. **Reduce regulatory uncertainty through active engagement with operators and clear communication on the timeline of regulatory changes.** Cambodia's communication regulatory framework is in transition. It is drafting several laws, sub-decrees and Prakas on key aspects, including competition and spectrum management, with some amendments to the Telecom Law also being planned. These are critical topics; clear regulations will support Cambodia's communication sector to clarify uncertainties in the current framework. Cambodian authorities should engage with operators to brief them about upcoming regulatory changes, as soon as possible, to lessen regulatory uncertainty and provide investment certainty. Transition periods could be established to grant operators sufficient time to bring operations into compliance.

2.3.3. Broadband strategies and plans

The Cambodian government published the "Cambodia Digital Economy and Society Policy Framework 2021-2035" (DESPF) in May 2021 (Government of Cambodia, 2021[27]). The DESPF 2021-2035 policy framework builds upon the 2016 "Telecommunication ICT Development Policy 2020" (Government of Cambodia, 2016[32]). The DESPF 2021-2035 has five components, divided into two foundations: i) developing infrastructures to enable digital transformation; and ii) building reliability and confidence in digital systems. It also has three pillars: i) digital citizens; ii) digital government; and iii) digital business (Figure 2.8) (Government of Cambodia, 2021[27]).

Figure 2.8. Cambodia Digital Economy and Society Policy Framework 2021-2035



Note: The diagram depicts only a few policy measures related to connectivity, although there are several others under the foundation "enabling infrastructures for digital transformation". These measures have been selected and summarised for reasons of space.
Source: OECD elaboration based on Cambodia (2021[27]), *Cambodia Digital Economy and Society Policy Framework,* https://mef.gov.kh/download-counter?post=7116.

Several measures relate to connectivity under the foundation, "enabling infrastructures for digital transformation" (Figure 2.8). A key goal aims to accelerate development of high-quality broadband networks at affordable prices and to reach 95% population coverage of fixed and mobile broadband infrastructure (Government of Cambodia, 2021[27]).

Further measures include amending regulations related to digital infrastructure and regulatory functions to improve competition and openness, as well as developing regulations on spectrum management, as noted above (Government of Cambodia, 2021[27]). Promoting infrastructure sharing and putting in place various initiatives and tools to promote infrastructure investment are additional goals (Government of Cambodia, 2021[27]).

The policy framework also emphasises the fundamental role of a reliable power supply for communication networks, and thus the prioritisation of affordable and reliable electricity infrastructure for strategic digital assets (Government of Cambodia, 2021[27]).

MPTC was tasked with drafting the Cambodian Digital Government Policy 2022-2035 (MPTC, 2022[33]) to further define actions to support digital government, one of the DESPF's pillars. One strategic goal relates to promoting development of digital government infrastructure, including broadband infrastructure (MPTC, 2022[33]). In addition, MPTC is drafting the "National Digital Development Policy 2030", which presumably will align with the DESPF.

2.4. Competition, investment and innovation in broadband markets

2.4.1. Competition

Cambodia's mobile market has been dynamic over the last decade, with the number of mobile operators dropping from eight to five between 2012 and the end of 2021. Now the market seems to be stabilising with roughly two market leaders, Viettel Cambodia (Metfone) and Smart Axiata. They held 41.8% and 37% market share based on mobile broadband subscriptions as of 2021, respectively, according to data from national authorities. CamGSM (Cellcard) is ranked third with 18.9% market share. South East Asia Telecom (Yes) and XinWei (Cambodia) Telecom round out the market as smaller players with 2.3% and less than 1% market share (0.002%), respectively (Figure 2.5).

According to Cambodian authorities, all mobile operators provide services mainly with their own networks. Since two players hold strong positions in the market, the Herfindahl-Hirschman index (HHI) for Cambodia's mobile market is 3 482, despite the five-player market. Therefore, although the number of operators exerts a positive competitive pressure in the market, the strong positions of Viettel Cambodia (Metfone) and Smart Axiata increase market concentration. This may, in turn, increase the risk of possible anti-competitive behaviour.

The fixed market is much more diverse. More than 30 operators offer fixed broadband services, although many of these ISPs are small. Viettel Cambodia (Metfone) holds over half of the market in terms of fixed broadband subscriptions (50.8%), followed by Smart Axiata (15.1%), King Technology (13%), EZECOM (4.7%), COGETEL (4.4%), Cambodian Singmeng Telemedia (4%), NeocomISP Ltd (1.2%) and Telecom Cambodia (1%). Several other providers split the remaining 5.8% of the market (Figure 2.6). Largely driven by Viettel Cambodia's (Metfone) substantial market share, the HHI for Cambodia's fixed market is 3 041 based on these market shares. Compared to the mobile market, Cambodia's fixed market is slightly less concentrated overall in terms of HHI. Several operators compete at the retail level, although Viettel Cambodia (Metfone) holds half the market.

As competition can be an effective lever to lower prices, retail prices can also be an indicator of the competitiveness of the retail market. From this perspective, competition in the retail mobile market seems to have been sufficient to lower prices to below regional averages. For entry-level mobile broadband services, Cambodia's 2022 prices were at USD PPP 11.0, third lowest in the region and below the regional average of USD PPP 15.5 (ITU, 2023[10]).

The retail fixed market also seems to have benefitted from competitive pressure on prices. For entry-level fixed services, Cambodia's prices are the second lowest in the region at USD PPP 41.1 in 2022, compared to the regional average of USD PPP 51.6 (ITU, 2023[10]). This suggests a positive competitive pressure from the several players in the fixed retail market. Nevertheless, as noted below, despite retail prices being lower than regional averages, some people in the country may not be able to afford services (see Figure 2.12).

On the fixed side, competition seems to be primarily taking place at the retail level. According to Cambodian authorities, all operators except one, Telecom Cambodia, provide their services mainly over third-party infrastructure. However, Telecom Cambodia only holds 1% of the fixed market share. This suggests it focuses on the wholesale market rather than on the retail market.

Consequently, there is strong competition for services at the retail level, but not for end-to-end infrastructure. As noted, Telecom Cambodia is the only operator providing services mainly with its own network. The lack of infrastructure-based competition in the fixed broadband market seems to have resulted in a significant shortfall in infrastructure investment in fixed networks. This has had two consequences. First, operators report that coverage of fixed broadband networks is concentrated in densely populated areas, suggesting low national coverage (see Broadband deployment section). Second, quality of services offered to end-users is low (see Quality of networks section). Promoting infrastructure competition is therefore key to improving the performance of fixed networks, boosting investment and thus the extension and improvement of network quality.

Considering the wholesale market in the country, according to Cambodian authorities, three operators provide hosting services on passive infrastructure (towers and masts): Camtower Link Communication, Edotco and Global Tower Corporation. Cambodian authorities further report that Telecom Cambodia, CFOCN and Telcotech offer wholesale services, including dark fibre products, backhaul network access and duct access. While not mentioned as offering wholesale services by national authorities currently, Angkor Data Infrastructure and Micromax are also licensed to deploy fibre infrastructure and therefore could offer wholesale services in the future. This could increase the supply and capacity of wholesale networks. Quantitative data on the wholesale market share of these operators are not available. However, informational interviews suggest that CFOCN is a prominent player in this market.

While wholesale offers exist, operators seem concerned about the price of such services and the insufficient supply in both mobile and fixed retail markets, but especially for fixed wholesale offers. There seems to be only a few wholesale offers, with many retail operators vying to contract wholesale services. This includes last mile for fixed networks, as many operators offer services mainly over third-party networks.

Competition in the communication sector is primarily governed through two laws. The 2021 Law on Competition is the overarching competition legislation across the economy and the 2015 Telecom Law is the sectorial regulation that contains certain competition provisions.

The Law on Competition, enacted in 2021, has a broad jurisdiction to uphold competition across the Cambodian economy (Government of Cambodia, 2021[21]). It regulates any activity that inhibits, limits or distorts competition (Government of Cambodia, 2021[21]). These regulations fall into three main categories: i) anti-competitive agreements (horizontal or vertical agreements); ii) abuses of a dominant position; and iii) anti-competitive mergers (Government of Cambodia, 2021[21]). However, the Law on Competition does not address its applicability to state-owned entities, such as Telecom Cambodia, although a broad interpretation would include it (Government of Cambodia, 2021[21]).[4] More legal clarity in this regard would be welcome.

Furthermore, the 2021 Law on Competition establishes a new body, the Cambodian Competition Commission (CCC). The CCC is under the jurisdiction of the Ministry of Commerce with the remit to uphold competition (Government of Cambodia, 2021[21]). Hosting the CCC under this ministry is generally not considered best practice as it limits the independence of the competition authority.

Given the cross-cutting aspect of competition, the CCC interacts with other relevant ministries and agencies in their areas of competence. For example, an MPTC representative acts as a member of the CCC, along with other representatives from other competent ministries. In addition, TRC interacts with the CCC. TRC monitors and evaluates the state of competition in the communication sector (Government of Cambodia, 2015[19]). As the broad competition authority, the CCC works with TRC in matters related to the communication sector. Either TRC or the CCC can raise competition violations in the communication sector, and they can jointly rule on these violations. However, an additional Prakas is being drafted under the Telecom Law. This is expected to provide further details on co-operation between the two bodies.

The Telecom Law requires all operators to adhere to the principle of fair competition and prohibits anti-competitive behaviour in the communication sector (Art. 61) (Government of Cambodia, 2015[19]). It further requires operators to interconnect; provide infrastructure and services; and allow shared use of networks, infrastructure and equipment, upon request and agreement (Art. 31-32) (Government of Cambodia, 2015[19]).

Agreements between operators for interconnection, use of infrastructure or services, or infrastructure sharing, should be on a non-discriminatory basis and at an affordable price (Government of Cambodia, 2015[19]). Indeed, discrimination or refusal to provide communication services to another communication operator without just cause is considered an abuse against free and fair competition (Art. 62) (Government of Cambodia, 2015[19]). In case operators cannot reach an agreement, TRC will mediate and decide on the agreement terms (Government of Cambodia, 2015[19]).

In addition to the competition provisions in the Telecom Law, Prakas 232 sets a price floor for off-net calls. This incorporates a termination charge, transit fee and a so-called "regulator fee". Presumably, this intends to avoid unhealthy competition on price (e.g. where prices are set below the cost base) (Ministry of Economy and Finance and Ministry of Post and Telecommunications, 2009[34]).

The "regulator fee" mentioned in the Prakas is in addition to termination charges and transit fees. If these charges are passed on to consumers, they may artificially increase the price of voice services and decrease affordability. Given that Prakas 232 was passed in 2009 and focuses primarily on voice calling, it may be outdated, and its overall utility and impact should be reassessed.

On mergers and acquisitions, the Telecom Law outlines broad requirements, namely that TRC approval is required (Art. 63) (Government of Cambodia, 2015[19]). Sub-Decree No. 60, issued in March 2023, further defined the procedures for any business merger or acquisition that may impact competition in the country at a broader level (Government of Cambodia, 2023[35]). It stipulates that any business combination above a certain threshold must notify the CCC and receive approval. This may be tacit, if the CCC does not request further information or require a second review before the consolidation (Government of Cambodia, 2023[35]).

Mergers involving communication operators would fall under the "general merger classification" (Ministry of Commerce, 2023[36]). If any of the merging entities in the prior financial year had figures above certain thresholds, then the merging parties must notify the CCC and await its response before undertaking the merger (Ministry of Commerce, 2023[36]).[5] Presumably, then, any merger in the communication sector above these thresholds would have to obtain approval from both TRC and the CCC. The legislation does not clearly define how this would work in practice and which body takes precedence in case of disagreement.

Building upon these provisions in the Telecom Law, MPTC is drafting a Prakas on competition. This is expected to clarify the classification of an operator with Significant Market Power (SMP) and the evaluation of dominance in the communication sector. This Prakas had not been passed at the time of writing. Under the current framework, there are no regulatory tools related to functional or structural separation of incumbent or SMP players.

As evidenced by recent and planned legislative action, Cambodia is seeking to strengthen the competition regulatory framework. The 2021 Law on Competition and the newly-established CCC put in place a robust framework to consider competition across the economy. However, while the mobile and especially fixed retail markets have several players, those with strong market shares may limit the overall level of competition. The Prakas being drafted on competition to define regulatory aspects may help in this regard. Early indications suggest beneficial changes (e.g. to clarify the determination of an SMP operator). Defining other *ex ante* regulatory tools, which TRC could apply to regulate SMP or dominant operators, may also be useful. This could include asymmetric wholesale access obligations. Further, the Prakas being

drafted is expected to clarify how TRC and the CCC will interact on competition issues occurring in the sector. This would also be welcome to define each body's role and how they will co-ordinate.

Recommendations

4. **Leverage the ongoing legislative processes to define SMP regulation and clarify the roles of TRC and the CCC on competition matters in the communication sector**. Cambodia is developing regulation on several topics, including a Prakas that is expected to clarify competition aspects. This Prakas could define the assessment criteria to define whether an operator has SMP. This will be an important component of Cambodia's competitive framework, especially considering the strong position of certain players (e.g. Viettel Cambodia in the fixed retail market). It would also be beneficial for the regulation to clarify the interaction between, and mandates of, the CCC and TRC regarding competition in the communication sector (e.g. on mergers). In addition, MPTC could consider whether to include additional tools to regulate SMP in the Prakas (e.g. asymmetrical wholesale access obligations, the possibility to mandate functional/structural separation).
5. **Undertake competition assessments once the Prakas on competition aspects comes into effect.** There are strong players in both the retail fixed and mobile markets in terms of market share. Once the Prakas on competition comes into effect (which is expected to include SMP designation), competition analyses could identify evidence of any operator with SMP and the need to apply any *ex ante* regulation on any operators designated with SMP.
6. **Consider fostering the wholesale market and monitoring wholesale prices.** Wholesale supply has been reported to be low, especially for fixed wholesale services. Cambodia could consider fostering entry and competition in the wholesale market, including by providing necessary licences to any eligible operator wishing to offer wholesale services. As wholesale prices may be high, Cambodia could regularly assess the wholesale market, including geographic segmentation and whether capacity meets demand, and monitor prices for wholesale services. Based on this assessment, Cambodian authorities could consider *ex ante* regulatory remedies. Such measures should be designed to ensure a level playing field and encourage new entrants to the market and the deployment of wholesale network infrastructure and services, without discouraging investment.

2.4.2. Investment

Sufficient investment in high-quality communication networks is a necessary and critical component to meet connectivity goals. Cambodia's regulatory framework has several measures to promote investment. One of its most distinctive features is its lack of foreign capital or ownership restrictions. The Telecom Law does not restrict who may apply for licences, allowing foreign companies to enter the market freely. The Law on Investment prohibits discrimination against foreign investors based on their nationality but has restrictions on land ownership (Chapter 5) (Government of Cambodia, 2021[22]). In state-owned entities such as Telecom Cambodia, the state must own, directly or indirectly, at least 51% of capital or voting rights (OECD, 2022[37]; Government of Cambodia, 1996[38]). Despite these few limitations, this framework has greatly benefitted the communication sector by allowing the entry of foreign players. In fact, foreign communication operators occupy a large share of the market. Viettel Cambodia (Metfone) and Smart Axiata are both foreign-owned operators, as noted above. They rank in the top two in both the fixed and mobile markets based on market shares in terms of subscriptions (see Figure 2.5 and Figure 2.6).

In addition to the openness of the market to foreign players, the Telecom Law also has measures to facilitate and promote infrastructure sharing, which may help lower costs of infrastructure investment. For example, Art. 32 directs network operators to allow the shared use of infrastructure, network and equipment with other operators (Government of Cambodia, 2015[19]). Private operators can negotiate sharing agreements directly and must inform TRC once an agreement has been reached. According to Cambodian authorities, infrastructure sharing of passive elements is most common in Cambodia and active infrastructure sharing is yet to be seen.

In addition, fixed network operators can invest jointly in network infrastructure (co-investment). Although not set out in the Telecom Law, according to Cambodian authorities the government may mandate fixed operators to jointly invest to deploy network infrastructure according to terms agreed between the operators. In 2020, MPTC asked TRC to explore the option of joint investment for deployment of 5G networks (Chan, 2020[39]).

However, despite these regulatory measures, investment in communication networks in Cambodia is low. Total investment numbers from the International Telecommunication Union (ITU) for mobile and fixed networks reported a 66% decline over 2016-21 (see Figure 2.7) (ITU, 2023[10]). Considering investment in mobile networks in particular, mobile network investment (Capex) in Cambodia has been relatively stable, with an 16% growth rate over 2013-22 (GSMA Intelligence, 2023[12]). However, Cambodia's 2022 mobile investment (Capex) in nominal terms (USD 155 million) was lower than the regional average (USD 1 billion) and the third lowest in the region (GSMA Intelligence, 2023[12]).

In contrast, both sources report revenues growing at a positive rate. Total revenues from both mobile and fixed markets grew 15% over 2018-21 (ITU, 2023[10]). Mobile revenues grew 42% over 2013-22 (GSMA Intelligence, 2023[12]). Positive revenue growth should help fuel investments, but investments do not seem to be keeping pace.

These low levels of investment may stem from several causes:

First, fees levied on operators may hinder investment. Operators must pay fees to obtain licences (application/registration fee, initial fee, a licence fee [which may be set as a percentage of annual gross income], renewal fee, fees for additional service and other fees as determined by TRC) (MPTC, 2017[24]). In addition, operators must contribute to USO (2% of gross annual revenues) and the capacity building, research and development (CBRD) fund (1% of annual revenues) (Government of Cambodia, 2015[19]). According to Cambodian authorities, communication operators also must pay a percentage of their annual gross revenue according to their respective licensed operations, called a "revenue share". Spectrum and numbering fees also apply.

These fees may place a burden on investment. Contributions to the USO and CBRD funds together account for 3% of annual revenues, even without counting the other fees, including the percentage-based "revenue share". In addition, according to local news, MPTC conducted audits in 2021 and concluded some operators had miscalculated their percentage-based fee contributions (Khmer Times, 2021[40]). Those operators with insufficient contributions were required to pay the remaining balance, as well as compounded interest over the years in which contributions were miscalculated. For some operators, this could result in a substantial amount due, which may delay any investments in the near term.

Second, the level of investment may be impeded by implementation of the licensing framework. As noted above, operators have pointed to delays in receiving the required licences to install and deploy fibre in the country. In addition, operators note requirements to obtain individual licences to connect one base station with fibre at a time instead of a general license. This increases operators' administrative burden and likely delays deployment plans. These are clear barriers to investment. Operators wanting to install and deploy these networks should be able to obtain the required licences quickly.

Third, operators' uncertainty over application of regulation may also hinder investment decisions. For example, the regulation of fibre installation seems to be changing. Local news sources report Cambodian

authorities cutting down overhead fibre lines to clean up installations (Turton, 2022[31]). These moves are likely motivated by aims to organise overhead fibre lines. However, cutting them down represents a sunk investment cost for operators. This may hinder investment if operators fear their fibre lines will be cut before they can recoup investment. Therefore, a clear regulatory framework and application would be conducive to investment and give operators more certainty. This could include, for instance, clear requirements on how and where to build fibre, preferably in consultation with industry and considering local market conditions.

Recommendations

7. **Assess the impact the level of fees may have on operators' investment decisions.** To further strengthen its regulatory framework to foster investment, Cambodia could assess the level of fees applying to communication operators. It could ensure fees are reasonable, do not hinder investment, nor result in operators passing on fees to consumers to meet operators' financial obligations. When enforcing adherence to the regulatory framework to pay fees, authorities should consider the potential impact on investment. For instance, longer periods to pay fines may allow operators to meet their mandatory financial obligations while still making it possible for them to invest.
8. **Support investment through expedient licensing processes**. Delays to receive needed licences pose an unnecessary but real barrier to investment. In cases where licences are required to install or deploy infrastructure, for instance to deploy and maintain fibre, TRC should provide the required licences to all interested operators meeting required criteria on a non-discriminatory and timely basis. Further, TRC could consider decreasing administrative barriers, such as by providing a general licence to lay fibre to support mobile networks. Licences terms can clearly specify for what purposes this fibre can be laid and where.
9. **Apply regulation impartially and clearly communicate upcoming changes to industry**. In cases where regulatory approaches may be changing (e.g. regarding fibre installation), authorities should clearly communicate their plans to industry and discuss how to balance regulatory objectives with operator's costs and investment plans. Additionally, the regulatory framework should be applied consistently and impartially to all market players. Clear instructions on how and where to build fibre would provide clarity to market players. Such actions would be conducive to investment.

2.4.3. Innovation

Innovation can expand end-user choice through the introduction of new technologies and services in the market. Cambodia's 5G deployment can shed some light on the ease of introducing new technologies and services. CamGSM(Cellcard), Smart Axiata and Viettel Cambodia (Metfone) all launched trials in 2019, and South East Asia Telecom (Yes) launched a trial in 2020 (Cellcard, 2019[41]; Smart Axiata, 2019[42]; Viettel, 2019[43]; Vannak, 2020[44]).

Thus, the four biggest mobile operators in the country have shown interest in testing new 5G services, presumably for future 5G network deployment. However, despite these successful trials, news outlets report TRC later withdrew the licences used to test 5G services, expressing concerns over "inefficiency" if all operators deployed their own 5G networks (Barton, 2021[45]).

Furthermore, the government has not yet released its 5G plans at the time of writing, including on spectrum release, which is stalling deployment progress. In addition, operators seem to be delaying their 5G deployment plans until they receive appropriate licences to operate 5G networks and hear further information from the government. At the time of writing, no commercial 5G services were available in the country.

The government should announce its 5G policy and spectrum release plans in the short term to provide clarity to operators considering their 5G deployment plan. They should also provide the necessary licences (e.g. 5G licences) to facilitate deployment of new technologies and services.

Despite the 5G delays, aspects of the regulatory framework in Cambodia seek to promote innovation. As noted above, TRC assigned licences to the four mobile operators to test 5G services, although these licences were later withdrawn (Barton, 2021[45]). Granting trial licences enables innovation by allowing operators to test new services in a relatively risk-free environment. In this case, the stated reason for TRC's withdrawal of the 5G trial licences relate more to investment and deployment decisions, which are normally for the operators to decide. Moving forward, TRC should continue to issue trial licences to operators wanting to test new technologies and services and allow operators to make their own decisions regarding their deployment.

The Telecom Law, in addition, establishes the CBRD Fund to promote capacity building and research and development (R&D) in the communication sector (Art. 43-46) (Government of Cambodia, 2015[19]). MPTC supervises and evaluates the fund's activities, which are sponsored by operator contributions (1% of annual gross revenues) (Government of Cambodia, 2015[19]). The fund seeks to build infrastructure and promote R&D to support innovation in the sector, providing ICT skills training and sponsoring programmes to foster R&D and entrepreneurship (Government of Cambodia, 2020[46]). Operators can apply to receive up to 20% of their contributions for projects that support the CBRD Fund's objectives (Government of Cambodia, 2020[46]). According to local news sources, in 2017 the fund raised USD 4.5 million to support capacity building and training projects, as well as for research projects on topics such as Internet of Things, data science and Khmer language processing (Chan, 2018[47]). Other projects through the fund focused on building infrastructure for R&D in the information and communications technology sector, including the establishment of laboratories (Chan, 2018[47]).

The effectiveness of the CBRD Fund should be monitored to ensure it meets the stated objectives. Cambodia should only collect fees from industry that are necessary to perform innovation activities efficiently. The benefits should also be weighed against the financial contributions levied on operators and their potential impact on investment decisions, a key ingredient to deploy innovative new technologies and solutions.

Apart from funding to support R&D, the regulatory framework itself can foster innovation by adopting a technology-neutral approach. Such an approach focuses on outcomes rather than on technologies for regulations, licences and policies. In this way, it allows new and non-traditional solutions to emerge. In Cambodia, the regulatory framework is often not technology-neutral. For instance, spectrum licences and licences to offer services are often tied to a certain technology. However, the USO Programme technically adopts a technology-neutral approach by focusing on broad outcome-based targets without specifying technologies (Government of Cambodia, 2020[26]).

Recommendation

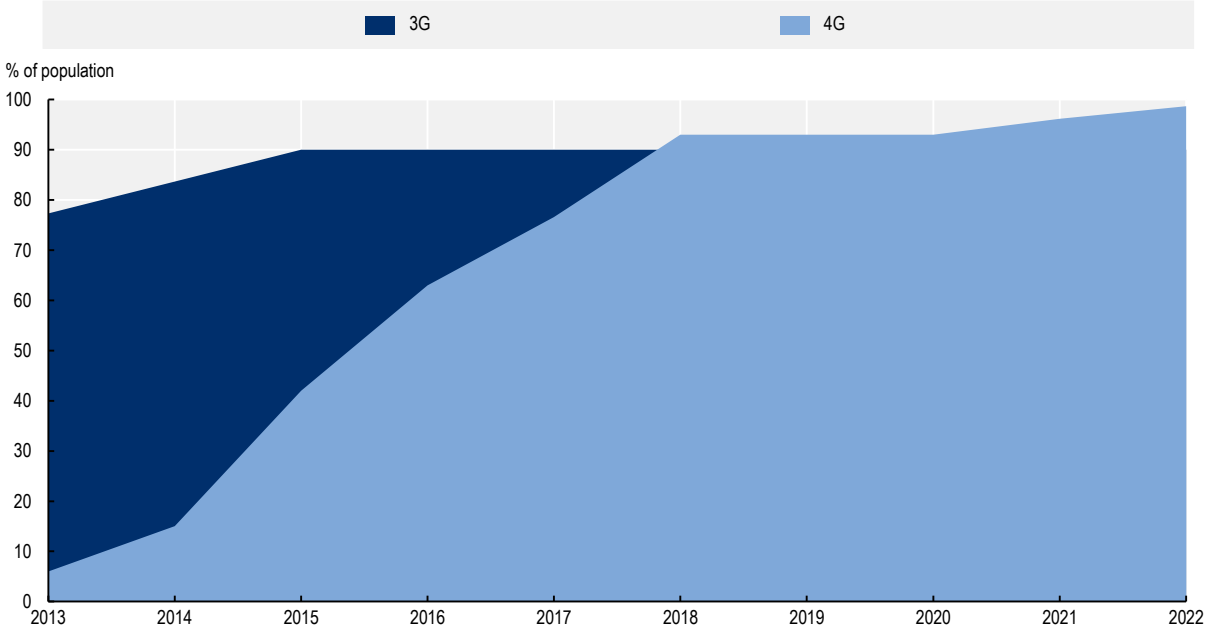
10. **Support industrial efforts to deploy 5G networks.** TRC should issue licences to operate 5G networks to eligible operators as soon as possible. In addition, the government's delays to outline its plans to assign additional spectrum for 5G creates disincentives for operators to invest in 5G. To support operators' deployment plans, the government should quickly issue its spectrum release plans and provide more information to operators on its 5G plans (e.g. roadmap/policy). More generally, and to support future innovation, TRC should continue to issue trial licences to help operators test new technologies and services.

2.5. Broadband deployment and digital divides

2.5.1. Broadband deployment

For mobile broadband, a combination of factors such as initially high levels of competition and the country's relatively flat geography has favoured extensive 3G and 4G network coverage. 3G networks reached their maximum coverage of 90% of the population in 2015 (GSMA Intelligence, 2023[12]). 4G networks, launched in 2013, reached 93% of the population in five years by 2018, and 99% of the population by 2022 (GSMA Intelligence, 2023[12]) (Figure 2.9). As mentioned above, 5G technology has not yet been deployed in Cambodia.

Figure 2.9. Mobile broadband coverage, 2013-22



Source: GSMA Intelligence (2023[12]), *Database (2023)*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/nexgsm

In terms of backbone/long-haul networks, Cambodia has 59 702 km (route km) of fibre from Telecom Cambodia, CFOCN (HyalRoute), Telcotech, Viettel Cambodia and the Greater Mekong Subregion IHN (ITU, 2023[48]).[6] Cambodia's backbone network coverage is among the best in SEA, second only to Singapore, with 54% of the population within 10 km of a node (SEA average 43%). The network is not overly dense; high coverage may be explained by the high concentration of the population in urban areas and low population density outside these areas.

In almost all backbone links, at least three different operator cables share the same route, and in many cases, four or even five. This contrasts with the secondary branches of the backbone network that do not mesh with each other and are also usually implemented by a single operator: CFOCN (HyalRoute) (ITU, 2023[48]). This seems to confirm the prominent role of CFOCN in the backbone segment to reach the secondary population centres, which operators also mentioned in informational interviews.

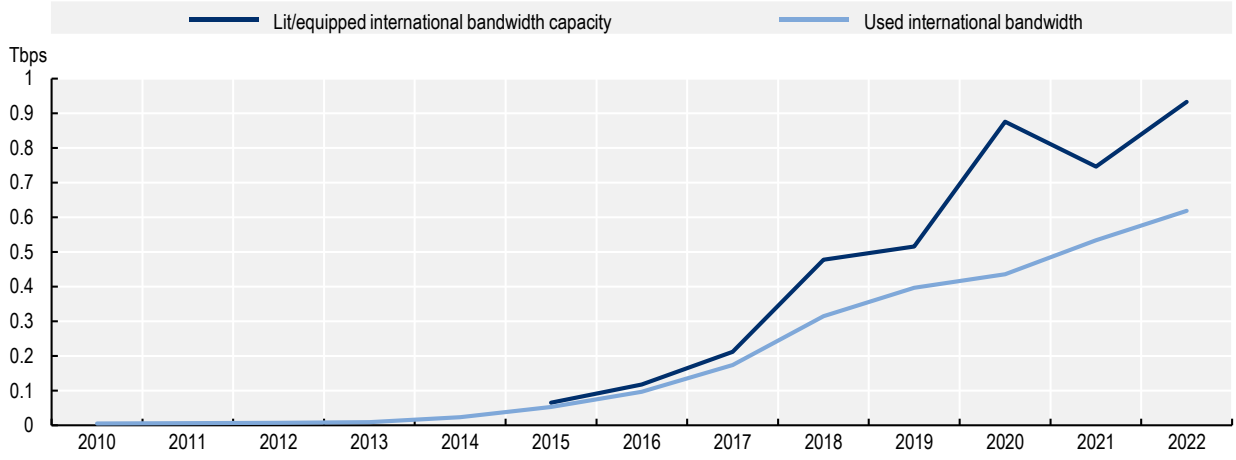
However, Cambodia's surplus of backbone infrastructure contrasts with the limited availability of backhaul networks to connect high-quality broadband access networks (e.g. FTTH, 4G/5G). Moreover, operators report difficulties obtaining licences to deploy networks, creating additional barriers to expanding and upgrading their networks.

On the other hand, operators report some shortcomings in the wholesale market. These shortcomings include a lack of capacity, limited availability of backhaul networks, high prices of wholesale products and poor quality of wholesale services.

These wholesale market failures can hurt downstream broadband networks and services. Cost overruns can reduce the affordability of services and hinder the building and upgrade access networks. This is especially true in areas with low or limited profitability, such as rural areas. This, in turn, may contribute to widening the digital divide. Therefore, it is crucial to address these wholesale inefficiencies decisively by taking measures to ensure a level playing field and incentivise investment (see recommendations).

In terms of international connectivity, as of 2022 Cambodia had an equipped bandwidth capacity of 0.9 terabits per second (Tbps) (Figure 2.10) (ITU, 2023[10]). At this level, Cambodia is the third lowest in the region, above only Brunei Darussalam (0.5 Tbps) and Laos (0.2 Tbps) (ITU, 2023[10]). Since 2015, international connectivity capacity was scaled up to meet the expected increase in Internet traffic demand from users of newly deployed 4G networks. The data show that international bandwidth usage indeed increased significantly over these years. In 2022, it reached 0.6 Tbps, two-thirds (66%) of the equipped capacity (Figure 2.10) (ITU, 2023[10]).

Figure 2.10. International bandwidth, 2010-22



Note: Lit/equipped international bandwidth capacity refers to the total lit capacity of international links, namely fibre-optic cables, international radio links and satellite uplinks to orbital satellites in the end of the reference year (expressed in Mbit/s). If the traffic is asymmetric (i.e., different incoming and outgoing traffic), then the highest value out of the two should be provided. Average usage of all international links, including optical fibre cables, radio links and traffic processed by satellite ground stations and teleports to orbital satellites (expressed in Mbit/s). The average is calculated over the twelve-month period of the reference year. If the traffic is asymmetric (i.e. different incoming and outgoing traffic), then the highest value out of the two should be provided. All international links used by all types of operators, namely fixed, mobile and satellite operators should be taken into account. The combined average usage of all international links can be reported as the sum of the average usage of each link (ITU, 2020[11]).
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023),* www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/ylgzvc

Cambodia is connected to two submarine cable systems. The long-distance Asia-Africa-Europe-1 (AAE-1) connects the country to south and west Asia, north Africa, and south and west Europe (Table 2.3) and Table 2.3). For its part, the regional Malaysia-Cambodia-Thailand (MCT) cable system connects it within the region (Table 2.2).

Of the non-landlocked countries in the region, Cambodia is connected to the least number of submarine cables with 2. It is behind other mainland SEA countries such as Malaysia (25 cables), Thailand (13), Viet Nam (7) and Myanmar (5). Cambodia is connected to Malaysia, Myanmar, Thailand and Viet Nam, but not to Singapore, one of the main international connectivity hubs in the region (Table 2.2). However, a direct submarine cable between Cambodia and Hong Kong, China, the other major hub in the region, is being developed to improve international connectivity through this node. It is expected to come into service in 2024 (Khmer Times, 2023[49]).

Table 2.2. Cambodia's connections to other SEA countries via submarine cables

Cable system	Brunei Darussalam	Indonesia	Lao People's Democratic Republic	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
Asia-Africa-Europe-1 (AAE-1)				x	x			x	x
Malaysia-Cambodia-Thailand (MCT) Cable				x				x	

Source: OECD elaboration from TeleGeography (2023[50]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

Table 2.3. Cambodia's connections with other regions via submarine cables

Cable system	Northern Africa	Sub-Saharan Africa	North America	Eastern Asia	Southern Asia	Western Asia	Northern Europe	Southern Europe	Western Europe	Australia and New Zealand	Micronesia
Asia-Africa-Europe-1 (AAE-1)	x			x	x	x		x	x		

Source: OECD elaboration from TeleGeography (2023[50]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

In addition to submarine cables, Cambodia also has international terrestrial connectivity to its neighbouring countries (Lao PDR, Thailand, Viet Nam) via terrestrial fibre networks (operated by Telecom Cambodia, CFOCN, Telcotech and Viettel), as well as through the Greater Mekong Subregional Information Superhighway (GMS IS) (ITU, 2023[48]). The GMS IS planned to provide international terrestrial fibre connectivity to link Cambodia, the People's Republic of China (Yunnan Province), Lao PDR, Myanmar, Thailand and Viet Nam (ADB, 2005[51]).

According to Packet Clearing House, Cambodia has one active Internet exchange point, the Cambodian Network Exchange (CNX) (Table 2.4) (PCH, 2023[52]). CNX handles the most traffic and has three peering nodes in Phnom Penh. CNX is a subsidiary of an ISP (Sabay Digital Corporation Ltd), and claims to be a non-profit, open and neutral Internet exchange (Cambodian Network Exchange, 2023[53]). This traffic exchange infrastructure appears to be performing relatively well to handle the growing Internet traffic in Cambodia (as shown by international bandwidth usage in Figure 2.10). Quality indicators such as median fixed and mobile broadband latency (5 ms and 23 ms, respectively) are near the region's median and above the global performance (July 2023) (Ookla, 2023[54]).

Table 2.4. Internet exchange points, 2023

Name	City
Cambodian Network Exchange	Phnom Penh

Source: PCH (2023[52]), *Internet Exchange Directory*, www.pch.net/ixp/dir (accessed 5 December 2023).

In 2021, the government enacted a sub-decree to establish the National Internet Gateway (NIG) (Government of Cambodia, 2021[55]). The NIG would consist of the Domestic Internet Exchange (DIX) for the exchange of domestic Internet data, and the International Internet Gateway (IIG) for the exchange of Internet data both domestically and internationally (Art. 4) (Government of Cambodia, 2021[55]). The NIG would be operated in at least three locations (Phnom Penh, Poipet Municipality and Bavet Municipality) (Art. 4) by "NIG Operators", which would be determined by the Government in accordance with MPTC's request (Art. 5) (Government of Cambodia, 2021[55]).

ISPs and "concerned persons" (defined as "telecommunication services operators, content service providers, associations and other relevant institutions that connect and exchange data with each other through Internet gateway, either directly or indirectly") should establish connection and/or set up peering of their networks with the DIX (Art. 7) (Government of Cambodia, 2021[55]). Operators who are "licensed to operate International Telecommunications Gateway, Submarine Cable Landing Stations, or Satellite Ground Stations providing services in the Kingdom of Cambodia" should route their connections to the NIG (Art. 8) (Government of Cambodia, 2021[55]).

Interface fees and other costs for the Internet connections in a form of transiting or peering through the NIG would be charged based on the number, type and bandwidth of the interface. This would be determined by the joint Prakas between the MPTC Minister and the Minister of Economy and Finance (Art. 11) (Government of Cambodia, 2021[55]). In February 2022, MPTC announced that NIG operations had been postponed "due to the disruption caused by the spread of the COVID-19 pandemic" (Comms Update, 2022[56]), which is a welcome development.

Mandatory funnelling of all traffic through the NIG and the requirement of paid interconnection to transit of peers is unlikely to benefit the quality or affordability of communication services. It could also lead to deterioration in the resilience of communication services in Cambodia, as the NIG would become a single point of failure for Internet traffic exchange at the national level. In addition, across OECD countries, IXP interconnection is not regulated, and the establishment of a national Internet gateway is not standard practice.

2.5.2. Digital divides

Despite positive developments in mobile broadband penetration, Internet usage is among the lowest in the region (60% of individuals, only above the Philippines and Myanmar, 2021) (ITU, 2023[10]). There are also significant differences or divides depending on several factors. The geographical divide between urban and rural areas in terms of the population using the Internet is ten percentage points (30% in rural areas compared to 40% in urban areas as of 2017) (ITU, 2023[10]). However, the age gap is much wider than the geographical divide in Cambodia. While 86% of those aged 15-24 use the Internet, only 40% of those aged 25-74 do so. The percentage drops to 4.5% for those aged 75 and over (2016) (ITU, 2023[10]). The differences in Internet usage are much less pronounced by gender, with a one percentage point difference in favour of men (2019) (ITU, 2023[10]).

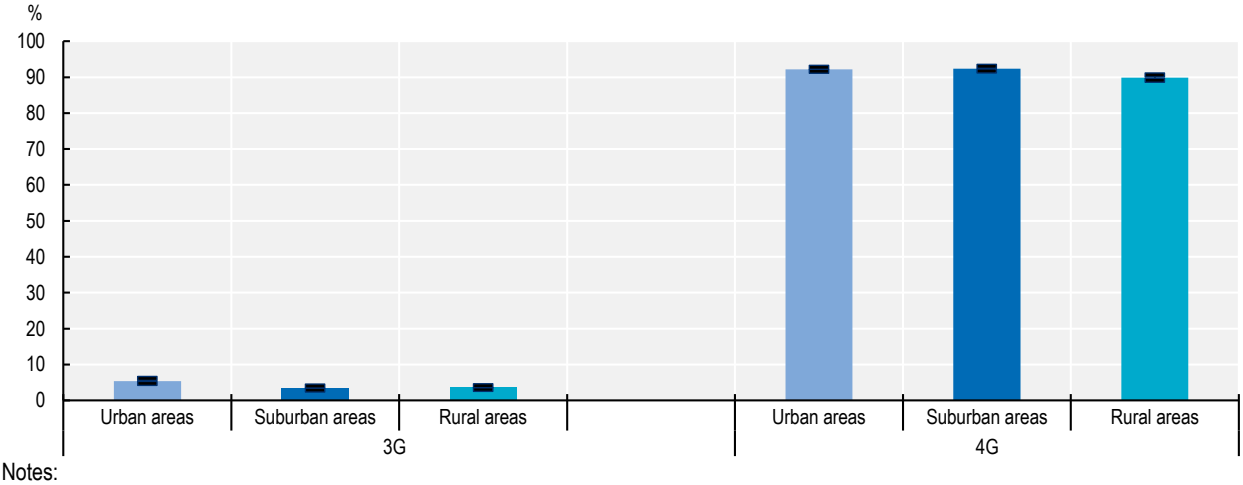
There are several reasons behind these divides. Looking further at the supply-side reasons, mobile broadband mobile network availability, understood as the proportion of time users have a 3G and 4G connection (Opensignal, 2023[57]), shows high values and little difference between urban, suburban and rural areas. According to Opensignal, 4G network availability in rural areas was 89.9%, only 2.3 percentage points lower than in urban areas (92.2%) (December 2022 - February 2023) (Figure 2.11) (Opensignal,

2023[58]).[7] Despite the high level of mobile network availability, the lower quality of mobile broadband services in rural areas may contribute to the geographical divide (Figure 2.13).

On the other hand, operators report that high-quality networks are mainly deployed in densely populated areas, and Cambodian authorities also recognise that Internet infrastructure is more widely available in large cities and towns, so strengthening digital connectivity is a priority to enable digital transformation (Government of Cambodia, 2021[27]).

In any case, any lack of coverage, availability or quality of broadband networks in Cambodia's rural areas has a significant impact, given that about 99% of the land mass is classified as "rural" (the second highest percentage in the region only surpassed by Lao PDR) (2015) (European Commission, Joint Research Centre, 2015[8]). In all, 51.6% of the population lives in rural areas (2015) (European Commission, Joint Research Centre, 2015[8]).

Figure 2.11. Network availability, percentage of time (3G, 4G), December 2022 – February 2023



Notes:
1. Data was collected by Opensignal from its users over 90 days (1 December 2022–28 February 2023).
2. 3G availability shows the proportion of time that all Opensignal users had a 3G connection. 4G availability shows the proportion of time Opensignal users with a 4G device and a 4G subscription – but have never connected to 5G – had a 4G connection. (Opensignal, 2023[57]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[59]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[60]).
Source: © Opensignal Limited - All rights reserved (2023[58]), http://www.opensignal.com.

StatLink https://stat.link/lkpfit

In terms of affordability as a demand-side driver, broadband prices relative to income levels in Cambodia, in terms of percentage of gross national income (GNI) per capita, are among the highest in the region. Mobile broadband prices on this metric are the second highest in the region after Lao PDR, 3.1% of GNI per capita (2022) (ITU, 2023[10]). Meanwhile, fixed broadband prices are second highest only to Myanmar, 11.6% of GNI per capita (2022) (ITU, 2023[10]). Despite the sharp decline between 2010 and 2013, fixed broadband prices have remained at around 10% of GNI per capita. This is well above the 2% affordability target (Figure 2.12).

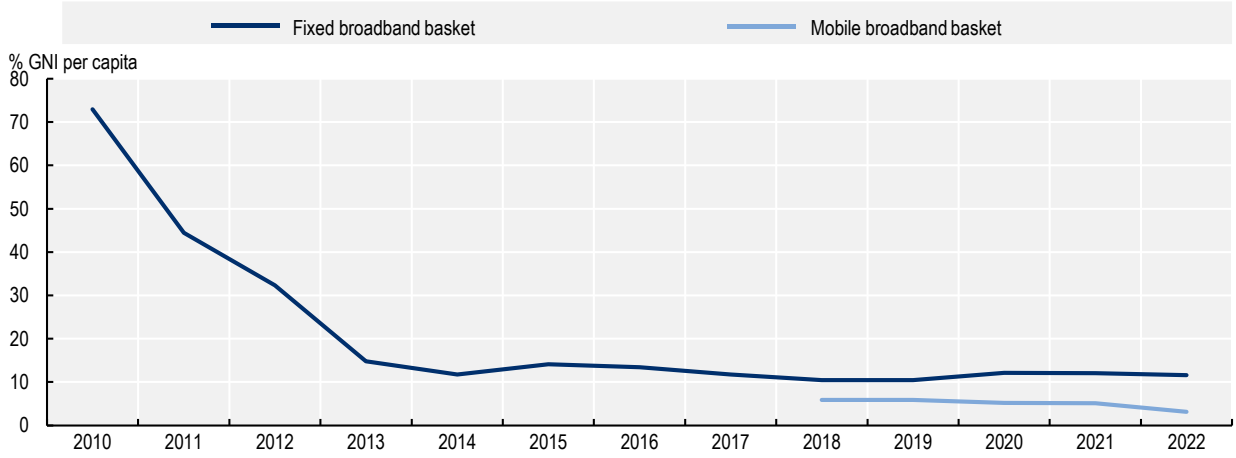
Mobile handset prices are also high relative to income levels in Cambodia. According to Tarifica, the reference price of a handset with Internet-browsing capability is USD 29 (nominal prices) (2022) (Tarifica, 2023[61]).[8] This represents 20.8% of average monthly income, the highest percentage among countries surveyed in this study. This percentage is three times that of Indonesia and up to 53 times that of Singapore.

Certain taxes apply to communication services and devices, which may contribute to their low affordability. First, the standard value-added tax (VAT) of 10% applies to all communication devices and services (Art. 65) (Government of Cambodia, 2023[62]). Second, a specific tax also applies to communication services (Art. 88) (Government of Cambodia, 2023[62]), which is set at 3% on "local and international telecommunication services" (VDB Loi, 2022[63]).

This additional specific tax levied on communication services further increases the prices paid by customers. It thus contributes to the high cost relative to national incomes. Moreover, it hinders affordability for a service that has positive spill-over effects to other sectors of the economy. Existing price regulation from 2009 (Prakas 232) on voice telephony sets minimum prices. This presumably aims to avoid unhealthy price competition (Ministry of Economy and Finance and Ministry of Post and Telecommunications, 2009[34]). However, it can be counterproductive for affordability.

Nevertheless, this low affordability does not seem to have affected the uptake of broadband mobile services, which is above average for the region. However, better affordability would contribute to connect more consumers and businesses that are unconnected. Meanwhile, the high cost of fixed services compared to income may have influenced their low uptake. However, other factors such as the smaller footprint of these networks or the low percentage of households with computers may also have played a role.

Figure 2.12. Prices for fixed and mobile broadband services (percentage GNI per capita), 2010-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2010 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[13]). Mobile basket prices are not available from 2010 to 2017.
Source: ITU (2023[10]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/v4erx9

Demand-side causes behind the different divides may include the low level of digital skills, perceived security of broadband services, distrust of digital tools, and perceived usefulness of digital tools and services (e.g. limited local content).

According to the DESPF 2021-2035 (Government of Cambodia, 2021[27]), only about 30% of Cambodians have basic digital skills. According to ITU data, only 38% of the population reported having the most widespread skill, "sending emails with attached files" (2017), one of the lowest percentages in the region (2017) (ITU, 2023[10]). The remaining digital skills covered by the data, such as "transferring files between a computer and other devices" or "using basic arithmetic formula in a spreadsheet" report lower percentages (ITU, 2023[10]). The age divide in Internet use has a direct counterpart in digital literacy by age. The 75+ age group, has the lowest percentage of people with digital skills across all of groups , followed by the 25-74 age group (2017) (ITU, 2023[10]). Geographical and gender gaps can also be seen in terms of digital literacy as of 2017. Digital skills are higher for urban dwellers and, with a smaller difference, for men (ITU, 2023[10]) National authorities also point to distrust in digital services and limited local content as possible causes contributing to geographical, age and gender divides in Internet usage.

2.5.3. Policies and regulation

In a liberalised communication market such as Cambodia's, network deployment depends mainly on the business decisions of operators. However, public authorities can play an important role. In this regard, the Cambodian authorities have taken measures to facilitate network deployment, make sufficient spectrum available to the market and bridge the digital divide, including the main ones detailed below.

Permits for network construction and rights of way and access to passive infrastructure

Measures to facilitate network construction and obtain rights of way can also be helpful tools to facilitate network deployment. The Telecommunications Law states that operators must negotiate and obtain permission from authorities before installing cables and equipment on both public and private property (Government of Cambodia, 2015[19]). Operators must also negotiate and sign a contract with the owner before installing cables and related equipment on private property (Art. 28) (Government of Cambodia, 2015[19]). The Law also establishes the obligation to inform competent authorities and telecommunication operators at least 15 days before excavating private or public land to avoid damage to telecommunication infrastructure and networks (Art. 30) (Government of Cambodia, 2015[19]).

The Telecom Law also provides for other measures to facilitate and reduce the cost of network deployment. This includes the possibility of passive infrastructure sharing between communication networks and other networks such as energy supply, public lighting, drinking water supply, liquid waste disposal and solid waste disposal. This sharing would take place under conditions established by sub-decree (Art. 35) (Government of Cambodia, 2015[19]).

According to national authorities, subordinate legislation is drafted to develop these provisions. Among other aspects, harmonised conditions for granting of permits and rights of way, definitions of competent authorities or administrative procedures, conditions for contracts with private landowners and dispute settlement procedures could be further developed to facilitate network deployment.

Instruction No. 24 on Measures to Improve the Efficiency and Quality of Telecommunication Services (Open Development Cambodia, 2021[64]) includes provisions to facilitate network rollout aimed at municipalities and owners of high-rise buildings. These include reserving space for communication equipment, installing light poles that can be equipped with communication equipment in municipalities; co-operating with operators to provide in-building solutions; and treating telecommunication services as essential public services, similar to electricity and water supply.

Spectrum management

Spectrum management is a powerful tool to facilitate the deployment of mobile communication networks. In Cambodia, spectrum management is governed by the Telecom Law, which mandates MPTC to develop spectrum regulation, national spectrum plans and the national frequency allocation table (Government of Cambodia, 2015[19]). TRC issues spectrum licences, enforces licensing conditions and monitors frequency use.

The Telecom Law does not explicitly designate the spectrum assignment method. To supplement the current framework, MPTC released a sub-decree on the preparation, management allocation and assignment of spectrum, including by auction. Well-designed auctions are considered the gold standard in spectrum assignment as they provide a transparent mechanism to determine the market value of the spectrum made available (OECD, 2022[65]).

According to the sub-decree, spectrum licences have a validity of 15 years (Art. 15) (Government of Cambodia, 2023[66]). They may be renewed one time for a maximum of five years, upon application to TRC one year before expiry. While a validity of 15 years is rather short, it does follow regional peers (e.g. Thailand, Singapore for mobile spectrum licences). Spectrum licensees must pay a spectrum licence fee for the right to use the spectrum, which is set by an inter-ministerial declaration (Art. 17) (Government of Cambodia, 2023[66]).

Thus far, spectrum assignment has largely been conducted on a first-come, first-served basis. However, in 2016, the government held a “comparative tender” assignment process (i.e. “beauty contest”) to allocate mobile spectrum blocks in the 800 MHz and 2.6 GHz bands. The government had previously revoked these bands because the original licence holders had failed to use them (Comms Update, 2016[67]). South East Asia Telecom (Yes) won the 2x10 MHz block in the 2.6 GHz band. However, the 2x5 MHz block in the 800 MHz band went unsold (Comms Update, 2016[67]).

To date, 555.6 MHz has been assigned across the 800 MHz, 900 MHz, 1.8 GHz, 2.1 GHz, 2.3 GHz and 2.6 GHz bands according to national authorities. Notably, the 700 MHz band, a valuable band to support mobile network coverage, is still used for analogue television. However, there are plans to reallocate the band for mobile use (Vanyuth, 2022[68]).

According to national authorities, Smart Axiata holds the most mobile spectrum with 232 MHz, followed by Viettel (Cambodia) with 150.8 MHz, CamGSM (Cellcard) with 132 MHz, South East Asia Telecom (Yes) with 30.8 MHz and Xinwei (Cambodia) Telecom with 10 MHz. The lower amounts of spectrum held by South East Asia Telecom and Xinwei (Cambodia) Telecom may make it challenging for them to compete with the other operators.

Overall, the amount of mobile spectrum disbursed is lower than in some SEA countries. Thailand and Singapore have both assigned more spectrum to support mobile communication services, including in millimetre wave bands. For example, Thai operators hold from 270 MHz – 1 420 MHz per operator, while established operators in Singapore hold around 1 000 MHz on average, according to national authorities. An insufficient availability of spectrum may also contribute to issues of capacity and therefore impact quality of service. This is a noted problem for the country, as mentioned in the following section. Assigning additional spectrum can increase capacity on current networks and support Cambodia’s rollout of next generation networks.

Universal Service Obligation

To address the lack of network coverage in some geographical areas, the Telecommunications Law establishes the basic regulation of the USO Programme (Art. 37-42) (Government of Cambodia, 2015[19]). This is elaborated in the Sub-Decree on the Mechanism for Implementation of Universal Service Obligation Programme (Government of Cambodia, 2020[26]). The USO Programme promotes network deployment and bridges the digital divide to support "broadband Internet". The programme prioritises subnational administrations, rural areas, areas where people earn less than the minimum wages guaranteed for workers, public education or research institutions, and public hospitals and health centres. It does not specify a minimum level of quality for broadband service provided under the USO.

The programme finances the construction of communication networks and infrastructure, which become the operator's property. All operators contributing to the fund are eligible to apply for 50% of the cost to build and deploy infrastructure and networks. If the recipient is the incumbent operator it must allow other operators to use these networks and infrastructure. Funding for the USO Programme comes from several sources: the operators' contribution of 2% of their gross revenue each year; capital granted by the state, ministries or institutions; and other sources such as private national or international institutions (Government of Cambodia, 2020[26]).

Digital skills

The DESPF 2021-2035 includes the enhancement of digital skills among its priorities, under the "Digital Citizens" pillar. There are three specific areas of focus: digital leadership, a digital talent pool and digital citizens in both the public and private sectors, particularly at the local community level (Government of Cambodia, 2021[27]). The DESPF also includes building trust in digital systems, focusing on responsive and effective regulatory frameworks, and strengthening digital security management.

In addition, the CBRD Fund aims at building capacity and skills and providing education and training in ICTs (Government of Cambodia, 2020[46]). Under the Fund, the Cambodia Academy of Digital Technology, established under MPTC, conducted a study to assess the current and future demand for and supply of digital and ICT skills focused primarily on strengthening the human capital of Cambodian businesses (CADT, 2021[69]).

According to the study, there is not yet a high demand for ICT-related skills and occupations. However, companies expect an increase in the coming years due to new businesses in cloud services, data management systems and financial technology (fintech). To meet this demand, the study identifies the need to strengthen subjects related to new technologies, such as machine learning, artificial intelligence, fintech and data science in the ICT curricula of higher education institutions. It also recommends providing support and resources to ensure these institutions keep pace with technological change.

Consumer rights

In the field of consumer rights, the Telecommunications Law provides for subscribers' rights (Art. 65) and the provision of a dispute resolution mechanism between operators and subscribers under TRC (Art. 67-68) (Government of Cambodia, 2015[19]). In practice, TRC provides an online tool where users can submit their complaints and consult the procedures free of charge (TRC, 2022[70]). In addition, MPTC was drafting a Prakas on consumer protection in the telecommunications sector as of 2022.

Recommendations

11. **Reduce barriers to broadband deployment by streamlining access to rights of way, public infrastructure and permits for network construction**. It is recommended that the first part of the Telecommunications Law (Articles 27-30) (Government of Cambodia, 2015[19]) on the use of land, buildings or structures for network deployment be developed to reduce barriers to broadband deployment through streamlined access to rights of way and public infrastructure, and permits for network construction, as well as facilitate access to passive infrastructure.
12. **Promote co-ordination of civil works and passive infrastructure sharing between different networks, especially between communication and electricity networks**. Synergies should be sought with policies to expand and upgrade the electricity grid, as proposed in the "Cambodia Digital Economy and Society Policy Framework 2021-2035" (Government of Cambodia, 2021[27]). Specifically, it is recommended that co-ordination of civil works and passive infrastructure sharing between the two network types be promoted to reduce the cost of deploying backhaul networks in underserved areas. This would also improve the quality of the power supply to communication networks, thus eliminating one of the most common causes of service outages. More generally, it is recommended that, building on Instruction No. 24 on Measures to Improve the Efficiency and Quality of Telecommunications Services (Open Development Cambodia, 2021[64]), specific regulations could be developed to promote access to public and private premises or other assets for the installation of telecommunications equipment, as well as to promote the sharing of passive infrastructure (e.g. ducts) or the co-ordination of civil works between different types of networks.
13. **Promote and invest in improving digital literacy**. It is recommended to develop a national plan to improve digital literacy and raise digital awareness across the population, tailoring it to different socio-economic groups. This plan could benefit from the 2021 study to assess the current and future supply and demand of digital and ICT skills (Government of Cambodia, 2020[46]). It could build on initiatives such as the CBRD Implementation Facility (Government of Cambodia, 2020[46]).
14. **Take actions to improve the affordability of communication services and access devices**. Cambodia should consider the 3% tax on “local and international telecommunications services” (VDB Loi, 2022[63]) and identify ways to reduce or eliminate it. This would serve to improve affordability of communication services and lower barriers to adoption for some socio-economic groups (e.g. low income). A reduced VAT rate for these services, which stands at 10% (Government of Cambodia, 2023[62]), could also be considered.

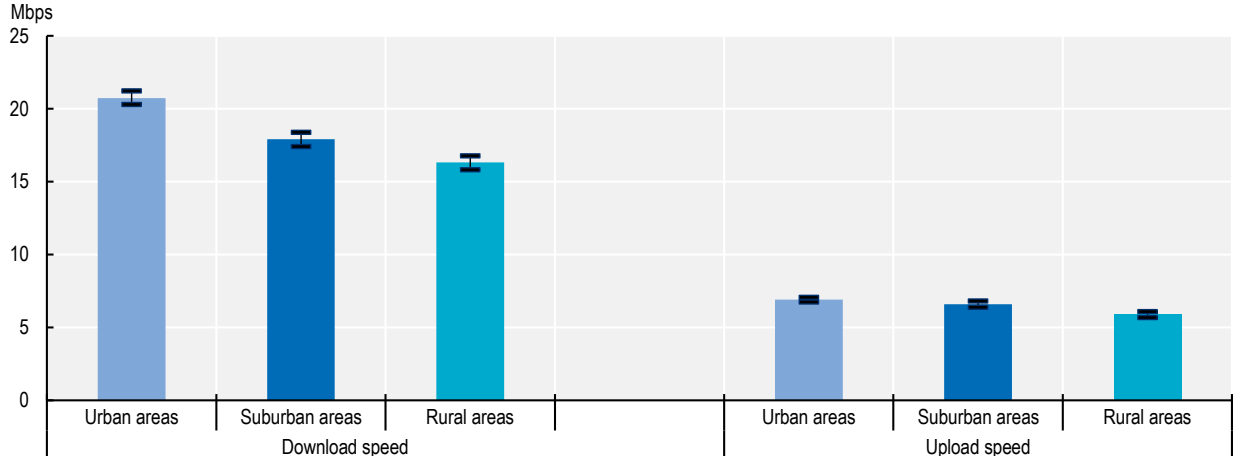
    In a different vein, Cambodia could consider subsidies for low-income and other non-adopting households and SMEs, to enable them to subscribe to fixed broadband services and buy computers or other access devices.
15. **Leverage synergies between programmes to promote the provision and adoption of connectivity services.** To maximise the joint impact of different initiatives to bridge the digital divide, it is recommended to build synergies between the USO Programme (Government of Cambodia, 2020[26]) and other potential initiatives to reduce the coverage gap, and initiatives to reduce the adoption gap (such as those aimed at improving digital literacy or raising awareness of the benefits of, and trust in, digital services). This could be achieved, for example, by co-ordinating the extension of coverage in a given area, providing training or awareness-raising activities, or providing public access points available to local communities.

2.6. Quality of networks (resilience, reliability, security and capacity)

Cambodia's end-user broadband speeds are among the lowest in the region. In July 2023, the median fixed broadband connection speed in Cambodia was 22.4 Mbps/24.4 Mbps (download/upload) (ITU, 2023[10]). This was the second lowest in the region, slightly above the value recorded in Myanmar, and well below the regional median (69.1 Mbps/46.5 Mbps) (Ookla, 2023[54]). However, in the same month, the median fixed broadband latency of 5 milliseconds (ms) was close to the median for the region (Ookla, 2023[54]).

Mobile broadband speeds are also among the lowest in the region at 23.7 Mbps/10.0 Mbps, well below the regional median (35.1 Mbps/13.5 Mbps) (July 2023) (Ookla, 2023[54]). The median mobile broadband latency was close to the median for the region, at 5 ms (July 2023) (Ookla, 2023[54]). User experience measures show similar results. Over 90 days beginning in December 2022, the national average mobile speed observed by users connected to 4G in Cambodia was 18.5 Mbps/6.5 Mbps (download/upload) (Opensignal, 2023[58]). Moreover, experienced 4G download speeds for rural users were 21% lower than for urban users, and upload speeds were 15% lower (Figure 2.13) (Opensignal, 2023[58]).

Figure 2.13. Download/upload speed experience 4G, December 2022 – February 2023



Notes:
1. Data were collected by Opensignal from its users, over 90-days period (1 December 2022–28 February 2023).
2. Opensignal download/upload speed experience represents the typical everyday speeds an Opensignal user experiences across an operator's mobile data networks. 5G download/upload speed is the average speed observed by Opensignal users with active 5G connection. 4G download/upload speed is the average speed observed by Opensignal users when they were connected to 4G (Opensignal, 2023[57]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[59]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[60]).
Source: © Opensignal Limited - All rights reserved (2023[58]), http://www.opensignal.com.

StatLink https://stat.link/8en2xb

This low performance in terms of speed contrasts with the predominance of high capacity technologies in access networks, such as FTTH (Figure 2.3) and 4G (Figure 2.9), as well as with the relatively high coverage of fibre backbones (Figure 2.10). It may stem from several factors. Insufficient segmentation of the last mile in the access network (of the cable or the coverage area of the antenna sector), can result in

an overload of users sharing its capacity. This, in turn, can lead to congestion in the network and worsen end-user quality. At higher levels of the network, under-dimensioning or technological obsolescence of active equipment in any segment of the network (backbone, backhaul or access) can have the same effect.

Although quantitative data on network capacity are not available, some qualitative data suggest that some of the capacity bottlenecks mentioned above do exist in Cambodia. On the fixed access side, the lack of infrastructure-based competition and the low market share of the infrastructure owner (i.e. Telecom Cambodia, with 1% fixed market share) suggest low investment to provide the necessary capacity to all other ISPs. On the backbone and backhaul side, retail operators have reported a lack of capacity for wholesale services. In either case, the solution lies in taking suitable measures to encourage the necessary investment to expand and upgrade the infrastructure and equipment of these networks.

The meshed topology of the national backbone networks contributes to the resilience of Cambodia's broadband services by providing alternative routes for traffic in the event of network failures (ITU, 2023[48]). However, there is no physical diversity in terms of IXPs, which are concentrated in Phnom Penh, where content providers' servers (e.g. CDNs, cloud services) tend to be hosted. Similarly, submarine cable landing stations are concentrated in a single location, the town of Sihanoukville, in the south-west of the country, on the Gulf of Thailand. This means that, regardless of alternative backbone network routes, most Internet traffic is routed to these two enclaves, creating potential single points of failure for Internet traffic that could affect the entire country. This is compounded by the vulnerability of the Phnom Penh Plain and the Cambodian coast to natural disasters, which pose a high risk of disruption to the network infrastructure in this area. Beyond the failure of network elements, operators point to power outages as one of the main causes of connectivity disruptions, as well as accidental or intentional fibre cuts.

2.6.1. Policies and regulation

As shown in the previous sections, the quality of broadband services in Cambodia is poor compared to regional neighbours. The Cambodian government has taken several measures to address these issues to ensure resilient, reliable, secure and high-capacity networks. The most notable of these are detailed below.

Measurement and publication of quality-of-service data

The MPTC published the Prakas on Quality of Telecommunications Services in 2022, which determined the key quality indicators, measurement methods, and monitoring mechanisms for the quality of communication services (MPTC, 2022[25]). According to the Prakas, operators must provide reports on quality of service to TRC every six months. This includes metrics such as the availability of the core network and the accumulated downtime of base stations.

In 2022, MPTC launched the MPTC Speed Test Application. The app measures the performance of mobile broadband services in Cambodia aiming to provide consumers with accessibility, accuracy and transparency of broadband performance data, while committing to protect consumer privacy. The crowdsourced data collected will then contribute to the Measuring Broadband Cambodia (MBC) Programme.

The app is available on users' smartphones. It measures mobile broadband download speed, upload speed, latency, packet loss, jitter, web browsing and YouTube streaming. Furthermore, if measurement shows that Internet service quality is abnormal or at an unusable level, users may use the results as evidence to file a complaint to TRC (MPTC, 2022[71]).

Measures to improve network resilience and capacity

In addition to the 2022 Prakas on Quality of Telecommunication Services, MPTC stipulates various measures for various stakeholders to improve the quality of service through Instruction No. 24 on "Measures to improve the efficiency and quality of telecommunication services" [unofficial translation]

(Open Development Cambodia, 2021[64]). Operators must plan and submit to TRC the construction of adequately dimensioned base stations according to the number of subscribers and the area to be covered. They must also take measures to ensure continuity of power supply to base stations (e.g. batteries to maintain power supply during outages). In addition, operators must review network topology, monitor network performance, increase capacity in the event of network congestion, and repair damaged cables in a timely manner, under the Prakas. Owners of townships and high-rise buildings must reserve space for telecommunication equipment, co-operate with operators and treat communication services as an essential utility (Open Development Cambodia, 2021[64]). The Instruction also included measures for citizens, such as stopping the installation of illegal radio repeaters and co-operating by reporting service quality problems to TRC (Open Development Cambodia, 2021[64]).

Measures to improve network security

While no specific legislation related to the security of communication networks currently applies in Cambodia, MPTC is drafting a Law on Cyber Security. According to information from national officials, the Law is expected to manage cybersecurity of critical information infrastructure to maintain national essential services, including communication networks.

The Cambodia Computer Emergency Response Team (CamCERT) is the country's national computer emergency response team (CERT), established under MPTC. CamCERT has been monitoring security incidents; developing the early warning system on ICT security; and researching new technologies for potential security issues (Government of Cambodia, 2023[35]).

Recommendations

16. **Publish open, verifiable, granular and reliable subscription, coverage and quality of service data**. Operators are required to provide quality of service reports to TRC every six months under the Prakas on Quality of Telecommunications Services (MPTC, 2022[25]). MPTC could regularly make these indicators public. MPTC could also consider publishing crowdsourced quality of service data collected through the MPTC Speed Test Application to provide users with available information on broadband performance.
17. **Promote measures to improve the quality of communication networks**. MPTC could encourage operators to implement the measures contained in Instruction No. 24 on Measures to Improve the Efficiency and Quality of Telecommunication Services (Open Development Cambodia, 2021[64]). Implementation of these measures and compliance with minimum quality parameters should be a condition for obtaining or renewing licences to provide communication services; for the allocation of radio frequencies; or for the receipt of public funds, such as those from the Universal Service Programme.
18. **Promote measures to improve the resilience of traffic exchange infrastructures and international connectivity**. These measures would include encouraging the geographic distribution of existing IXPs with redundant configurations and the connection between IXP peers both nationally and internationally. Furthermore, the geographical diversification of international connectivity could be increased, including distribution of submarine cable stations in different locations or establishment of alternative terrestrial routes to landing stations in other countries in the region. Accordingly, implementation of the NIG, which would channel all domestic and international traffic in Cambodia as set out in the relevant sub-decree, is strongly discouraged. The NIG would likely negatively affect the quality and resilience of communication services in Cambodia by acting as a bottleneck and single point of failure for all networks.

2.7. Environmental impacts of networks

No information is available to assess the impact of telecommunications networks in Cambodia. However, according to Cambodian authorities, Cambodia adopts the standards and recommendations on environment and sustainability from international bodies, such as the ITU. In addition, the government recently passed the Code on Environment and Natural Resources (enacted on 29 June 2023). This comprehensive law covers several aspects, including certain regulatory provisions related to environmental impact assessments (EIAs) (Government of Cambodia, 2023[72]). Namely, EIAs should be conducted for all public and private investment projects that may have impacts on the environment, economy, society, health or culture, subject to further regulatory clarification by the Ministry of Environment and Natural Resources (Government of Cambodia, 2023[72]). Project owners are also subject to certain monitoring and reporting obligations (Government of Cambodia, 2023[72]). Some infrastructure projects related to network deployment, such as the installation of submarine cables, may fall under this EIA requirement. Additionally, the Telecommunications Law establishes that infrastructure sharing with other sectors must be carried out with respect to the environment, although these conditions will be developed by sub-decree (Art. 35) (Government of Cambodia, 2015[19]).

Recommendations

19. **Assess the environmental impact of investment projects in communication networks, while promoting sustainable networks**. The Cambodian authorities could consider developing further guidelines regarding the EIA of public and private investment projects related to communication network deployment in the framework of the legislative development of the Code on Environment and Natural Resources (Government of Cambodia, 2023[72]). These assessments should be based on transparent criteria to promote sustainable networks, without increasing administrative burdens or disincentivising investment. In the same vein, the sub-decree regulating infrastructure sharing under the Law on Telecommunications (Article 35) (Government of Cambodia, 2015[19]) should be developed in a way that reduces the environmental impact of network deployment.
20. **Encourage communication network operators to report regularly on their environmental impacts and initiatives**. In the framework of the monitoring and reporting obligations of project owners in the Code on Environment and Natural Resources (Government of Cambodia, 2023[72]), legislative developments could encourage communication network operators to report regularly on their environmental impacts and initiatives to improve them, as well as to report on the positive environmental effects of connectivity.

2.8. Regular assessment of broadband markets

TRC publishes the most recent data on the take-up of connectivity services on its website, although time series data are not available. Specifically, these include mobile and fixed telephone subscriptions, and Internet subscriptions. It also publishes market information, such as the number of licences by type, including ISPs, tower sharing, submarine cable and optical cable network and international gateway, as well as the number of certificates (Internet café and domain name certificates) (TRC, 2023[73]). While this information is positive, further information could help assess the state of connectivity in the country and thus shape future policies. Such information could include availability, performance and adoption of connectivity services and infrastructure deployment. Efforts under the MBC Programme to collect data on the quality of broadband services in Cambodia, including through the MPTC Speed Test Application, are also welcome (MPTC, 2022[71]). As planned, MBC should regularly report such data publicly after assuring their quality.

Recommendations

21. **Regularly assess the state of connectivity to determine whether public policy initiatives are appropriate, and whether and how they should be adjusted.** To this end, it is proposed to take the necessary steps to extend the scope of the information collected by TRC on Internet subscriptions. This would entail collecting, analysing and publishing data on the availability, performance and take-up of connectivity services and infrastructure deployment. It is strongly recommended to carry out this assessment with sufficient geographical granularity to identify territorial differences (e.g. between urban and rural areas) and thus adjust regulatory measures and other types of support programmes for network expansion and upgrading.

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Notes

[1] Urban cluster (moderate-density cluster) is defined as contiguous grid cells with a density of at least 300 inhabitants per square kilometre and has a population of at least 5 000 in the cluster (European Commission, Joint Research Centre, 2015[8]).

[2] Urban centre (high-density cluster) is defined as contiguous grid cells with a density of at least 1 500 inhabitants per square kilometre. An urban centre has a population of at least 50 000 (European Commission, Joint Research Centre, 2015[8]).

[3] Rural area (or mostly low-density cells) is defined as grid cells of 1 square kilometre with a density below 300 inhabitants per square kilometre and other grid cells outside urban clusters or centres (European Commission, 2015[76]).

[4] Article 2 of the Law on Competition states its application to all "persons conducting business activities" that harm competition in Cambodia, while Article 3(11) defines "persons" to include "natural persons or legal persons carrying on business activities" (Government of Cambodia, 2021[21]). These articles do not explicitly mention the Law's applicability to state-owned enterprises.

[5] These thresholds include: figures of any of the merging entities' in the prior financial year above KHR 340 billion (USD 82.4 million) for total assets, KHR 270 billion (USD 65.5 million) for total revenue, KHR 120 billion (USD 29.1 million) for value of purchase orders, or if the operating cost of the proposed merger is greater than KHR 41 billion (USD 9.9 million) (Ministry of Commerce, 2023[36]). A Bloomberg exchange rate of 4 124.50 KHR = 1 USD, as of 5 July 2023, was used to calculate the value in USD (Bloomberg, 2023[75]).

[6] Transmission network length refers to the physical length of fibre optic cable in a network irrespective of the number of optical fibres contained within the constituent cables of that network and can also be applied to microwave terrestrial networks. It is expressed in route kilometres (route-kms) (ITU, 2012[77]).

[7] Reproduced with permission of Opensignal, based on independent analysis of mobile measurements recorded during the period December 1, 2022 - February 28, 2023, © 2023 Opensignal Limited - All rights reserved.

[8] The data source for handset price is Tarifica; the source for GNI per capita, USD, 2022 is GSMA Intelligence. The handset price is the price of the cheapest handset available in each market with Internet-browsing capability in USD (nominal prices), as gathered in 2022. The methodology for data collection can be found in the Mobile Connectivity Index Methodology (GSMA, 2022[74]).

3 Extending broadband connectivity in Indonesia

Indonesia is the largest country in Southeast Asia, with more than 18 000 islands and islets. More than half of the population, the largest in Southeast Asia, lives on the island of Java. The economy grows at pace, and the level of human development, including income, life expectancy, and education, is high. Indonesia shares similarities with the Philippines in the geographic distribution of population, as well as in human development indicators. These two countries are analysed as a cluster represented by Indonesia. The chapter outlines the geographic, economic and social conditions for broadband connectivity in Indonesia. It proceeds by examining the performance and structure of the market and reviewing Indonesia's communication policy and regulatory framework, including broadband strategies and plans. It then reviews competition, investment and innovation in broadband markets; broadband deployment and digital divides; networks' resilience, reliability, security and capacity; and the country's assessment of broadband markets. It offers recommendations to improve in these areas, which could be relevant for the other countries forming this cluster.

Policy recommendations

1. Establish an independent regulatory body with remit over the communication sector.
2. Consider conducting a competitive neutrality review in the communication sector.
3. Consider undertaking a competition assessment in the sector, leveraging KPPU's "Guideline on Competition Policy Assessment Checklist".
4. Consider further measures to decrease restrictions on foreign entry, including those applied more generally across the economy.
5. Foster deployment of middle and last mile networks in unserved areas.
6. Consider amending Indonesia's spectrum framework and assigning additional spectrum quickly to support 5G deployments.
7. Reduce barriers to broadband deployment through simplified procedures for obtaining permits, access to public infrastructure and rights of way.
8. Consider leveraging international connectivity infrastructure.
9. Leverage synergies between programmes to promote provision and adoption of connectivity services.
10. Publish open, verifiable, granular and reliable subscription, coverage and quality of service data.
11. Promote measures to improve the quality and resilience of international connectivity.
12. Support and promote smart and sustainable networks and devices and encourage communication network operators to periodically report on their environmental impacts and initiatives.
13. Regularly assess the state of connectivity to determine whether public policy initiatives are appropriate, and whether and how they should be adjusted.

Note: These tailored recommendations build on the OECD Council's Recommendation on Broadband Connectivity (OECD, 2021[1]), which sets out overarching principles for expanding connectivity and improving the quality of broadband networks. The number of recommendations is not an appropriate basis for comparison as they depend on several factors, including the depth of contributions and feedback received from national stakeholders. In addition, recommendations do not necessarily carry the same weight or importance.

3.1. Geographic, economic and social conditions for broadband connectivity

Indonesia, located in the Indian and Pacific oceans, is the largest country in Southeast Asia (SEA). It shares a border with Malaysia in the northern part of Borneo and with Papua New Guinea in the centre of New Guinea. Indonesia comprises some 18 110 islands and islets, of which around 6 000 are inhabited (Ministry of Foreign Affairs, n.d.[2]). Its five main areas are the islands of Sumatra, Kalimantan (two-thirds of the island of Borneo), Papua (western part of New Guinea island), Sulawesi and Java (Ministry of Foreign Affairs, n.d.[2]).

Indonesia has a population of more than 276 million people, as of 2022 (UNDESA, 2022[3]), largest in Southeast Asia followed by the Philippines with 116 million (UNDESA, 2022[3]).

The distribution and density of the population in Indonesia vary considerably from region to region. More than half of the population lives on Java, which hosts the capital Jakarta. The island of Sumatra is a distant second in population, followed by Sulawesi, Kalimantan and Papua.

Indonesia is one of the most disaster-prone countries in the world, frequently exposed to a range of hazards. More than 60% of Indonesia's districts have a high risk of flooding (World Bank, 2019[4]). Indonesia also faces a high risk of seismic, tsunami and volcanic activity, given its location in the Pacific

Ring of Fire and its 127 active volcanoes (World Bank, 2019[4]). Disasters affect people, as well as the economy. Over the last 15 years, Indonesia has suffered losses of approximately USD 16.8 billion due to disaster events (World Bank, 2019[4]).

Considering the socio-economic and demographic conditions that are closely related to broadband development, Indonesia and the Philippines have been grouped together for this publication. The two countries share many commonalities, especially on macroeconomic metrics that influence broadband deployment. These include gross domestic product (GDP) per capita, population, geographic distribution and human development indicators.

Indonesia's economy continues to grow at pace, with real GDP growth at 4.9% in 2023 and expected to be 5.2% in 2024 and 2025 (OECD, 2023[5]). Indonesia had a GDP per capita of USD PPP 14 687 in 2022, placing it fifth highest in the region (IMF, 2023[6]). The Philippines was in seventh place at USD PPP 10 497 (IMF, 2023[6]).

Indonesia and the Philippines have similar geographic breakdowns between urban and rural areas, with around 96% of their land mass classified as "rural"[1] (European Commission, Joint Research Centre, 2015[7]). However, the proportion of the population living in the remaining 4% of the territory ("urban centre" [2] and "urban cluster" [3]) is high in both countries, at 81.5% in Indonesia and 59.5% in the Philippines (2015) (European Commission, Joint Research Centre, 2015[7]). Specifically in Indonesia, 57% of the population live in an "urban centre" (2015) (European Commission, Joint Research Centre, 2015[7]), a percentage second only to Singapore. Cities such as Jakarta have more than 10 million inhabitants. Other major cities on Java Island are Surabaya (the second largest city in Indonesia), Bekasi, Bandung, Depok, Tarangen and Semarang. The island of Sumatra has Medan, the third largest city in Indonesia, and Palembang.

Finally, Indonesia and the Philippines also show similarities in the Human Development Index. Both are in the middle to lower positions among SEA. The level of human development considers indicators across longevity, education and income (Table 3.1).

Table 3.1. Human development (2021) and degree of urbanisation (2015), Indonesia and Philippines

	Life expectancy (years, 2021)	Expected years of schooling (children, 2021)	Mean years of schooling (adults, 2021)	Gross domestic product per capita (current prices, PPP, 2022)	Population living in urban centres (%, 2015)	Population living in urban clusters (%, 2015)	Population living in rural areas (%, 2015)
Indonesia	67.6(9)	13.7(4)	8.6(6)	14 687(5)	57.0	24.4	18.5
Philippines	69.3(7)	13.1(6)	9.0(4)	10 497(7)	39.4	20.1	40.5
OECD average	80.0	17.1	12.3	53 957	48.8 (2022 data)	28.11 (2022 data)	23.11 (2022 data)

Note: The numbers in parentheses refer to the simple ranking (i.e. no weighting) of SEA countries for each indicator. The OECD average for human development indicators is a simple average across OECD member countries. The urbanisation indicators for SEA countries refer to the population percentage in urban centres, urban clusters and rural areas, respectively. For the OECD, figures are given for the rate of the population living in predominantly urban, intermediate, and rural regions, respectively.

Source: [Human development indicators] UNDP (2022[8]), *Human Development Report 2021/2022: Uncertain Times, Unsettled Lives: Shaping our Future in a Transforming World*, www.undp.org/egypt/publications/human-development-report-2021-22-uncertain-times-unsettled-lives-shaping-our-future-transforming-world. [GDP per capita, SEA countries] IMF (2023[6]), *World Economic Outlook Database, April 2023*, www.imf.org/en/Publications/WEO/weo-database/2023/April (accessed on 28 June 2023). [GDP per capita, OECD] OECD (2023[9]), *Gross domestic product (GDP)* (indicator), https://doi.org/10.1787/dc2f7aec-en (accessed on 30 June 2023). [Urbanisation indicators for SEA] European Commission, Joint Research Centre (2015[10]), *Global Human Settlement Layer (GHSL)*, https://ghsl.jrc.ec.europa.eu/CFS.php. [urbanisation indicators for OECD] OECD (2023[11]), *OECD.Stat* (database),*" Regions and cities: Regional statistics: Regional demography: Demographic indicators by rural/urban typology, Country level: OECD: share of national population by typology"*, https://stats.oecd.org/ (accessed on 28 August 2023).

The following sections on Indonesia are less detailed than the other country chapters, due to a lower participation rate by national authorities to provide and validate information, as well as to review drafts. Therefore, the information presented relies more heavily on desk research and informational interviews with relevant stakeholders over the course of drafting.

3.2. Market landscape

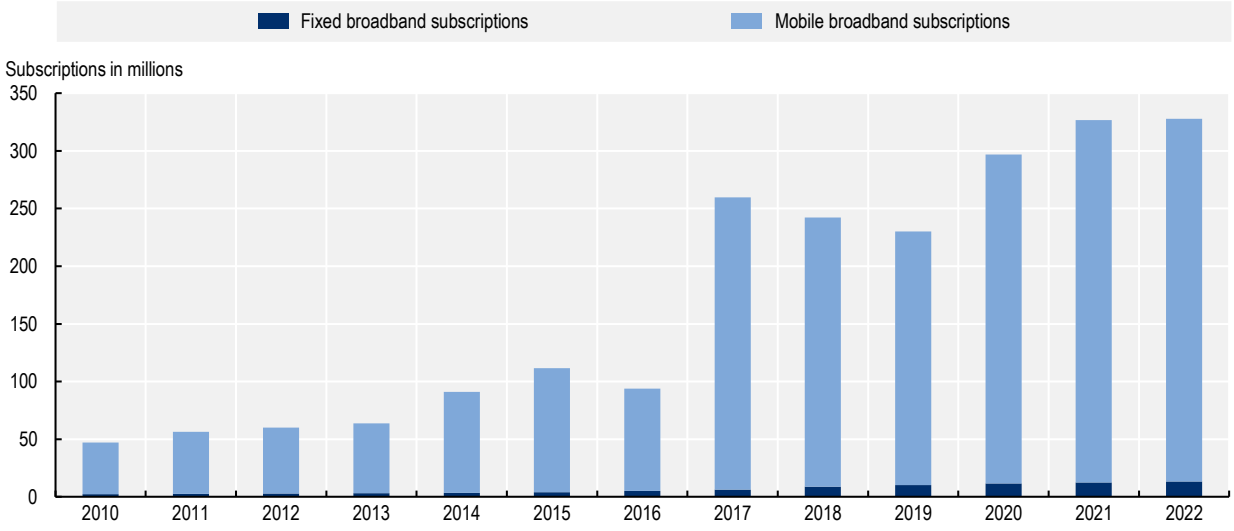
3.2.1. Market performance

Indonesia's broadband market, given its large population, accounted for 43% of the total broadband subscriptions in the SEA region in 2022 (ITU, 2023[12]) in terms of total subscriptions increased around sevenfold over 2010-22 compared to 2010 values (Figure 3.1) (ITU, 2023[12]). Mobile broadband subscriptions account for the majority of the total, as elsewhere in SEA, with fixed broadband subscriptions accounting for 4% in 2022 (ITU, 2023[12]).[4]

This distribution translates into penetration. Mobile broadband penetration in Indonesia ranks in the middle of the region, with 114.8 subscriptions per 100 inhabitants in 2021 (ITU, 2023[12]). However, fixed broadband penetration is among the lowest, with a rate of 4.9 subscriptions per 100 inhabitants, above only Cambodia, Myanmar and Lao People's Democratic Republic in 2022 (Lao PDR) (ITU, 2023[12]).

Figure 3.1 shows steady growth in fixed broadband with an average annual growth rate of 16% over the last decade (2010-22) (ITU, 2023[12]). However, the steady growth resulted in fixed broadband subscriptions growing from 2.3 million (2010) to 13.4 million in 2022 (ITU, 2023[12]). Considering the growth of mobile broadband, Indonesia's growth trend is not as linear as observed in other countries in the region. In 2017, the number of mobile broadband subscribers almost tripled (from 89 million in 2016 to 253 million subscribers in 2017), a spike that coincided with the rollout of 4G. This was followed by a slight decline in 2018-19 before rebounding in 2020 (ITU, 2023[12]).

Figure 3.1. Broadband subscriptions, 2010-22



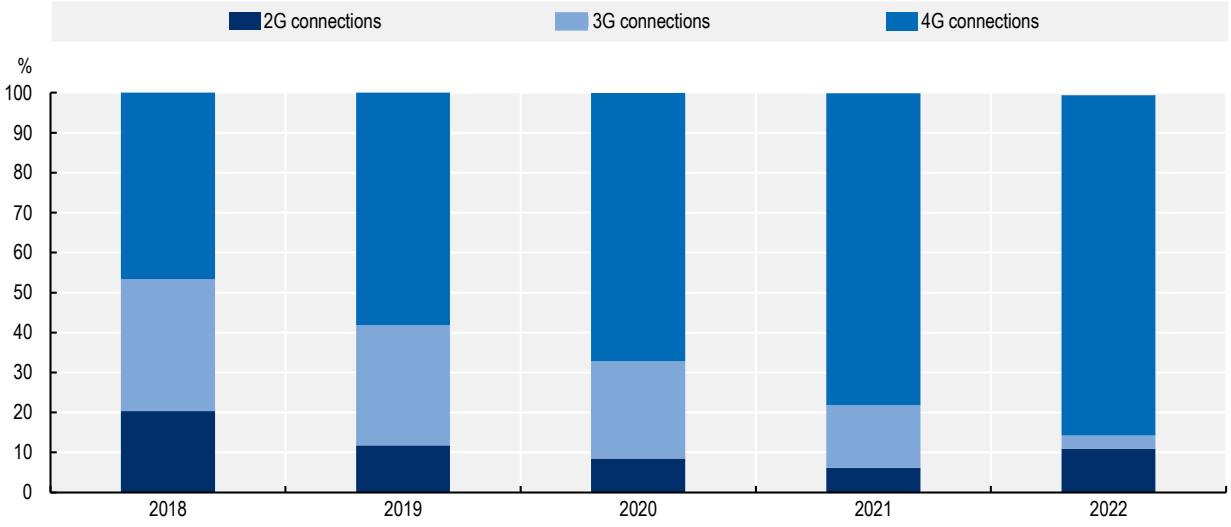
Notes:
1. For mobile broadband subscriptions in 2022, data from 2021 has been used.

2. Fixed broadband subscriptions refer to fixed subscriptions to high-speed access to the public Internet (TCP/IP connection) at downstream speeds equal to, or greater than, 256 kbit/s. This includes cable modem, DSL, fibre-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. It includes fixed WiMAX and any other fixed wireless technologies. This total is measured irrespective of the method of payment. It excludes subscriptions with access to data communications (including the Internet) via mobile-cellular networks. It includes both residential subscriptions and subscriptions for organisations. Mobile broadband subscriptions (active mobile-broadband subscriptions in ITU Database) refer to the sum of active handset-based and computer-based (USB/dongles) mobile-broadband subscriptions that allow access to the Internet. It covers actual subscribers, not potential subscribers, even though the latter may have broadband-enabled handsets. Subscriptions must include a recurring subscription fee or pass a usage requirement if in the prepayment modality – users must have accessed the Internet in the last three months (ITU, 2020[13]).
Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/f0hwu6

The most widely used mobile technology in Indonesia is 4G, which accounts for 85% of connections in 2022, surpassed in the region only by Malaysia (94% of connections), benefiting from wide 4G network coverage (97% of the population in 2022 (GSMA Intelligence, 2023[14]) and the affordability of mobile broadband services. The share of 4G connections has increased in recent years to the detriment of 3G and 2G technologies (Figure 3.2), which accounted for 3% and 11% of connections, respectively, in 2022 (GSMA Intelligence, 2023[14]). Although 5G networks covered 10% of the population in 2022 (Figure 3.9) (GSMA Intelligence, 2023[14]), the technology has not reached a significant penetration in 2022 (GSMA Intelligence, 2023[14]).

Figure 3.2. Percentage of mobile connections by technology, 2018-22

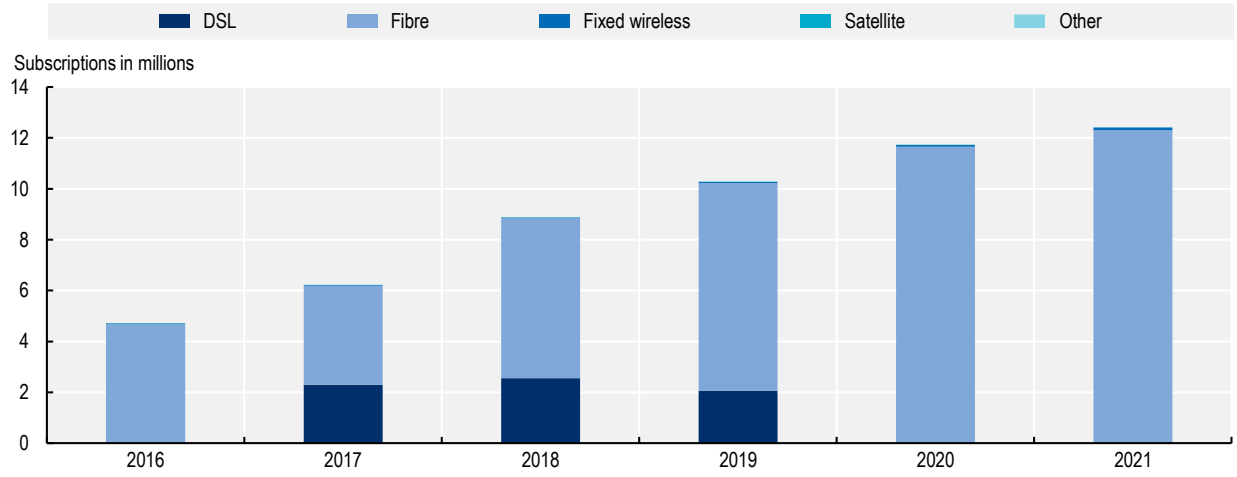


Source: GSMA Intelligence (2023[14]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/slpt5f

While only representing a small proportion of total broadband subscriptions in the country, fixed broadband subscriptions are dominated by fibre technology (Figure 3.3) (ITU, 2023[12]). In 2021, fibre accounted for 99% of fixed broadband subscriptions, while the remaining 1% was from fixed wireless access and satellite. Fibre is predominant across the region, accounting for 50% or more of fixed subscriptions in 2021 in all SEA countries in which data are available (ITU, 2023[12]).[5]

Figure 3.3. Fixed broadband subscriptions by technology, 2016-21



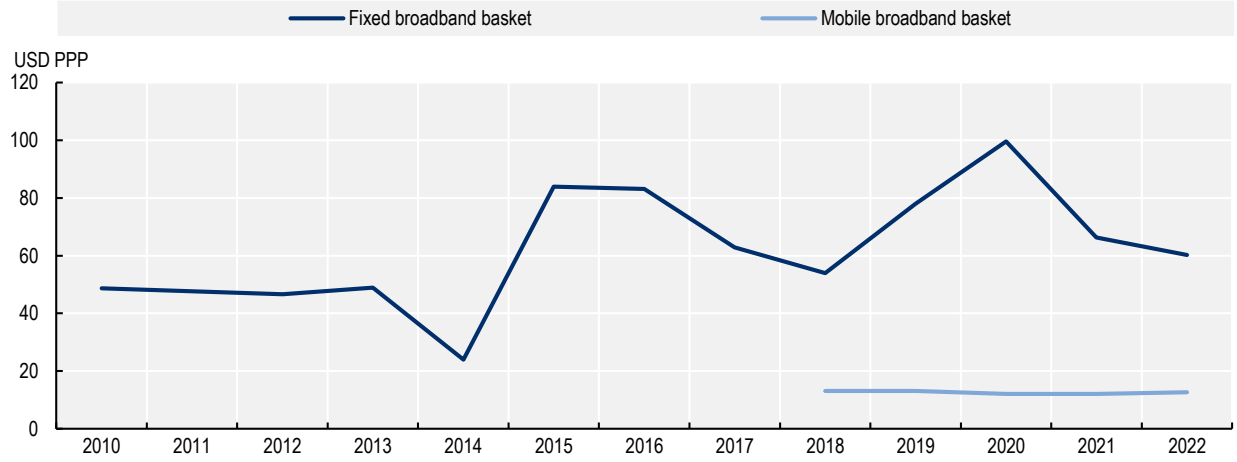
Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/ugyleb

Prices for entry-level fixed communication service baskets (5 GB) are higher than entry-level mobile service baskets (70 min + 20 SMS + 500 MB), as in other SEA countries (Figure 3.4). Prices increased from USD PPP 48.7 in 2010 to USD PPP 60.2 in 2022, an increase of 24% over the period (ITU, 2023[12]). Regionally, Indonesia has the second highest price after the Philippines (USD PPP 84.4) and above the regional average of USD PPP 51.6 in 2022 (ITU, 2023[12]).

Mobile communication prices for entry-level service baskets are less than one-fourth of fixed service baskets at USD PPP 12.6 in 2022 (ITU, 2023[12]) . Prices have been stable since 2018, with prices between USD PPP 12-13 over that period (Figure 3.4). Indonesia ranks fourth lowest regionally, and below the regional average of USD PPP 15.5 (ITU, 2023[12]).

Figure 3.4. Prices for entry-level fixed and mobile communication services, USD PPP, 2010-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2010 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality,

while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[15]). Mobile basket prices are not available from 2010 to 2017.
Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/1dewug

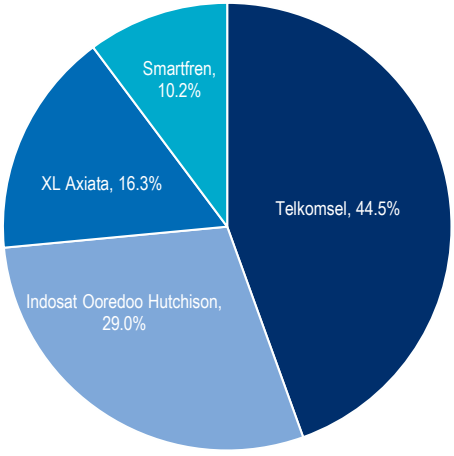
3.2.2. Market structure

Indonesia liberalised its communication market in the late 1990s. Prior to liberalisation, two operators under state control dominated the market: PT. Telekomunikasi Indonesia (Persero) Tbk (Telkom Indonesia) for domestic services and PT Indosat Tbk for international services (Rasyid, 2005[16]). The government began privatising these state-owned operators with initial public offerings of Indosat in 1994 and Telekom Indonesia in 1995 (Rasyid, 2005[16]). Later, in 2002, the government divested a share of around 42% in Indosat. However, the government has not fully privatised either of these two entities, as discussed below.

In 1995, in keeping with the government's privatisation actions, private entities were allowed to provide cellular (mobile) services and value-added services, such as Internet access and Voice over Internet Protocol, allowing further competition to the market (Rasyid, 2005[16]). While liberalisation has allowed for the entry of additional market players, the historic incumbents still play an important role in both the fixed and mobile markets (Figure 3.5 and Figure 3.6).

There are four main mobile operators in Indonesia. According to national authorities, PT Telekomunikasi Selular (Telkomsel) led the market with 44.5% market share based on mobile broadband subscribers in Q4 2022. It was followed by PT Indosat Tbk (trading as Indosat Ooredoo Hutchison following the recent merger) with 29%, PT XL Axiata Tbk (XL Axiata) with 16.3% and PT Smartfren Telecom Tbk (Smartfren) with 10.2% (Figure 3.5). National authorities did not report any mobile virtual network operators on the market.

Figure 3.5. Mobile market shares based on mobile broadband subscribers, Q4 2022



Note: Mobile broadband subscribers refer to the mobile broadband subscribers that contracted services including voice and data plans, and data-only plans.
Source: OECD elaboration based on data from Indonesian authorities.

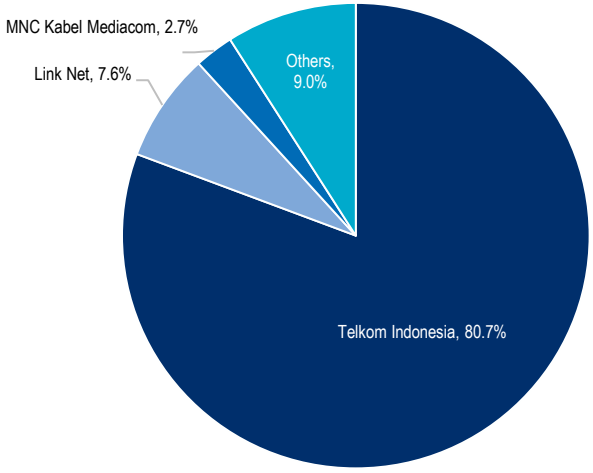
StatLink https://stat.link/objx4z

In the fixed broadband residential market (B2C), according to data provided by national authorities as of Q4 2021, Telkom Indonesia holds 80.7% of the market based on subscribers. Link Net Tbk (Link Net) is a distant competitor with 7.6%, followed by MNC Kabel Mediacom with 2.7% (Figure 3.6). More than

500 fixed providers collectively hold the remaining 9% of total fixed broadband subscribers. These are likely small providers offering services on a local level, given the geographical challenges of offering fixed service nationwide.

In the fixed broadband business market (B2B), according to national authorities as of Q4 2021, Telkom Indonesia accounts for 89.7% of subscribers. It is followed by Supra Primatama Nusanta at 1.4%. More than 500 other small operators collectively hold the remaining 8.9% of total business fixed subscribers. In the wholesale market, unsurprisingly, Telkom Indonesia is also the largest company providing network wholesale services, according to national authorities. Other wholesale providers include PT Mora Telematika Indonesia, PT Aplikanusa Lintasarta, PT Indonesia Comnets Plus, PT Tower Bersama Infrastructure Tbk and Link Net.

Figure 3.6. Fixed market shares based on fixed broadband subscribers (B2C), Q4 2021



Note: Fixed broadband subscribers refer to the number of subscribers of fixed broadband plans in the consumer (business-to-consumer) retail market. The "Others" category includes over 500 fixed operators, none of which have a market share greater than 2% (based on fixed broadband subscribers).
Source: OECD elaboration based on data from Indonesian authorities.

StatLink https://stat.link/ymclj7

There have been recent mergers in both the fixed and mobile markets in Indonesia. In the fixed market, Axiata and its Indonesian subsidiary, XL Axiata, together acquired 66.03% of shares of Link Net, a fixed provider, in June 2022 (XL Axiata, 2022[17]). Axiata (Axiata Investments (Indonesia) Sdn. Bhd.) and XL Axiata increased their shares in Link Net to collectively hold over 95% as of April 2023, with the remaining held by treasury stock and the public (Link Net, 2023[18]). Axiata was required to issue a mandatory tender offer to acquire the remaining shares (XL Axiata, 2022[17]).

In the mobile market, Ooredoo Group and CK Hutchison ("3") completed the merger of their Indonesian businesses in January 2022. In so doing, they became the second largest mobile operator in the country under the merged name, "Indosat Ooredoo Hutchison" (CK Hutchison Holdings Ltd, 2022[19]). The merged entity is jointly controlled by Ooredoo Group and CK Hutchison, which together hold 65.6% of shares (CK Hutchison Holdings Ltd, 2022[19]). As of December 2022, other stakeholders comprise PT Perusahaan Pengelola Aset (Persero) with 9.6%; PT Tiga Telekomunikasi Indonesia (8.3%), the government of Indonesia holding one "Series A" share (explained in more detail below); and other public stakeholders holding the remaining 16.4% (Indosat Ooredoo Hutchison, 2023, p. 86[20]).

The Minister of Communications and Informatics approved the merger in January 2022, with conditions (MCI, 2022[21]). As its first condition, the merged entity must build at least 52 885 sites by 2025, an increase of 11 400 sites compared to previous requirements (MCI, 2022[21]). The second condition requires expanding coverage to at least 7 660 additional villages and sub-districts. This would expand the total area covered by Indosat Ooredoo Hutchison's mobile services to at least 59 538 villages and sub-districts by 2025 (MCI, 2022[21]). In addition, the quality of service must increase by 12.5% (download throughput) and 8% (upload throughput), respectively (MCI, 2022[21]). Finally, Indosat must return 5 MHz of spectrum (1 975-1 980 MHz/2 165-2 170 MHz) within one year (MCI, 2022[21]).

Following the merger's completion in January 2022, the merging entities notified the competition authority, the Commission for the Supervision of Business Competition (KPPU). Based on KPPU's initial assessment that the merger would result in a Herfindahl-Hirschman Index (HHI) rating of over 2 500 and a change in HHI of more than 150 points, it subsequently conducted a comprehensive review of the merger (KPPU, 2022[22]). Following this review, Indosat reported receiving KPPU's positive evaluation that the merger would be unlikely to result in monopolistic practices or unfair competition in September 2022 (Indosat, 2022[23]).

There is some state ownership of key players in the fixed and mobile markets, primarily in Telkom Indonesia and its subsidiary, Telkomsel. The Indonesian government acts as the controlling shareholder with 52.09% of Telkom Indonesia's shares (including one "Series A" share), as of Q4 2022. The remaining 47.91% is divided between 37.4% foreign ownership and 10.51% local ownership, although the government is the only shareholder with more than 5% ownership (Telkom Indonesia, 2023, p. 72[24]). Telkomsel is a direct but not fully owned subsidiary of Telkom Indonesia. Telkom Indonesia owned 65% of Telkomsel (as of Q4 2022) (Telkom Indonesia, 2023, p. 76[24]). The Singtel Group owned the remaining 35% (as of 31 March 2023) (Singtel, 2023, p. 5[25]). However, in June 2023, Telkom Indonesia and Telksomsel agreed to integrate Telkom Indonesia's fixed business-to-consumer unit, IndiHome, into Telkomsel (Telkomsel, 2023[26]). Telkomsel will fully manage IndiHome, while Telkom Indonesia will focus on the fixed business-to-business market (Telkomsel, 2023[26]). Following the integration, Telkom Indonesia owns a 69.9% stake in Telkomsel, while Singtel owns 30.1% (Telkomsel, 2023[26]).

The government also owns one "Series A" share in Indosat Ooredoo Hutchison (Indosat Ooredoo Hutchison, 2023, p. 86[20]). In addition, PT Perusahaan Pengelola Aset (PPA) holds a 9.6% stake in the merged entity (Indosat Ooredoo Hutchison, 2023, p. 86[20]). PPA is "a state-owned asset management company with specialisation in [state-owned enterprise, or SOE] restructuring and revitalisation" as well as "SOEs asset management activities and advisory" (PPA, n.d.[27]). State influence, therefore, seems possible in Indosat Ooredoo Hutchison.

Of particular interest is the single "Series A" share the government owns in both Indosat Ooredoo Hutchison and Telkom Indonesia. No other shareholder holds this share type in either company. As a Series A shareholder, the government has special rights, as described below for Telkom Indonesia:

> The company issued only 1 Series A Dwiwarna share which is held by the Government and cannot be transferred to any party, and has a veto right in the General Meeting of Stockholders of the Company with respect to election and removal of the Boards of Commissioners and Directors, issuance of new shares, and amendments of the Company's Articles of Association. *(Telkom Indonesia, 2023, p. 404[24])*

Similar rights are outlined under the Series A share issued by Indosat Ooredoo Hutchison. These include veto rights in cases of mergers or acquisitions, bankruptcy and amendments to the rights of series A shareholders, among others (Indosat Ooredoo Hutchison, 2023, p. 350[20]). The Series A shareholder also has the right to "appoint one director and one commissioner of the Company" (Indosat Ooredoo Hutchison, 2023, p. 350[20]). This suggests the government retains influence over some of Indosat Ooredoo Hutchison's key business decisions, despite having a lower percentage of shares compared to Telkom Indonesia.

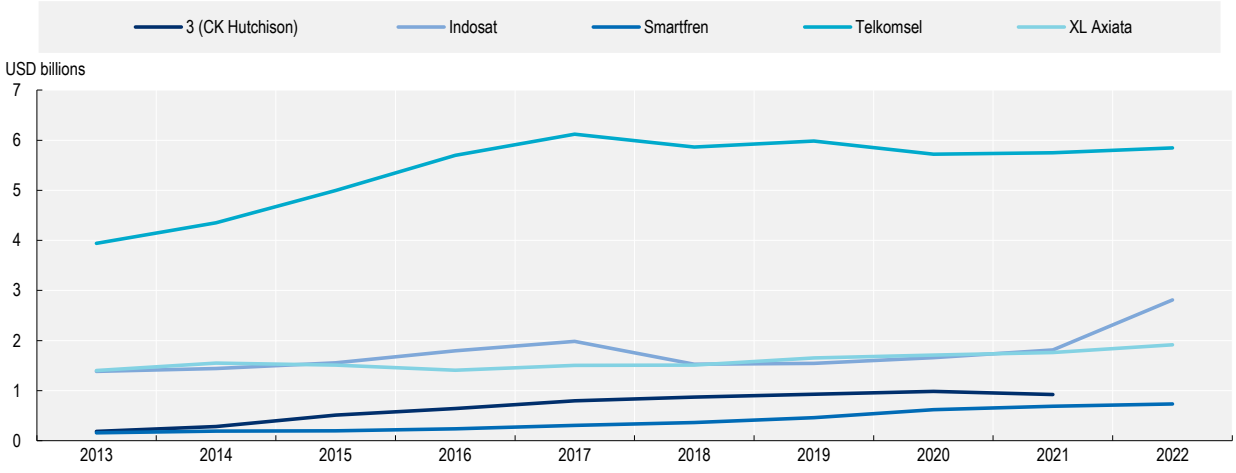
In contrast, the Indonesian government does not seem to own shares in XL Axiata (although the Malaysian government owns shares in its parent company, Axiata Group) (XL Axiata, 2023[28]).[6] The Indonesian government similarly does not seem to have ownership in Link Net, as XL Axiata's subsidiary (Link Net, 2023[18]).

Overall, the state has clear ownership in one of the three main players in the fixed market (Telkom Indonesia) and in two of the four main players in the mobile market (Telkomsel and Indosat Ooredoo Hutchison). These operators have the largest market shares in their respective markets (leader in both markets and the second in mobile).

In terms of market revenue, while data on revenues and investment are unavailable for the fixed market, estimates for the mobile market show steady growth. Total revenues of the mobile sector in the country have increased steadily from 2013-22, growing by 56% over that period (GSMA Intelligence, 2023[14]).

Indonesia was second in the region in terms of mobile revenues (nominal terms) in 2022, just behind Thailand and followed by Viet Nam (GSMA Intelligence, 2023[14]). By operator, Telkomsel is the clear leader in terms of nominal revenue, unsurprising given its market position. It is followed by Indosat (Indosat Ooredoo Hutchison), XL Axiata and Smartfren, in 2022 (Figure 3.7) (GSMA Intelligence, 2023[14]). Revenues from 3 (CK Hutchison) are reported only until 2021, as the entity merged with Indosat to become Indosat Oordeoo Hutchison in 2022. Similarly, data from Indosat from 2013-21 are prior to the merger.

Figure 3.7. Mobile revenues by operator, 2013-22



Note: In 2022, Indosat merged with 3 (CK Hutchison) Indonesia to become "Indosat Ooredoo Hutchison". Revenue data for 2013-21 for Indosat and 3 (CK Hutchison), respectively, are pre-merger. Revenue from Net1 was omitted due to company's cease in operations in November 2021 (Detikinet, 2021[29]).
Source: GSMA Intelligence (2023[14]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

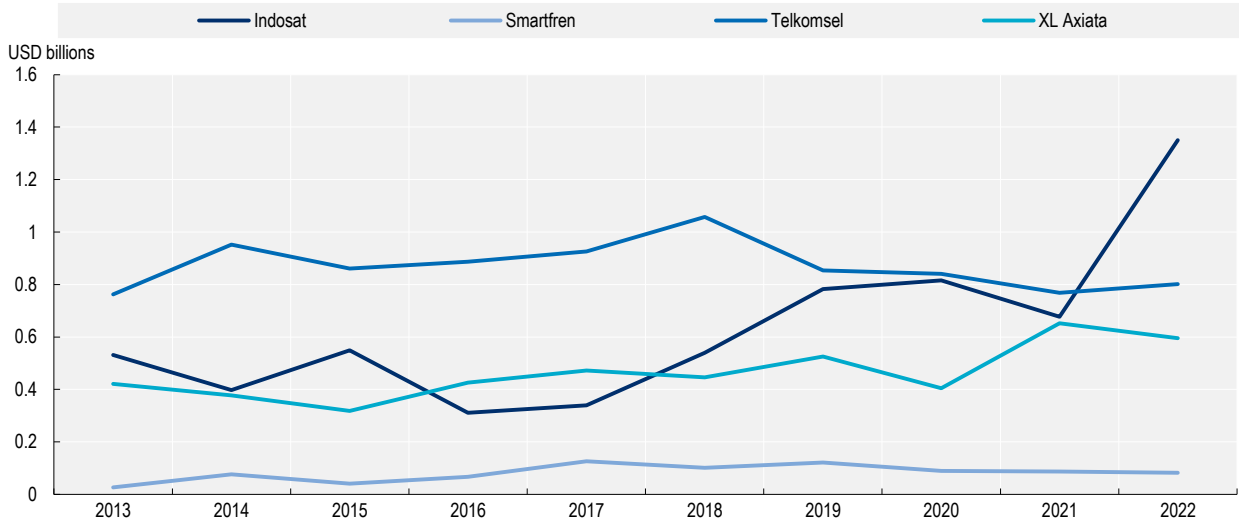
StatLink https://stat.link/gajcio

Coupled with the strong growth in revenue in the mobile market, investment in mobile networks (capital expenditure (Capex)) also grew over 2013-22, although at a lower rate of 23% (GSMA Intelligence, 2023[14]). The level of mobile investments in 2022 (nominal terms) put Indonesia in second place in the region, just behind Thailand (GSMA Intelligence, 2023[14]). By operator, Indosat (Indosat Ooredoo Hutchison) surpassed Telkomsel as the leading investor in 2022 in nominal terms with an investment of USD 1.3 billion (Figure 3.8). This almost doubled Indosat's Capex figure in 2021 (USD 677 million), prior to the merger with CK Hutchison (pre-merger investment data for CK Hutchison not shown in graph). The

increase may be due in part to the coverage, rollout and quality of service requirements set by the ministry as merger conditions.

The combined entity is clearly investing heavily, with its 2022 Capex-to-revenue ratio at 48% (GSMA Intelligence, 2023[14]). XL Axiata also has a relatively high ratio, with investment accounting for roughly 30% of its revenues in 2022 (GSMA Intelligence, 2023[14]). Although Telkomsel is second in terms of investment in nominal terms in 2022, its Capex ratio is lower at 14% in 2022 (GSMA Intelligence, 2023[14]). Smartfren had a similar Capex ratio at 11% in 2022 (GSMA Intelligence, 2023[14]).

Figure 3.8. Investment in mobile networks (total Capex) by operator, 2013-22



Note: In 2022, Indosat merged with 3 (CK Hutchison) Indonesia to become "Indosat Ooredoo Hutchison". Investment data from 2013-21 for 3 (CK Hutchison) are not shown in the graph. Data from 2013-21 for Indosat are pre-merger. Revenue from Net1 was omitted due to company's cease in operations in November 2021 (Detikinet, 2021[29]).
Source: GSMA Intelligence (2023[14]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

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3.3. Communication policy and regulatory framework

3.3.1. Institutional framework

The Ministry of Communications and Informatics (MCI) has the main responsibility over the communication market in Indonesia, covering both the communication and broadcasting sectors (MCI, n.d.[30]). It also regulates the communication sector, taking over from the Indonesian Telecommunication Regulatory Body (BRTI) when it was disbanded in 2020 due to a governmental decision to streamline functions (MCI, 2020[31]; MCI, 2020[32]). During its operation, BRTI regulated the communication sector but worked under and was responsible to the ministry (ADB, 2020[33]).

The move to disband BRTI and further centralise regulatory functions in the ministry goes against OECD Recommendations and good practice, which support independent regulatory bodies, especially over the communication sector. The 2021 OECD Broadband Recommendation calls for regulatory decisions in the communication sector to be made, "in an independent, impartial, objective (evidence- and knowledge-based), proportionate, and consistent manner" (OECD, 2021[1]). Similarly, the 2012 Recommendation of the OECD Council on the Regulatory Policy and Governance advocates for regulators to make objective,

impartial and consistent decisions, avoiding conflicts of interest (OECD, 2012[34]). The Annex to the Recommendation suggests consideration of independent regulators where regulatory decisions can have a significant economic impact on regulated parties (OECD, 2012[34]). This clearly applies to the communication sector.

Separating regulatory and policy-making functions is vital to promote independent, impartial and objective regulatory decisions, which are based on evidence and insulated from political influence. Across the OECD, this is standard practice, with 84% of communication regulators in OECD member countries established by legislation to be independent (OECD, 2022[35]).

An independent regulatory body is even more important in cases where the government owns shares in communication operators, as is the case in Indonesia. For example, the government retains ownership in Telkom Indonesia, Telkomsel and Indosat Ooredoo Hutchison, including Series A shares that denote specific rights to the government. Among these, Telkomsel and Indosat Ooredoo Hutchison are two of the main players, collectively holding almost three-quarters of the mobile market (Figure 3.5). Meanwhile, Telkom Indonesia is the leading operator in the fixed market with over 80% market share (Figure 3.6). Under the current institutional framework, the government acts as both policy maker and regulator.

Recommendation

1. **Establish an independent regulatory body with remit over the communication sector.** There is no independent regulator in the country, as MCI acts as both the policy-making entity and regulator. An independent regulator, equipped with the tools to monitor and enforce regulation over the communication sector, is considered good practice across the OECD. This is even more important in cases with state ownership in communication operators, as in Indonesia. Therefore, Indonesia should establish an independent regulatory body for the communication sector to strengthen its institutional framework, in line with OECD Recommendations (OECD, 2012[34]; OECD, 2021[1]).

3.3.2. Regulatory framework

Law Number 36 of 1999 on Telecommunications (Telecoms Law) is the main law in the communication sector (Government of Indonesia, 1999[36]). Accompanying this are several relevant Government Regulations (GR) and Ministry of Communications and Informatics Regulations (MR). One such implementing regulation is GR 46/2021 on Post, Telecommunications and Broadcasting, which details regulation regarding operation of communication networks, provision of service and spectrum use (Government of Indonesia, 2021[37]).

To operate communication networks or offer services in Indonesia, operators must obtain the relevant licence from MCI. Licences are required for communication network operation, communication services operation, special communication operation (Government of Indonesia, 1999[36]). Communication network operation comprises both fixed and mobile network operations, while communication service operation comprises basic telephony service operations; telephony value-added service operations; and multimedia service operations (Government of Indonesia, 2021[37]). Special telecommunication operations are conducted for personal or state purposes (Government of Indonesia, 2021[37]). The Telecoms Law requires licensed network operators and service providers to pay a fee based on a percentage of revenue, as well as contribute to universal service (Art. 16 and 26) (Government of Indonesia, 1999[36]).

3.3.3. Broadband strategies and plans

MCI released its strategic plan for 2020-24 in 2021, which sets out its main objectives and work plan until 2024. It focuses on advancing digital transformation across business, society and government, enhancing provision of communication infrastructure throughout Indonesia, and increasing transparency in public information and communication management (MCI, 2021[38]).

MCI set ten strategic targets to develop the communication and informatics sector for 2020-24 (Table 3.2). Three aim to extend connectivity in the country: increasing the coverage of high-speed and affordable broadband networks, promoting deployment of national next generation broadband connectivity and increasing availability of radio frequency spectrum (MCI, 2021[38]).

Table 3.2. Strategic targets for MCI's 2020-24 strategic plan

No	Strategic targets
1	Increase coverage of high-speed and affordable broadband networks.
2	Increase coverage of digital broadcasting.
3	Increase coverage of postal services.
4	Promote national next generation broadband connectivity.
5	Increase availability of radio frequency spectrum and improve the management of public services in the post, communication and informatics sectors.
6	Increase the use of ICT services by business.
7	Develop a "Digital Intelligent Society".
8	Support the digitalisation of government.
9	Increase the quality of information management and public communications.
10	Promote good governance.

Source: OECD elaboration based on MCI (2021, pp. 85-86[38]), *Strategic Development Plan Ministry of Communications and Informatics Year 2020-2024*, www.kominfo.go.id/content/detail/35108/rencana-strategis-kementerian-kominfo-2020-2024-untuk-percepatan-transformasi-digital-nasional/0/pengumuman.

Each strategic target includes goals to be achieved over 2020-24. For example, the target related to increasing the coverage of broadband networks puts in place specific goals related to 4G and fibre coverage, adoption of fixed broadband services, capacity of national satellites, and the affordability of fixed and mobile broadband services (MCI, 2021[38]). The target to promote next generation broadband connectivity defines specific 5G deployment goals, while the target related to spectrum seeks to increase the amount of spectrum available, among others (MCI, 2021[38]).

3.4. Competition, investment and innovation in broadband markets

3.4.1. Competition

As evidenced by the market structure presented above, several players operate in Indonesia's communication markets. However, some hold relatively more market shares than others, changing the competitive landscape. In the mobile market, Telkomsel leads with a 44.5% share in 2022, based on mobile broadband subscribers, according to national authorities. It is followed by Indosat Ooredoo Hutchison with 29%, XL Axiata with 16.3% and Smartfren with roughly 10% (Figure 3.5). Based on these data, the HHI is 3 191, driven largely by Telkomsel's market share. However, the newly merged entity, Indosat Ooredoo Hutchison, trails in market share by only roughly 15%. Meanwhile, the other two operators have non-negligible market shares (XL Axiata with 16% and Smartfren with 10%). This suggests there is some competitive pressure on Telkomsel. Nevertheless, the two leading operators have state ownership and

were incumbents prior to liberalisation through Telkom Indonesia (Telkomsel) and Indosat (Indosat Ooredoo Hutchison).

The fixed market is less balanced than the mobile market. In the fixed residential market (B2C), Telkom Indonesia holds 80.7% of the market based on fixed broadband subscribers as of Q4 2021. It is followed distantly by Link Net with close to 8% and MNC Kabel Mediacom with close to 3%. The remaining 9% is split by more than 500 smaller fixed providers (Figure 3.6). Based on these market shares, the HHI for the fixed residential market is 6 590, driven by Telkom Indonesia's share. While there are many more fixed providers compared to mobile providers, the strong position of Telkom Indonesia and the comparatively small market shares of other competitors suggest a much more concentrated market. The recent acquisition of Link Net by mobile operator XL Axiata may help increase competitive pressure on Telkom Indonesia. For their part, XL Axiata and Link Net seem intent on expanding their fixed footprint and increasing their market share. They have announced goals to pass one million homes with fibre by 2024, and an additional five million homes in the next five years, including outside of the most populous island, Java (Link Net, 2023[39]).

With respect to the fixed business market (B2B), Telkom Indonesia holds an even higher percentage of fixed business subscribers (close to 90%). Smaller providers hold the rest of the market (around 10%). Telkom Indonesia similarly is the largest provider in the wholesale market according to national authorities, which is unsurprising given its leading position in the fixed retail markets. This suggests that it holds the largest fixed network footprint across the country. National authorities also report five other wholesale providers, although no market shares were provided. Nevertheless, Telekom Indonesia – the incumbent – seems to dominate both fixed retail (B2C, B2B) and wholesale markets.

The regulatory framework governing competition is primarily defined through the Competition Law, which covers the broad economy (Government of Indonesia, 1999[40]). The Telecoms Law and associated ministerial regulations also contain provisions that aim to uphold competition. However, the Telecom Law states that the Competition Law and its implementing regulation are the prevailing laws to uphold fair competition in the communication sector, as stipulated in the "elucidation" section regarding Art. 10 (Government of Indonesia, 1999[36]). The Commission for the Supervision of Business Competition (KPPU) upholds the Competition Law. KPPU's duties include reviewing government policies related to monopolistic practice or unfair competition, investigating allegations of violations, assessing business activities and imposing sanctions (Government of Indonesia, 1999[40]).

KPPU is established through the law as an independent body, although its members are appointed by the president, upon approval of the legislature (Government of Indonesia, 1999[40]). Its budget is allocated by the state (Government of Indonesia, 1999[40]). Government influence may be possible through the appointment of high-level positions, as well as through its budget appropriation. Putting in place additional measures can help insulate KPPU from government influence. Such measures could include long-term budget allocations and a transparent selection and appointment process for KPPU leadership. Ensuring the body with the remit to uphold competition in the communication sector is independent of political influence is especially important given the state's ownership in key market players (e.g. Telkom Indonesia, Telkomsel, and to a lesser degree, Indosat Ooredoo Hutchison).

Under the Competition Law, an entity is found to have a dominant position if it holds a share of more than 50% in a particular market. Similarly, two or three entities shall be found dominant if they hold more than 75% of the market share (Art. 25) (Government of Indonesia, 1999[40]). The law prohibits business actors from using their dominant position either directly or indirectly to i) influence the market to hamper consumer choice of competitive goods or services; ii) restrict development of technology or the market; or iii) hinder business entry (Government of Indonesia, 1999[40]).

Market share under the Competition Law is based on the "percentage of the sale or purchase value of certain goods or services controlled by a certain business actor in the relevant market within a certain calendar year" (Art. 1[13]) (unofficial translation) (Government of Indonesia, 1999[40]). While this differs

from mobile subscribers, the subscriber market shares in Figure 3.5 and Figure 3.6 are likely still probative. Under these criteria, Telkom Indonesia would clearly hold a dominant position in the fixed residential (B2C) and business (B2B) markets, with over 50% market share. However, Telkomsel and Indosat Ooredoo Hutchison would not be considered as holding dominant positions as together in the mobile market they hold just under 75% of the market.

Another aspect to consider is the degree of competitive neutrality of the regulatory framework, which is especially important considering state ownership in key players in the communication sector. Competitive neutrality ensures that all players (e.g. public, private, Indonesian or foreign) face the same set of rules and compete on a level playing field (OECD, 2021[41]). However, entities with state ownership may receive treatment that could give them an edge over private competitors. In this regard, Indonesia could consider conducting a competitive neutrality review in the communication sector to assess the current level of competitive neutrality and identify ways to improve it to encourage greater competition.

The Competition Law further stipulates that business entities must notify KPPU of any mergers or acquisitions above a certain monetary threshold. It prohibits consolidation where it may "cause monopolistic practices and or unfair business competition" (Art. 28) (Government of Indonesia, 1999[40]). KPPU has put in place several guidelines and implementing regulation related to mergers. These include the 2020 Merger Guidelines (KPPU, 2020[42]) and the updated KPPU Regulation No. 3 of 2023, promulgated in March 2023 (KPPU, 2023[43]). Unlike merger regulation in other countries, the KPPU's review process occurs after the merger has taken place. Merging entities must notify the KPPU within 30 business days after the merger "legally comes into effect" (KPPU, 2020[42]). Despite this notification scheme after the legal closure, Art. 47 of the Competition Law asserts that KPPU can annul mergers or acquisitions if they violate Art. 28 (Government of Indonesia, 1999[40]).

Although KPPU can prohibit mergers or acquisitions, it has not done so in recent years (The Law Reviews, 2023[44]). Nevertheless, empowering the competition authority to approve or prohibit mergers or acquisitions due to impacts on competition is considered OECD good practice. While KPPU has not undertaken this right in recent years, the regulation covering mergers seems to give it this power without legislative changes.

In the recent merger of the Ooredoo Group and CK Hutchison, the merging entities notified KPPU. KPPU conducted a comprehensive merger review based on its initial assessment of market concentration and impact resulting from the merger (i.e. an HHI over 2 500, resulting in an HHI change of more than 150) (KPPU, 2022[22]). The companies reported KPPU's decision that the merger would be unlikely to result in monopolistic practices or unfair competition (Indosat, 2022[23]).

At the sectoral level, the Telecoms Law broadly prohibits monopolistic behaviour and unfair competition among communication operators (Art. 10) (Government of Indonesia, 1999[36]). Further, it establishes that all communication network operators have the right to interconnect (Art. 25) (Government of Indonesia, 1999[36]).

MR 5/2021 provides more detailed provisions on operation of communication networks, including on interconnection (MCI, 2021[45]). It also includes provisions regarding wholesale services, which must be offered on a "fair, reasonable and non-discriminatory" basis (Art. 37) (MCI, 2021[45]). Additionally, MR 5/2021 empowers MCI to regulate pricing of certain network operation and service tariffs to uphold competition and protect public interest (Chapter IX) (MCI, 2021[45]). Most recently, MR 576/2022 established evaluation guidelines to determine the upper and lower limits for communication network operation and service tariffs (MCI, 2022[46]).

As noted above, KPPU has the power to review governmental policies regarding competition provisions, which could include competition provisions in sectoral regulations. For this purpose, KPPU developed the "Guideline on Competition Policy Assessment Checklist", (KPPU Regulation No. 4/2016), reportedly based off the OECD's Competition Assessment Toolkit (OECD, 2021[41]). The OECD Competition Assessment

Toolkit is a checklist which aims to help governments identify unneeded restrictions on market activity to lower barriers to competition while still upholding policy aims (OECD, n.d.[47]). The *OECD Competitive Neutrality Reviews: Small-Package Delivery Services in Indonesia* recommends encouraging a wider use of the KPPU's checklist (Regulation No. 4/2016) by ministries, for example by making it mandatory when establishing new recommendations (OECD, 2021, p. 55[41]). KPPU's checklist, as well as the OECD's toolkit, could be a helpful guide to conduct a competition assessment in the sector to identify whether there are regulatory restrictions which could hinder market competition in the communication sector. This could be especially helpful to assess for the fixed market given Telkom Indonesia's current market shares in both residential and business fixed markets.

Recommendations

2. **Consider conducting a competitive neutrality review in the communication sector.** Given state ownership in key players in the communication sector, Indonesia could consider conducting a competitive neutrality review to assess whether changes to the regulatory framework may help to ensure all players compete on a level playing field.
3. **Consider undertaking a competition assessment in the sector, leveraging KPPU's "Guideline on Competition Policy Assessment Checklist".** Indonesia could undertake a competition assessment to identify whether there are regulatory restrictions which could hinder market competition in the communication sector. Such an assessment would be particularly pertinent for the fixed market, given Telkom Indonesia's market shares. In this regard, KPPU's Guideline on Competition Policy Assessment Checklist", (KPPU Regulation No. 4/2016), as well as the OECD's Competition Assessment Toolkit could be helpful.

3.4.2. Investment

Extending communication networks and improving their quality depends on sufficient investment. Indonesia's geography may increase the investment burden, above those of contiguous countries. These circumstances must be duly assessed when considering the level of investment in communication markets in the country. With respect to investments in mobile networks (Capex), Indonesia is the second highest in the region in nominal terms, behind Thailand, as of 2022 (GSMA Intelligence, 2023[14]). Indonesia's mobile investment (Capex) has shown stable growth from 2013-22, at a rate of 23% over that period, from USD 2.3 billion to USD 2.8 billion (GSMA Intelligence, 2023[14]). 4G mobile coverage by population reached 97% in 2022 (Figure 3.9), suggesting that operators have invested sufficiently to reach almost all of the country's population with 4G technology (GSMA Intelligence, 2023[14]). 5G coverage in 2022 reached 10% of the population, suggesting continued investment is needed to extend 5G coverage (GSMA Intelligence, 2023[14]).

Looking at fixed networks, Indonesia ranks fourth lowest in the region with only 4.9 fixed broadband subscriptions per 100 inhabitants (ITU, 2023[12]). Some of this may be due to coverage and, relatedly, low levels of investment to deploy fixed networks. While no information on fixed network investment is available, Indonesia's non-contiguous landscape likely increases the investment burden required to deploy fixed networks in the country. According to interviews with operators, much of the fixed network footprint is concentrated in the larger and inhabited islands, such as Java. Therefore, extending fixed network territorial coverage in particular likely entails connecting to other islands, which may be more financially burdensome compared to expanding coverage in a contiguous country. It is especially important in Indonesia as an archipelago with around 6 000 inhabited islands and islets (Ministry of Foreign Affairs, n.d.[2]). Additionally, other infrastructure, such as roads and electricity grids, may be less developed outside

of the most populous islands. This may pose an additional financial burden to overcome to deploy networks in these areas.

In addition to the cost of network deployment, fees levied on operators may influence investment decisions. These fees include an annual "telecommunications operations rights fee" (telecommunications BHP) of 0.5% of operators' gross revenues and an annual universal service contribution of 1.25% of operators' gross revenues (Art. 188) (MCI, 2021[45]). Spectrum fees also apply (Art. 59) (Government of Indonesia, 2021[37]).

Some aspects of Indonesia's regulatory framework aim to promote infrastructure investment, namely related to lowering foreign investment requirements and allowing infrastructure sharing. PR No. 10 of 2021, as amended by Presidential Decree No. 49 of 2021, established important changes to Indonesia's investment regime. They moved the country from a "negative list" for investment regulation to a positive one (OECD, 2023[48]). This "positive investment list" is generally open by default, whereby business sectors have no foreign investment restrictions unless specified (Medina, 2023[49]).

The new investment rules lifted foreign equity requirements in the communication sector (OECD, 2023[48]). This is a welcome move towards liberalisation, supporting promotion of investment in the sector. However, according to the OECD Services Trade Restrictiveness Index (STRI), despite these improvements, communication sector remains one of the most restricted service sectors in Indonesia. Its classification as one of Indonesia's most restrictive sectors is largely driven by barriers to competition, namely due to state ownership of communication players (OECD, 2023[48]). Other general regulations that apply to all economic sectors may also play a role. These include land ownership restrictions by foreigners; requirements that Indonesian nationals hold certain management positions; or commercial or local presence requirements (OECD, 2023[48]).

Nevertheless, Indonesia also has put in place other measures to encourage investment. Infrastructure sharing, for example, is a welcome measure. GR 46/2021 stipulates that business entities owning passive infrastructure (e.g. ducts, towers, poles, manholes) must open access to their infrastructure on a fair and non-discriminatory basis (Art. 25) (Government of Indonesia, 2021[37]). Furthermore, MR 5/2021 allows active infrastructure sharing at the initiative of private players and driven by business decision. Such agreements must be reported to MCI Minister (Art. 34-5) (MCI, 2021[45]).

Recommendation

4. **Consider further measures to decrease restrictions on foreign entry, including those applied more generally across the economy**. While recent legislative action to decrease foreign equity requirements in the communication sector is commendable, other economy-wide regulation appears to pose barriers to foreign actors to participate in the market. These include land ownership restrictions, requirements for Indonesian nationals to hold certain management positions, or commercial or local presence requirements, as outlined by Indonesia's STRI 2022 country note (OECD, 2023[48]). Lowering these regulatory barriers may help encourage foreign players to participate in the market, which could stimulate competition with incumbent operators to further invest to expand their networks. In addition, the existence of state ownership of communication players may pose another barrier. Indonesia could consider possible reforms of state ownership, notably of Telkom Indonesia, to make Indonesia's communication sector more conducive to foreign players and stimulate further competition in the market.

3.4.3. Innovation

To support innovation, Indonesia has emphasised its goal to promote next generation services and networks. For example, MCI's strategic plan for 2020-24 promotes next generation broadband connectivity as a strategic target (MCI, 2021[38]). Indonesia has also eased certain regulatory requirements to facilitate testing and trials. For example, GR 46/2021 grants an exemption to mandatory certification of compliance with technical standards for equipment and devices used for research and development and technology trials (Art. 35) (Government of Indonesia, 2021[37]). Similarly, spectrum fees are waived in cases of research, technology trials, or non-commercial testing of devices or equipment. However, this only applies to trials by government institutions or by Indonesian education and training organisations (Art. 62) (Government of Indonesia, 2021[37]).

To launch any new technology in their networks (e.g. 5G), mobile operators must undergo tests and receive a certificate of "operational worthiness" from MCI to certify that their facilities and infrastructure under the new network technology are fit for operation (Art. 4) (MCI, 2021[45]). In 2021, Telkomsel and XL Axiata announced receiving this certificate to launch 5G services (Telkomsel, 2021[50]; XL Axiata, 2021[51]). Indosat Ooredoo (now Indosat Ooredoo Hutchison) similarly reported launching 5G service in 2021 (Ooredoo Group, 2021[52]). This suggests a healthy industrial appetite to deploy new services and the necessary regulatory support to obtain legal requirements for 5G deployments.

However, 5G deployment appears to be limited thus far. As of September 2023, 5G has been deployed in 49 cities in Indonesia (MCI, 2023[53]). This limited deployment is also reflected in the low coverage of 5G service as of 2022 (Figure 3.9). The limited availability of spectrum appears to be one cause of the limited deployment, with some operators forced to repurpose existing spectrum for 5G. For example, XL Axiata announced using dynamic spectrum sharing on its spectrum holdings in the 1.8 GHz and 2.1 GHz bands for its 5G service (XL Axiata, 2021[51]).

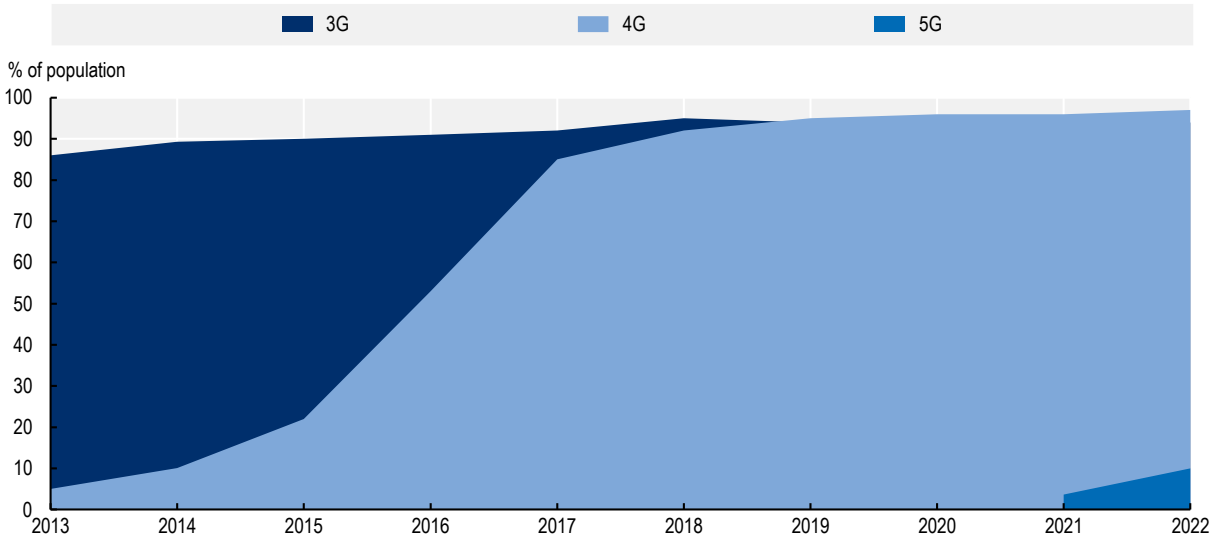
Indonesia has promoted policies that show support for innovative new services, such as 5G, and its regulatory framework does not appear to be hindering their deployment. However, the government's delay to assign sufficient spectrum appears to be holding 5G deployment back, as discussed in the Spectrum management section below.

3.5. Broadband deployment and digital divides

3.5.1. Broadband deployment

Indonesia made significant progress in mobile broadband development over the past decade. 3G coverage, which has exceeded 90% of the population since 2015, stands at 94% (GSMA Intelligence, 2023[14]). The 4G rollout took place mainly between 2013 and 2017, contributing to a near tripling of mobile subscriptions (Figure 3.9). In 2022, 4G coverage will reach 97% of the population (GSMA Intelligence, 2023[14]). 5G rollout in Indonesia is at an early stage, with coverage reaching 10% of the population in 2022 (GSMA Intelligence, 2023[14]). This will be an important next step to extend high-quality connectivity.

Figure 3.9. Mobile broadband coverage, 2013-22



Source: GSMA Intelligence (2023[14]), *Database,* www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/p34dl8

Although no data are available on coverage of fixed broadband networks, the penetration of services is one of the lowest in the region with 4.9 subscribers per 100 inhabitants (2022) (ITU, 2023[12]). Several factors could cause such a low rate: insufficient coverage; the relatively high price for fixed services; lack of digital literacy; or low household computer penetration. Lack of competition in the fixed market is a further concern. Local actors also report other factors limiting fixed deployment. These include difficulties in setting fees and in obtaining permits due to lack of harmonised procedures between island and local administrations.

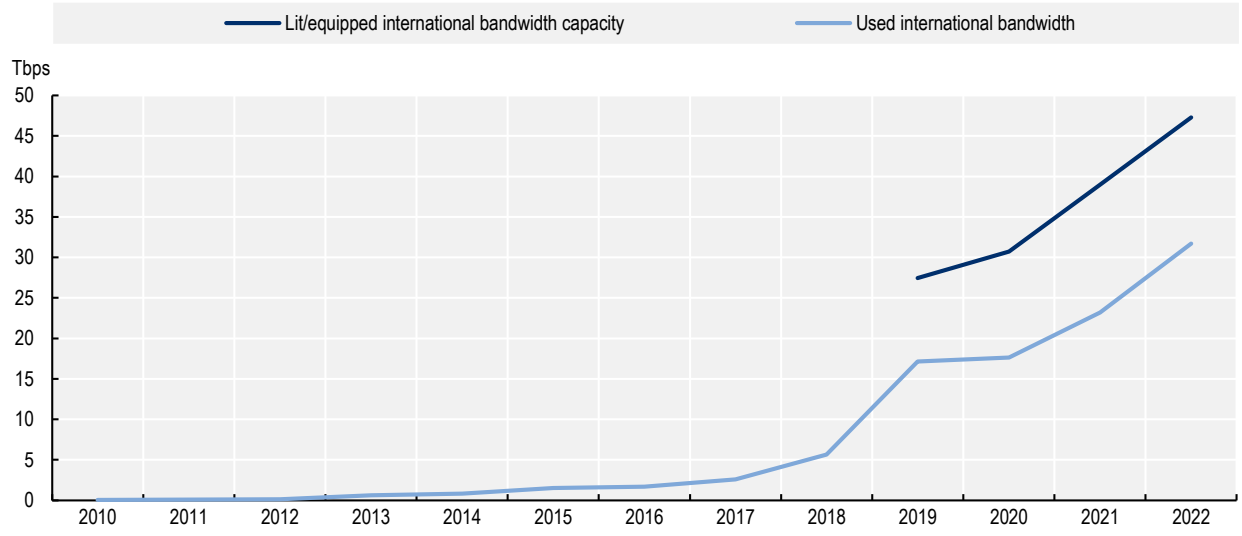
In terms of backbone/long-haul networks, Indonesia has a total route length of 237 934 km (route km) of fibre.[7] On the more populated islands, most connections are offered by multiple operators. These include Telkom Indonesia, Biznet Networks, PT Excelcomindo Pratama, PT Indonesia Satellite Corp, Moratelindo, and PT Perushahaan Gas Negara Tbk (ITU, 2023[54]). However, on less populated islands such as Borneo, Sulawesi or Papua, the number of operators with backbone infrastructure is much smaller. In many cases, there is only Telkom Indonesia fibre and the government-funded Palapa Ring Project (ITU, 2023[54]).

The backbone networks in Indonesia have a significant proportion of submarine cable segments. These cables connect remote islands but also connect nodes distributed along the coast. In total, 16 submarine cable systems only interconnect Indonesian islands (Table 3.3). In terms of technology, most of the backbone links are fibre-based. However, unlike in other countries, Indonesia has a significant proportion of microwave-based links, 8 231 km in total (ITU, 2023[54]). These are mainly on the islands of Borneo, Sulawesi, Papua, Bali, and Nusa Tenggara. Most are redundant links to other fibre links along the same path (technology diversity). Others provide alternative paths for other fibre routes (path diversity e.g. on Sulawesi). However, on Papua, they provide the only backbone connection to the interior.

Indonesia's backbone network coverage is relatively low with 36% of the population within 10 km of a node (SEA average 43%) (ITU, 2023[54]). This means that long-distance backhaul networks will need to be built to connect broadband access networks and reach end-users. This can be a barrier to extending coverage in areas of low commercial interest, such as sparsely populated areas.

Indonesia has the third largest international bandwidth capacity, 47.3 terabits per second (Tbps) (2022) (ITU, 2023[12]) representing 12% of the regional capacity. This makes it third in the region behind the 54% of international connectivity capacity provided by Singapore and the 23% provided by Malaysia (2022) (ITU, 2023[12]). However, Indonesia's used capacity represents 67% of the installed capacity. This means the country uses its capacity for its own traffic rather than acting as a router for international traffic. In contrast, the used capacity in Singapore and Malaysia represents less than 20% of installed capacity (ITU, 2023[12]). This is also reflected in the rapid growth in the use of international bandwidth from 2018 onwards, which is linked to the large increase in mobile broadband penetration in these years (Figure 3.10).

Figure 3.10. International bandwidth, 2010-22



Note: Lit/equipped international bandwidth capacity refers to the total lit capacity of international links, namely fibre-optic cables, international radio links and satellite uplinks to orbital satellites in the end of the reference year (expressed in Mbit/s). If the traffic is asymmetric (i.e., different incoming and outgoing traffic), then the highest value out of the two should be provided. Average usage of all international links, including optical fibre cables, radio links and traffic processed by satellite ground stations and teleports to orbital satellites (expressed in Mbit/s). The average is calculated over the twelve-month period of the reference year. If the traffic is asymmetric (i.e. different incoming and outgoing traffic), then the highest value out of the two should be provided. All international links used by all types of operators, namely fixed, mobile and satellite operators should be taken into account. The combined average usage of all international links can be reported as the sum of the average usage of each link (ITU, 2020[13]).

Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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Indonesia's international connectivity is provided by a remarkable number of submarine cables. Indonesia has the largest number of submarine cable connections in the SEA region, 48 in total. Of these, 32 are the domestic inter-island connections mentioned above; 16 are cable systems connecting countries in the region; and 11 are long-distance cables connecting various regions on a global scale (inter-regional cables) (TeleGeography, 2023[55]). The regional systems connect Indonesia mainly with Singapore (ten cables) and Malaysia (seven cables), while one cable connects with Thailand (Thailand-Indonesia-Singapore cable). However, considering all submarine cable connections, Indonesia is connected to all SEA countries except Cambodia and the landlocked Lao PDR (Table 3.3).

Indonesia is also connected by submarine cable to virtually all regions of the world (Table 3.4) through long-distance systems such as SeaMeWe-3 and 5 (TeleGeography, 2023[55]). Most connections are with Micronesia (six cables) and North America (five cables), as well as with Australia and New Zealand (four).

The high number of connections to the regional submarine cable systems (16 landing stations, the highest in the region), coupled with its significant international connectivity to long-distance cables, puts Indonesia in a good position to potentially leverage this infrastructure to become a regional hub for content and applications, as well as international connectivity.

Table 3.3. Indonesia's connections with other SEA countries via submarine cables

Cable system	Brunei Darussalam	Cambodia	Lao People's Democratic Republic	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
Apricot						x	x		
Asia Connect Cable-1 (ACC-1)						x	x		
Australia-Singapore Cable (ASC)							x		
B2JS (Jakarta-Bangka-Batam-Singapore) Cable System							x		
Batam Dumai Melaka (BDM) Cable System				x					
Batam Sarawak Internet Cable System (BaSICS)				x					
Batam Singapore Cable System (BSCS)							x		
Batam-Rengit Cable System (BRCS)				x					
Bifrost						x	x		
Dumai-Melaka Cable System				x					
East-West Submarine Cable System				x					
Echo							x		
Hawaiki Nui							x		
INDIGO-West							x		
Indonesia Global Gateway (IGG) System							x		
JAKABARE							x		
Jakarta-Bangka-Bintan-Batam-Singapore (B3JS)							x		
JASUKA				x					
Kumul Domestic Submarine Cable System									
Matrix Cable System							x		
Moratelindo International Cable System-1 (MIC-1)							x		
PGASCOM							x		
SeaMeWe-3	x			x	x	x	x	x	x
SeaMeWe-5				x	x		x		
SEA-US						x			
SEAX-1				x			x		
Thailand-Indonesia-Singapore (TIS)							x	x	

Source: OECD elaboration from TeleGeography (2023[55]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

Table 3.4. Indonesia's connections with other regions via submarine cables

Cable System	Northern Africa	Sub-Saharan Africa	Latin America and the Caribbean	North America	Eastern Asia	Southern Asia	Western Asia	Northern Europe	Southern Euproe	Western Europe	Australia and New Zealand	Melanesia	Micronesia
Apricot					x								x
Asia Connect Cable-1 (ACC-1)				x									x
Australia-Singapore Cable (ASC)											x		
Bifrost			x	x									x
Echo				x									x
Hawaiki Nui				x							x		x
INDIGO-West											x		
Kumul Domestic Submarine Cable System												x	
SeaMeWe-3	x	x			x	x	x	x	x	x	x		
SeaMeWe-5	x	x				x	x		x	x			
SEA-US				x									x

Note: According to TeleGeography (2023[55]), the following cable systems will be ready: Apricot 2024, Asia Connect Cable-1 2025, Bifrost 2024, Echo 2023 and Hawaiki Nui 2025.
Source: OECD elaboration from TeleGeography (2023[55]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

In addition to its extensive international connectivity infrastructure, Indonesia also has an elaborate Internet traffic exchange infrastructure with 17 IXPs (Table 3.5) (PCH, 2023[56]). Most of them, 13, are located on Java, the most populated island and therefore the one with the most Internet traffic. Of the 13, 8 are in Jakarta, responding to its high population and therefore traffic demand. Another IXP is located on the island of Batam, responding to the high number of submarine cable landing points in this location. Of the remaining three, two are on Bali (Denpasar) and one is on Sumatra (Bandar Lampung). Despite this high number, there are no local IXPs on three of the main islands, Kalimantan (Borneo), Sulawesi and Papua (New Guinea). This could disadvantage local traffic as local ISPs have to use inter-island links to exchange traffic.

Table 3.5. Internet exchange points, 2023

Name	City	Island
IIX-Lampung	Bandar Lampung	Sumatra
IIX-Jabar	Bandung	Java
Batam Internet Exchange	Batam	Batam Island
Bali Internet eXchange	Denpasar	Bali
cloudXchange	Denpasar	Bali
Biznet Internet Exchange	Jakarta	Java
Matrix Cable System Internet Exchange	Jakarta	Java
Indonesian Internet Exchange	Jakarta	Java

Name	City	Island
Jakarta Internet Exchange	Jakarta	Java
OpenIXP Internet exchange Point	Jakarta	Java
Batam Internet Exchange - Jakarta	Jakarta	Java
NEX Internet Exchange	Jakarta	Java
Cyber 2 Internet Exchange	Jakarta	Java
IIX Jawa Timur	Surabaya	Java
CitranetIX	Surabaya	Java
Universitas Negeri Yogyakarta Internet Exchange Point	Yogyakarta	Java
CitranetIX	Yogyakarta	Java

Source: PCH (2023[56]), *Internet Exchange Directory*, www.pch.net/ixp/dir (accessed on 5 December 2023).

3.5.2. Digital divides

Despite positive developments in mobile broadband penetration, Internet usage in Indonesia is among the lowest in the region. At 62% of individuals, it is only above Cambodia, the Philippines and Myanmar) (2021) (ITU, 2023[12]). There are also significant differences or divides depending on several factors. The geographical divide between urban and rural areas using the Internet is 23 percentage points (49% in rural areas compared to 72% in urban areas as of 2021) (ITU, 2023[12]). The age gap is also wide in Indonesia. While 92% of those aged 15-24 use the Internet, only 56% of those aged 25-74 do so, and the rate drops to 5% for those aged 75 and over (2021) (ITU, 2023[12]). The differences in Internet usage by gender are also pronounced, with a 6 percentage point difference in favour of men. This is surpassed by Myanmar with a 10 percentage point difference (2021) (ITU, 2023[12]).

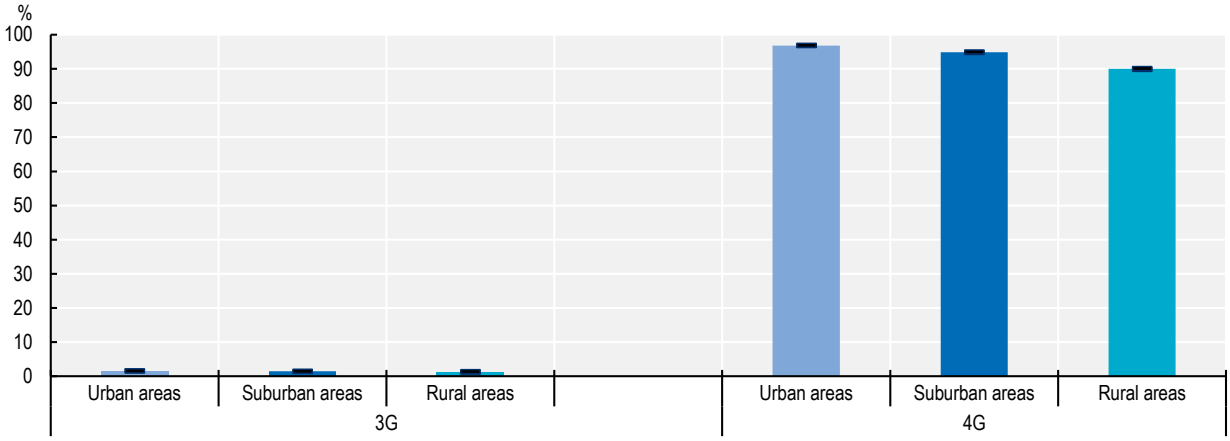
There are several reasons behind these divides on the supply side. Looking further at the supply-side reasons, mobile broadband mobile network availability, understood as the proportion of time users have a 3G and 4G connection (Opensignal, 2023[57]), shows some differences between urban, suburban and rural areas (Figure 3.11). According to Opensignal, mobile broadband availability is lower in rural areas (7 percentage points lower than in urban areas for 4G networks). Even so, availability in rural areas is still high at 90% (4G networks) (Opensignal, 2023[58]).[8] Despite the high level of mobile network availability, the lower quality of mobile broadband services in rural areas may contribute to the geographical divide (Figure 3.13).

With regard to fixed broadband, data disaggregated by degree of urbanisation are not available. However, interviews with local stakeholders indicate that network deployment is concentrated in the urban centres of the most populated islands, particularly in Java around Jakarta. This may limit connectivity for some users such as small and medium-sized enterprises and public administrations, which need the performance generally offered by these networks (e.g. higher upload speed and reliability).

Interviews for this study identified two main obstacles to network deployment in non-densely populated areas: lack of infrastructure in the backhaul section; and the long delays and administrative burdens in obtaining network construction permits. Regarding the first aspect, local stakeholders indicate that initiatives such as the Palapa Ring and other private initiatives are enabling the availability of inter-island backhaul links. However, there is a lack of infrastructure to connect the landing stations of these submarine cables to medium and small towns, i.e. there is a deficit in terms of backhaul and terrestrial backhaul networks. The cost of building this infrastructure can make a network deployment project unviable for a given area, especially without high demand, as is the case in rural areas. In terms of administrative barriers,

the problem is exacerbated outside major cities by lack of uniform rules at island and local level. This greatly increases the uncertainty and complexity of obtaining construction permits, or the excessive and costly nature of obtaining construction permits for network rollout works.

Figure 3.11. Network availability, percentage of time (3G, 4G), December 2022 – February 2023



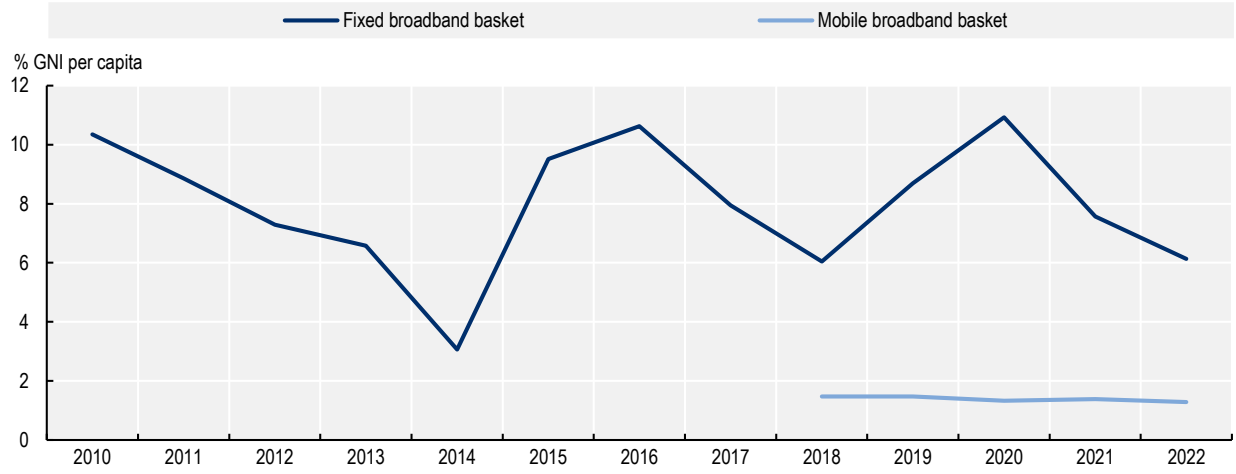
Notes:
1. Data was collected by Opensignal from its users over 90 days (1 December 2022–28 February 2023).
2. 3G availability shows the proportion of time that all Opensignal users had a 3G connection. 4G availability shows the proportion of time Opensignal users with a 4G device and a 4G subscription – but have never connected to 5G – had a 4G connection. 5G availability shows the proportion of time Opensignal users with a 5G device and a 5G subscription had an active 5G connection (Opensignal, 2023[57]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[59]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[60]).
Source: © Opensignal Limited - All rights reserved (2023[58]), http://www.opensignal.com.

StatLink https://stat.link/aribyv

Mobile broadband prices in Indonesia are relatively affordable in terms of purchasing power. Prices are below the target of less than 2% of gross national income (GNI) per capita for entry-level broadband services set by the Broadband Commission in support of the Sustainable Development Goals (UN Broadband Commission for Sustainable Development, 2022[61]) over the past few years (Figure 3.12) (ITU, 2023[12]).[9] Mobile handset prices are also relatively affordable in Indonesia. According to Tarifica, the benchmark price of entry-level internet-enabled handset account for 7.74% of average monthly income (2022) (Tarifica, 2023[62]). Of the countries surveyed, only Singapore has more affordable prices, where the reference price is 0.39% of monthly income (2022) (Tarifica, 2023[62]).

However, fixed broadband prices are significantly above this threshold, reaching 6.1% of GNI per capita in 2022, at the SEA average (ITU, 2023[12]). These data suggest that, at least for mobile broadband, the price of broadband access does not appear to be a determining factor in the digital divide between different socio-economic groups. However, it could be an important factor for fixed broadband, which can have long-term consequences on fostering an inclusive, high-quality access to broadband services.

Figure 3.12. Prices for fixed and mobile broadband services (percentage GNI per capita), 2010-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2010 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[15]). Mobile basket prices are not available from 2010 to 2017.
Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/4y0p6g

On the demand side, the data show a certain level of digital literacy among the Indonesian population. In Indonesia, 60% of the population has the most common skill, which is "using copy and paste tools within a document" (2017) (ITU, 2023[12]), a Figure similar to that of Brunei Darussalam. This is well above a similar indicator for other countries studied in this report, such as Viet Nam at 26% or Thailand at 23% (ITU, 2023[12]). However, it is lower than countries such as Singapore where 70.3% of the population (2021) have this basic skill (ITU, 2023[12]). Moreover, only 26% of the population in Indonesia has the more advanced skill of "sending e-mails with attached files" (2017) (ITU, 2023[12]). Data on digital literacy are not available for older age groups so it is not possible to infer the influence of age on digital literacy or the age gap.

3.5.3. Policies and regulation

Indonesian authorities have acted to foster infrastructure investment in two main areas: spectrum management and access to infrastructure. These are described below.

Access to passive infrastructure

GR 46/2021 stipulates that central and regional governments may play a role in providing facilities such as lands, buildings or passive infrastructure to be jointly used by telecommunications operators. Passive infrastructure operators who manage ducts, towers, poles and manholes for communication services must open their access to passive infrastructure use for telecommunication operators. Such use is based on

co-operation among parties in a fair, reasonable, and non-discriminatory manner at a reasonable cost (Government of Indonesia, 2021[37]).

Spectrum management

The Telecoms Law stipulates that the government supervises and controls the use of spectrum and requires operators to obtain a licence for the right to use spectrum in the country (Government of Indonesia, 1999[36]). MCI is the responsible body to manage spectrum. There are three types of spectrum licences: bandwidth, apparatus and class, according to GR 46/2021 (Government of Indonesia, 2021[37]). The transfer of spectrum is allowed but requires prior ministerial approval (Art. 15) (MCI, 2021[63]).

Bandwidth licences ("IPFR") grant the right to operate radio stations and use a given bandwidth of radio frequency in a certain area (Art. 10) (MCI, 2021[63]). Under MR No. 7/2021, bandwidth licences may be assigned through several methods, including auctions and "beauty contests". This is especially the case in bands where demand exceeds supply (Art. 12), such as for mobile communication services (MCI, 2021[63]). Well-designed spectrum auctions are considered best practice in OECD countries as they allow a transparent mechanism to determine the market value of the spectrum being made available (OECD, 2022[64]).

Bandwidth licences are valid for up to ten years and can be renewed once for up to ten years based on MCI's evaluation (Art. 20) (MCI, 2021[63]). Spectrum licence holders may be given priority for the renewal, subject to certain conditions (Art. 21) (MCI, 2021[63]). An initial duration of ten years for a licence is shorter than in other countries in the region and in many OECD countries. For example, a mobile spectrum licence in Cambodia, Singapore, Thailand and Viet Nam has a validity of 15 years. Assigning spectrum for a longer period helps provide mobile operators the investment certainty that when they deploy networks, they will have access to spectrum required to provide high-quality communication services. Indonesia could thus consider extending the initial validity of the spectrum licence especially for mobile communication services, while balancing other policy goals such as providing sufficient flexibility to ensure spectrum is used in the most efficient way to meet societal demands.

Spectrum license holders must pay fees, depending on the type of licence and the assignment method. Holders of bandwidth licences ("IPFR") must pay a spectrum usage fee (referred to as a "BHP IPFR") (MCI, 2021[63]). Some operators in Indonesia point to high spectrum costs, on top of the additional fees to operate in the country, as adding financial burden and limiting their ability to invest. Indonesia's unique geography may also require higher deployment costs to extend network coverage. Therefore, Indonesia could consider assessing whether spectrum costs may limit operators' ability to invest and, if so, adopting approaches to lower spectrum fees to foster network deployment and investment. For example, the government could seek to promote efficient spectrum use, rather than fiscal revenue maximisation in spectrum assignments. A revenue maximisation approach when assigning spectrum is not a guiding policy principle in many OECD countries (OECD, 2022[64]). When designing auctions, Indonesia could also consider ensuring reserve prices are set at a level that allows operators to demonstrate their valuation of the spectrum, which also serves to avoid unsold spectrum (OECD, 2022[64]).

The amount of available spectrum to provide communication services is also important, especially considering deployment of 5G networks. The 850 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 2.3 GHz bands have been assigned for mobile communications, according to national authorities. However, the overall amount of spectrum may be insufficient to support next generation networks. While Telkomsel, Indosat Ooredoo Hutchison and XL Axiata have all launched 5G networks, 5G network coverage in the country is low (Figure 3.9). Spectrum availability may be contributing to 5G's slow deployment. While some operators have additional spectrum to launch 5G, others must rely on existing spectrum holdings. For example, XL Axiata reported using dynamic spectrum sharing on the 1.8 GHz and 2.1 GHz bands to support its 4G and 5G services, as "an alternative choice considering the limited frequency that XL Axiata has to deploy 5G" (XL Axiata, 2021[51]).

Given these concerns, MCI should consider assigning additional mobile spectrum in the short term to support the deployment of 5G networks. In October 2023, MCI announced a public consultation regarding the use of spectrum in the 700 MHz and 26 GHz bands to support mobile communications (MCI, 2023[65]). This is a welcome development. Providing a sufficient amount of spectrum helps ensure mobile operators have the needed spectrum to support high-capacity 5G networks.

Universal Service Obligation

The Telecommunications Act stipulates obligations for communication network operators and/or communication service operators to contribute to universal service (Government of Indonesia, 1999[36]). MCI designates areas covered by universal service and supervises implementation of these obligations (Government of Indonesia, 2021[37]). Network operators and communication service operators must contribute 1.25% of their gross revenue (MCI, 2021[45]).

BAKTI (Badan Aksesibilitas Telekomunikasi dan Informasi, Telecommunication and Information Accessibility Body) manages the Universal Service Obligation (USO) fund. It also manages several projects based on the fund, such as the Palapa Ring Project, provision of a Base retriever station (BTS), Project SMF SATRIA, and provision of public Internet access services (BAKTI, 2023[66]).

Public initiatives to extend networks in unserved areas

The Palapa Ring Project builds the country's fibre-optic backbone network in non-commercial regions to integrate communication infrastructure. The project also aims to provide access at equal prices of fast Internet service (broadband) in all cities/regencies in Indonesia. It is divided into three work packages (West, Central and East) with cable reaching more than 12 000 km.

The project is implemented under two schemes: Government and Business Entities Co-operation (KPBU) and non-KPBU (built by operators). It has seven small fibre optic loops (for Sumatra, Java, Kalimantan, Nusa Tenggara, Papua, Sulawesi and Maluku) and one backhaul to connect them all. The project started in 2019 (MCI, 2021[38]), and plans to integrate the three packages are under way (ANTARA, 2022[67]).

Indonesia's geography means that fibre optic cables cannot reach all areas. Therefore, MCI is preparing to build SATRIA-1, a multifunction satellite (geostationary Very High Throughput communications satellite). It will have a capacity of 150 gigabits per second (Gbps). MCI plans to build 150 000 antennas in five regions outside Java, especially in non-commercial areas. SATRIA-1 launched in 2022 and will operate commercially by the end of 2023 (MCI, 2023[68]).

The government also plans to build two other satellites. SATRIA-2 will have a capacity of 300 Gbps and SATRIA-3 will have 500 Gbps. These are predicted to operate in 2024 and 2030, respectively (MCI, 2022[69]). Given developments in LEO satellites, the government could assess whether aiming only at geostationary satellites is the most effective strategy to address its connectivity targets.

As part of the USO project, MCI is building a BTS to provide mobile communication services in non-commercial areas. This project, which has been running for 14 years, set a goal to build BTSs for 4G service in 7 904 villages between 2021 and 2022 (MCI, 2021[70]; MCI, 2023[71]).

MCI also provides Internet access services, which are focused on specific public locations. These include schools, vocational training centres, community health centres, tourist locations and village halls. They also target rural government offices and areas that still need telecommunications, and information facilities and infrastructure. As of December 2020, Internet services were available in 11 817 locations across the country (MCI, 2021[72]).

Price regulation

Regarding the regulation of tariffs for communication services, MCI sets out a formula for operators to calculate their own tariffs. MCI may also stipulate the upper limit and lower limit tariff by considering the public interest and fair competition (Government of Indonesia, 2021[37]).

Digital skills programme

MCI has provided training in digital skills at basic, intermediate and advanced levels (MCI, 2021[72]). Since 2018, MCI has implemented Digital Talent Scholarship to improve the skills and competitiveness, productivity and professionalism of personnel in the field of information and communication technology. For 2022, the ministry allotted a quota of 200 000 seats for technical training, including in cloud computing, big data, artificial intelligence and cybersecurity (ANTARA, 2022[73]). In addition, Digital Leadership Academy is an intensive training programme designed for policy makers in government and private institutions to increase the capacities in digital technology and policy sectors. A national movement, Siber kreasi (Cyber Creative), also aimed to increase basic digital skill and digital literacy.

Consumer rights regulation

Communication service providers must compile statistical information related to complaints, such as the number of complaints and the number of complaints handled within standard hours, and publish it quarterly and annually.

Disputes between communication service providers or between communication service providers and users can be resolved through mediation through the director general. Mediation is a dispute resolution process to obtain an agreement through a negotiation or deliberation process between the parties assisted by the director general as mediator. If an agreement is not reached within 30 days from the start of the process, the dispute is resolved in accordance with laws and regulations (MCI, 2021[74]).

Recommendations

5. **Foster deployment of middle and last mile networks in unserved areas.** Building on the Palapa Ring Project to deploy a fibre backbone network, it is recommended to foster deployment of networks that extend the reach of this backbone network ever closer to the user by deploying fibre-based middle and last mile networks in unserved areas.

   This infrastructure would enable upgrading and increasing the capacity of broadband networks, thereby improving the quality of end-user services, as well as extending the coverage of high-quality networks, including Fibre-to-the-Home (FTTH) and 5G. It would also encourage new entrants to provide services at a local level, lowering the barrier to entry for the large investments required to connect backbone networks to population centres.

   Measures to support deployment of middle and last mile networks (e.g. public-private partnerships, subsidy schemes) should be transparent and avoid distortions of competition. This includes open and transparent procedures for awarding contracts or granting subsidies, and open, fair-priced and equal access to the deployed infrastructure for all market players.

   Synergies could also be explored with construction of other types of infrastructure, in particular roads, or other types of networks (electricity, gas). In this way, the costs of civil works could be shared, taking advantage of the joint deployment of communication networks to provide digital services such as road sensors or smart grids).

6. **Consider amending Indonesia's spectrum framework and assigning additional spectrum quickly to support 5G deployments.** Indonesia could consider assessing whether changes to its spectrum framework could promote network deployment and investment. For instance, Indonesia could study whether extending the initial duration of spectrum licences supporting mobile communication may grant greater investment certainty for operators deploying their networks. In addition, it could assess whether the current level of spectrum fees hinders operators' ability to invest and, if so, consider lowering overall spectrum costs. Furthermore, Indonesian operators' current spectrum holdings may be insufficient to support 5G deployments. MCI should consider assigning additional spectrum in the short term to support the deployment of next generation networks such as 5G.
7. **Reduce barriers to broadband deployment through simplified procedures for obtaining permits, access to public infrastructure and rights of way**. Indonesian authorities could consider adopting measures to simplify and streamline procedures for obtaining permits for network construction, access to public infrastructure and rights of way. In particular, it could focus on improving co-ordination between all authorities by breaking down potential silos and establishing a single point of contact or "one-stop shop" for operators.
8. **Consider leveraging international connectivity infrastructure**. Leverage Indonesia's strong international connectivity, and the relatively large number of IXPs, to serve as a gateway to the Internet for other less connected countries (as a main or back-up route to hubs in Singapore or Hong Kong, China), and for hosting content and other digital services (CDN nodes and cloud services) for the region.
9. **Leverage synergies between programmes to promote provision and adoption of connectivity services**. To maximise the joint impact of different initiatives to bridge the digital divide, it is recommended to build synergies between different initiatives to reduce the coverage gap (public Internet access services, satellite access). Initiatives could reduce the adoption gap, such as those aimed at improving digital literacy or raising awareness of the benefits of, and trust in, digital services. This could be achieved, for example, by co-ordinating extension of coverage in a given area, providing training or awareness-raising activities, or encouraging the development of locally relevant and easy-to-use applications and content.

3.6. Quality of networks (resilience, reliability, security and capacity)

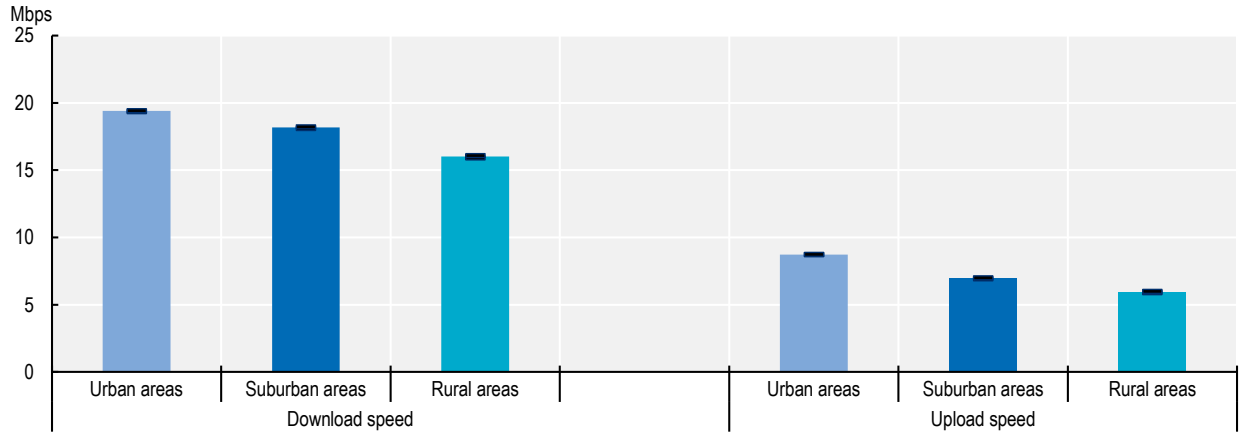
Indonesia's end-user broadband performance is among the lowest in the region for both fixed and mobile services. Fixed broadband speed was 27.1 megabits per second (Mbps)/14.7 Mbps (download/upload), the third lowest in the region above Myanmar and Cambodia for download speed and the lowest in the region for upload speed (Ookla, 2023[75]).[10] Median fixed broadband latency was among the highest in the region at 7 milliseconds (ms), just below Myanmar (8 ms) (July 2023) (Ookla, 2023[75]).[11] The quality of mobile broadband connections is also relatively low. The median mobile download speed was 24.2 Mbps/13.4 Mbps. This was the third lowest in the region for download speed, above Myanmar and Cambodia, the fourth lowest for upload speed, above the Philippines, Cambodia and Myanmar (July 2023) (Ookla, 2023[75]).

This low quality contrasts with the dominant technologies for both fixed access (FTTH for 99% of subscriptions in 2021) (ITU, 2023[12]) and mobile access (4G for 85% of connections in 2022) (GSMA Intelligence, 2023[14]), both of which can provide higher quality connections. There are several potential reasons for this. Insufficient segmentation of the last mile in the access network (of the cable or the coverage area of the antenna sector) can result in an overload of users sharing its capacity. This, in turn, can lead to congestion in the network and worsen end-user quality. At higher levels of the network, under-

dimensioning or technological obsolescence of active equipment in any segment of the network (backbone, backhaul or access) can have the same effect.

The user experience measures are somewhat worse, revealing some differences according to access technology and user location. The highest 4G speed experienced in urban areas was 19.4 Mbps for download and 8.7 Mbps for upload. For their part, rural users experienced 17.5% lower download speeds and a remarkable 31.8% lower upload speed (Figure 3.13) (Opensignal, 2023[58]). These results may indicate lower performance access networks in rural areas or under-dimensioning backbone and backhaul networks capacity.

Figure 3.13. Download/upload speed experience 4G, December 2022 – February 2023



Notes:
1. Data were collected by Opensignal from its users, over 90-days period (1 December 2022–28 February 2023).
2. Opensignal download/upload speed experience represents the typical everyday speeds an Opensignal user experiences across an operator's mobile data networks. 5G download/upload speed is the average speed observed by Opensignal users with active 5G connection. 4G download/upload speed is the average speed observed by Opensignal users when they were connected to 4G (Opensignal, 2023[57]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[59]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[60]).
Source: © Opensignal Limited - All rights reserved (2023[58]), http://www.opensignal.com.

StatLink https://stat.link/ple38o

In terms of network resilience, the high level of path redundancy of the national backbone networks, both terrestrial and maritime, provides alternative routes for traffic in the event of network failures. In this way, it contributes to the resilience of Indonesia's broadband services. In the more densely populated islands, a meshed topology creates this redundancy. It connects the coastal fibre rings via inland links, in particular Java and Sumatra, and connects Sulawesi and Borneo via microwave links. In the less populated islands, this redundancy is achieved by the ring topology of the lines connecting the coastal populations, e.g. in Kalimantan (Borneo) and Sulawesi islands. Inter-island sea links also often have a meshed configuration, which enhances the resilience of the inter-island link by providing alternative routes for traffic (ITU, 2023[54]).

Indonesia's international connectivity is also geographically diverse, taking advantage of its island geography. Batam, on the Singapore Strait, has the largest number of landing stations with 14, of which 11 are regional cable systems. It is followed by the city of Jakarta on Java with seven landing stations, of which four are extra-regional cable systems (Asia Connect Cable-1, Bifrost, Hawaiki Nui and INDIGO-West). The city of Tanjung Pakis, also on the island of Java, hosts the Apricot and Echo landing sites. Dumai and Medan in Sumatra host SeaMeWe-3 and SeaMeWe-3 landing stations, and the islands of Sulawesi (Makassar and Manado) host Bifrost and Asia Connect Cable landing stations (TeleGeography, 2023[55]).

3.6.1. Policies and regulation

Measurement and publication of quality of service data

Communication service providers are required to comply with technical standards and quality of service standards established for each service. In addition, compliance with quality of service standards must be measured, aggregated, and published quarterly and annually. For the Internet service, quality of service thresholds are defined for parameters, including packet loss rate, latency and network availability (MCI, 2021[74]).

Measures to improve network security

MCIT Regulation No. 26/2007 sets out the basic principles of IP networks security in Indonesia (MCI, 2007[76]). In addition, the Indonesian Internet Infrastructure Security Incident Response Team (ID-SIRTII) ensures network security. To that end, it monitors network threats and formulates plans to ensure network security through early detection and early warnings (MCI, 2010[77]).

Recommendations

10. **Publish open, verifiable, granular and reliable subscription, coverage and quality of service data.** Building on the reporting requirements for some of the quality-of-service indicators in the regulation (MCI, 2021[74]), it is recommended that open, verifiable, granular and reliable subscription and coverage data be published. In terms of quality-of-service data, the Vietnamese authorities could consider collecting and publishing indicators related to network resilience, in particular persistent outages.
11. **Promote measures to improve the quality and resilience of international connectivity.** Indonesian authorities could promote improved resilience of communication networks, in particular in geographical areas at high risk of natural disasters, including network diversity and redundancy. These actions could also support network investments necessary to implement the protection measures.

3.7. Environmental impacts of networks

No information is available to assess the impact of communication networks in Indonesia. However, policies and measures at different levels mitigate the environmental impacts of digital technologies, including connectivity, and help reduce the environmental impacts of other sectors.

Recommendation

12. **Support and promote smart and sustainable networks and devices and encourage communication network operators to periodically report on their environmental impacts and initiatives.** Indonesian authorities could consider designing a plan to support and promote smart and sustainable networks and devices. This plan could also include actions to encourage communication network operators to periodically report on their environmental impacts and initiatives to improve them, and to report on the positive environmental effects of connectivity.

3.8. Regular assessment of broadband markets

MCI publishes some broadband data in the "Telecommunications" section of its One Data Portal (MCI, 2021[78]). Specifically, it provides the latest available data on fixed and active mobile broadband subscriptions, fixed and mobile Internet traffic, total lit/equipped international bandwidth and signal coverage.

Recommendation

13. **Regularly assess the state of connectivity to determine whether public policy initiatives are appropriate, and whether and how they should be adjusted.** Building on the data on broadband connectivity collected and published by MCI on the Open Data Portal (MCI, 2021[78]), it is recommended to establish a system for regular assessment of the state of connectivity to determine whether and how public policy initiatives are appropriate. Disaggregating these indicators with sufficient geographical granularity could help differentiate data in areas with different degrees of urbanisation (rural, urban areas) and better understand trends in availability, performance and adoption of connectivity services. This information could be integrated into geographic information systems and published electronically.

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XL Axiata (2022), “Axiata and XL Axiata successfully complete the acquisition of 66.03% of Link Net’s shares”, 22 June, Press Release, XL Axiata, https://www.xlaxiata.co.id/en/news/axiata-and-xlaxiata-successfully-acquisition-linknet-shares#:~:text=Axiata%20and%20XL%20Axiata%20Successfully,Link%20Net's%20Shares%20%7C%20XL%20AXIATA. [17]

XL Axiata (2021), “XL Axiata passes the feasibility test of 5G operation ready to deploy 5G network in Indonesia”, 12 August, Press Release, XL Axiata, http://xlaxiata.co.id/en/news/xlaxiata-ready-to-deploy-5g-network. [51]

Notes

[1] Rural area (or mostly low-density cells) is defined as grid cells of 1 square kilometre with a density below 300 inhabitants per square kilometre and other grid cells outside urban clusters or centres (European Commission, Joint Research Centre, 2015[7]).

[2] Urban centre (high-density cluster) is defined as contiguous grid cells with a density of at least 1 500 inhabitants per square kilometre. An urban centre has a population of at least 50 000 (European Commission, Joint Research Centre, 2015[7]).

[3] Urban cluster (moderate-density cluster) is defined as contiguous grid cells with a density of at least 300 inhabitants per square kilometre and has a population of at least 5 000 in the cluster (European Commission, Joint Research Centre, 2015[7]).

[4] For mobile broadband subscriptions in 2022, data from 2021 has been used.

[5] Data are unavailable for the Philippines.

[6] As of 31 July 2023, there are three shareholders with over 5% stake of Axiata Group Berhad, XL Axiata’s parent company: Khazanah Nasional Berhad, with 36.43% of shares, Citigroup Nominees (Tempatan) Sdn Bhd – Employee provident fund board with 16.73% and Amanah Raya Trustees Berhad – Amanah Saham Bumiputera with 11.93% (Axiata Group, 2023[82]). Khazanah Nasional Berhad is majority owned by the Malaysian Minister of Finance (Khazanah Nasional Berhad, n.d.[79]). Amanah Raya Berhad also is owned by the Malaysian Minister of Finance (Amanahraya Trustees, 2023[80]).

[7] The indicator of ’transmission network length’, defined in the framework of the ITU Broadband Map (UNDESA, 2022[3]), refers to the physical length of fibre optic cable in a network irrespective of the number of optical fibres contained within the constituent cables of that network and can also be applied to microwave terrestrial networks. It is expressed in route kilometres (route-kms) (ITU, 2012[83]).

[8] Reproduced with permission of Opensignal, based on independent analysis of mobile measurements recorded during the period December 1, 2022 - February 28, 2023, © 2023 Opensignal Limited - All rights reserved.

[9] Specifically, “by 2025, entry-level broadband services should be made affordable in developing countries at less than 2% of monthly Gross National Income (GNI) per capita” (UN Broadband Commission for Sustainable Development, 2022[61]).

[10] Data collected and aggregated according to Ookla’s Speedtest® Methodology (Ookla, 2023[81]).

[11] Latency or ping is the reaction time of connection — that is, how quickly the user device gets a response after you've sent out a request. A fast ping means a more responsive connection, especially in applications where timing is everything (like video games). Ookla® measures several types of latency. The figures referenced in the text refer to ‘minimum latency’ that measures the best case latency for the user at the time they decide to take a Speedtest®. The lowest ping value is determined across one or more pings made before the download speed test – this represents the ‘minimum latency’ (Ookla, 2023[81]).

4 Extending broadband connectivity in Singapore

Singapore is almost entirely a dense city-state and the most advanced in terms of connectivity. Its level of human development, including income, life expectancy and education, is very high. Brunei Darussalam has similar demographic characteristics and also enjoys a high level of economic and human development. These countries are therefore analysed as a cluster, represented by Singapore. The chapter outlines the geographic, economic and social conditions for broadband connectivity in Singapore. It proceeds by examining the performance and structure of the market and reviewing Singapore's communication policy and regulatory framework, including broadband strategies and plans. It then reviews competition, investment and innovation in broadband markets; broadband deployment and digital divides; the resilience, reliability, security and capacity of networks; and the country's assessment of broadband markets. It offers recommendations to improve in these areas, which could be relevant for the other countries forming this cluster.

Policy recommendations

1. Consider increasing the independence of the Infocomm Media Development Authority by amending some of the legislative power of the Ministry of Communications and Information.
2. Strengthen the regulatory independence of Infocomm Media Development Authority by adopting measures to increase transparency in the selection process of top officials.
3. Continue to support innovation in uses and applications that take advantage of high quality, ubiquitous connectivity for all.
4. Continue to promote measures to improve the quality, resilience and security of communication networks.
5. Support and promote smart and sustainable networks and devices and encourage communication network operators to periodically report on their environmental impacts and initiatives.
6. Regularly assess the state of connectivity to determine whether public policy initiatives are appropriate, and whether and how they should be adjusted.

Note: These tailored recommendations build on the OECD Council's Recommendation on Broadband Connectivity (OECD, 2021[1]), which sets out overarching principles for expanding connectivity and improving the quality of broadband networks around a number of policy areas or pillars. The number of recommendations per country are not a good basis of comparison. These depend on several factors, including the depth of contributions and feedback received from national stakeholders.

4.1. Geographic, economic and social conditions for broadband connectivity

Singapore is a city-state located at the southern tip of the Malay Peninsula. It consists of Singapore Island and some 60 small islets, with the main island occupying almost all of the combined area. The main island is separated from peninsular Malaysia to the north by the Johor Strait. The southern limits of the state run through the Singapore Strait, where outliers of the Riau-Lingga Archipelago form part of Indonesia (Britannica, 2022[2]).

Singapore has a population of approximately 6 million people as of 2022 (UNDESA, 2022[3]). Urban centres account for almost the entire population (99.8% in 2015) and half of the territory (50.2%, 2015) (European Commission, Joint Research Centre, 2015[4]).

Nearly two-thirds of the main island is less than 15 m above sea level. Bukit Timah Hill, the highest summit, has an elevation of only 162 m and forms a block of rugged terrain in the island's centre (Britannica, 2022[2]). The country is exposed to flash floods due to monsoon rains, which subside relatively quickly (National Library Board, 2019[5]). In any case, Singapore has consistently sought to reduce its vulnerability through coping mechanisms. These include addressing infrastructure deficiencies and instilling a sense of public responsibility to respond to emergencies (UNOCHA, 2021[6]).

Singapore and Brunei Darussalam are analysed as a single cluster in this study and share several commonalities. They are the countries with the highest gross domestic product (GDP) per capita in the region, both above the OECD average (see Chapter 1). Singapore had a GDP per capita PPP of 127 564 current international dollars in 2022, ranking first among Southeast Asian (SEA) countries (IMF, 2023[7]). It was followed by Brunei Darussalam at 70 500 current international dollars (IMF, 2023[7]). Singapore and Brunei Darussalam have similar geographic breakdowns between urban and rural areas. As mentioned earlier, Singapore is a city-state, with 99.9% of its population living in an urban area (e.g. an “urban centre”[1] or “urban cluster”[2]) (European Commission, Joint Research Centre, 2015[4]). With 76.3% of its population

living in an urban area, Brunei Darussalam is also relatively urbanised among SEA countries (European Commission, Joint Research Centre, 2015[4]).

The United Nations Development Programme (UNDP) classifies Singapore and Brunei Darussalam as having a "very high" human development (UNDP, 2022[8]). Indicators across longevity, education and income for both countries are high among ASEAN countries (Table 4.1). The main difference between the two countries is the type of urbanisation, which in Brunei Darussalam is mostly urban cluster-based (64.1% of urban cluster) and in Singapore is urban centre-based (99.8% of urban centre).

Table 4.1. Human development (2021) and degree of urbanisation (2015), Singapore and Brunei Darussalam

	Life expectancy (years, 2021)	Expected years of schooling (children, 2021)	Mean years of schooling (adults, 2021)	Gross domestic product per capita, current prices (PPP, international dollars, 2022)	Population living in urban centres (%, 2015)	Population living in urban clusters (%, 2015)	Population living in rural areas (%, 2015)
Singapore	82.8 (1)	16.5 (1)	11.9 (1)	127 564 (1)	99.8	0.1	0.1
Brunei Darussalam	74.6 (4)	14.0 (3)	9.2 (3)	70 500 (2)	12.3	64.1	23.7
OECD average	80.0	17.1	12.3	58 937	48.8 (2022 data)	28.11 (2022 data)	23.11 (2022 data)

Note: The numbers in parentheses refer to the simple ranking (i.e. no weighting) of SEA countries for each indicator. The OECD average for human development indicators is a simple average across OECD member countries. The urbanisation indicators for SEA countries refer to the population percentage in urban centres, urban clusters and rural areas, respectively. For the OECD, figures are given for the rate of the population living in predominantly urban, intermediate, and rural regions, respectively.

Source: [Human development indicators] UNDP (2022[8]), *Human Development Report 2021/2022: Uncertain Times, Unsettled Lives: Shaping our Future in a Transforming World*, www.undp.org/egypt/publications/human-development-report-2021-22-uncertain-times-unsettled-lives-shaping-our-future-transforming-world. [GDP per capita, SEA countries] IMF (2023[7]), *World Economic Outlook Database, April 2023*, www.imf.org/en/Publications/WEO/weo-database/2023/April (accessed on 28 June 2023). [GDP per capita, OECD] OECD (2023[9]), *Gross domestic product (GDP)* (indicator), https://doi.org/10.1787/dc2f7aec-en (accessed on 30 June 2023). [Urbanisation indicators for SEA] European Commission, Joint Research Centre (2015[4]), *Global Human Settlement Layer (GHSL)*, https://ghsl.jrc.ec.europa.eu/CFS.php. [urbanisation indicators for OECD] OECD (2023[10]), *OECD.Stat* (database),*"Regions and cities: Regional statistics: Regional demography: Demographic indicators by rural/urban typology, Country level: OECD: share of national population by typology"*, https://stats.oecd.org/ (accessed on 28 August 2023).

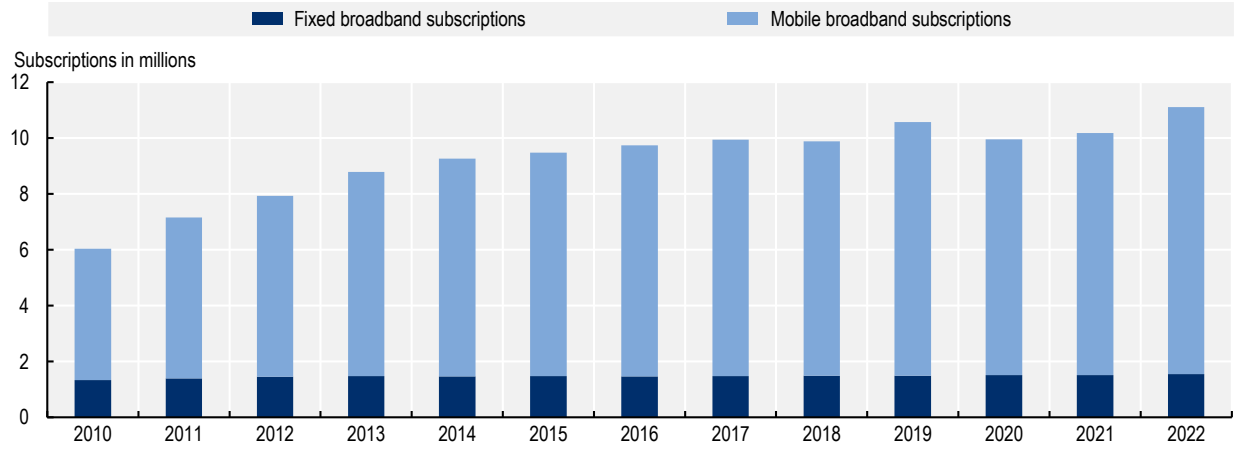
4.2. Market landscape

4.2.1. Market performance

The broadband market in Singapore is characterised by the exceptional circumstance of full mobile and fixed broadband coverage, reaching 100% of the population and 100% of households respectively. Against this background, according to data from national authorities the number of broadband subscriptions rose to 11 million by 2022, with mobile broadband accounting for 86% in 2022 (Figure 4.1).[3] Mobile broadband subscriptions grew at an average annual rate of 6% over the last decade (2011-22), compared to 1% for fixed subscriptions (Figure 4.1). Mobile broadband reached 169.6 subscribers per 100 inhabitants in 2022, the highest in the region and well above the OECD average (127.9 mobile subscribers per 100 inhabitants, 2022) (OECD, 2023[11]).[4]

Fixed broadband penetration is 27.4 subscribers per 100 inhabitants.[5] This is also the highest in the region, although below the OECD average (34.9 subscribers per 100 inhabitants, 2022). In terms of households that are passed by fixed broadband networks, there are 92.7 residential wired broadband subscriptions per 100 households in December 2022 (IMDA, 2023[12]) (IMDA, 2023[12]).[6] Given that each subscription is available to all household members, this figure illustrates the high proportion of inhabitants with access to fixed broadband.

Figure 4.1. Broadband subscriptions, 2010-22

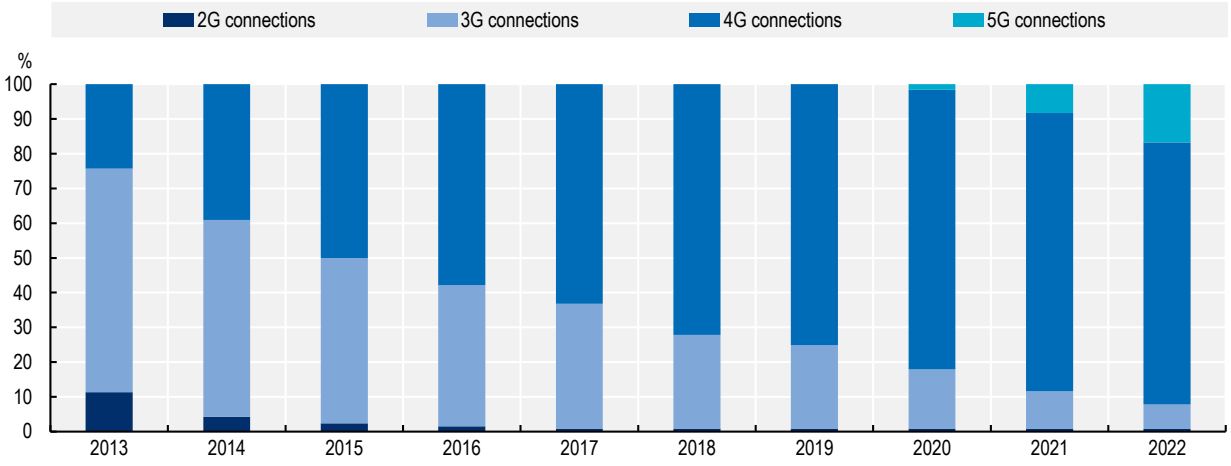


Note: Fixed broadband subscriptions refer to fixed subscriptions to high-speed access to the public Internet (TCP/IP connection) at downstream speeds equal to, or greater than, 256 kbit/s. This includes cable modem, DSL, fibre-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. It includes fixed WiMAX and any other fixed wireless technologies. This total is measured irrespective of the method of payment. It excludes subscriptions with access to data communications (including the Internet) via mobile-cellular networks. It includes both residential subscriptions and subscriptions for organisations. Mobile broadband subscriptions (active mobile-broadband subscriptions in ITU Database) refer to the sum of active handset-based and computer-based (USB/dongles) mobile-broadband subscriptions that allow access to the Internet. It covers actual subscribers, not potential subscribers, even though the latter may have broadband-enabled handsets. Subscriptions must include a recurring subscription fee or pass a usage requirement if in the prepayment modality – users must have accessed the Internet in the last three months (ITU, 2020[13]).
Source: Data provided by national authorities.

StatLink https://stat.link/7xktco

In terms of technology, 4G dominates mobile broadband with 75.4% of connections, followed by 3G with 7.0% of connections and 5G with 16.8% in 2022 (GSMA Intelligence, 2023[14]). Over the last decade (2013-2022), 4G connections have increased at the expense of 3G as users have adopted 4G compatible handsets. Since 2020, this upward trend has been reversed, with the rise in 5G adoption coinciding with the rollout of these networks (Figure 4.2). The share of 5G connections has risen sharply since then, reaching a penetration share of 16.8%. This is similar to other countries in the region with high 5G coverage such as Thailand, where 12.9% of mobile broadband connections are 5G in 2022 (GSMA Intelligence, 2023[14]).

Figure 4.2. Percentage of mobile connections per technology, 2013-22

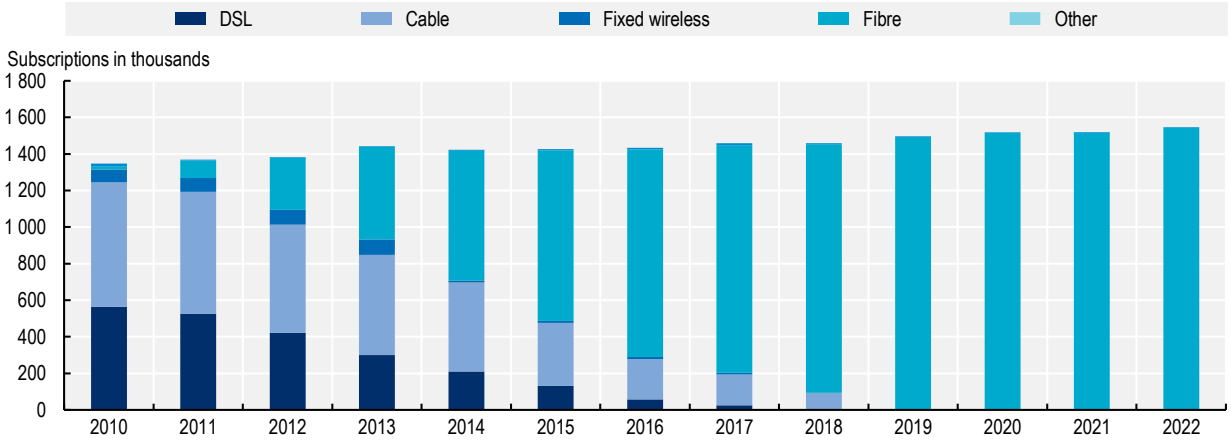


Source: GSMA Intelligence (2023[14]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/sa2hjw

The dominant access technology for fixed broadband in Singapore is Fibre-to-the-Home (FTTH) for virtually all subscriptions in 2022. Between 2010 and 2019, with the deployment of the Next Generation Nationwide Broadband Network (NBN), there was a migration from copper-based technologies, cable modem and digital subscriber line (DSL) to fibre-based technologies. Fixed terrestrial wireless was present in the early years of the migration to fibre, accounting for 5% (FTTH) of subscriptions (2010-13) and then declining to virtually disappear (Figure 4.3).

Figure 4.3. Fixed broadband subscriptions by technology, 2010-21



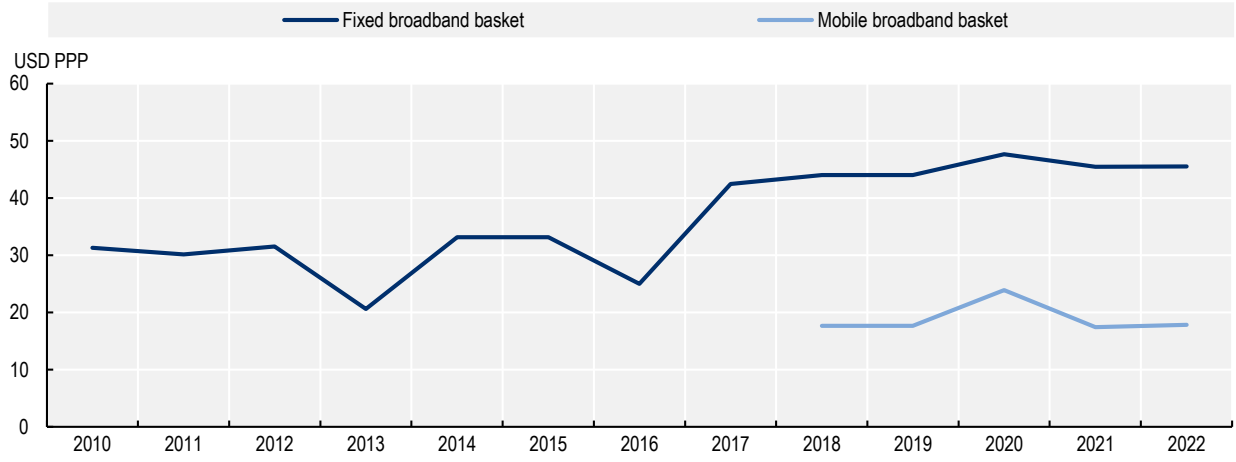
Source: Data provided by national authorities.

StatLink https://stat.link/yw5dj1

Prices for both mobile and fixed entry-level broadband services have remained largely stable and affordable (Figure 4.4, Figure 4.10). In 2022, the price of entry-level fixed service (5 GB) was USD PPP 45.5, which is below the regional average of USD PPP 51.6 (ITU, 2023[15]). On the mobile side, the price for entry-level mobile services (70 min + 20 SMS + 500 MB) in 2022 was USD PPP 17.9, slightly

above the regional average of USD PPP 15.5 USD PPP (ITU, 2023[15]). In both cases, broadband prices do not differ much from the regional average. However, when prices are calculated as a percentage of the gross national income (GNI) per capita of the country, Singapore's mobile and fixed prices for entry-level services are the most affordable in the region due to the country's higher GNI. Mobile prices were 0.3% of GNI per capita in 2022, while fixed prices represented 0.6% GNI per capita, well below the regional average (1.6% (mobile) and 6.2% (fixed) of GNI per capita, respectively) (ITU, 2023[15]).

Figure 4.4. Prices for entry-level fixed and mobile communication services, USD PPP, 2010-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2010 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[16]). Mobile basket prices are not available from 2010 to 2017.
Source: ITU (2023[15]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/n9erqw

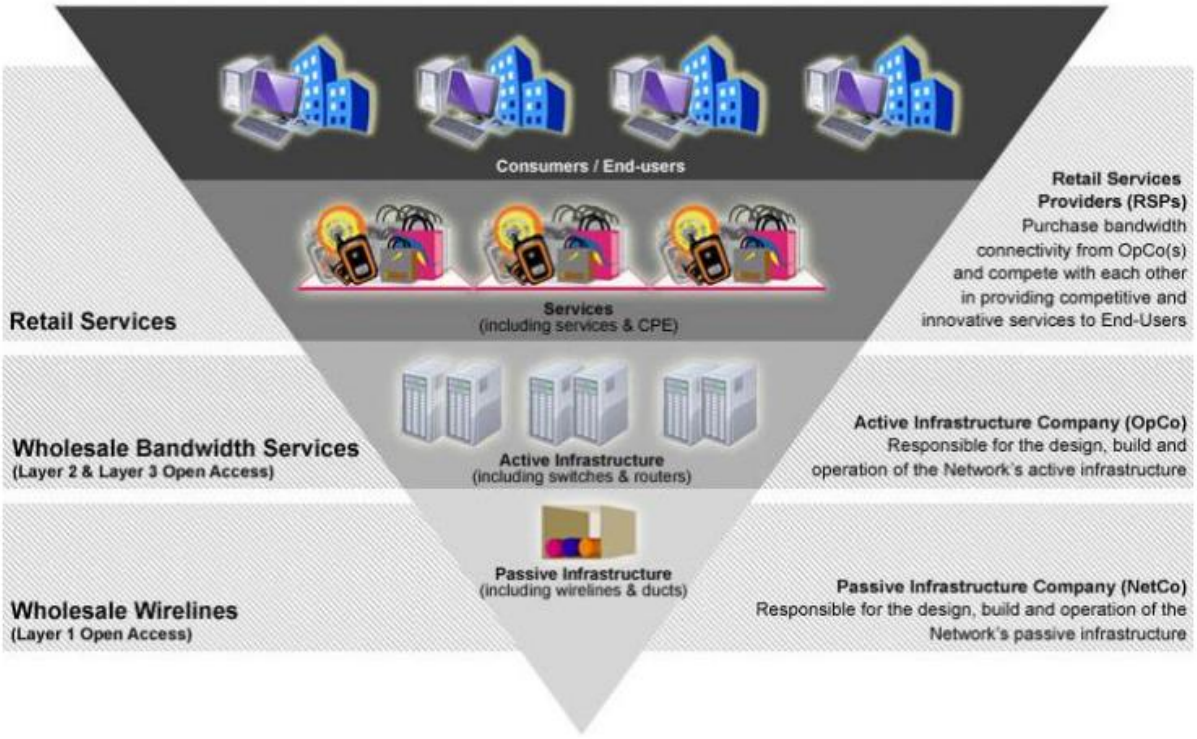
4.2.2. Market structure

Singapore liberalised the telecommunications sector in 2000, introducing full market competition in the sector (IMDA, 2000[17]). The limits on the number or type of licences were removed, except for instances where there were physical or resource constraints, in which case licences were awarded on a merit basis. The direct and indirect foreign equity limits for public communication service licences were also lifted (IMDA, 2000[17]). This move to liberalise was influenced by the liberalisation of the communication sector in several other countries around that time and the need to stimulate innovation to meet the increasingly diversified and sophisticated demand for communication services. The liberalisation of the communication sector has attracted global players to provide enterprise solutions (e.g. AT&T, BT, Vodafone, Telstra), satellite communication services (e.g. Inmarsat, Iridium Communications), and Internet exchange services (e.g. BBIX and Equinix). Singapore is also an international connectivity hub, where global digital giants like Meta, Amazon and Google have invested heavily in establishing connectivity in Singapore.

A defining aspect of Singapore's broadband markets is the Nationwide Broadband Network (NBN), a nationwide shared infrastructure upon which retail operators can offer end-user services. It was conceived

as the wired network of the “Next Generation National Infocomms Infrastructure”, under the Intelligent Nation 2015 (iN2015) master plan (IDA, 2011[18]). The model for building and operating the NBN is structured around the network layers (Figure 4.5). The passive infrastructure (including wirelines and ducts) is operated by a Passive Infrastructure Company (NetCo), which provides wholesale wireline access (Layer 1 Open Access). The active infrastructure (including switches and routers) is operated by an Active Infrastructure Company(ies) (OpCo(s)), which provides wholesale bandwidth services (Layer 2 and Layer 3 Open Access). Finally, Retail Service Providers (RSPs) purchase bandwidth connectivity from the OpCo(s) and provide services to end-users.

Figure 4.5. NBN structure



Source: Infocomm Development Authority of Singapore (IDA) (2013[19]), *Fact sheet (July 2013): Next Generation Nationwide Broadband Network*, https://www.imda.gov.sg/-/media/imda/files/community/consumer-education/fibre-broadband/nextgennbnfactsheet.pdf.

The Infocomm Development Authority (IDA) selected the NBN operators to build and operate the NBN network through an open tender process. It named the OpenNet Consortium (later acquired by NetLink Trust) as the appointed NBN NetCo in 2008 and Nucleus Connect as the appointed NBN OpCo in 2009, although other OpCos can provide services in this layer (IDA, 2011[18]). OpenNet was initially a consortium of four businesses (Axia NetMedia Corporation, Singapore Telecommunications Ltd (Singtel), Singapore Press Holdings Ltd and SP Telecommunications Pte Ltd) (IMDA, 2008[20]). In 2011, Singtel established NetLink Trust to hold the passive non-fibre assets (e.g. ducts), supporting OpenNet's fibre network rollout. In 2013, NetLink Trust acquired OpenNet (NetLink Trust, 2023[21]).

In 2017, Singtel decreased its deemed interest in NetLink Trust from 100% to roughly 25% (NetLink Trust, 2017[22]) As of 26 May 2023, Singtel indirectly retains 24.79% (deemed interest) in NetLink Trust through the shares of its wholly-owned subsidiary (Singtel Interactive Pte. Ltd.) (NetLink Trust, 2023, pp. 212-3[23]). Singtel Interactive Pte. Ltd. is the largest shareholder (NetLink Trust, 2023, p. 212[23]). The public held approximately 66.5% of NetLink Trust’s remaining shares (NetLink Trust, 2023, p. 213[23]).

For its part, Temasek Holdings is the largest shareholder of Singtel with just over 50% of shares (Singtel, 2023, p. 269[24]). It is classified as the only "substantial shareholder" considering its direct interest as well as deemed interest based on its subsidiaries and associated companies (Singtel, 2023, p. 269[24]). A Temasek Board member also acts as Chairman of the Singtel Board (Singtel, n.d.[25]; Temasek, n.d.[26]). Similarly, Temasek is listed as a "substantial unitholder" of NetLink Trust through Singtel's shares in NetLink, as well as shares, or deemed interest, held by other companies in Temasek's portfolio (NetLink Trust, 2023, p. 213[23]). Nucleus Connect, an OpCo, is a wholly owned subsidiary of StarHub Ltd.(StarHub) but with a separate legal status, board and brand (IMDA, 2009[27]; StarHub, 2022[28]).

StarHub also lists Temasek as a "substantial shareholder", with 55.87% of shares, as of 1 March 2023, as "deemed interest" (StarHub, 2022, p. 286[28]). This means that other companies under Temasek's portfolio own shares or have deemed interest. This is primarily through the holdings of its wholly-owned subsidiary, Singapore Technologies Telemedia (Temasek, n.d.[29]). Similarly, Temasek is the largest shareholder of Keppel Corporation, the parent company of M1 Ltd (M1), with 21.12% of shares and 0.23% deemed interest as of 2 March 2023 (Keppel Corporation, 2023, pp. 224, 245[30]).[7] Temasek is one of two "substantial shareholders" of Keppel Corporation (Keppel Corporation, 2023, p. 233[30]).

Temasek, an investment holding company, is designated as a "fifth schedule entity" under Singapore's Constitution, which subjects it to certain obligations (Temasek, n.d.[31]). These include requiring presidential approval for certain actions, such as the appointment or removal of the Chief Executive Officer (CEO) or members of Temasek's Board. Presidential approval is also needed when a proposed financial transaction will decrease Temasek's reserves to below the amount held before the term of the current government (Temasek, n.d.[31]). The Minister for Finance is Temasek's sole shareholder.

However, there are certain safeguards in place to protect Temasek's independence. For example, Temasek stipulates that :

> *Neither the President nor the Government is involved in Temasek's investment or other business and corporate decisions, except in relation to the President's role in the protection of Temasek's reserves. Similarly, Temasek does not direct the business decisions and operations of its portfolio companies. (Temasek, n.d.[32])*

The Ministry of Finance also asserts that there is no governmental influence over Temasek's individual investment decisions, nor is there government representation on Temasek's board (Ministry of Finance, 2023[33]). The government is involved to establish Temasek's overall investment mandate and objective; ensure Temasek's board is competent; and review portfolio risk and allocate government capital across Temasek and two other entities (Ministry of Finance, 2023[33]).

Nevertheless, the government, through Temasek, retains ownership in Singtel and, in turn, NetLink Trust. Similarly, the government, through Temasek, retains ownership through deemed interest in StarHub, and in turn, Nucleus Connect. Therefore, there is a degree of government ownership of both NetLink Trust and Nucleus Connect of the NBN, as well as in three main market players (for fixed and mobile): Singtel, StarHub and M1.

To support the NBN's rollout, the government provided grants of SGD 250 million (USD 181 million) to Nucleus Connect (OpCo) and SGD 750 million (USD 544 million) to OpenNet (NetCo) to jointly deploy the NBN network nationwide (IMDA, 2009[27]).[8] However, Singapore introduced structural and operational separation rules for NBN operators to ensure effective and equal open access downstream, which is explained in more detail in the "Competition" section below.

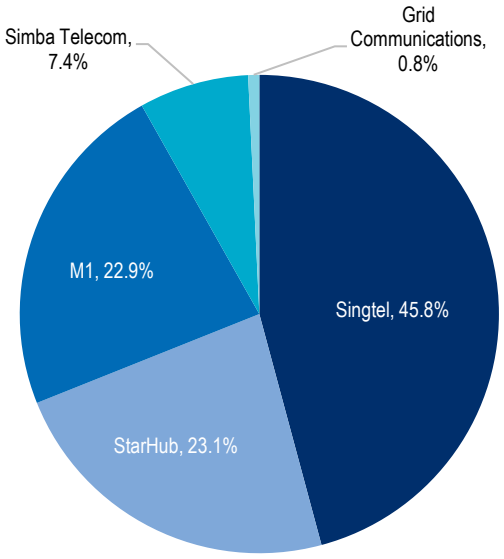
The NBN shared infrastructure provides the foundation for fixed broadband services in Singapore, especially for the residential market. For the residential market, RSPs provide fixed broadband services to residential users using NBN infrastructure. For the non-residential market, fixed broadband service providers can offer services using the NBN infrastructure, their self-owned fibre network or a third party's fibre network. Several operators offer retail fixed services to both residential and non-residential end-users.

While information on fixed market shares by operator are unavailable, the main providers of fixed retail services in the country seem to be Singtel, StarHub/MyRepublic and M1, according to desk research and informational interviews, however other providers also offer fixed services on the market. IMDA reported total fixed broadband subscriptions (residential and corporate) as of December 2022 to be 1.5 million (IMDA, 2023[12]).[9] Singtel announced 666 000 fixed broadband lines in December 2022, which would account for roughly 40% of the total fixed subscriptions reported by IMDA (Singtel, 2023, p. 10[34]). While not directly comparable with Singtel's numbers as StarHub/MyRepublic only reports fixed residential subscribers, as of December 2022 it had 578 000 subscribers (StarHub Ltd., 2023, p. 14[35]).[10] This suggests it is also an important player. M1 also seems to be present, although data on its fixed broadband subscriptions or subscribers is difficult to obtain.

Four main mobile network operators provide mobile broadband services in the retail market: Singtel, StarHub, M1 and Simba Telecom (formerly TPG Telecom). In addition, there are more than ten mobile virtual network operators (MVNOs) in the market, including MyRepublic (using M1's network), Circles.Life, Zero 1 and RedOne, among others. Singtel, the incumbent operator, leads with around 45.8% of the market based on mobile connections, followed by StarHub with 23.1%, M1 in a close third with 22.9% and Simba Telecom with 7.4% (Figure 4.6) (GSMA Intelligence, 2023[14]). Grid Communications holds the remaining 0.8% (GSMA Intelligence, 2023[14]).

According to information from national authorities, all four main mobile operators provide services primarily with their own networks. However, they may still contract wholesale services according to business decisions. For example, mobile operators may use NBN infrastructure to connect mobile base stations.

Figure 4.6. Mobile market shares based on mobile connections, Q4 2022



Note: Mobile connections are defined as "a unique SIM card (or phone number, where SIM cards are not used) that has been registered on a mobile network" (GSMA, 2022[36]).
Source: GSMA Intelligence (2023[14]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/1aht5d

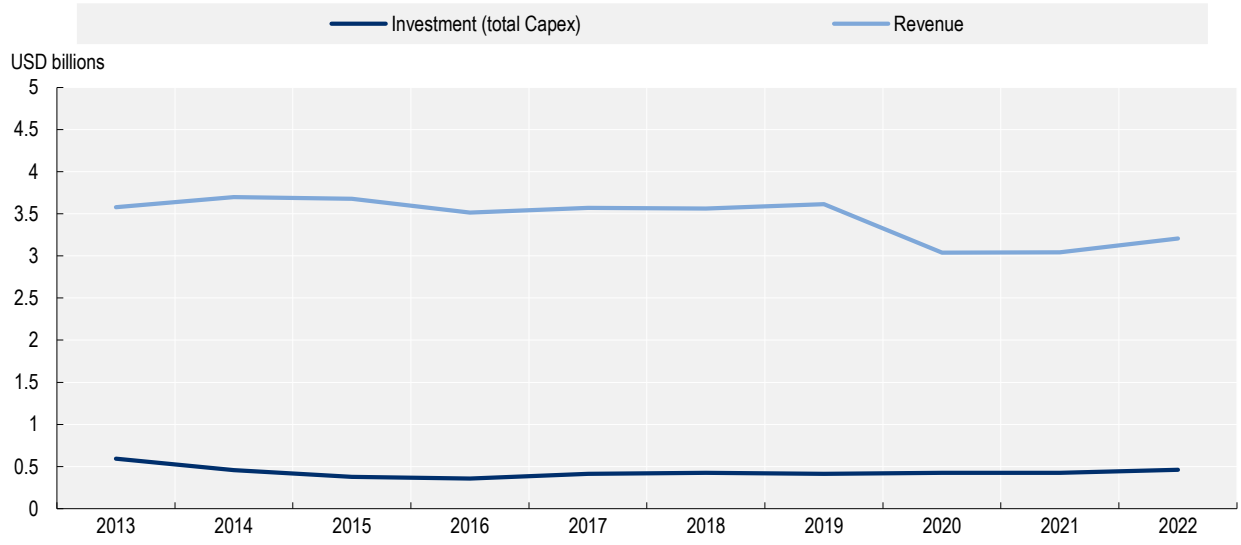
Both the mobile and fixed markets have seen changes in composition. In the mobile market, Simba Telecom launched commercial services in 2020 and has been gaining subscribers in the past few years (Simba Telecom, 2022[37]). In the fixed market, StarHub Online Pte Ltd acquired a majority stake in MyRepublic Broadband, representing MyRepublic Group's broadband operations in Singapore in 2022.

IMDA approved the acquisition on 9 March 2022 after a thorough competition assessment of relevant markets that would be affected, including both residential and non-residential fixed broadband markets (IMDA, 2022[38]).[11] After finding that the acquisition would not substantially lessen competition in any communication market in Singapore, and would not harm public interest, IMDA approved the acquisition without conditions (IMDA, 2022[38]).

Another aspect of market health and development is financial performance and investment by market operators. In Singapore, revenues from all communication services have a slightly decreasing trend over the past decade, according to information provided by national authorities. Annual revenues ranged from a high of SGD 14.1 billion (USD 10.2 billion) in 2010 to a low of SGD 9.5 billion (USD 6.9 billion) in 2018.[12] They rebounded to SGD 10 billion (USD 7.3 billion) in 2019, the last year of available data. Total investment in communication services follows a similar slight downward trend, according to information provided by national authorities. The highest investment of SGD 2.1 billion (USD 1.5 billion) occurred in 2010, with the lowest of SGD 969 million (USD 703 million) in 2020, the latest data provided.[13]

While revenue and investment data are unavailable for the fixed market, GSMA Intelligence data show a similar trend for the mobile market compared to the overall communication sector. Mobile revenues in nominal terms decreased by 10% over 2013-22, from USD 3.6 billion in 2013 to USD 3.2 billion in 2022 (Figure 4.7) (GSMA Intelligence, 2023[14]). Compared to other countries in the region, Singapore is ranked sixth in terms of revenues (nominal terms) for the mobile sector in 2022 (GSMA Intelligence, 2023[14]). However, the size of Singapore's market must be considered with this ranking, as its population limits potential revenue growth in the market. Even so, its nominal revenues rank above countries with higher populations (e.g. Myanmar and Cambodia).

Figure 4.7. Mobile revenues and investment (total Capex), 2013-22



Source: GSMA Intelligence (2023[14]), *Database,* www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/cwayne

In terms of investment in mobile networks, capital expenditure (Capex) in the country decreased by 23% over the period 2013-22 (GSMA Intelligence, 2023[14]). In nominal terms, Capex fell from USD 594 million in 2013 to USD 459 million in 2022 (GSMA Intelligence, 2023[14]). Regionally, total mobile investment levels (nominally) in Singapore again place it sixth as of 2022, the same ranking as the one based on revenues of the mobile sector.

4.3. Communication policy and regulatory framework

4.3.1. Institutional framework

The Ministry of Communications and Information (MCI) and the Infocomm Media Development Authority (IMDA) are the main bodies covering the communication sector in Singapore. MCI develops the government's national information and communication policies and oversees development of the communication and media sectors, among other areas of focus. For national strategic policies, MCI can provide guidance to IMDA on strategic directions, focus areas and programmes. The Telecommunication Act 1999 (Telecoms Act) grants the MCI Minister certain powers, such as issuing a written order in certain cases (Art. 91-2) and exempting certain persons from any or all provisions of the Telecoms Act (Art. 96) (Government of Singapore, 1999[39]).

IMDA is a statutory board that acts as the regulatory authority with responsibility over the communication and broadcasting sectors in Singapore. Around 40% of communication regulators in OECD countries as of 2022 are similarly converged regulators, with mandates covering both sectors (OECD, 2022[40]). Based on the IMDA Act, IMDA regulates and promotes development of the communication and broadcasting sectors, as well as upholds fair and effective market competition, among other functions (Singapore, 2016[41]).

To effectively perform its functions, IMDA may issue additional instruments that impose legal obligations, such as codes of practice and standards of performance. For example, the Code of Practice for Competition in the Telecommunication and Media Services 2022 sets out a competition framework and "imposes binding legal obligations" on relevant licensees (IMDA, 2022[42]). IMDA is also responsible for licensing as well as spectrum management and makes enforcement and regulatory decisions and policies independently of MCI. IMDA may advise the government on relevant matters relating to the communication and broadcasting sectors (Singapore, 2016[41]).

According to national authorities, IMDA is financed through fees collected from the industry (e.g. licence and spectrum fees) and the national budget from the Ministry of Finance. This is similar to many OECD countries, with roughly half of communication regulators (46%) being funded through a mix of budget from the government and fees collected from industry (33%) (OECD, 2021[43]).

MCI may interact with the functioning of IMDA in several ways. The MCI Minister may provide direction to IMDA in the performance of its duties (Art. 5) (Government of Singapore, 2018[44]). Further, the MCI Minister may request information from IMDA, which must be provided, and may propose a transfer of IMDA's functions to another body corporate for privatisation (Singapore, 2016[41]).[14] IMDA's 2021-22 Annual report summarises the relationship between MCI and IMDA ("the Authority") (IMDA, 2022, p. 74[45]):

> As a statutory board, the Authority is subjected to the control of its supervisory Ministry, MCI, and is required to follow the policies and instructions issued from time to time by MCI and other government ministries and departments such as the Ministry of Finance ("MOF"). (IMDA, 2022[45])

IMDA may issue codes of practice, standards, directions and advisory guidelines, without MCI approval. However, the MCI Minister must approve regulations (i.e. subsidiary legislation) IMDA may make to carry out the Telecoms Act's provisions, including regulations relating to the conditions for the grant of licences and spectrum rights, control and regulation of interference, and use of communication equipment, among others (Art. 97) (Government of Singapore, 1999[39]). In cases where a licensee wishes to appeal a decision of IMDA, the licensee may request that IMDA reconsider the matter or make an appeal directly to the MCI Minister (Art. 89) (Government of Singapore, 1999[39]). Further, as noted above, MCI has certain powers that may infringe upon or limit IMDA's authority in some cases (e.g. the power of exemption, the power of written order under the Telecoms Act). However, IMDA has the clear remit to regulate and monitor the communication sector.

These suggest that MCI may have power to influence IMDA's functioning, despite the latter's status as a statutory board. This may limit IMDA's independence. Both the 2021 Broadband Recommendation on Broadband Connectivity and the 2012 Recommendation of the OECD Council on the Regulatory Policy and Governance advocate for regulatory independence and independent regulators in certain cases, such as when regulating the communication sector (OECD, 2021[1]; OECD, 2012[46]). Singapore could consider measures to ensure IMDA's independence, such as amending some legislative powers granted to MCI over IMDA. This may help insulate IMDA from political influence and ensure it is equipped to fulfil its mandate.

As the parent ministry, MCI is also involved in appointing the IMDA Board, which provides guidance and advice to IMDA's management on all matters under IMDA's purview. The MCI Minister appoints IMDA Board members, Chairperson, Deputy Chairperson and Chief Executive (Singapore, 2016[41]). During the appointment process, the minister must assess whether candidates will collectively have the required knowledge, skills and experience to assist IMDA in performing its functions and confirm they do not meet any criteria for disqualification. Criteria for disqualification, as outlined in the IMDA Act, include bankruptcy, imprisonment, holding a judiciary office (e.g. judge), state of mental capacity or being disqualified under other Acts (Singapore, 2016[41]). The term of appointment is three years or less, but Board members may be reappointed (Singapore, 2016[41]).

There are 20 IMDA Board members, which is the maximum allowed by law (Singapore, 2016[41]). These Board Members come from several different organisations and may retain their positions, with the exception being the IMDA Chief Executive (IMDA, 2023[47]). The current Chairperson is from the Ministry of Health, and the current Deputy Chairperson holds positions within MCI and the Prime Minister's Office (IMDA, 2023[47]). Another Board Member is from the Government Technology Agency, a body under the Prime Minister's Office (Government of Singapore, 2023[48]; IMDA, 2023[47]). The risk of governance influence may be possible as Board members, especially the Chairperson and Deputy Chairperson, are from government bodies. According to the IMDA Act, the Chief Executive may not be appointed as either Chairperson or Deputy Chairperson to ensure the Board's leadership does not overlap with that of IMDA's.

The MCI Minister's appointment of IMDA's Board opens another avenue of possible political influence on IMDA. Additionally, the Board appointment process as outlined in the IMDA Act defines only broad criteria. This could be to allow for flexibility to adapt to the needed skills and expertise for an evolving digital landscape. Nevertheless, this allows for a good deal of discretion on the part of the minister, which could introduce further risk of political influence.

The appointment of IMDA senior management is carried out in alignment with the Public Service Division (PSD)'s broad guidelines for public sector officers across the government (Public Service Division, 2023[49]). However, the appointment process remains somewhat opaque. As IMDA senior leadership manages the organisation's day-to-day work, the appointment of these positions, as well as importantly that of the Chief Executive's appointment by the Minister, could be more transparent. This would ensure the process is merit-based and as insulated as possible from undue political influence.

Nevertheless, Singapore's appointment process by the MCI Minister is similar when compared to OECD countries. In many cases, a governmental or ministerial body appoints the leadership of communication regulators around the OECD (OECD, 2021[43]). Certain measures can help insulate the process from undue influence. These include promoting transparency in the appointment process and enacting a merit-based approach to nominate and appoint leadership, such as through an independent selection panel (OECD, 2021[43]).

Ensuring the independence of IMDA is important given state involvement of key players in the fixed and mobile markets, through Temasek, the investment holding company under the Minister for Finance. In such circumstances, a clearly established independent regulator is key to avoiding conflicts of interest arising when the government acts as both the regulator and the regulated entity.

However, despite these possible risks of political influence, Singapore has a strong track record against political corruption and good governance practices. It ranks highly on several international benchmarks, including the World Justice Project's Rule of Law Index and Chandler's Good Government Index (Chandler Institute of Governance, 2023[50]; World Justice Project, 2023[51]).

Recommendations

1. **Consider increasing the independence of IMDA by amending some of the legislative power of MCI.** While IMDA is a statutory body with remit over the communication sector, MCI has legislative power that may limit IMDA's independence. This includes ministerial approval for subsidiary legislation, ministerial powers to issue orders, grant exemptions and propose changes to IMDA's functions. In addition, government officials are on IMDA's Board, including the Chairperson and Deputy Chairperson, which may further risk governmental influence on IMDA. Limiting some of these legislative powers in the relevant legislation (Telecoms Act, IMDA Act) could ensure IMDA's independence. Such independence can also help avoid conflicts of interest, given state involvement in communication markets.
2. **Strengthen the regulatory independence of IMDA by adopting measures to increase transparency in the selection process of top officials**. As the MCI Minister selects the IMDA Board and Chief Executive Officer, this may introduce political influence in the appointment process, especially as the current process allows the minister to exercise a high degree of discretion. Singapore could consider adopting measures to increase the transparency of its appointment process, such as by clearly defining the process and the selection criteria of the IMDA Board, particularly the Chief Executive Officer. In addition, implementing an independent selection panel in selection processes of key high-level officials and board members could help ensure that senior staff have relevant skills and experience, and that political influence is limited.

4.3.2. Regulatory framework

The Telecoms Act (Government of Singapore, 1999[39]) and the IMDA Act (Singapore, 2016[41]) establish the basis for Singapore's communication regulatory framework. The Telecoms Act gives IMDA the power to grant licences and impose licence conditions (Art. 5) (Government of Singapore, 1999[39]). There are two main types of licences granted for the provision of communication services: a Facilities-Based Operations (FBO) licence and a Services-Based Operations (SBO) licence. An FBO licence allows operators to deploy communication networks, systems or facilities to offer communication services. It is granted on a technology-neutral basis (IMDA, 2021[52]). An SBO licence allows operators to provide communication services (IMDA, 2022[53]). The provision of communication services is included under an FBO licence, meaning a FBO licensee only requires a single licence for all the networks/services it intends to operate/offer (IMDA, 2021[52]). However, should an SBO licensee want to deploy its own network, it would need an FBO licence to replace its prior SBO licence (IMDA, 2021[52]). FBO licences are granted on an individual basis, whereas an SBO licence may be either on an individual or class basis, depending on the service.

FBO licensees that plan to develop large-scale services nationwide may apply to be designated as a Public Telecommunications Licensee (PTL), which grant it provisions to facilitate network installation and maintenance and protect their systems (IMDA, 2021[52]). IMDA may require PTLs to adhere to universal service obligations (IMDA, 2021[52]). NetLink Trust, Singtel and Starhub are designated as PTLs (IMDA, 2023[54]). The term of the FBO licence is 15 years and 20 years for FBOs designated as PTLs (IMDA, 2021[52]). These two FBO licence types may be renewed for an additional period as decided by IMDA (IMDA, 2021[52]).

An SBO licence covers several scenarios, including leasing network elements from an FBO to provide its own communication services, reselling an FBO's communication services to a third party, or deploying networks and providing communication services to third parties residing within their property boundaries (IMDA, 2022[53]). An individual SBO licence is required to provide services such as international simple resale (voice and data traffic), public Internet access services and mobile virtual network operation, among others (IMDA, 2022[53]). On the other hand, several communication services fall under the class SBO licence category, including Internet-based voice and data services, call-back services and public payphone services, among others (IMDA, 2022[53]). SBO individual licences have a validity of five years, with the possibility of renewal (IMDA, 2022[53]). This is a relatively short licence validity and requires service providers to reapply every five years. SBO class licences do not require renewals after being granted (IMDA, 2022[53]).

According to the Telecoms Act, any licence may include requirements related to interconnection, sharing of facilities, sharing or trading of spectrum, and compliance to applicable codes of practice and standards of performance (Government of Singapore, 1999[39]). IMDA must approve equipment connected to the network or belonging to a licensee before use (Government of Singapore, 1999[39]). The Act also establishes certain rights-of-way provisions to facilitate network installations and contains provisions to prevent damage to cables (Government of Singapore, 1999[39]).

In addition, the Act grants IMDA the power to issue codes of practice and performance standards, directions to licensees and advisory guidelines concerning any aspect of communication (Government of Singapore, 1999[39]). IMDA has issued several codes of practice related to the communication sector, which include the Code of Practice for Competition in the Provision of Telecommunication and Media Services 2022, the Code of Practice for Info-communication Facilities in Buildings and the Next Generation Nationwide Broadband Network NetCo Interconnection Code.

4.3.3. Broadband strategies and plans

In 2006, Singapore launched its Intelligent Nation 2015 (iN2015) masterplan. One key pillar aimed to establish “next generation national infocomm infrastructure” (Next Gen NII) (IMDA, 2006[55]). Under the Next Gen NII, the NBN was set forth to foster deployment of high-speed broadband across the country, as discussed above (IDA, 2006[56]). The Next Gen NII also included a mobile component to deploy wireless broadband in the north, east and west of the country (IDA, 2006[56]).

In 2015, Singapore announced the “Infocomm Media 2025 (ICM2025)”, expanding on the iN2015 Masterplan. The ICM2025 is organised around three themes: i) leveraging big data and advanced communication and computational technologies; ii) fostering a risk-taking and experimental environment; and iii) connecting people using digital tools (MCI, 2015[57]). In addition, supporting broad policy aims to foster high-quality communication networks in the country, IMDA has included network rollout requirements for certain spectrum bands. For example, operators receiving 5G spectrum (i.e. 2.1 GHz, 3.5 GHz bands) must reach 50% coverage of their 5G standalone networks within two years and nationwide coverage within five years (IMDA, 2021[58]).

Building on previous plans, Singapore launched the Digital Connectivity Blueprint in June 2023 (MCI, IMDA, 2023[59]). The Blueprint aims to enable Singapore’s entire “digital infrastructure stack” (MCI, IMDA, 2023[59]). Two of the Blueprint’s five strategic priorities relate specifically to connectivity. One priority aims to double submarine cable landings within the next 10 years to further expand and diversify Singapore’s submarine cable network. Another priority sets a goal of 10 Gbps domestic connectivity within the next five years (MCI, IMDA, 2023[59]). Singapore plans to support this second priority through actions such as facilitating a tenfold increase in the NBN’s bandwidth and allocating spectrum to support faster Wi-Fi networks and 5G Standalone (SA) networks (MCI, IMDA, 2023[59]). Resilience, security and sustainability of Singapore’s digital infrastructure are also included in the Blueprint’s strategic priorities.

4.4. Competition, investment and innovation in broadband markets

4.4.1. Competition

The market structure presented above allows for an initial assessment of market competition in Singapore. In the retail mobile market, Singtel holds 45.8% of mobile connections, followed by StarHub with 23.1%, M1 with 22.9%, Simba Telecom with 7.4% and Grid Communications with 0.8% as of Q4 2022 (Figure 4.6) (GSMA Intelligence, 2023[14]). Based on these market shares, the mobile market has an Herfindahl-Hirschman Index (HHI) of 3 214, driven in large part by Singtel's market share. Singtel, StarHub, M1 and Simba Telecom operate their own networks. Several MVNOs also operate in the market. The presence of four MNOs, one of which recently launched service (Simba Telecom), and several MVNOs seems to suggest a sufficient level of competition, despite Singtel's market share.

While, fixed market share data is unavailable, Singtel, StarHub/MyRepublic and M1 also seem to be important players in the fixed retail market. Other providers also offer fixed services. The barriers to entry are low to offer fixed broadband services (residential and non-residential), as any new entrant can contract wholesale services and bandwidth capacity from NetLink Trust and any OpCo. This puts the new entrant on a level playing field with respect to network capacity and service.

In its 2022 competition assessment prior to StarHub's acquisition of MyRepublic, IMDA reached similar conclusions for the residential fixed broadband market. It found the acquisition unlikely to affect competition due to several market characteristics. In addition to low barriers of entry, a number of providers offered residential fixed broadband services (more than five apart from the entities involved in the acquisition). Moreover, the non-residential fixed broadband market had more than 30 service providers (IMDA, 2022[60]). These conclusions supported IMDA's decision to allow the acquisition to proceed without conditions (IMDA, 2022[60]).

While competition at the retail level in the fixed market seems strong, the competition at the infrastructure level is important to consider. This is relevant given the NBN's integral role in the fixed market as the primary provider at the infrastructure level for residential fixed broadband subscribers. As shown in Figure 4.5 and noted above, only one NetCo deploys, maintains and operates the passive infrastructure (e.g. dark fibre, ducts). To ensure effective open access of the fixed market, IMDA has imposed structural separation on the appointed NBN NetCo (i.e. NetLink Trust). This separation ensures that the NetCo is independent from, and not under any effective control of, any of its downstream operators (IMDA, n.d.[61]). In 2017, Singtel sold approximately 75% of its shares in NetLink Trust (NetLink Trust, 2023[21]). This was to comply with the structural separation requirements put in place by IMDA. In addition, NetLink Trust's interconnection offer must comply with the Interconnection Code and receive IMDA approval (IMDA, 2020[62]).

IMDA also imposed an operational separation on the appointed NBN OpCo (i.e. Nucleus Connect), which is responsible for the NBN's active infrastructure. The appointed NBN OpCo may be fully owned by its downstream operating units, but is required to treat all RSPs, including affiliated operators, the same (IMDA, n.d.[61]). Nucleus Connect is just one OpCo of the NBN's active infrastructure layer and is a wholly-owned subsidiary of StarHub Ltd. According to NetLink Trust reports from 2017, there were 13 OpCos (NetLink Trust, 2017[63]). Although the total may have changed since 2017, the OpCo layer remains dynamic according to national authorities. Such safeguards on the appointed NetCo and OpCo seem to limit harmful impacts on overall competition.

The IMDA Act and the Telecoms Act establish authority to carry out the regulatory tools mentioned above to uphold competition. These acts give IMDA the authority to maintain and promote fair and efficient market conduct and effective competition in the media and communication markets. While the Competition and Consumer Commission of Singapore (CCCS) is the general competition authority, IMDA has the mandate to oversee and govern competition of the communication and media sectors.

Under its mandate, IMDA issued the Code of Practice for Competition in the Provision of Telecom Services in 2010. It was revised in 2022 into a unified competition management framework, covering the communication and media sectors – the Code of Practice for Competition in the Provision of Telecommunication and Media Services (the Code) (IMDA, 2022[42]). The Code is legally binding and aims to maintain effective and sustainable competition as well as safeguard consumer interests in the communication, broadcasting and newspaper markets (IMDA, 2022[42]). At the time of writing, IMDA is consulting on advisory guidelines on collective dominance under Section 8 of the Code, intended to clarify how abuse of collective dominance in communication and media markets is treated (IMDA, 2023[64]).

The Code classifies a business as a "Dominant Entity" in either one of two scenarios. In the first, a business operates facilities to provide communication services that are sufficiently difficult or costly for a new entrant to replicate, creating a significate barrier to entry by an efficient competitor. In the second, it has the ability to exercise significant market power in any market in which it operates.

A Dominant Entity is subject to various *ex ante* obligations under the Code. These include obligations to provide non-discriminatory services at fair and reasonable prices and conditions, allow the resale of end-user services and submit tariffs to IMDA for approval (IMDA, 2022[42]). In addition, Dominant Entities are subject to *ex post* competition regulations prohibiting abuse of a dominant position and anti-competitive conduct (IMDA, 2022[42]). Today, NetLink Trust Pte Ltd and Singtel are classified as Dominant Entities. Singtel, for example, must submit its Reference Interconnection Order (RIO) to IMDA for approval, which is published and made available for public consultation (IMDA, 2023[65]). Non-dominant entities are not subject to such obligations; however they must publish tariffs, along with terms and conditions of standard services to increase transparency for the customer (IMDA, 2023[66]).

All communication licensees must interconnect with other licensees and submit a copy of all interconnection agreements to IMDA (IMDA, 2022[42]). Operators are encouraged to conclude these agreements through commercial negotiations, but IMDA has additional provisions to ensure interconnection with dominant licensees. Specifically, IMDA requires dominant licensees to provide the following three interconnection options: i) according to an IMDA-approved RIO offer; ii) on the same terms as an existing interconnection agreement; or iii) through an individualised interconnection agreement (IMDA, 2022[42]). In this regard, IMDA has detailed requirements and pricing provisions for RIOs, as well as dispute resolution mechanisms in case no agreement on interconnection can be reached (IMDA, 2022[42]). In particular, given the critical nature of NBN infrastructure for provision of fixed services, the NetCo Interconnection Code and OpCo Interconnection Code specifies the terms, prices and conditions of NetLink Trust's (NBN NetCo) and Nucleus Connect's (NBN OpCo) interconnection offers (IMDA, 2020[62]; IMDA, 2020[67]).

The Code also contains provisions governing mergers and acquisitions involving communication licensees. Parties must obtain IMDA approval where an acquisition would result in an acquiring party obtaining between 12% and 30%, or 30% or more voting shares/voting power in a communication licensee (IMDA, 2022[42]). IMDA will analyse the potential acquisition's impact on competition, or the development of future competition, in any communication market. In cases where the proceeding is expected to substantially lessen competition or is in the public interest to deny, IMDA may reject the request. IMDA may also approve in part or in full, or with conditions designed to reduce anti-competitive harm or effect or address public interest concerns (IMDA, 2022[42]).

For StarHub Online Pte Ltd's acquisition of a majority interest in MyRepublic Broadband Pte Ltd in 2022, the IMDA conducted a competition assessment to analyse the potential impact the proposed acquisition may have on relevant markets. The acquisition was approved after IMDA concluded the acquisition was unlikely to substantially lessen competition in any communication market in Singapore, and the absence of public interest concerns (IMDA, 2022[38]). Ensuring that the regulatory authority can approve or deny merger or acquisition proceedings, or impose conditions, is generally considered to be best practice in the OECD.

Overall, the competition regulatory framework in Singapore seems robust. There is a mechanism to determine and classify dominant entities and a framework to consider and approve business consolidation proceedings. Further, IMDA has several regulatory tools, which it has previously employed, to uphold the competition framework. For example, IMDA publishes its enforcement decisions in cases where licensees violated IMDA's licences and codes of practice, including the Code of Practice for Competition in the Provision of Telecommunication and Media Services (IMDA, 2023[68]). IMDA has a clear mandate to regulate on competition issues in the communication sector, and with little overlap seen with the general competition authority.

4.4.2. Investment

Singapore's regulatory framework includes different measures to promote and foster investment in communication networks. IMDA has aimed to promote investment and ease network deployment for several years. Indeed, one motivation behind the NBN was to overcome barriers to deploy fibre network infrastructure nationwide. The government supported the NBN's initial network deployment by providing SGD 250 million (USD 181 million) to Nucleus Connect and SGD 750 million (USD 544 million) to OpenNet as investment funding to jointly deploy the NBN network (IMDA, 2009[27]).[15]

IMDA also imposed open access requirements to ensure that fixed service providers can access passive and active infrastructure at non-discriminatory prices, terms and conditions. Likely given the importance of the continued investment by NetLink Trust – the NBN NetCo – to maintain and upgrade its passive fibre infrastructure, it is the only operator regulated under a "Regulated Asset Base regime" (NetLinkNBN, 2022[69]). This allows NetLink to recoup its investments and operating expenses and receive a set rate of return for its fibre assets, as regulated by IMDA (NetLinkNBN, 2022[69]).

Singapore also encourages infrastructure sharing to reduce the cost of investment. The Code of Practice for Competition generally does not obligate licensees to share their communication infrastructure with other licensees (IMDA, 2022[42]). However, IMDA may require sharing of communication infrastructure it deems as "critical support infrastructure" or an "essential resource" (IMDA, 2022[42]). IMDA, for example, has designated mobile radio systems in tunnels, wiring in buildings, ducts, manholes, poles and towers as critical support infrastructure (IMDA, 2022[42]). Licensees typically negotiate their contracts for infrastructure sharing, but IMDA can intervene if an agreement cannot be reached. As one example, Singtel's RIO, currently under consultation, stipulates that Singtel must offer access to essential support facilities, such as access to ducts and manholes (IMDA, 2023[65]). In addition, the open access requirements noted above can be considered a type of mandated infrastructure sharing, whereby NetLink Trust must offer certain services related to its passive fibre infrastructure network to all requesting qualified parties. Apart from NBN, other fixed operators – such as those providing services with their own networks to non-residential customers – may invest jointly in network infrastructure, with IMDA monitoring these co-investments to ensure no damage to competition.

On the mobile side, given that each MNO has its own business strategy, commercial goals and deployment plans, IMDA has said it will not impose shared requirements at the network-wide level. It will thus maintain the existing regulatory framework, which encourages private operators to voluntarily make commercial agreements. However, there is a clear example of co-investment on the mobile side. In 2020, IMDA selected a consortium of two competing operators, StarHub and M1, to obtain 3.5 GHz and millimetre wave spectrum rights to deploy a national 5G network (IMDA, 2023[70]). Through the consortium, StarHub and M1 announced plans to jointly build and operate a 5G network. Cited benefits include optimising costs of both infrastructure and spectrum (StarHub, 2020[71]).

Singapore also supports investment by removing restrictions on foreign direct investment. Other than the requirement that an applicant for an FBO licence must be incorporated under the Singapore Companies Act, there are no restrictions on foreign control or ownership of operators of communication services (IMDA, 2021[52]).

Licence fees are an important factor when it comes to infrastructure investment decisions. FBO licensees and licensees offering public mobile data services are subject to an annual license fee according to the sum of the following (IMDA, 2021[52]):

- For annual gross turnover (AGTO) of up to SGD 50 million (USD 36 million), an annual fee of SGD 80 000 (USD 58 013) applies.
- If AGTO is above SGD 50 million up to SGD 100 million (USD 73 million), an additional license fee is added at 0.8% of the amount above SGD 50 million (USD 36 million).
- If AGTO is above SGD 100 million (USD 73 million), an additional licence fee is added at 1% license fee on the excess above SGD 100 million (USD 73 million).[16]

For FBOs designated as PTLs, the annual license fees for the first SGD 50 million (USD 36 million) in AGTO are higher, at SGD 200 000 (USD 145 033). However, the percentage of additional licence fees according to higher AGTO (i.e. 0.8% and 1%) is the same as listed in the paragraph above (IMDA, 2021[52]).[17] Annual licence fees also apply to SBOs, but these are lower than FBOs (IMDA, 2022[53]).

Licensees using spectrum must also pay for spectrum use. Fees for long-term use of spectrum are classified into two types: i) application and processing; and ii) frequency management. Application and processing fees are a one-time charge, payable at the time of assignment (IMDA, 2022[72]). Frequency management fees are payable annually to cover IMDA's operating costs of ensuring the safe use of frequency (IMDA, 2022[72]). For public mobile services, the application fee per frequency is SGD 300 (USD 218) and the management fee is SGD 7 700 (USD 5 584) per 5 MHz (IMDA, 2022[72]).[18] These appear to be set based on cost recovery. Annual spectrum fees, or another form of annual regulatory fee, are seen in some other OECD countries, and are often set at levels to recoup administrative costs (OECD, 2022[73]).

In addition, mobile operators in Singapore also often pay substantial assignment fees for the right to use mobile spectrum. For example, in the most recent auction of spectrum in the 2.1 GHz band, StarHub/M1 paid SGD 52.5 million (USD 38 million) for 25 MHz; Singtel paid SGD 65 million (USD 47 million) for 25 MHz; and Simba Telecom (TPG Telecom) paid SGD 31 million (USD 22 million) for 10 MHz (IMDA, 2023[74]).[19] This is just one example, as auction fees depend on several factors, such as the demand for the spectrum band in question and its characteristics. Auctions are considered best practice around the OECD in cases where demand exceeds supply, as well-designed auctions allow the parties that will use it most efficiently to obtain the spectrum (OECD, 2022[73]).

Considering the overall level of fees with operators primarily being required to pay only licence and spectrum fees, these do not seem to be set at levels that place an unreasonable burden on investment. However, given the graduated scale of FBO licence fees, this must be monitored based on the actual fees that apply to the main operators in the country.

As mentioned in the "Market structure" section, total investment in communication services, reported by national authorities, and mobile investment specifically, based on GSMA Intelligence data, showed a slight decreasing trend in past years. Mobile investment, in nominal terms, places Singapore in the bottom half of the region (sixth in 2022) (GSMA Intelligence, 2023[14]). However, this simple ranking hides differences between countries that may affect the amount of investment required to deploy and maintain high-quality networks. For example, Singapore has a much smaller geography for network deployment. This means the needed investment to maintain and upgrade its networks is likely much lower than in countries with more area to cover. In addition, Singapore has been a frontrunner to deploy 5G networks. This suggests that mobile operators are indeed investing at sufficient levels to deploy and upgrade high-quality networks. Mobile operators may also be able to leverage the NBN's fixed infrastructure (e.g. to connect mobile base stations), which is likely less costly than managing their own infrastructure.

On the fixed side, the NBN has helped decrease infrastructure investment costs and deploy high-quality fibre infrastructure in the country. Singapore will embark on a nationwide upgrade of the existing fibre-

based NBN, in partnership with the industry, to facilitate a ten-fold increase in speed in the next five years, as part of Singapore's Digital Connectivity Blueprint. Broadband speeds of up to 10 Gbps, alongside Wi-Fi 6E and its 5G Standalone networks, will provide end-to-end 10 Gbps connectivity. Singapore aims to begin the upgrade in mid-2024 (MCI, IMDA, 2023[59]). Singapore's regulatory framework, together with the several mechanisms in place to foster investment, seem to largely be functioning well.

4.4.3. Innovation

Innovation seems to be a high priority for Singapore, as evidenced by aspects of its regulatory framework and several governmental programmes aiming to foster innovation. One way to promote innovation through the regulatory framework is to adopt technology-neutral approach. In Singapore, the Code of Practice for Competition in the Provision of Telecommunication and Media Services establishes that regulatory requirements should aim to be technology-neutral, where possible (IMDA, 2022[42]). Based on information from national authorities, the SBO licence takes a technology-neutral approach and does not dictate the technology of the service to be provided. However, spectrum licences are not technology-neutral.

As a concrete example of the country's efforts to foster innovation, Singapore has promoted 5G networks and services in several ways over the past years. In 2017, under its technical and market trial frameworks, IMDA waived frequency fees to test equipment, conduct research and development (R&D), and trial 5G networks and services (IMDA, 2023[75]). In 2019, IMDA issued the 5G call for proposal (CFP), kicking off the process to assign 5G spectrum in the 3.5 GHz and millimetre wave bands, which were assigned the following year (IMDA, 2023[70]). In 2021, IMDA assigned additional spectrum in the 2.1 GHz band, which was refarmed from 3G use, to support 5G deployments (IMDA, 2023[74]). These actions supported Singapore's early deployment of 5G networks. Singtel reported 95% nationwide standalone 5G coverage as of July 2022, while StarHub and M1 announced 95% of nationwide outdoor coverage at the end of 2022 (Singtel, 2022[76]; StarHub, 2022[77]; M1, 2022[78]). In addition, Simba Telecom reported its target to achieve 60% outdoor 5G coverage by the end of 2023 (Tuas Limited, 2023[79]).

In 2019, to stimulate uptake of 5G services, IMDA established a 5G Innovation Programme to trial use cases. The programme aimed to promote the trial, research and development of 5G-based solutions across six priority areas: i) maritime; ii) urban mobility; iii) smart estates; iv) industry 4.0; v) consumer applications; and vi) government applications (IMDA, 2023[80]). Building on these efforts, IMDA established an additional fund of SGD 30 million (USD 22 million) in 2021 for commercialisation and uptake of 5G solutions (IMDA, 2021[81]).[20]

IMDA also continues to co-operate with industry to develop human resources for 5G, open 5G testbeds and support R&D (IMDA, 2023[80]). In addition, Singapore is already looking towards 6G and launched the "Future Communications Connectivity" 6G Lab with a local university in 2022, reportedly the first in Southeast Asia (SUTD, 2022[82]). The 6G Lab is part of the Future Communications Research and Development Programme, which has SGP 70 million (USD 51 million) in funding (SUTD, 2022[82]).[21]

Together, these actions seem to have succeeded in supporting innovative new services and network deployment in Singapore, as evidenced by the near-nationwide coverage of 5G networks. Its programmes to support industry, for instance through the 5G funds, as well as the trial licences, also help support adoption and commercialisation of services to meet real-life use cases.

4.5. Broadband deployment and digital divides

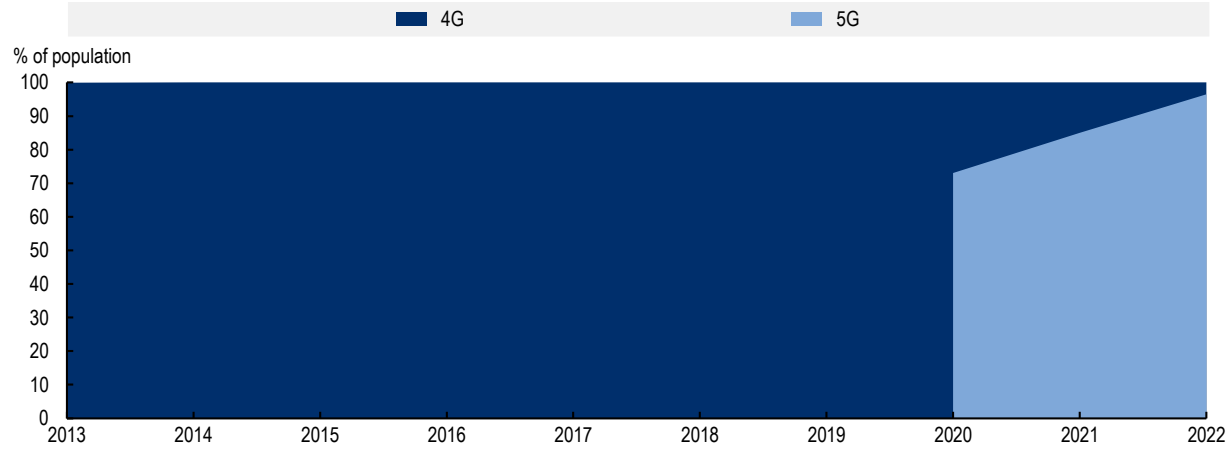
4.5.1. Broadband deployment

The public initiative to build nationwide networks has been driving broadband deployment in Singapore since the late 1990s. The first national broadband network, Singapore ONE under the IT2000 Masterplan, aimed at positioning Singapore as a global IT hub and “Intelligent Island”. Singapore ONE was based on copper-based technologies, DSL and cable modem. With the Intelligent Nation 2015 ("iN2015") Masterplan, this network evolved into the nationwide FTTH NBN, introduced above (IDA, 2010[83]). These initiatives demonstrate how Singapore invests strategically ahead of demand to provide high-quality digital connectivity to drive the digital economy. Launched in 2008-09, the NBN reached 100% fibre coverage of premises (residential and non-residential) in 2013 (IMDA).

The NBN, with a ring backbone section and a final fibre-to-the-building section, was designed with a technology-agnostic strategy to support fibre-based access technologies and wavelengths (passive optical network, e.g. GPON, and active optical network, e.g. ITU-T G.652D optical fibres). The NBN network reaches all premises via fibre, allowing RSPs to provide fixed broadband services without deploying additional infrastructure by contracting wholesale services over this network. Today, RSPs offer competitively priced GPON-based broadband services ranging from 500 megabits per second (Mbps) to 2 gigabits per second (Gbps), with most offering 1 Gbps service plans (MCI, IMDA, 2023[59]). Moreover, the NBN encourages deployment of wireless networks, fixed and mobile, by providing backhaul connectivity to access nodes. In particular, the full coverage of the NBN FTTH network greatly facilitates deployment of small cells for high-frequency wireless networks, such as 5G and Wi-Fi 6E.

In terms of mobile networks, 3G was introduced almost 20 years ago and 4G networks were rolled out in the mid-2010s, reaching 100% population coverage in 2014 (IMDA). Operators are expected to stop providing 3G services by the end of July 2024, making more spectrum available for 5G services (IMDA, 2023[84]) (IMDA, 2023[84]). In 2020, the Singapore government announced the final award of two 5G licences to Singtel and a joint venture consortium between Starhub and M1. The two licensees were expected to deploy a standalone 5G network by 2021, cover at least half of Singapore by the end of 2022 and complete nationwide deployment by 2025. In 2021 IMDA made more spectrum available for 5G, thus facilitating a third 5G standalone network. According to the GSMA, 5G coverage reached 96.5% of the population in 2022 (GSMA Intelligence, 2023[14]) (GSMA Intelligence, 2023[14]) (Figure 4.8). Additionally, IMDA, in collaboration with the Maritime and Port Authority of Singapore, will expand coverage in port waters. Together, they will establish the world's first and largest public 5G maritime test bed to trial, innovate and commercialise use cases such as automated vessel movement and remote piloting (IMDA, 2022[85]).

Figure 4.8. Mobile broadband coverage, 2013-22



Source: GSMA Intelligence (2023[14]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

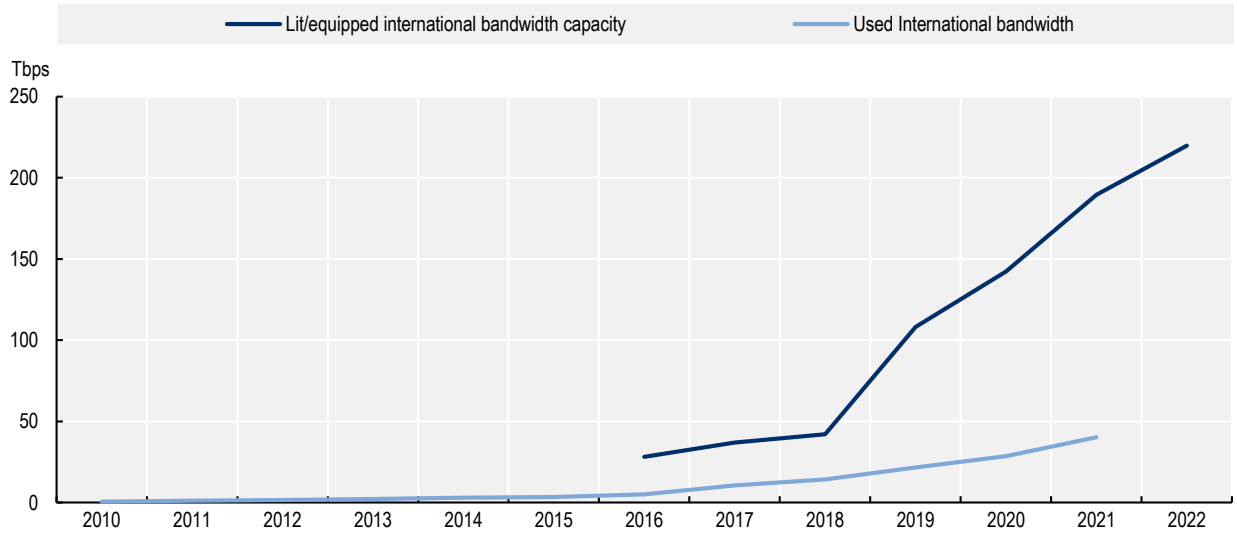
StatLink https://stat.link/24xhtq

In terms of other wireless networks, the Wireless@SG initiative was launched in December 2006 to accelerate deployment of high-speed wireless broadband and promote the wireless broadband lifestyle among Singapore's citizens and residents. The programme uses a federated model, where Wireless@SG access points enable seamless roaming across the Wireless@SG hotspots deployed by different operators. These are commercially supported by building owners and Wireless@SG operators. IMDA ensures consistent user experience by stipulating standards for identity management, login and security (IMDA, 2023[86]). The network has a coverage of 5 962 hotspots provided by StarHub, M1 and Singtel (December 2022) (IMDA, 2023[87]).

MCI and IMDA foresee seamless end-to-end connectivity between outdoor and indoor environments for the NBN (MCI, IMDA, 2023[59]). To this end, Singapore plans to allocate spectrum both to enable faster Wi-Fi networks and to enhance performance and support enterprise adoption of 5G SA networks. In addition, while the NBN has supported the country's growing demand for teleworking and home learning in recent years, MCI and IMDA are planning a tenfold increase in bandwidth. They have already announced plans to work with the communication industry to achieve broadband speeds of up to 10 Gbps (Yuan, 2023[88]).

In terms of international connectivity, Singapore has 220 terabits per second (Tbps) of equipped capacity as of 2022 (ITU, 2023[15]). This equates to 54% of the region’s international capacity, making it SEA’s international connectivity hub. Data show that Singapore's international equipped bandwidth increased significantly in recent years, increasing fivefold between 2018 and 2022 (Figure 4.9) (ITU, 2023[15]). The used capacity of Singapore’s Internet exchanges, although much lower at 40.3 Tbps (2022) (18% of equipped capacity, 2021), is also the highest in the region (ITU, 2023[15]).

Figure 4.9. International bandwidth, 2010-22



Note: Lit/equipped international bandwidth capacity refers to the total lit capacity of international links, namely fibre-optic cables, international radio links and satellite uplinks to orbital satellites in the end of the reference year (expressed in Mbit/s). If the traffic is asymmetric (i.e., different incoming and outgoing traffic), then the highest value out of the two should be provided. Average usage of all international links, including optical fibre cables, radio links and traffic processed by satellite ground stations and teleports to orbital satellites (expressed in Mbit/s). The average is calculated over the twelve-month period of the reference year. If the traffic is asymmetric (i.e. different incoming and outgoing traffic), then the highest value out of the two should be provided. All international links used by all types of operators, namely fixed, mobile and satellite operators should be taken into account. The combined average usage of all international links can be reported as the sum of the average usage of each link (ITU, 2020[13]).
Source: ITU (2023[15]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/2bnumj

Singapore's international connectivity is provided by 39 submarine cable systems, 28 extra-regional and 11 intra-regional (13 of which are planned between 2023 and 2026). This makes it one of the world's leading submarine cable hubs in terms of number of cables landed and total capacity. These systems provide connectivity primarily to the East and Southeast Asia regions but also to the rest of the world through long-haul systems such as SeaMeWe 3, 4 and 5 (Table 4.3) (TeleGeography, 2023[89]).

At the intra-SEA level, Singapore is connected to 11 regional cable systems, of which 8 are exclusively between Indonesia and Singapore. Taking all cables together, Singapore is connected by 19 submarine cable systems to Indonesia, 13 to the Philippines, 12 to Malaysia, 10 to Thailand, 6 to Viet Nam and 4 each to Myanmar and Brunei Darussalam; the only countries in the region not directly connected to Singapore are Cambodia and the land-locked Lao People's Democratic Republic (Table 3.3) (TeleGeography, 2023[89]). These connections make Singapore the hub for international connectivity in the SEA region.

Increasing international connectivity capacity is a strategic priority for the coming years. This priority is in line with Singapore's approach to economic development, which focuses on international openness, including in the digital economy. To this end, Singapore authorities are committed to providing space and resources to double the number of submarine cable landings over the next ten years. This will allow operators to further expand and diversify the submarine cable network. They also plan to help deploy LEO satellite services by ensuring sufficient spectrum resources for satellite systems and developing business-friendly frameworks and policies (MCI, IMDA, 2023[59]).

Table 4.2. Singapore's connections with other SEA countries via submarine cables

Cable system	Brunei Darussalam	Cambodia	Indonesia	Lao People's Democratic Republic	Malaysia	Myanmar	Philippines	Thailand	Viet Nam
APCN-2					x		x		
Apricot			x				x		
Asia Connect Cable-1 (ACC-1)			x				x		
Asia Direct Cable (ADC)							x	x	x
Asia Link Cable (ALC)	x						x		
Asia Pacific Gateway (APG)					x			x	x
Asia Submarine-cable Express (ASE)/Cahaya Malaysia					x		x		
Asia-America Gateway (AAG) Cable System	x				x		x	x	x
Australia-Singapore Cable (ASC)			x						
B2JS (Jakarta-Bangka-Batam-Singapore) Cable System			x						
Batam Singapore Cable System (BSCS)			x						
Bifrost			x				x		
EAC-C2C							x		
Echo			x						
Hawaiki Nui			x						
i2i Cable Network (i2icn)									
India Asia Xpress (IAX)					x			x	
INDIGO-West			x						
Indonesia Global Gateway (IGG) System			x						
JAKABARE			x						
Jakarta-Bangka-Bintan-Batam-Singapore (B3JS)			x						
Matrix Cable System			x						
MIST					x	x			
Moratelindo International Cable System-1 (MIC-1)			x						
PEACE Cable									
PGASCOM			x						
SEA-H2X					x		x	x	
SeaMeWe-3	x		x		x	x	x	x	x
SeaMeWe-4					x			x	
SeaMeWe-5			x		x	x			
SeaMeWe-6					x				
SEAX-1			x		x				
Singapore India Gateway (SING) Cable								x	
Singapore-Myanmar (SIGMAR)						x			
Southeast Asia-Japan Cable (SJC)	x						x		
Southeast Asia-Japan Cable 2 (SJC2)								x	x
Tata TGN-Intra Asia (TGN-IA)							x		x
Tata TGN-Tata Indicom									
Thailand-Indonesia-Singapore (TIS)			x					x	

Source: OECD elaboration from TeleGeography (2023[89]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

Table 4.3. Singapore's connections with other regions via submarine cables

Cable system	Northern Africa	Sub-Saharan Africa	Latin America and the	North America	Eastern Asia	Southern Asia	Western Asia	Northern Europe	Southern Europe	Western Europe	Australia and New Zealand	Micronesia
APCN-2					x							
Apricot					x							x
Asia Connect Cable-1 (ACC-1)				x								x
Asia Direct Cable (ADC)					x							
Asia Link Cable (ALC)					x							
Asia Pacific Gateway (APG)					x							
Asia Submarine-cable Express (ASE)/Cahaya Malaysia					x							
Asia-America Gateway (AAG) Cable System				x	x							x
Australia-Singapore Cable (ASC)											x	
Bifrost			x	x								x
EAC-C2C					x							
Echo				x								x
Hawaiki Nui				x							x	x
i2i Cable Network (i2icn)						x						
India Asia Xpress (IAX)						x						
INDIGO-West											x	
MIST						x						
PEACE Cable	x	x				x	x		x	x		
SEA-H2X					x							
SeaMeWe-3	x	x			x	x	x	x	x	x	x	
SeaMeWe-4												
SeaMeWe-5												
SeaMeWe-6												
Singapore India Gateway (SING) Cable					x							
Southeast Asia-Japan Cable (SJC)				x	x							x
Southeast Asia-Japan Cable 2 (SJC2)	x	x			x	x	x	x	x	x	x	
Tata TGN-Intra Asia (TGN-IA)					x							
Tata TGN-Tata Indicom					x							

Note: Asia Direct Cable (ADC), Echo, India Asia Xpress (IAX), MIST are expected to be ready by 2023; Apricot, Bifrost, SEA-H2X, Southeast Asia-Japan Cable 2 (SJC2) are expected to be ready by 2024; Asia Connect Cable-1 (ACC-1), Asia Link Cable (ALC), Hawaiki Nui, SeaMeWe-6 are expected to be ready by 2025; Singapore India Gateway (SING) Cable is expected to be ready by 2026 (TeleGeography, 2023[89]).
Source: OECD elaboration from TeleGeography (2023[89]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

According to information from Packet Clearing House, Singapore has nine Internet exchange points (Table 2.4) (PCH, 2023[90]). The two IXPs with the largest number of participants are Equinix Internet Exchange Singapore and the Singapore Internet Exchange (SGIX) (PCH, 2023[90]). Equinix® is a digital infrastructure provider (Equinix, 2023[91]) while SGIX as a not-for-profit organisation founded in 2009 with 11 members from all levels of the industry, including national telecom operators, international telecom operators, Internet service providers, and content and gaming providers. SGIX provides services on a cost-recovery basis and aims to promote efficient exchange of Internet traffic in Singapore and improve network performance for all peering members while lowering overall interconnectivity costs (IMDA, 2023[92]).

Table 4.4. Internet exchange points, 2023

Name	City
Singapore Internet Exchange	Singapore
Equinix Singapore IBX	Singapore
Singapore Open Exchange	Singapore
MegaPort IX Singapore	Singapore
BBIX Singapore	Singapore
DE-CIX ASEAN (Singapore, Malaysia, Brunei Darussalam)	Singapore
AMS-IX Singapore	Singapore
EDGE Internet Exchange	Singapore
Internet Exchange 42	Singapore

Source: PCH (2023[90]), *Internet Exchange Directory*, www.pch.net/ixp/dir (accessed 5 December 2023).

4.5.2. Digital divides

The massive deployment of broadband networks in Singapore is accompanied by a high Internet penetration rate, reaching 97% of the population (2021) (ITU, 2023[15]), a figure well above the regional median (68%) (2021) (ITU, 2023[15]). There is no geographical disparity within Singapore, as the entire national territory is urban and covers a small land area. The gender gap is 0.3 percentage points in favour of men (2021) (ITU, 2023[15]). However, there is a digital divide by age. The percentage of people aged 60 and over using the Internet is high (78%), but the rate is 20 points lower than for younger age groups (99% for 18-39 age groups and 98% for 40-59 age groups (2022) (IMDA, 2023[93]).

The supply-side reasons for the absence of a digital divide lie in the ubiquitous coverage of broadband services (see above) and their good quality (see below), as well as their affordability. Prices for broadband services in Singapore are the most affordable in the region, at 0.25% of monthly GNI per capita for mobile services and 0.64% for fixed services (2022) (ITU, 2023[15]). In both cases, prices are well below the affordability target of less than 2% of GNI per capita for basic broadband services set by the Broadband Commission in support of the Sustainable Development Goals (UN Broadband Commission for Sustainable Development, 2022[94]). At between 0.4-0.8% of GNI per capita, fixed broadband prices in Singapore have remained affordable over the past decade (2010-22) (Mobile broadband prices in Indonesia are relatively affordable in terms of purchasing power. Prices are below the target of less than 2% of gross national income (GNI) per capita for entry-level broadband services set by the Broadband Commission in support of the Sustainable Development Goals (UN Broadband Commission for Sustainable Development, 2022[61]) over the past few years (Figure 3.12) (ITU, 2023[12]). Mobile handset prices are also relatively affordable in Indonesia. According to Tarifica, the benchmark price of entry-level internet-enabled handset account for 7.74% of average monthly income (2022) (Tarifica, 2023[62]). Of the countries surveyed, only Singapore has more affordable prices, where the reference price is 0.39% of monthly income (2022) (Tarifica, 2023[62]).

However, fixed broadband prices are significantly above this threshold, reaching 6.1% of GNI per capita in 2022, at the SEA average (ITU, 2023[12]). These data suggest that, at least for mobile broadband, the price of broadband access does not appear to be a determining factor in the digital divide between different socio-economic groups. However, it could be an important factor for fixed broadband, which can have long-term consequences on fostering an inclusive, high-quality access to broadband services.

Figure 3.12) (ITU, 2023[15]). Mobile broadband affordability is also stable, at around 0.3% of GNI in recent years (2018-22) (Mobile broadband prices in Indonesia are relatively affordable in terms of purchasing power. Prices are below the target of less than 2% of gross national income (GNI) per capita for entry-level broadband services set by the Broadband Commission in support of the Sustainable Development Goals (UN Broadband Commission for Sustainable Development, 2022[61]) over the past few years (Figure 3.12)

(ITU, 2023[12]). Mobile handset prices are also relatively affordable in Indonesia. According to Tarifica, the benchmark price of entry-level internet-enabled handset account for 7.74% of average monthly income (2022) (Tarifica, 2023[62]). Of the countries surveyed, only Singapore has more affordable prices, where the reference price is 0.39% of monthly income (2022) (Tarifica, 2023[62]).

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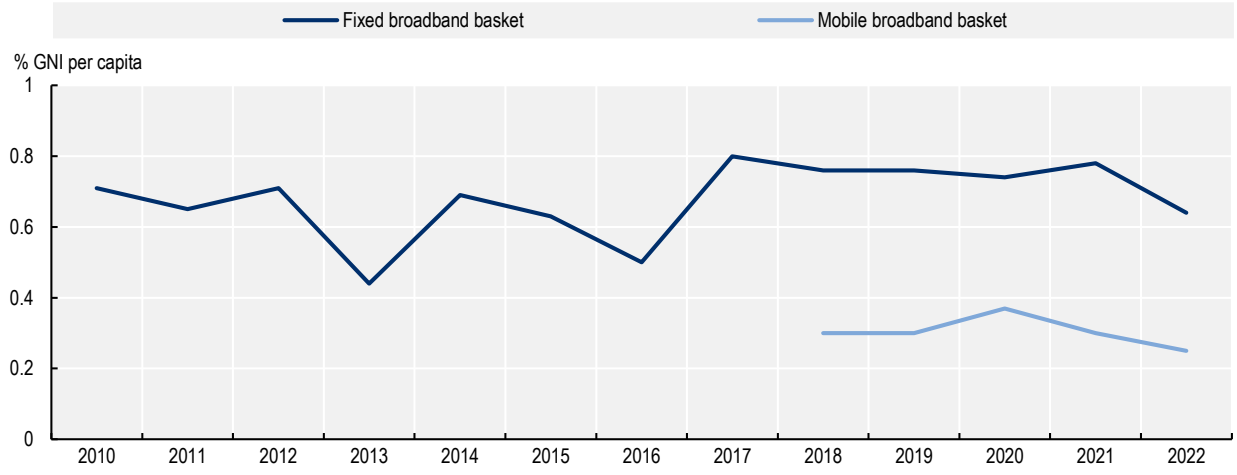
Figure 3.12) (ITU, 2023[15]). As for the access devices, the reference price of a smartphone is USD 21.90 (nominal prices) (2022) (Tarifica, 2023[95]), which represents 0.4% of GNI per capita, PPP (current international USD) (2022).[22] These data suggest that neither the price of broadband services nor the access devices appear to be a hurdle for broadband adoption.

Figure 4.10. Prices for fixed and mobile broadband services (percentage GNI per capita), 2010-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2010 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[16]). Mobile basket prices are not available from 2010 to 2017.
Source: ITU (2023[15]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/ndqxet

On the demand side, the data show a high level of digital literacy among the Singaporean population. More than three-quarters (81%) of the population has the most common ability to "check the reliability of information found on line" (2021) (ITU, 2023[15]). Meanwhile, 61% of the population has the less common ability to "find, download, install and configure software". While lower, this percentage still exceeds the percentage of the population with the most common ability in the next highest digital literacy countries, Indonesia and Brunei Darussalam (2021) (ITU, 2023[15]). Data on digital literacy are not available for older age groups so it is not possible to infer its influence on age and the age gap.

However, according to the IMDA Annual Survey on Infocomm Usage in Households 2022, the two main reasons for not having Internet connection at home were lack of interest or need to use the Internet; and lack of knowledge, skills or confidence. In terms of business digital technology adoption and according to the IMDA Digital Acceleration Index Study in Businesses in 2022 (IMDA, 2023[96]), the top three obstacles faced by Singapore businesses to digital transformation were “financial resources”, “cultural resistance” and “integrating new technology”.

4.5.3. Policies and regulation

The Singaporean authorities have acted in several areas to facilitate network deployment and make sufficient spectrum available to the market. They have also launched several initiatives to narrow the gaps in broadband penetration, address supply- and demand-side hurdles, and bridge the digital divide. The main ones are described below.

Rights of way

The Telecoms Act (Part 3) provides right-of-way to licensees to provide any communication service or installation of any communication system. Specifically, it authorises public communication licensees to enter land or buildings under certain conditions. It also establishes a mechanism for authorities to help resolve disputes (Government of Singapore, 1999[39]). Moreover, IMDA has issued the Code of Practice for Info-communication Facilities in Buildings to help with installation and operation of communication facilities on land or in buildings (IMDA, 2023[97]).

Access to passive infrastructure and co-ordination of civil works

The Code of Practice for Competition (IMDA, 2022[42]) sets out the access to the passive infrastructures owned by NetLink Trust and Singtel according to the NetLink Trust's Interconnection Offer and Singtel's Reference Interconnection Offer.

Moreover, there is a whole-of government initiative to minimise land use and road opening (“dig-once”) called the Common Service Duct (CSD) framework. CSD is a common set of ducts and manholes that may be singly or jointly built, owned and maintained by PTLs, designated to serve an area with limited access or road openings. CSDs are designated for shared use by multiple Facilities-based Licensees to house telecommunication cables for deployment of telecommunication networks.

The CSD framework is also regulated under the Code of Practice for Competition. The code provides that IMDA will designate a PTL to be the CSD owner and operator (“Designated CSD Owner”). IMDA has designated NetLink Trust for this role as it is seen as the neutral-passive infrastructure network operator. NetLink must lease the passive infrastructure at wholesale, non-discriminatory and cost-based terms to any licensee, according to a Reference Interconnection Offer. All other PTLs may choose to be co-owner(s) of the ducts. The Designated CSD Owner shall be fully responsible for the operation and maintenance of the manholes, and the Designated CSD Owner and co-owner(s), if any, shall maintain its own ducts or may jointly appoint a single party to maintain them. The Designated CSD Owner shall set aside additional duct capacity of no less than 20% of its own duct requirement for leasing to Facilities-based Licensees (“Set-aside Duct”). They should first approach the CSD Owner for CSD services (IMDA, 2023[98]).

Spectrum management

The Telecoms Law authorises IMDA to manage spectrum and grant licences for spectrum use (Government of Singapore, 1999[39]). IMDA also prescribes the basis for restricting participation of certain persons in the spectrum allocation process and revoking spectrum rights (Government of Singapore, 1999[39]). In addition, it has the remit to develop the Radio Spectrum Master Plan, which details its spectrum assignment plans, spectrum policies and technological trends in spectrum use (IMDA, 2023[99]). At the time

of writing, Singapore is currently updating the Radio Spectrum Master Plan (IMDA, 2023[99]). The Spectrum Management Handbook provides further information on IMDA's spectrum management activities, assignment policies and application procedures (IMDA, 2022[72]).

Spectrum can be assigned though either an auction, tender ("beauty contest") or direct assignment approach, or in any combination thereof (Government of Singapore, 1999[39]). Auctions are the most common assignment approach for spectrum in high demand, such as for mobile services. However, IMDA has also employed a beauty contest approach in recent assignment proceedings. For example, in the 2019 5G Call for Proposal, IMDA selected winning bidders based on submitted proposals (IMDA, 2023[70]). According to national authorities, IMDA took this approach due to the perceived importance of driving 5G network rollout. IMDA returned to an auction approach to assign spectrum in the 2.1 GHz band (IMDA, 2023[74]). As noted above, well-designed spectrum auctions are generally considered to be best practice around OECD countries as they assign the licence to the bidder that will use it most efficiently (OECD, 2022[73]).

According to national authorities, spectrum licences for mobile services last for 15 years. Upon expiry of spectrum rights, IMDA will typically consult industry on the policy and regulatory framework for issuing or renewing the rights. While 15 years is rather short, the main issue is whether operators have enough regulatory certainty to ensure continued access to the spectrum needed to operate their networks. Therefore, IMDA's approach to consult with operators before spectrum rights expire is especially important to ensure operators continue to operate, maintain and upgrade their networks.

Spectrum trading is permitted with IMDA approval (Government of Singapore, 1999[39]). While IMDA has considered spectrum sharing, challenges may exist due to the country's small geographic area. For example, dynamic spectrum sharing to allow coexistence of 5G and fixed satellite services was deemed unfeasible due to Singapore's geography (IMDA, 2019[100]).

Adequate assignment of mobile spectrum is important, especially to support deployment of high-quality mobile networks. Singapore has assigned several spectrum bands across low, medium and high bands in a timely fashion, which has no doubt supported deployment of next-generation networks. It has assigned spectrum in the 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3500 GHz, 26 GHz and 28 GHz bands. It has also designed assignment processes to achieve certain policy objectives, such as competition and network deployment aims. For example, in past assignment procedures, Singapore has examples of reserving spectrum for new entrants, establishing spectrum caps, and setting coverage obligations for winning bidders. On average, MNOs hold around 1 000 MHz each. However, Simba Telecom, as a new entrant, holds less than more established players like Singtel. This is a substantial amount of spectrum assigned, making it comparable to Thailand and above other countries in the region such as Viet Nam and Cambodia. These actions were key enablers to support Singapore's swift 5G network deployment.

Universal Service Obligation

The Universal Service Obligation (USO) in Singapore is a license condition imposed on PTLs (IMDA, 2013[101]). In the fixed broadband services market, USOs are imposed on NetLink Trust as a NetCo and on Nucleus Connect as an OpCo for the operation of the NBN. NetCo's USO, which came into effect in 2013, requires NetCo to provide optical fibre services to any location in mainland Singapore or connected Singapore islands at the request of communication licensees. OpCo's USO, from 2013, requires OpCos to meet all requests to activate wholesale bandwidth services over NetCo's Fibre in homes, offices and buildings (IMDA, 2015[102]). There is no Universal Service Fund, or any mechanism for financial support from the government or other operators.

Support programmes

Given the near ubiquitous coverage of the NBN (see section on "Broadband deployment"), efforts to bridge the digital divide are focused on adoption support programmes for low-income and other non-adopting households and users.

The Home Access and NEU PC Plus schemes offer subsidised broadband connectivity, and digital devices to all low-income households, particularly those with students and persons with disabilities. The schemes support digital needs and enable these households to use PCs with broadband services for three years for free (Navvaro, 4 July 2020[103]). The "DigitalAccess@Home" scheme has also been launched to provide subsidised Internet access and devices to lower-income households to support their lifestyle needs, including work and social activities (IMDA, 2023[104]).

The "Mobile Access for Seniors" scheme provides smartphone and mobile plans to interested lower-income seniors who cannot afford them. Specifically, a smartphone and a two-year mobile plan are available at a low cost for Singaporeans aged 60 and over who have acquired digital skills through the Senior Go Digital programme provided by IMDA (IMDA, 2023[105]).

Price regulation

IMDA only imposes rate regulation on dominant licensees that may not be affected by market forces (IMDA, 2023[66]). The Code of Practice for Competition in the Provision of Telecommunication and Media Services 2022 (TMCC) requires dominant licensees to submit tariffs to IMDA for approval before providing services. IMDA assesses whether the tariff plans submitted are fair and reasonable. The dominant licensees must publish IMDA-approved tariffs before the services are available (IMDA, 2022[42]). For their part, non-dominant licensees are not required to submit tariffs to IMDA for approval. However, they must publish the tariffs and terms and conditions of their services for the benefit of end-users (IMDA, 2022[42]).

Digital skills programme

In 2021, IMDA launched the "Digital For Life Movement". This initiative brings together citizens, the private sector and the public sector to support digital learning for Singaporeans of all ages and social strata (IMDA, 2023[106]). Another initiative is the "SG Women in Tech", driven by IMDA and supported by community and industry partners, which aims to attract, retain and develop women talent across a diversity of jobs in the infocomm workforce (SG Women In Tech, 2023[107]).

The "TechSkills Accelerator" (TeSA) is a national initiative driven by IMDA in collaboration with industry and other government agencies to build and develop a skilled ICT workforce for Singapore's digital economy. Over the years, TeSA programmes have helped fill talent shortages by placing individuals in tech jobs in areas such as AI, cybersecurity, 6G, software development and cloud. The initiative has also helped upskill and reskill the existing tech workforce through tech courses and industry-recognized certifications to keep pace with changing skills (IMDA, 2023[108]).

Consumer rights regulation

The Code of Practice for Competition (IMDA, 2022[42]) contains various consumer protection provisions to which all FBO and SBO licensees must comply, where applicable. Specifically, licensees must disclose and publish information on service, and inform end-users regarding important matters before signing contracts. In addition, the code places restrictions on service termination or suspension and prohibit operators from charging for unsolicited services.

Singapore offers a variety of resolution options for contractual disputes over communication services to consumers. The Consumer Association of Singapore and the Small Claims Tribunal both offer solutions to disputes. In 2022, IMDA also introduced the Alternative Dispute Resolution Scheme (ADR) to provide

affordable and effective solutions for dispute resolution. ADR is a two-step process administered by the Singapore Mediation Centre (SMC), a neutral third party appointed by IMDA. The first step is a facilitated agreement (mediation) in which a mediator will help disputing parties reach a settlement. If a settlement cannot be reached, the consumer may choose to escalate to the second step (determination) where a determinant will render a binding decision. Consumers can opt directly for the second step (IMDA, 2023[109]).

IMDA has also published statistics on the performance of service providers in handling complaints from consumers to encourage service providers to improve their customer service standards (IMDA, 2023[110]).

Recommendation

3. **Continue to support innovation in uses and applications that take advantage of high quality, ubiquitous connectivity for all**. Recognising there are socio-economic groups that may face barriers to taking advantage of all these applications, continue to take action to reduce these barriers, in particular for older people. Businesses should make appropriate and effective digital solutions affordable and accessible to businesses, in particular SMEs.

4.6. Quality of networks (resilience, reliability, security and capacity)

This section analyses the quality of broadband networks in Singapore in line with the objective of Pillar III of the OECD Council Recommendation on Broadband Connectivity to ensure resilient, reliable, secure, and high-capacity networks. After examining recent policy and regulatory measures in this area, the analysis identifies areas for improvement and proposes policy recommendations to address them.

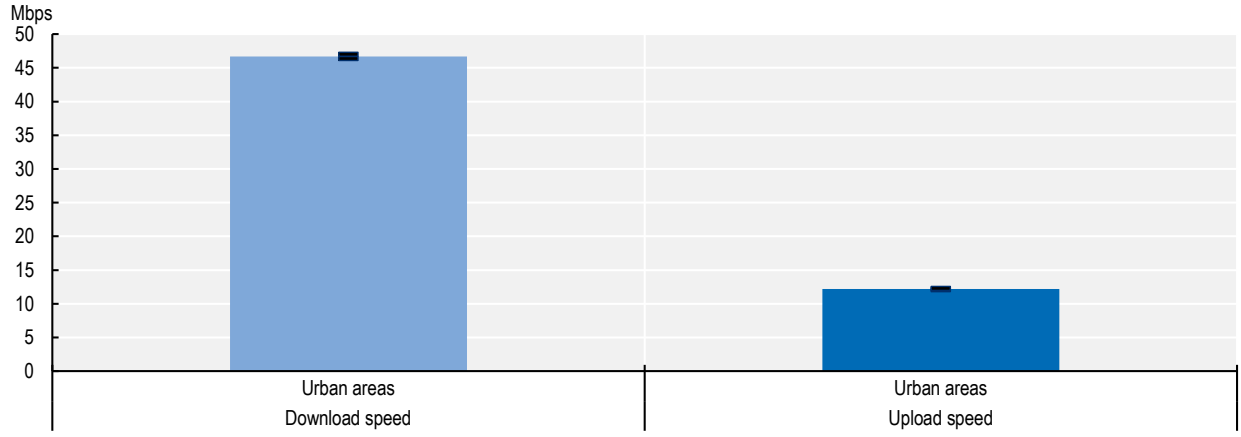
Singapore's end-user broadband quality of service is high at both regional and global levels. Fixed connectivity stands out both for its speed and its symmetry (similar upload and download speeds). According to Ookla, the median speed for fixed broadband access is the highest in the region. It was ranked first globally at 247.44 Mbps/205.73 Mbps (download/upload) (July 2023), well above global performance in the same month (82.59 Mbps/36.8 Mbps) (Ookla, 2023[111]). [23] Latency is also the lowest in the region – 4 ms (July 2023) (Ookla, 2023[111]), less than half the global average latency (9 ms). [24]

This outstanding fixed broadband performance goes hand in hand with the high quality of the fibre-based NBN network. This network can deliver per-user speeds of 1 Gbps and above, a speed accessible to 98% of households, according to national authorities. The network also continues to evolve: Singapore authorities have already announced a nationwide upgrade of the NBN infrastructure in collaboration with industry to increase speeds up to tenfold (10 Gbps) over the next five years (Yuan, 2023[88]).

The performance of mobile broadband connections is also high. For mobile broadband access, the median speed is 77.95 Mbps/15.77 Mbps (download/upload) (July 2023). This is the second in the region after Brunei Darussalam, and well above the global median download speed (39.77 Mbps/10.18 Mbps) (July 2023) (Ookla, 2023[111]). Latency is 17 ms, also significantly lower than the global figure (28 ms) (Ookla, 2023[111]).

Measures of user experience reveal some differences by technology. According to Opensignal data, over 90 days beginning in December 2022, the national average download/upload speed observed by users connected to 4G was 46.7 Mbps/12.2 Mbps (download/upload). Meanwhile, the observed speed reached 354.4 Mbps/27.1 Mbps (download/upload) for users with active 5G connections (Figure 4.11) (Figure 4.12) (Opensignal, 2023[112]).[25]

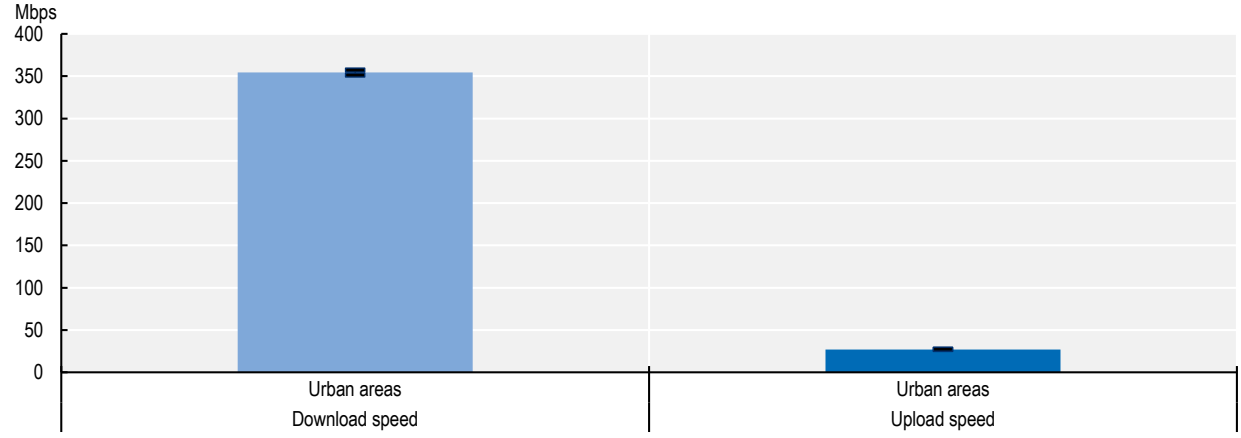
Figure 4.11. Download/upload speed experience 4G, December 2022 – February 2023



Notes:
1. Data were collected by Opensignal from its users, over 90-days period (1 December 2022–28 February 2023).
2. Opensignal download/upload speed experience represents the typical everyday speeds an Opensignal user experiences across an operator's mobile data networks. 4G download/upload speed is the average speed observed by Opensignal users when they were connected to 4G (Opensignal, 2023[113]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[114]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[115]).
Source: © Opensignal Limited - All rights reserved (2023[112]), http://www.opensignal.com.

StatLink https://stat.link/y8niju

Figure 4.12. Download/upload speed experience 5G, December 2022 – February 2023



Notes:
1. Data were collected by Opensignal from its users, over 90-days period (1 December 2022–28 February 2023).
2. Opensignal download/upload speed experience represents the typical everyday speeds an Opensignal user experiences across an operator's mobile data networks. 5G download/upload speed is the average speed observed by Opensignal users with active 5G connection (Opensignal, 2023[113]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.

4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[114]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[115]).
Source: © Opensignal Limited - All rights reserved (2023[112]), http://www.opensignal.com.

StatLink https://stat.link/4bm0nk

The topology of the NBN contributes to the resilience of Singapore's broadband services. A two-tier fibre ring network topology was chosen to provide the highest level of resilience and redundancy. In addition to providing failover protection in the event of network disruption, this configuration was simpler and more cost effective to implement. It required less cabling and digging than star or mesh configurations. It was also a scalable configuration that could easily grow with the fibre network (Chye, 2021[116]). Looking at the passive infrastructure layer of the NBN, NetLink reported a 99.99% network availability in 2023 (NetLink Trust, 2023[117]).

Moreover, Singapore authorities claim that both wired and wireless connectivity infrastructures are built with design principles of network redundancy and diversity to safeguard against widespread service disruption. For example, Singapore's 5G networks are built to minimise bottleneck situations.

However, the authorities also recognise the increasing complexity of technologies and networks that makes it impossible to eliminate all service disruptions. Therefore, they are working with industry to increase network resilience, improve situational awareness and ensure a rapid response to incidents and restoration of service in the event of a disruption (MCI, IMDA, 2023[59]).

4.6.1. Policies and regulation

The Singaporean authorities have taken several measures to improve the quality of networks. The main ones are described below.

Publication of quality-of-service data

IMDA regulates the performance of carrier services by setting quality of service standards and requiring them to submit data regularly. IMDA regularly reviews quality of service requirements to consider industry and technology changes, as well as changes in consumer demand, to ensure that requirements remain relevant (IMDA, 2023[118]).

Based on this information, IMDA monitors and publishes monthly data on quality of service indicators of communication services, including fibre broadband access, mobile broadband and fibre connection services. These indicators include local and international latency on performance, network availability,[26] number of complaints,[27] data success,[28] and drop rate[29] for reliability. Data on installation-related service levels are collected and published for fibre connection services (NetLink Trust fibre connection) (IMDA, 2023[119]).

Measures to improve network resilience

The IMDA has developed regulatory requirements for compliance by designated mobile and fixed-line network operators to ensure the resilience of their networks and services. The requirements reflect international best practices to minimise network outages. Operators are to conduct regular audits of their networks and infrastructure to demonstrate compliance with IMDA's requirements. IMDA will take enforcement actions on operators if they are found to have caused unintended service disruption and network outages.

Measures to improve network security

The Cyber Security Agency of Singapore (CSA), established in 2015, oversees the security of Singapore's cyberspace and works with the various sectoral leads to protect critical information infrastructure. While part of the Prime Minister's Office, the CSA is administered by MCI. In the same year, the Infocommunications Singapore Computer Emergency Response Team (ISG-CERT) was established to help IMDA respond effectively to cybersecurity threats in Singapore's communication and media sectors.

In 2021, the CSA published the Singapore Cybersecurity Strategy 2021 (Cyber Security Agency of Singapore, 2021[120]), which reviewed and updated the cybersecurity strategy launched in 2016. The Singapore Cybersecurity Strategy 2021 comprises three strategic pillars (build resilient infrastructure, enable a safer cyberspace, enhance international cyber co-operation) and two foundational enablers (develop a vibrant cybersecurity ecosystem, grow a robust cyber talent pipeline).

In terms of legislation, Singapore has the Cyber Security Act and codes of practice (Government of Singapore, 2018[121]). The Act provides a legal framework for the oversight and maintenance of national cyber security. For their part, CSA codes of practice impose requirements on owners of critical information infrastructures (Cyber Security Agency of Singapore, 2022[122]). IMDA also issued regulatory requirements to secure the infrastructure assets in communication and broadcast networks. Operators are required to comply with such regulatory requirements, and the operators' networks are audited for compliance regularly. Should there be any cybersecurity incidents or attacks, the operators must remediate and implement measures to mitigate risks. IMDA and CSA will also work with the operators to assess if any other systemic issues need to be addressed. In addition, IMDA has issued the Cyber Security Vulnerability Reporting Guide for researchers to report cyber security vulnerabilities detected in public applications and networks (IMDA, 2023[123]).

Recommendation

4. **Continue to promote measures to improve the quality, resilience and security of communication networks.** Continue to promote measures to ensure the resilience of communication networks, such as network diversity and redundancy, and assess the effectiveness of such measures.

4.7. Environmental impacts of networks

This section analyses the environmental impact of the networks in Singapore in line with the objective of Pillar IV of the OECD Council Recommendation on Broadband Connectivity to minimise negative environmental impacts of communication networks. After examining recent policy and regulatory measures in this area, the analysis identifies areas for improvement and proposes policy recommendations to address them.

The environmental impact of the networks in terms of energy consumption is measured in the framework of the statistics collected and published annually by the Energy Market Authority. In 2021, for example, all sectors saw a growth in electricity consumption. The Information and Communications sector had the largest percentage growth at 30.7% (EMA, 2022[124]).

In policy terms, IMDA has introduced initiatives to reduce data centre (DC) power consumption. IMDA developed a Singapore Standard for DCs in 2011 to reduce energy consumption and operating costs of DCs, as well as to enhance their competitiveness. The Green DC Standard helps organisations establish the systems and processes to improve the energy efficiency of their DCs. The standard has been revised

several times since 2011 (IMDA, 2023[125]). In 2018, IMDA invited proposals and provided grants for research in the area of improving energy efficiency in DCs (IMDA, 2018[126]). In 2023, IMDA published new sustainability standards for DCs operating in tropical climates. These target safe operation of DCs, while optimising energy efficiency while focusing on Singapore's geographic characteristics. IMDA has worked with several DC operators in Singapore to pilot this new standard to reduce energy usage. According to IMDA, Singapore operator Digital Realty has referenced the standard and successfully increased the DC operating temperature by 2°C in two of its 4.5 MW data halls. This translates to approximately 2-3% reduction in total energy usage in these data halls compared to 2018 (IMDA, 2023[127]).

As part of Singapore's Digital Connectivity Blueprint launched in June 2023, IMDA is also working on a green DC roadmap, which will chart the overall longer-term growth pathway of our DC sector to enhance energy efficiency, accelerate alternative energy pathways and expand DC capacity for the digital economy.

In line with this policy emphasis from IMDA, some operators are also acting on sustainability. For example, NetLink Trust has committed to reducing certain classes of emissions by 50% by 2030, compared to FY 2022 rates, and to achieve net zero by 2050 (NetLink Trust, 2023[117]).

Furthermore, to advance Singapore as a regional hub for digital sustainability, IMDA is building international public-private partnerships to advance digital sustainability development towards a green digital future. IMDA works with key collaborators such as IBM and Microsoft to exchange best practices and promote green software implementations (IMDA, 2023[127]).

Recommendation

5. **Support and promote smart and sustainable networks and devices and encourage communication network operators to periodically report on their environmental impacts and initiatives.** Learn from the Singapore authorities' experience in standardisation and working with industry to reduce energy consumption in data centres and take steps to promote smart and sustainable networks. Build on the collection of information on electricity consumption and efficiency indicators to encourage communication network operators to report regularly on their environmental impacts and initiatives to improve them, and report on the positive environmental impact of connectivity.

4.8. Regular assessment of broadband markets

This section analyses the collection, analysis, and publication of data on the availability, performance and adoption of connectivity services and infrastructure deployment in Singapore in line with the objective of Pillar V of the OECD Council Recommendation on Broadband Connectivity to regularly assess the state of connectivity. After examining recent policy and regulatory measures in this area, the analysis identifies areas for improvement and proposes policy recommendations to address them.

IMDA publishes regular and comprehensive information on the state of connectivity services and infrastructures in Singapore. In terms of adoption, it publishes information on subscriptions broken down by residential and corporate users and by wired (xDSL and fibre) and wireless technologies (3G, 3.5G/HSDPA, 4G/LTE, WiMAX). Availability (coverage) information is published for 3G and 4G services, and capacity information for international connectivity. Finally, it publishes quality of service information (see details in the previous section) (IMDA, 2023[128]).

Recommendation

6. **Regularly assess the state of connectivity to determine whether public policy initiatives are appropriate, and whether and how they should be adjusted**. Indicators collected and published by IMDA on the availability, performance and adoption of connectivity services and infrastructure deployment (e.g. adding 5G indicators) should be continually reviewed and updated to periodically assess the state of connectivity and determine whether and how public policy initiatives are appropriate and should be adjusted.

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Notes

[1] Urban centre (high-density cluster) is defined as contiguous grid cells with a density of at least 1 500 inhabitants per square kilometre. An urban centre has a population of at least 50 000 (European Commission, Joint Research Centre, 2015[4]).

[2] Urban cluster (moderate-density cluster) is defined as contiguous grid cells with a density of at least 300 inhabitants per square kilometre and has a population of at least 5 000 in the cluster (European Commission, Joint Research Centre, 2015[4]).

[3] Total broadband subscriptions are calculated as the sum of fixed and mobile broadband subscriptions defined by the OECD in the Broadband Portal (OECD, 2015[130]), based on data provided directly by IMDA.

[4] This calculation is based on active mobile broadband subscription provided directly by IMDA, and World Bank population data (World Bank, 2023[133]).

[5] This calculation is based on fixed broadband subscription provided directly by IMDA, and World Bank population data (World Bank, 2023[133]).

[6] Residential Wired Broadband Household Penetration Rate measures the total number of residential wired broadband subscriptions as a percentage of the total number of households in Singapore and excludes all wireless access plans (provided via 3G, 3.5G/HSDPA, 4G/LTE, WiMAX or its equivalent and Wi-Fi hotspots). This metric does not necessarily reflect of the proportion of households with broadband in Singapore as some households subscribe to more than one broadband connection (IMDA, 2023[12]).

[7] In 2022, Keppel Corporation reported 100% gross interest and 84% effective equity interest in M1 Ltd. and M1 Net Ltd., as well as 50% gross interest and 42% effective equity interest in M1 Network Private Limited (Keppel Corporation, 2023, p. 212[30]). Its shareholdings of these companies are held jointly with other subsidiaries (Keppel Corporation, 2023, pp. 212, 214[30]).

[8] An exchange rate of SGD 1.379=USD 1 was used, based on Singapore's 2022 exchange rate at (OECD, 2023[131]).

[9] The total fixed subscriptions sum IMDA data as of December 2022 for "total residential wired broadband" and "total corporate wired broadband" subscriptions (IMDA, 2023[12]). Total residential wired broadband refers to "all retail residential wired broadband subscriptions (i.e. for connection speeds equal to, or greater than, 256 kbit/s, in one or both directions) provided over xDSL, leased line and optical fibre. Residential wireless broadband subscriptions will be excluded. Provision of Broadband Internet access services via cable modem has ceased since 2020" (IMDA, 2023[12]). Total corporate wired broadband follows the same definition for "all retail corporate wired broadband subscriptions" (IMDA, 2023[12]).

[10] Data reported for StarHub/MyRepublic relate to "Number of residential broadband subscribers - subscription-based (in thousands)" and include residential subscribers from MyRepublic (StarHub Ltd., 2023, p. 14[35]).

[11] These are called “business public Internet access services market” and “residential public Internet access services market” (IMDA, 2022[38]). Three other relevant markets were identified, including business and residential local telephony services and local managed data network services (IMDA, 2022[38]).

[12] An exchange rate of SGD 1.379=1 USD was used, based on Singapore’s 2022 exchange rate at (OECD, 2023[131]).

[13] An exchange rate of SGD 1.379=1 USD was used, based on Singapore’s 2022 exchange rate at (OECD, 2023[131]).

[14] Art. 5 of (Government of Singapore, 2018[44]) specifies that the “responsible Minister for a Group 1 public body may give to the public body directions as to the performance by the public body of its functions.” Under the First Schedule, IMDA is classified as a Group 1 public body (Government of Singapore, 2018[44]).

[15] An exchange rate of SGD 1.379=USD 1 was used, based on Singapore’s 2022 exchange rate at (OECD, 2023[131]).

[16] An exchange rate of SGD 1.379=USD 1 was used, based on Singapore’s 2022 exchange rate at (OECD, 2023[131]). As a hypothetical example, if the annual gross turnover of an FBO is SGD 102 million, then the annual licence fee would be 80 000 + (0.8%* 50 million) + (1% * 2 million).

[17] An exchange rate of SGD 1.379=USD 1 was used, based on Singapore’s 2022 exchange rate at (OECD, 2023[131]). As a hypothetical example, if the annual gross turnover of a PTL is SGD 102 million, then the annual licence fee would be 200 000 + (0.8%* 50 million) + (1% * 2 million).

[18] An exchange rate of SGD 1.379=USD 1 was used, based on Singapore’s 2022 exchange rate at (OECD, 2023[131]).

[19] An exchange rate of SGD 1.379=USD 1 was used, based on Singapore’s 2022 exchange rate at (OECD, 2023[131]).

[20] An exchange rate of SGD 1.379=USD 1 was used, based on Singapore’s 2022 exchange rate at (OECD, 2023[131]).

[21] An exchange rate of SGD 1.379=USD 1 was used, based on Singapore’s 2022 exchange rate at (OECD, 2023[131]).

[22] The data source for handset price is Tarifica; the source for GNI per capita, USD, 2022 is GSMA Intelligence. The handset price is the price of the cheapest handset available in each market with Internet-browsing capability in USD (nominal prices), as gathered in 2022. The methodology for data collection can be found in the Mobile Connectivity Index Methodology (GSMA, 2022[132]).

[23] Data collected and aggregated according to Ookla’s Speedtest® Methodology (Ookla, 2023[129]).

[24] Latency or ping is the reaction time of connection — that is, how quickly the user device gets a response after you've sent out a request. A fast ping means a more responsive connection, especially in applications where timing is everything (like video games). Ookla® measures several types of latency. The figures referenced in the text refer to ‘minimum latency’ that measures the best case latency for the user at the

time they decide to take a Speedtest®. The lowest ping value is determined across one or more pings made before the download speed test – this represents the 'minimum latency' (Ookla, 2023[129]).

[25] Reproduced with permission of Opensignal, based on independent analysis of mobile measurements recorded during the period December 1, 2022 - February 28, 2023, © 2023 Opensignal Limited - All rights reserved.

[26] "Network availability" in this context, is the measure of the degree to which the network is operable and not in a state of failure or outage at any point of time.

[27] The term "complaints" is defined as any expression of dissatisfaction with the service providers' service, product, advertisement or policy via oral or written communication that requires some action by the service provider beyond the initial contact.

[28] Data success rate measures the percentage of successful data attempts.

[29] Data drop rate measures the inability of the 4G network to maintain a connection. It may happen because of radio link failures, uplink or downlink interference, bad coverage, unsuccessful handovers or any other reason.

5 Extending broadband connectivity in Thailand

Thailand is located in the centre of mainland Southeast Asia, with income levels in the middle of the regional group. Its level of human development, including income, life expectancy and education, is very high. Thailand shares these features with Malaysia alongside similar proportions of urban and rural population, so the two countries are analysed as a cluster represented by Thailand. The chapter outlines the geographic, economic and social conditions for broadband connectivity in Thailand. It proceeds by examining the performance and structure of the market and reviewing Thailand's communication policy and regulatory framework, including broadband strategies and plans. It then reviews competition, investment and innovation in broadband markets; broadband deployment and digital divides; the resilience, reliability, security and capacity of networks; and the country's assessment of broadband markets. It offers recommendations to improve in these areas, which could be relevant for the other countries forming this cluster.

Policy recommendations

1. Further strengthen the transparency of the selection process of high-level NBTC officials and avoid undue delays in future selection processes.
2. Consider revisiting NBTC's regulation governing mergers in the communication sector.
3. Carefully monitor the implementation of merger conditions in the recent merger of True and dtac in the mobile market.
4. Clarify any remaining uncertainty between the respective remit of NBTC and TCCT regarding competition in the communication sector.
5. Consider facilitating wholesale networks, especially in underserved areas, and monitoring wholesale prices.
6. Eliminate foreign direct investment restrictions.
7. Reduce barriers to broadband deployment through simplified procedures for obtaining permits, access to public infrastructure and rights of way.
8. Incentivise communication network operators to co-operate in network development activities.
9. Promote coordination of civil works and passive infrastructure sharing between networks to deploy high-capacity backbone and backhaul networks.
10. Consider leveraging Internet and international connectivity infrastructure.
11. Promote and invest in the improvement of digital skills.
12. Leverage synergies between programmes to promote the provision and adoption of connectivity services.
13. Publish open, verifiable, granular and reliable subscription, coverage and quality-of-service data.
14. Promote measures to improve the geographical diversification of communication infrastructures.
15. Support and promote smart and sustainable networks and devices and encourage communication network operators to periodically report on their environmental impacts and initiatives.
16. Regularly assess the state of connectivity, and availability, performance and adoption of connectivity services and infrastructure deployment.

Note: NBTC = National Broadcasting and Telecommunications Commission; TCCT = Trade Competition Commission of Thailand. These tailored recommendations build on the OECD Council's Recommendation on Broadband Connectivity (OECD, 2021[1]), which sets out overarching principles for expanding connectivity and improving the quality of broadband networks. The number of recommendations is not an appropriate basis for comparison as they depend on several factors, including the depth of contributions and feedback received from national stakeholders. In addition, recommendations do not necessarily carry the same weight or importance.

5.1. Geographic, economic and social conditions for broadband connectivity

Thailand is located in the centre of mainland Southeast Asia and has five distinct regions: the mountains in the north and west, the Khorat Plateau in the northeast; the Chao Phraya River basin in the centre; the maritime corner of the central region in the southeast; and the long, slender peninsular portion in the southwest (Britannica, 2022[2]).

Thailand had a population of 71.7 million as of 2022 (UN DESA, 2022[3]), concentrated mainly in the large metropolitan area of Bangkok, which has 15 million inhabitants (2015) (European Commission, Joint

Research Centre, 2015[4]), more than 20% of the country's population. Other urban centres of considerable size are Chiang Mai and Phitsanulok in the mountainous northwest; Phuket and Hat Yai on the peninsula's coast; Chonburi, Pattaya and Nakhon Pathom in the Chao Phraya River basin; and Khon Kaen, Nakhon Ratchasima, and Udon Thani in the northeast.

Due to its geography, Thailand is exposed to climate extremes. The Chao Phraya delta is particularly vulnerable to flooding, with agriculture and tourism at most risk. Over 9 million Thais already live at risk of flooding, either permanent or annual, and this number is projected to rise to 19 million by 2050 (ASEAN, 2021, p. 117[5]). In terms of economic impacts, Thailand's economic composition makes it especially vulnerable to physical infrastructure damage (ASEAN, 2021[5]).

Thailand is the representative country of the cluster comprising Thailand and Malaysia, as outlined in Chapter 1. These countries share many commonalities, especially on several macroeconomic metrics that influence a country's level of broadband deployment. Thailand had a gross domestic product (GDP) per capita of USD PPP 21 153 in 2022, ranking fourth among SEA countries (IMF, 2023[6]). Malaysia ranked third in GDP per capita, just above Thailand, at USD PPP 34 392 in 2022 (IMF, 2023[6]). However, Malaysia's population in 2022 was 33.9 million, around half of Thailand's (UN DESA, 2022[7]).

Thailand and Malaysia have similar geographic breakdowns between urban and rural areas. Around 96% of the land mass in both countries was classified as "rural"[1], with the remaining area classified as urban ("urban cluster"[2] or "urban centre"[3]) (European Commission, Joint Research Centre, 2015[4]). However, the population was more concentrated in urban areas in Malaysia than in Thailand ( ). In terms of human development, the United Nations Development Programme (UNDP) classifies Thailand and Malaysia as having a "very high" human development, along with Brunei Darussalam and Singapore in the region (UNDP, 2022[8]). The level of human development considers indicators across longevity, education and income ( ).

Table 5.1. Human development (2021) and degree of urbanisation (2015), Thailand and Malaysia

	Life expectancy (years, 2021)	Expected years of schooling (children, 2021)	Mean years of schooling (adults, 2021)	Gross domestic product per capita (current prices, PPP, 2022)	Population living in urban centres (%, 2015)	Population living in urban clusters (%, 2015)	Population living in rural areas (%, 2015)
Thailand	78.7 (2)	15.9 (2)	8.7 (5)	21 153 (4)	30.7	28.1	41.2
Malaysia	74.9 (3)	13.3 (5)	10.6 (2)	34 392 (3)	51.3	29.1	19.6
OECD Average	80.0	17.1	12.3	53 957	48.8 (2022 data)	28.11 (2022 data)	23.11 (2022 data)

Note: The numbers in parentheses refer to the simple ranking (i.e. no weighting) of SEA countries for each indicator. The OECD average for human development indicators is a simple average across OECD member countries. The urbanisation indicators for SEA countries refer to the population percentage in urban centres, urban clusters and rural areas, respectively. For the OECD, figures are given for the rate of the population living in predominantly urban, intermediate, and rural regions, respectively.
Source: [Human development indicators] UNDP (2022[8]), *Human Development Report 2021/2022: Uncertain Times, Unsettled Lives: Shaping our Future in a Transforming World*, www.undp.org/egypt/publications/human-development-report-2021-22-uncertain-times-unsettled-lives-shaping-our-future-transforming-world. [GDP per capita, SEA countries] IMF (2023[6]), *World Economic Outlook Database, April 2023*, www.imf.org/en/Publications/WEO/weo-database/2023/April (accessed on 28 June 2023). [GDP per capita, OECD] OECD (2023[9]), *Gross domestic product (GDP)* (indicator), https://doi.org/10.1787/dc2f7aec-en (accessed on 30 June 2023). [Urbanisation indicators for SEA] European Commission, Joint Research Centre (2015[4]), *Global Human Settlement Layer (GHSL)*, https://ghsl.jrc.ec.europa.eu/CFS.php. [urbanisation indicators for OECD] OECD (2023[10]), *OECD.Stat* (database),*"Regions and cities: Regional statistics: Regional demography: Demographic indicators by rural/urban typology, Country level: OECD: share of national population by typology"*, https://stats.oecd.org/ (accessed on 28 August 2023).

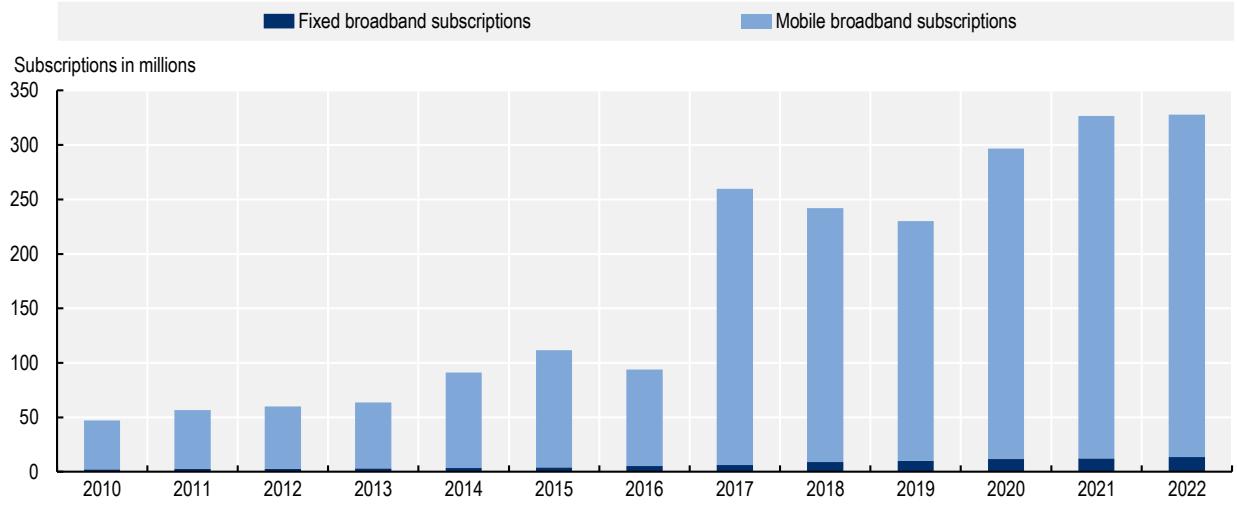
Given the similarities in geographical and economic conditions for broadband deployment in Thailand and Malaysia, the recommendations for Thailand may also apply to a certain extent to Malaysia. Nevertheless, the subsequent sections will focus on the situation in Thailand for further analysis.

5.2. Market landscape

5.2.1. Market performance

Thailand's broadband markets have made great strides over the past decade to increase network coverage and total number of broadband subscriptions, as well as deploy high-quality mobile and fixed technologies. Network coverage of fixed and mobile networks increased, with fixed networks reaching over half of all households in 2021 (based on government data). Mobile networks reached 98% population coverage for 3G and 4G by 2015 and 2016, respectively, and 85% for 5G by 2022 (GSMA Intelligence, 2023[11]). The total number of broadband subscriptions reached 100.6 million in 2022 with mobile broadband accounting for 87% (ITU, 2023[12]). Mobile connectivity has kept pace with successive technology upgrades, accelerating between 2012 and 2014, coinciding with deployment of 4G. In 2021, with deployment of 5G, connectivity grew by 27% in a single year (Figure 5.1) (ITU, 2023[12]). Fixed subscriptions have shown slow, but consistent, growth from 2010-22, with year-on-year growth rates ranging between 5-20% and an average year-on-year growth rate of 12% (ITU, 2023[12]). In terms of penetration, the number of mobile subscriptions reached 121.8 subscriptions per 100 inhabitants in 2022, above the regional average (103.7 subscriptions) (ITU, 2023[12]).

Figure 5.1. Broadband subscriptions, 2010-22

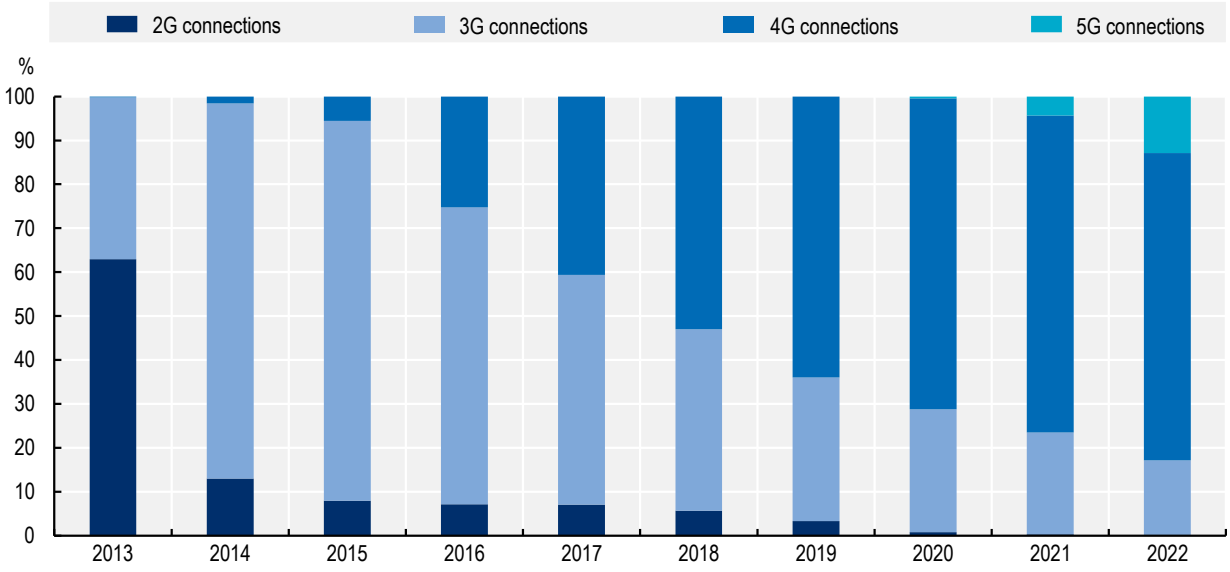


Note: Fixed broadband subscriptions refer to fixed subscriptions to high-speed access to the public Internet (TCP/IP connection) at downstream speeds equal to, or greater than, 256 kbit/s. This includes cable modem, DSL, fibre-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. It includes fixed WiMAX and any other fixed wireless technologies. This total is measured irrespective of the method of payment. It excludes subscriptions with access to data communications (including the Internet) via mobile-cellular networks. It includes both residential subscriptions and subscriptions for organisations. Mobile broadband subscriptions (active mobile-broadband subscriptions in ITU Database) refer to the sum of active handset-based and computer-based (USB/dongles) mobile-broadband subscriptions that allow access to the Internet. It covers actual subscribers, not potential subscribers, even though the latter may have broadband-enabled handsets. Subscriptions must include a recurring subscription fee or pass a usage requirement if in the prepayment modality – users must have accessed the Internet in the last three months (ITU, 2020[13]).
Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/nsuvtz

4G was the most common mobile broadband technology in Thailand in 2022 with 70% of mobile connections, followed by 3G with 17% and 5G with 13% (Figure 5.2) (GSMA Intelligence, 2023[11]). 3G connections have shown a steady decline since 2016, coinciding with the rise in 4G connections (GSMA Intelligence, 2023[11]). While 4G remains the most prevalent technology as of 2022, 4G connections decreased slightly from 2021 to 2022 (from 72% to 70%). This occurred simultaneously as 5G connections increased (from 4% to 13%) over the same period (GSMA Intelligence, 2023[11]). This suggests 5G connections will likely gain ground compared to 4G, especially considering the high 5G population coverage of 85% in 2022 (GSMA Intelligence, 2023[11]).

Figure 5.2. Percentage of mobile connections per technology, 2013-22

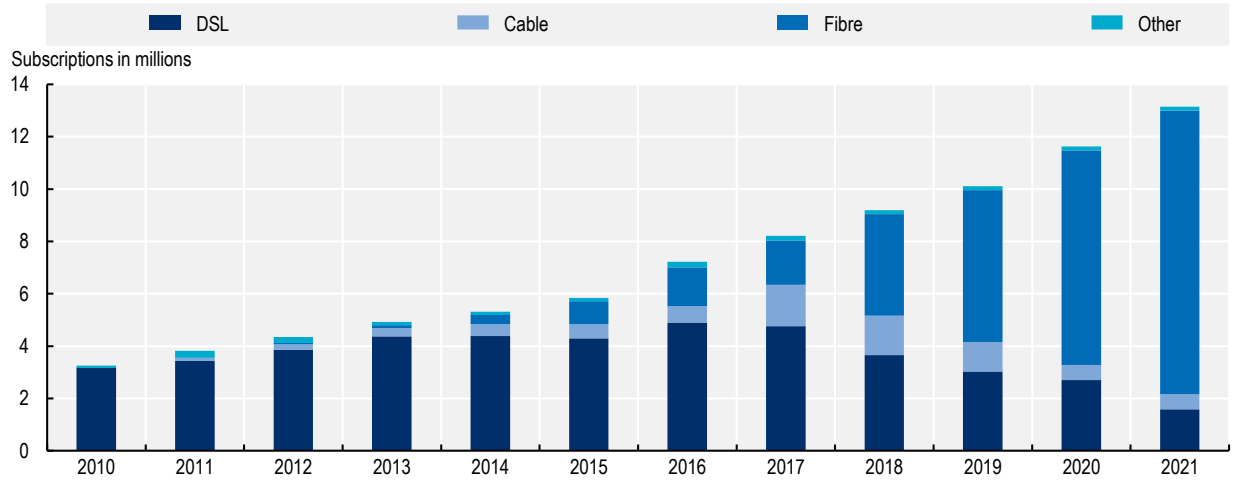


Source: GSMA Intelligence (2023[11]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/yvh69s

Fixed networks have also proven to be dynamic in recent years. Fibre-to-the-Home (FTTH), which overtook digital subscriber line (DSL) in 2018, represented the most widespread broadband fixed technology in 2021 with an impressive 82% of fixed subscriptions (Figure 5.3) (ITU, 2023[12]). Much of the fibre in the country has been deployed over aerial fibres. This is true in major metropolitan areas like Bangkok, as well as in suburban and rural areas. While this installation mode is often quicker and cheaper than laying fibre underground, aerial fibre is more exposed to the elements and adverse weather. As a result, aerial fibre might prove to be less resilient.

Figure 5.3. Fixed broadband subscriptions by technology, 2010-21

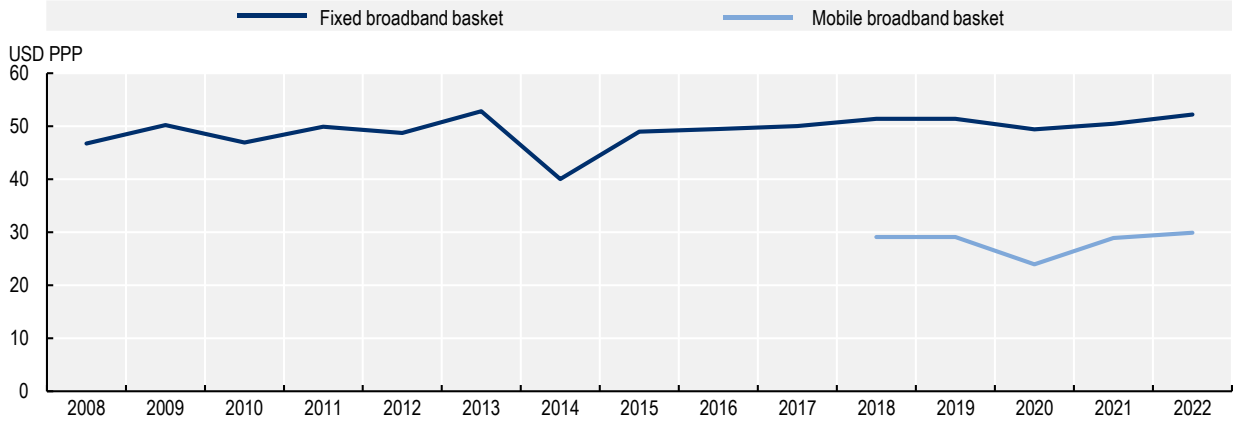


Note: 'Cable' data for 2021 and 'Other' data for 2020 and 2021 are estimates.
Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/clnpra

As mobile and fixed coverage and subscriptions have increased, prices for entry-level services for each have remained largely stable (Figure 5.4). In 2022, the price of entry-level fixed services (5 GB) was USD PPP 52.2, which was almost equal to the regional average of USD PPP 51.6 (ITU, 2023[12]). On the mobile side, the price for entry-level mobile services (70 min + 20 SMS + 500 MB) in 2022 was USD PPP 29.9, the highest price in the region and well above the regional average of USD PPP 15.5 (ITU, 2023[12]). However, in light of gross national income (GNI) per capita, Thailand's mobile and fixed prices for entry-level services rank more affordable than those of some regional peers. Mobile prices were 2.0% of GNI per capita in 2022, slightly above the regional average (1.6%). In addition, fixed prices represented 3.4% GNI per capita, roughly half of the regional average (6.2% of GNI per capita), as discussed further below (Figure 5.13) (ITU, 2023[12]).

Figure 5.4. Prices for entry-level fixed and mobile communication services, USD PPP, 2008-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2008 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[14]). Mobile basket prices are not available from 2008 to 2017.
Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023),* www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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5.2.2. Market structure

Thailand underwent a significant period of privatisation and liberalisation in the early 2000s to reform its communication market. Prior to the reforms, the state-owned enterprises Telecommunication Organization of Thailand (TOT) dominated domestic telephony services, while the Communication Authority of Thailand (CAT) dominated international telephony, postal and other non-voice services.

Since the late 1980s, TOT and CAT also performed certain roles normally undertaken by a regulatory body. For instance, they both issued licences ("build-transfer-operate concessions") to private operators for various services (Jittrapanun and Mesher, 2004[15]). These licences allowed private operators to enter the Thai market and could be seen as a first step towards liberalisation.

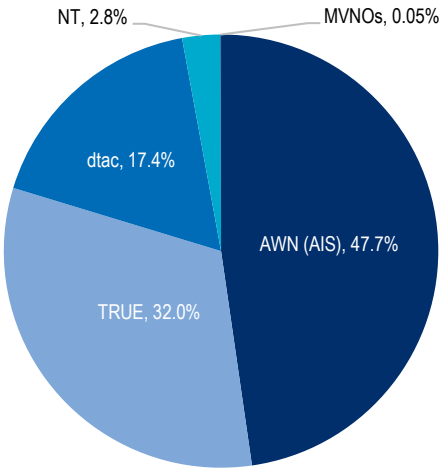
In 2000, the government aimed to privatise TOT and CAT. However, due to political uncertainty, they were established as "private" companies with the government owning all shares (Wisuttisak and Rahman, 2020[16]). This situation continues, with the Ministry of Finance owning all shares of the TOT-CAT merged entity, National Telecom (NT), making it a fully state-owned enterprise. The merger of the two state-owned entities had long been under discussion. TOT-CAT finally merged in 2021 to become NT, with the aim of improving efficiency and better competing against other market players (Inside Telecom, 2021[17]).

These efforts were supported by the establishment of an independent regulatory agency, the National Telecommunications Commission (NTC). The NTC was replaced by the National Broadcasting and Telecommunications Commission (NBTC) in 2010 under the Act on the Organization to Assign Radio frequency and to Regulate the Broadcasting and Telecommunications Services B.E. 2553 and its amendments (hereafter the "NBTC Act") (Government of Thailand, 2010[18]; Government of Thailand, 2021[19]).

While the incumbent operator has not been privatised, the pace of liberalisation has picked up, with several private operators offering services. The mobile market has four main operators: Advanced Wireless Network Company Ltd. (AWN), a subsidiary of Advanced Info Service Public Ltd. Co. (AIS), True Internet Corporation Co., Ltd. (True), Total Access Communication Public Company Ltd. (dtac, part of the Telenor Group), and NT. Mobile virtual network operators (MVNOs) also offer services.

The mobile market is more concentrated than the fixed market. As of Q4 2021, AIS was the leader with almost half of the market share (47.7%) based on mobile subscribers, based on data from national authorities. It is followed by True with 32.0%, dtac with 17.4% and NT with 2.8% (Figure 5.5). MVNOs represent a small proportion of mobile subscribers, with only 0.05% of the total. Three of the four main players in the fixed market also provide mobile services: AWN (AIS), True and NT.

Figure 5.5. Mobile market shares based on mobile subscribers, Q4 2021



Note: "Mobile subscribers" refer to the total number of mobile subscribers in Thailand with plans using data, voice or both.
Source: OECD elaboration based on data from Thai authorities.

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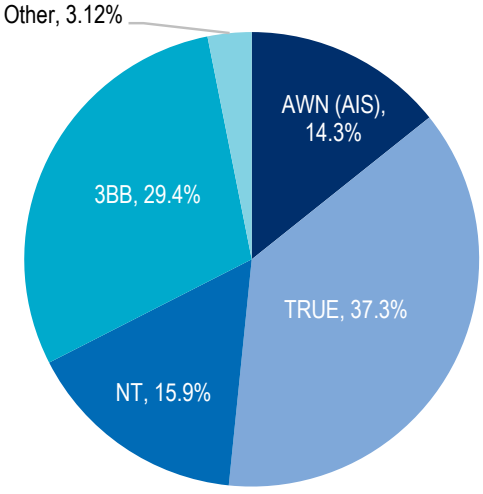
In the fixed market, there are four main players: AWN (AIS); True; Triple T Internet Co. (3BB), a subsidiary of Jasmine International; and NT. According to information from national authorities, True is the leader in the fixed market with 37.3% market share in terms of fixed broadband subscribers, followed closely by 3BB with 29.4%, NT (15.9%) and AWN (AIS) (14.3%) in Q4 2021 (Figure 5.6). Smaller operators make up the remaining 3.12% of the market. NT, AWN (AIS) and True also provide wholesale services.

Figure 5.6. Fixed market shares based on fixed broadband subscribers, Q4 2021



Source: OECD elaboration based on data from Thai authorities.

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As Figure 5.5 and Figure 5.6 show, competitors have assumed leading positions in the market from the national incumbent, NT. This is in part a testament to the impact of liberalisation on both the fixed and mobile markets. It also suggests equal treatment of new private players compared to the incumbent under Thai law.

However, the above market shares only provide a snapshot as of the end of 2021, which is the most recent data provided by national authorities. As such, they do not reflect recent market developments. In the mobile market, the merger of True and dtac was completed in March 2023 (Telenor Asia, 2023[20]). In the fixed market, AWN (AIS) indicated interest in the potential acquisition of two Jasmine International subsidiaries: 3BB and Jasmine Broadband Internet Infrastructure in 2022 (KPMG, 2022[21]).

Thailand's framework to assess mergers and acquisitions has been put to the test during the merger proceedings of True and dtac, which began in 2021. According to local news outlets, NBTC itself seems to have been uncertain about its own authority in the matter, convening specific subcommittees on the issue. This included whether it could approve or deny the merger, upon which it sought judgement from the Office of the Council of State (The Reporter Asia, 2022[22]). The Council of State reportedly upheld NBTC's 2018 regulation and the notify-only regime it establishes (The Nation Thailand, 2022[23]).

In October 2022, NBTC officially acknowledged the merger plan between True and dtac. This allowed the merger to proceed according to the plans presented. However, NBTC stipulated certain conditions involving requirements on prices, and provision of network services to support MVNOs, quality of service, coverage and innovation (NBTC, 2022[24]).

The decision was met with criticism from customer groups that argued the merger would harm competition. The Thailand Consumers Council (TCC) petitioned the Central Administrative Court in November 2022 to revoke NBTC's decision and to order an emergency investigation and temporary halt to merger proceedings until the court's verdict (TCC, 2022[25]). The Court dismissed the TCC's petition (Central Administrative Court, 2023[26]).

In March 2023, dtac announced the merger's completion (Telenor Asia, 2023[20]). Taking the market shares from end-2021 as an indication of possible outcomes following the merger, the market could evolve into essentially a duopoly, with AWN (AIS) controlling 47.72% of the market share and the merged entity becoming the market leader with 49.4%.

In addition, if the merged entity maintains and combines the individual spectrum holdings prior to the merger, it will change distribution of spectrum in the market. Before the proceeding, AWN (AIS) held 1 420 MHz across all bands; True held 990 MHz, NT had 540 MHz; and dtac had 270 MHz, according to national authorities. After dtac and True's merger, they would hold 1 260 MHz, just behind AWN (AIS); NT would trail with 540 MHz.

Another acquisition is being discussed in the fixed market. In July 2022, AWN (AIS) announced plans to acquire 99.87% interest in 3BB and a 19% interest in Jasmine Broadband Internet Infrastructure Fund (KPMG, 2022[21]). However, the deal for these two Jasmine International subsidiaries is still pending NBTC's regulatory review. Given AWN (AIS)'s dominance in the mobile market but weaker position in the fixed market, it may be motivated to increase its fixed footprint through the merger. This would allow it to offer better bundled offers, as well as to expand its backhaul network.

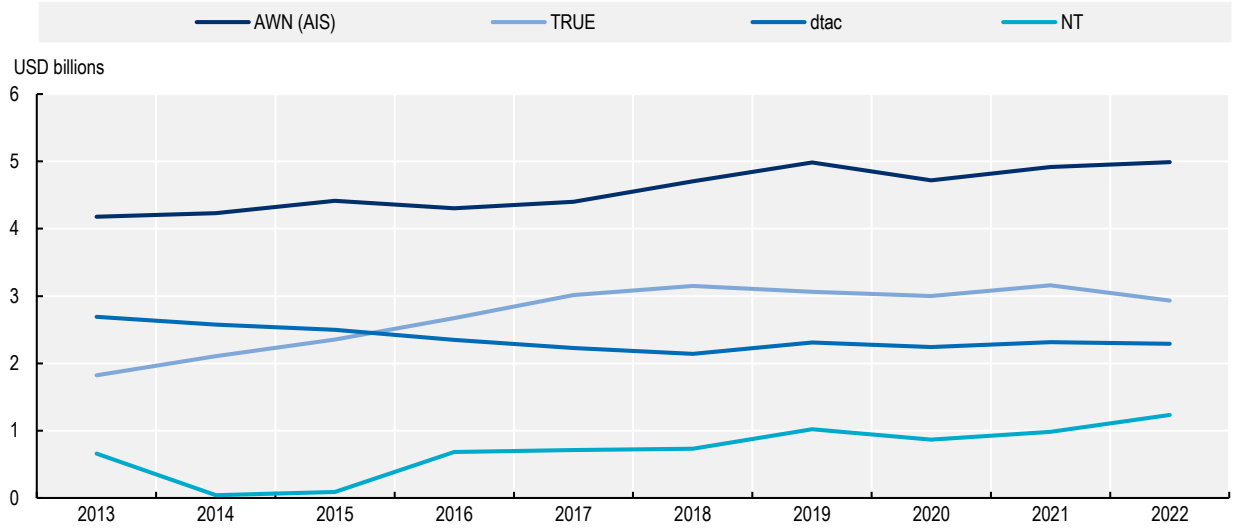
Should the acquisition occur, AWN (AIS) and the acquired 3BB would have the largest market share based on 2021 fixed broadband subscribers at around 43.66%. It would edge out True (with its market share of 37.3%), as well as NT (15.9%). If both deals go through, the merged entity of True and dtac and AWN (AIS), with its acquisition of 3BB, would be the top two providers with substantial market shares in both fixed and mobile markets.

Revenues and investment offer another way to understand the market, although data are only available for mobile markets in Thailand. In the mobile market, total revenues increased by 22% from 2013-22 in

nominal terms, from USD 9.38 billion in 2013 to USD 11.45 billion in 2022 (GSMA Intelligence, 2023[11]). These market revenues placed Thailand first in the region in 2022 in nominal terms, almost tied with Indonesia (USD 11.40 billion) (GSMA Intelligence, 2023[11]).

Perhaps unsurprisingly given its market share, market leader AWN (AIS) has consistently had the highest revenues of all players since 2013, reaching USD 4.99 billion in 2022 (nominal terms) (GSMA Intelligence, 2023[11]). In 2022, True had the next highest revenue with USD 2.93 billion. Dtac and NT followed at USD 2.29 billion and USD 1.23 billion, respectively (GSMA Intelligence, 2023[11]) (Figure 5.7). This order follows the ranking by market shares (Figure 5.5).

Figure 5.7. Mobile revenues by operator, 2013-22



Source: GSMA Intelligence (2023[11]), *Database,* www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

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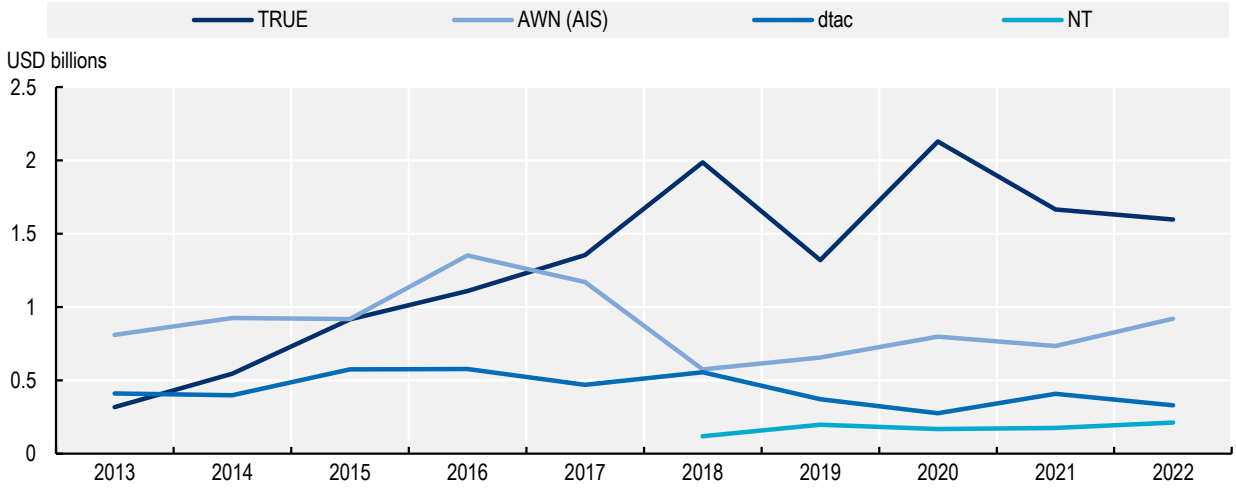
Comparing operators' revenues in the mobile market to the total spent on capital expenditures (Capex) tells a different story. Capex is a typical measure to track investment by operators on longer-term assets, such as to extend their network footprint. True stands out among its peers with a much more aggressive investment strategy. In 2022, True invested USD 1.60 billion in nominal terms, almost double the amount invested by AWN (AIS) (USD 919 million), and more than four times that of dtac (USD 329 million) and NT (USD 212 million) (GSMA Intelligence, 2023[11]) (Figure 5.8). True's level of Capex in 2022 accounted for 54% of its revenues, whereas AWN(AIS) and NT had a capex-to-revenue ratio of 18% and 17%, respectively. Meanwhile, dtac's capex represented 14% of its revenue (GSMA Intelligence, 2023[11]).

Overall, total investment in mobile markets grew rapidly over 2013-22. In 2022, investment reached USD 3.06 billion (nominal terms), fuelled by True's investments that make up just over half of the total (GSMA Intelligence, 2023[11]). This puts Thailand at the top of Southeast Asian (SEA) rankings in terms of mobile Capex investment in 2022, closely followed by Indonesia (GSMA Intelligence, 2023[11]).

Figure 5.8. Investment in mobile networks (total Capex) by operator, 2013-22



Source: GSMA Intelligence (2023[11]), *Database,* www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

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5.3. Communication policy and regulatory framework

5.3.1. Institutional framework

The main bodies covering the communication sector in Thailand are the Ministry of Digital Economy and Society (MDES) and NBTC. MDES develops policies for the digital economy and society, including for communication infrastructure. Under MDES, the Office of the National Digital Economy and Society Commission (ONDE) is the primary policy-making unit. It supports and co-ordinates with the National Committee on Economy and Society, a body with representatives from various ministries and chaired by the Prime Minister. The committee develops national plans and policies to promote digital transformation of the Thai economy and society (Government of Thailand, 2017[27]).

NBTC is an independent regulatory agency with remit over the communication and broadcasting sector in Thailand. As previously noted, NBTC was established through the NBTC Act (Government of Thailand, 2021[19]; Government of Thailand, 2010[18]). NBTC is charged with managing, assigning and licensing spectrum resources, setting technical standards and specifications, licensing and regulating broadcasting and communication services, and promoting competition in the market, among other duties (Government of Thailand, 2010[18]). Further, NBTC can establish rules under the scope of its duties, as well as monitor the provision of communication and broadcasting services (Government of Thailand, 2010[18]).

MDES and NBTC co-operate to develop policies to advance the communication services in Thailand. MDES develops the overarching digital policy across various sectors, including the communication sector, which is set forth in the Digital Economy and Society Development Plan (2018-2037). NBTC defines sector-specific plans, such as those related to spectrum management, broadcasting and the Telecommunications Master Plan No. 2 (2019-2023), which aligns with the Digital Economy and Society Development Plan. NBTC must consult on these sector-specific plans with MDES and relevant government bodies, as well as the public and operators, and consider comments received (Section 49) (Government of Thailand, 2010[18]).

Aside from roles and responsibilities of MDES and NBTC within Thailand's institutional framework, the level of NBTC's independence should be considered. Section 60 of the Thai Constitution defines the *de*

jure independence of NBTC (Government of Thailand, 2017[28]). NBTC can determine its own budget and revenues (Sections 57 and 65), only receiving government funds if its other sources cannot cover expenditures (Government of Thailand, 2010[18]). The NBTC Act and its amendments establish NBTC, its structure, functions and responsibilities, as well as the appointment process of NBTC Commissioner (Government of Thailand, 2021[19]; Government of Thailand, 2010[18]).

The selection process for NBTC's Commissioners begins with a selection committee that defines the required skills and experience of candidates. Subsequently, the Senate announces a public application process that lasts at least 30 days. The selection committee consists of representatives from the constitutional court, the Supreme Court, the Supreme Administrative Court, the National Anti-Corruption Commission, the State Audit Commission, the Ombudsman and the Bank of Thailand (Government of Thailand, 2021[19]; Government of Thailand, 2010[18]). After reviewing the candidate pool, the committee sends the names of candidates meeting the defined requirements to the Senate. The Senate must approve with at least half of the total number of existing members (Section 16), after which it sends the names of approved candidates to the Prime Minister, who then forwards the list to the King for royal appointment (Government of Thailand, 2021[19]; Government of Thailand, 2010[18]). Overall, the legislation requires a degree of transparency, as the Senate must publicly announce and accept applications for the Commissioner posts.

While the government is involved in the appointment of NBTC Commissioners to a degree (i.e. through Senate approval and royal appointment), the selection committee is made up of representatives from judiciary bodies, independent organs, and the Bank of Thailand, which may help to decrease the risk of political influence. Similarly, in many OECD countries, a governmental or ministerial body appoints the leadership of communication regulators (OECD, 2021[29]). Nevertheless, measures to promote transparency, such as an independent selection panel to nominate and appoint leaders based on merit, can help insulate the process from any undue influence (OECD, 2021[29]). In Mexico, for example, the selection process of the communication regulator, the Federal Institute of Telecommunications (IFT), is based on "a qualification procedure carried out by an Evaluating Committee, based on the federal executive's proposal, with the Senate's subsequent ratification" (OECD, 2017[30]).

While the process in Thailand is rather transparent, NBTC was delayed in finalising the appointment process of its Commissioners. Five commissioners received Senate approval in December 2021 and began their terms in April 2022 (Bangkok Post, 2023[31]; Bangkok Post, 2021[32]). The Senate approved the sixth in August 2022, whose term began in October 2022 (Bangkok Post, 2023[31]; Bangkok Post, 2022[33]). The seventh post (the Commissioner acting for the area of telecommunication) received Senate approval in February 2023 and is listed as being in office on NBTC's website as of June 2023 (Bangkok Post, 2023[31]; NBTC, 2023[34]).

Some of the delay may have stemmed from legislative changes. The NBTC Act was amended in 2021, after the selection process had already begun. The 2021 amendment, which focuses on articles related to selection of Commissioners, were put forward to address "practical problems" in recruitment (Government of Thailand, 2021[19]). It modifies the required characteristics of selection committee members and specifies aspects of the recruitment and selection procedures (Government of Thailand, 2021[19]). Previously, one Commissioner each needed experience in engineering, law and economics, respectively. With the new amendment, two of the seven Commissioners can have experience that "will benefit the performance of NBTC's duties" (Government of Thailand, 2021[19]). Moreover, under prior rules, one Commissioner could have experience in either support for promotion of rights and liberties or consumer protection. Under the new rules, one Commissioner is required to have experience in each of these fields (Government of Thailand, 2021[19]; Government of Thailand, 2010[18]).

In summary, under the amended rules, Commissioners should have qualifications and expertise in the following fields: one for broadcasting, one for television, one for telecommunication, one for consumer protection, one for the promotion of rights and liberties, and two other disciplines that support NBTC's

duties (Government of Thailand, 2021[19]). The current Commissioners chosen to fill the last two roles have expertise in economics and law (NBTC, 2023[34]).

Overall, the final Board largely seems to have relevant experience. However, passing the amendment during the selection process undoubtedly delayed the appointment of the Commissioners, and should not be a precedent. In future, care should be taken to fill the Commissioner positions without undue delays.

Once appointed, Commissioners hold office for a non-renewable term of six years. However, they only vacate their office once the incoming Commissioners have been appointed (Government of Thailand, 2021[19]; Government of Thailand, 2010[18]).[4] The Commissioners vote among themselves to nominate the Chairperson, who with the consent of the NBTC shall appoint and remove the NBTC Secretary-General (Government of Thailand, 2010[18]). The latter has a term of five years, which may be extended but "shall not hold office for more than two consecutive terms" [unofficial translation] (Government of Thailand, 2010[18]). The delay to appoint the seven NBTC Commissioners also resulted in delays to appoint the NBTC Secretary-General.

Recommendation

1. **Further strengthen the transparency of the selection process of high-level NBTC officials and avoid undue delays in future selection processes.** While NBTC is an independent regulator, the government is involved in the appointment of NBTC Commissioners, which may be an opportunity for political influence. The government could consider adopting further measures to insulate the process from political influence, such as by adopting measures to increase transparency, such as an independent selection panel. Future selection processes should aim to appoint Commissioners without undue delays, including to avoid changing relevant regulation during an ongoing process. In addition, promoting transparency in the appointment process to name the NBTC Secretary-General by the NBTC Commissioners may help instil trust and confidence.

5.3.2. Regulatory framework

Several laws govern the communication sector, namely the Telecommunications Business Act, B.E. 2544 (2001), the NBTC Act and the Radiocommunications Act, B.E. 2498 (1955), as amended. Under this governing legislation (Telecommunications Business Act and NBTC Act), NBTC may issue additional regulations ("notifications") on specific issues under its remit. The Telecommunications Business Act defines the licensing framework to provide telecommunication and broadcasting services in the country and sets forth three licence types (Government of Thailand, 2001[35]):

- Type One: for operators without their own network infrastructure that aim to provide services considered appropriate to promote liberalisation.
- Type Two: for operators with or without their own network infrastructure that aim to provide non-public services (e.g. to a limited group of people) or to provide services unlikely to significantly impact competition.
- Type Three: for operators with their own network infrastructure that aim to provide public services (e.g. to a wide group of people) or to provide services that may significantly impact competition or require consumer protection.

Interested parties must apply to NBTC and receive approval to provide service in the country. Licensees owning a network must allow other licensees to connect to their network and conform to technical standards for their network equipment and devices as relevant (Government of Thailand, 2001[35]). Section

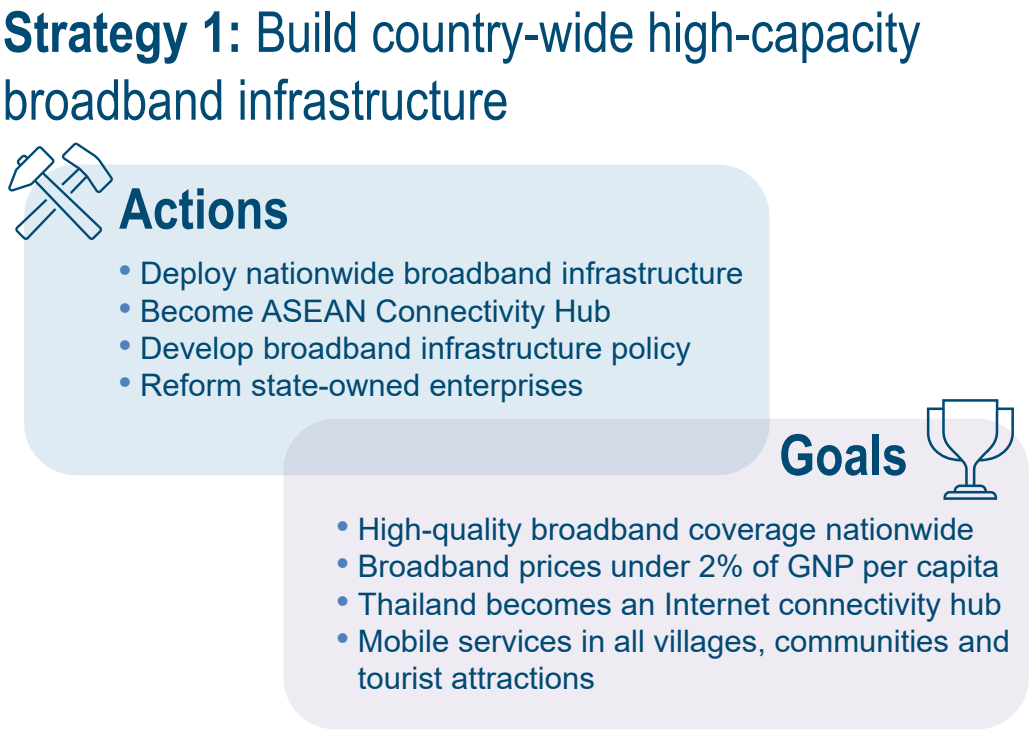
55 of the Telecommunications Business Act also authorises NBTC to set maximum fee thresholds for specific services being offered by licensees (Government of Thailand, 2001[35]). Licensees are furthermore required to charge the same rate for the same or similar categories of services to consumers (Government of Thailand, 2001[35]). The Act also authorises NBTC to manage a fund to promote universal service and require relevant licensees to contribute to and support its operations. In addition, it requires NBTC to approve contracts undertaken by a licensee and a communication service user (Government of Thailand, 2001[35]). Among these, the NBTC Act determines NBTC is responsible for licensing spectrum and establishing a frequency allocation plan. According to the above framework, NBTC is also responsible for licensing and assigning numbering resources.

The Radiocommunication Act, B.E. 2498 (1955) establishes the regulatory framework governing equipment and requires a licence to manufacture, own, use, import, export, trade or install any piece of radiocommunication equipment (Government of Thailand, 2015[36]). It also includes measures aimed at reducing harmful interference or the obstruction of radiocommunications.

5.3.3. Broadband strategies and plans

Promoting the digital economy seems to be a priority at the highest levels of the Thai government. For example, the National Committee on Economy and Society, established in 2017, is chaired by the Prime Minister. Together with ONDE under MDES, the committee aims to promote digital transformation. The Digital Economy and Society Development Plan (2018-37) is key to promote this transformation, which is led by MDES (MDES, 2019[37]). The first strategy (of six) aims to "build country-wide high-capacity digital infrastructure, ensuring accessibility, availability and affordability" (MDES, 2019[37]; MDES, 2018[38]).

Figure 5.9. Key actions and goals under Strategy 1 of the Digital Economy and Society Development Plan (2018-37)



Source: OECD elaboration based on MDES (2018[38]), *Thailand Digital Economy and Society Development Plan*, pg. 19, www.onde.go.th/assets/portals//files/Digital_Thailand_pocket_book_EN.pdf.

In addition, the NBTC Act tasks NBTC to create a five-year plan to define and structure its operations, a part of which corresponds to the Digital Economy and Society Development Plan. The Telecommunications Master Plan No. 2 (2019-23), published in January 2019, is the most recent plan (NBTC, 2019[39]). There are six strategies in the Master Plan covering: promoting competition; licensing and regulation of telecommunication and radio communication; effective management of spectrum and numbering resources; Universal Service and closing digital and skills divides; consumer protection; and supporting digital transformation (NBTC, 2019[40]). It has several comprehensive strategic goals that correspond to many of the tenets of the OECD Recommendation on Broadband Connectivity (hereafter, "OECD Broadband Recommendation") (OECD, 2021[1]). Areas of overlap include on measures to foster competition, investment and innovation; streamline licensing procedures; support efficient spectrum management; safeguard consumer rights; and close digital divides.

In conjunction, ONDE drafted the Action Plan for Broadband Infrastructure Phase 1 (2022-27) (ONDE, 2021[41]) as a roadmap to develop efficient, nationwide connectivity infrastructure. The plan sets out several goals, including to build fixed Internet with nationwide coverage with speeds of at least 100 Mbps; transition from analogue to digital systems, especially in television; increase data flows to and from Thailand; and support investment of data centres (ONDE, 2021[41]).

5.4. Competition, investment and innovation in broadband markets

5.4.1. Competition

The market structure of the fixed and mobile broadband networks in Thailand sheds light on the level of competition in the respective markets, allowing for an assessment of market concentration. As noted above, the mobile market has four main players: AWN (AIS) with 47.7% market share based on mobile broadband subscribers, followed by True (32.0%), dtac (17.4%) and NT (2.8%), as of Q4 2021, according to national authorities (Figure 5.5). MVNOs also operate in the country but only account for a small share of the market.

With four main players, including one that holds about half the market, the Herfindahl-Hirschman Index (HHI) based on these market shares is 3 612. This may indicate a moderately concentrated market, which some scales classify as those with HHIs between 1 500 and 2 500 (US DoJ, 2010[42]). However, this HHI and, consequently, the level of market concentration is likely to increase following the 2023 merger of True and dtac, the second and third largest players in the mobile market.

The fixed side also has four main players, but market shares by fixed broadband subscribers are more evenly distributed. True holds a 37.3% market share, followed by 3BB (29.4%), NT (15.9%) and AWN (AIS) (14.3%) as of Q4 2021, according to national authorities (Figure 5.6). Other providers account for 3.12% of total subscribers. Based on these market shares, the HHI for the fixed market is 2 724, considerably lower than the one for the mobile market. However, this HHI may also shift if AWN (AIS)'s proposed acquisitions proceed.

In light of these market structures and changes to the landscape (e.g. True-dtac merger and AWN (AIS)'s potential acquisition), Thailand's competitive regulatory framework is especially important. Upholding competition in the communication and broadcasting sectors is a key mandate of NBTC, as set out in the NBTC Act. The legislation empowers the regulator to prescribe further measures to prevent anti-competitive behaviour (Government of Thailand, 2010[18]). In addition, Section 21 of the Telecommunications Business Act gives NBTC the right to prescribe measures to prevent licensees from undertaking monopolistic practices that limit market competition. It also requires licensees to allow other licensees to connect to their networks (Government of Thailand, 2001[35]).

NBTC issued the Notification on "Criteria and Procedures for Identifying Operators with Significant Market Power (SMP) in Telecommunications Business B.E. 2557 (2014)" to determine market players with SMP for relevant markets defined by NBTC (NBTC, 2014[43]). These include markets that are highly concentrated according to the HHI, have persistently high barriers to entry or have low levels of competition (NBTC, 2014[43]). Where relevant markets have low levels of competition, NBTC may consider designating players with more than 40% market share as having SMP. It could do the same for players with between 25-40% market share in light of other factors that may impact dominance in a certain market (NBTC, 2014[43]). NBTC prepares a report analysing the level of competition in the relevant markets and defines a list of SMP operators in each relevant market. This is a basis for setting out measures on operators with SMP, in line with the competitive conditions of the market (NBTC, 2014[43]).

SMP operators, as well as Type Two or Three licensees designated by NBTC, must provide local loop unbundling on non-discriminatory and fair terms, according to NBTC's wholesale access regulation (NBTC, 2010[44]). Most recently, Decision No. 26/2564 defined SMP operators, including for mobile call termination and wholesale broadband access (NBTC, 2021[45]). For mobile call termination, AWN (AIS), True, dtac and NT were all listed as having SMP (NBTC, 2021[45]). For wholesale broadband access, NT, 3BB and True were classified as having SMP (NBTC, 2021[45]). SMP operators must comply with certain measures, such as applying fees based on costs (long-run incremental cost), offering wholesale access, reporting to NBTC and applying accounting separation (NBTC, 2021[45]).

Decision No. 26/2564 does not consider either the mobile or fixed retail markets to be relevant markets for consideration. This is somewhat surprising for the mobile retail market, given the 48% market share of AWN (AIS). Such an assessment may be even more warranted following the 2023 merger of True-dtac.

Given their immediate and sometimes significant impact on competition in the communication market in which the operators provide service, mergers and acquisitions are often closely monitored and regulated. The NBTC "Notification on measure to regulate mergers in the telecommunications business, 2018" (hereafter referred to as the 2018 merger regulation) sets forth the regulatory framework to assess mergers and acquisitions (NBTC, 2018[46]). Whereas previous legislation gave NBTC the right to approve or reject requests for mergers or acquisitions, the 2018 merger regulation changed this to a notify-only regime. Notification to NBTC of mergers exceeding financial thresholds must include, among other aspects, a competition analysis by an independent consultant (NBTC, 2018[46]). If this analysis finds the proposed merger results in an HHI of above 2 500, a change of more than 100, additional barriers to enter the market and the number of critical infrastructure being owned by the merged entity increases significantly, NBTC can consider specific conditions on the merger (NBTC, 2018[46]). However, NBTC cannot reject the merger or acquisition outright. The 2018 notify-only regime has caused a great deal of uncertainty, prolonged the period of consideration for the True-dtac merger and sparked legal contests regarding NBTC's authority in the case.

In OECD countries, regulators closely scrutinise mergers in the communication sector before deciding whether they can go ahead. In many cases, regulators introduce merger conditions, such as those in Italy in 2016 (Hutchinson/WIND/JV) and the United States in 2020 (T-Mobile/Sprint) (OECD, 2021[47]).

Under the 2018 merger regulation, NBTC can prescribe conditions on mergers that are likely to increase the level of market concentration. Given market characteristics before the True-dtac merger, it seems likely the merger will increase market concentration. The sum of True and dtac's pre-merger shares would result in a 49% market share and would increase the HHI to 4 726, up from the pre-merger HHI of 3 612. With True-dtac's combined market share of 49%, competing with AWN (AIS)'s 48%, the market would become essentially a duopoly, assuming the pre-merger market shares of the two combine. These circumstances meet the 2018 merger regulation's thresholds for NBTC to specify conditions, for example, the post-merger HHI is above the threshold of 2 500 and increases by more than 100) (NBTC, 2018[46]).

Indeed, NBTC did introduce merger conditions on several topics, including prices, provision of network services to support MVNOs, quality of service, coverage and innovation (NBTC, 2022[24]). Notwithstanding

these conditions, given the potential impact of mergers on competition, the move to a notify-only regime where mergers are no longer subject to regulatory approval is concerning. It raises the question of whether NBTC can fulfil its mandate to uphold competition in the market.

The recent merger proceedings of dtac and True have forced NBTC to consider its role under this regulatory regime. Therefore, some of the legal ambiguity that arose during the merger will be clearer for future proceedings. This sectoral regulation (2018 merger regulation), which specifies NBTC's mandate over mergers, takes precedence over the general competition authority in Thailand – the Trade Competition Commission of Thailand (TCCT). TCCT's remit does not extend to competition issues within the remit of sectoral regulators, as defined by their governing laws (Government of Thailand, 2017[48]).

However, NBTC has only issued regulation on certain competition issues (e.g. mergers, SMP definition). It is unclear which body would have responsibility for other competition issues involving actors in the communication market. The role and mandate of NBTC should be clearly defined and delineated from TCCT in cases where no specific regulation has been issued by NBTC on other competition aspects.

Consistency in the application of the regulatory framework is also important. For example, different approaches and interpretations may have been used to evaluate the merger between True and dtac and between TOT and CAT. In the True-dtac case, NBTC convened committees and held several meetings to discuss the merger and its own jurisdiction in the matter. This does not seem to be the same process for the TOT-CAT merger. Some interpretation also seems required to apply the current legal framework. If different approaches apply under some cases, clear criteria should be set forth in the regulation to establish under what conditions.

Recommendations

2. **Consider revisiting NBTC's regulation governing mergers in the communication sector.** In the medium term, it is highly recommended to revisit NBTC's "Notification on measures to regulate mergers in the telecommunications business" from 2018, which changed the mergers and acquisitions regulation to a notification-only regime. NBTC can no longer approve or reject requests for mergers and acquisitions, which lowers its power to judicate in such cases. It also risks increased market concentration, with potential detrimental effects on consumer welfare, investment and innovation. In addition, the regulatory framework governing mergers should be applied consistently for all mergers and acquisitions in the communication market, or clearly defined in the regulation when different approaches may apply.
3. **Carefully monitor the implementation of merger conditions in the recent merger of True and dtac in the mobile market**. It is imperative that NBTC closely monitor competition in the mobile market and ensure the implementation of merger conditions as stipulated. Where NBTC finds the mobile market to be a relevant market for competition assessment, which is likely given the high market shares of both AWN (AIS) and the merged entity following the proceedings, the regulator could consider SMP classifications and/or *ex ante* remedies, according to the assessment.
4. **Clarify any remaining uncertainty between the respective remit of NBTC and TCCT regarding competition in the communication sector.** NBTC has only issued notifications on certain competition issues (e.g. mergers, SMP definition). Uncertainty remains on the mandates of NBTC and TCCT on other competition issues upon which the NBTC has not issued a specific regulation. Thus, NBTC's role and mandate should be clearly defined and delineated from TCCT to clarify ambiguity in the respective remits of the two bodies.

5.4.2. Investment

Thailand's regulatory framework aims to ease infrastructure investment in communication networks, mainly by allowing infrastructure sharing and promoting open access. With prior NBTC approval, mobile network operators may share infrastructure such as towers/masts, base stations, cables, antennas and radio node controllers or base station controllers (Government of Thailand, 2019[49]). Currently, Thai operators share passive infrastructure and assets according to national authorities, even though active infrastructure sharing of certain radio access network (RAN) and core network elements are permitted. Thailand also promotes an open access model in the Net Pracharat project (discussed in the "Digital divides" section below). The project allows licensed operators to use the networks constructed under the project to provide last mile Internet services to users in underserved areas. Such open access models can help optimise communication resources and avoid duplication of investments, particularly in areas that are not financially viable.

Another way network operators may seek to optimise resources while still fostering connectivity is by contracting wholesale services, especially in underserved areas. A well-functioning wholesale market can provide another option for network operators to access backhaul and backbone capacity to supplement their own networks in such areas. In Thailand, wholesale access regulation exists, and some operators are offering wholesale services. However, competing operators report reluctance to contract these services due to price and quality. Thailand could consider two actions to encourage the wholesale market. First, it could facilitate the deployment of wholesale networks, especially in underserved areas where it may be difficult for operators to recoup investments. Second, NBTC could monitor prices for wholesale services nationwide, (not only in underserved areas) and consider measures if it finds prices are not set at fair levels. This would be especially relevant for operators classified as having SMP in the wholesale market in question.

Thailand's legal framework sets some restrictions on foreign direct investment (FDI). Section 8 of the Telecommunications Business Act prohibits a foreigner under the Foreign Business Act (including where the majority of shareholders are non-Thai) from applying to obtain either Type Two or Three licences (Government of Thailand, 2001[35]; Government of Thailand, 1999[50]). Type One licences apply to operators offering services without owning their own network; Type Two licences are namely for operators that offer services to a specific group of customers (with or without their own network); while Type Three licences target operators that own their network and offer services to the general public (Government of Thailand, 2001[35]). This essentially caps foreign ownership or investment at 49% of capital shares for Type Two or Three licensees. In addition, NBTC issued further regulation prohibiting "foreign dominance" (NBTC, 2022[51]).

Nevertheless, several of the main players in both the fixed and mobile markets have foreign investors, although their ownership is limited to less than half. For example, dtac (prior to the merger) was part of the Telenor Group (Telenor, 2023[52]). AWN's parent company, AIS, has a mix of shareholders, with the two largest being Intouch Holdings Plc (holding 40% of total shares) and Singtel Strategic Investments (holding 23%), both of which include foreign shareholders (AIS, 2022[53]). True (prior to the merger) also had China Mobile International Holdings Ltd. owning 18% of shares as of September 2022 (True, 2022[54]). Removing foreign ownership restrictions may help further increase foreign investment, especially as foreign players have already shown interest in Thailand's communication markets.

In addition to the FDI regulation, several fees apply to operators. According to Thai authorities, all operators providing commercial communication services must pay an annual business licence fee based on annual revenues. This ranges from 0.125% of annual revenues for licensees with revenues of up to THB 100 million (USD 2.86 million) to 1.5% for operators with annual revenues of more than THB 50 billion (USD 1.43 billion) (NBTC, 2017[55]).[5] Licence application processing fees also apply, which are quite nominal.

Spectrum fees apply as well. These are: 1) spectrum usage fees, for all operators or business entities using licensed spectrum; and 2) auction fees, where spectrum is auctioned (e.g. for mobile spectrum bands). Auction fees vary by auction, depending on spectrum band, demand and the amount of spectrum being sought. Numbering fees also apply. For instance, numbers for mobile service cost THB 1.50

(USD 0.04)/number/month (NBTC, 2020[56]).[6] Finally, licensees must contribute 2.5% of net income from communication services (e.g. gross income minus certain costs deductions) as a universal service contribution (NBTC, 2017[57]).

These fees factor into business decisions related to investment, as they pose an overhead cost to operate in the country. Several other aspects may influence an operator's propensity to invest. These include the company's business and investment strategy and future goals (including merger plans); the financial health of the business; the level of competition in the market; and the regulatory framework governing investment in the country, including for FDI.

Nevertheless, the fees operators may pay may increase operators' expenses and impact investment decisions. While the total level of fees that apply per operator varies, three out of four of the main mobile operators reported 2021 revenues above USD 1.43 billion (AIS [AWN], True, dtac; see Figure 5.7) (GSMA Intelligence, 2023[11]). This would likely place them in the highest licence fee category of 1.5%. When combined with the Universal Service Obligation of 2.5%, their fees represent at least 4% of revenues from communication services. This does not include spectrum or numbering fees, which would also apply to these mobile operators.

Consequently, high fees could impact operators' ability to make long-term investments. This is especially true on the mobile side, which have additional payments such as spectrum auction fees to obtain mobile spectrum, along with the spectrum usage fee.

On the mobile side, the current level of fees seems manageable as operators are investing in their networks (Figure 5.8). Indeed, Thailand is the regional leader in terms of total mobile Capex. These investments are likely supporting the expansion of high quality networks in the country, as evidenced by Thailand's impressive 5G mobile coverage (85% of the population in 2022) (GSMA Intelligence, 2023[11]). However, Thailand's median mobile performance in July 2023 places it in the middle of SEA countries. It has a 40.6 Mbps median download speed and 13.5 Mbps median upload speed (Ookla, 2023[58]).[7] Compared to its regional peers, these mobile speeds could imply more investment is still needed to improve mobile performance.

On the fixed side, operators seem to be heavily investing in fibre, as indicated by the high proportion of fibre of overall fixed subscriptions and its high median fixed download speeds (Figure 5.3). On speed metrics, Thailand is a clear leader, ranking second in the region behind Singapore. It is also fifth globally in terms of median fixed download speeds (211.3 Mbps download and 180.2 Mbps upload in July 2023) (Ookla, 2023[58]).

Current indications suggest that Thai operators are investing to expand and improve their networks. Nevertheless, Thailand should monitor the effect of fees on investment decisions moving forward to ensure operators have the financial capacity to invest over the long-term.

Recommendations

5. **Consider facilitating wholesale networks, especially in underserved areas, and monitoring wholesale prices.** In underserved areas, Thai authorities could facilitate the deployment of wholesale access networks to provide operators with another option to access backhaul and backbone capacity in such areas. In addition, NBTC could monitor prices for wholesale services, in general, to determine whether they are considered too high, especially for operators designated as having SMP in the relevant wholesale market.
6. **Eliminate foreign direct investment restrictions.** Eliminating FDI restrictions would help new players enter the market, spur competition and encourage further foreign investment. It would also increase the availability of latest technologies and acquisition of technical and specialised knowledge in the Thai market.

5.4.3. Innovation

Thailand has policies and regulations to promote innovation. For instance, the NBTC Telecommunications Master Plan No. 2 (2019-23) sets a goal to promote innovative research and development in equipment and technology through the Broadcasting and Telecommunications Research and Development (BTFP) Fund. The BTFP Fund supports various projects in the telecommunication and broadcasting sectors. Recent telecommunication projects include support for research and development of equipment to inspect communication cables (2018) and a project to leverage the Internet of Things and communication systems to develop telehealth services amid social distancing restrictions (2020) (BTFP, n.d.[59]).

Several other policies emphasise next-generation communication networks, especially 5G. To promote the provision of 5G, NBTC issued the “Notification Re: Criteria for Permitting Frequency Use for Innovation Development and Testing in a Sandbox Area (Sandbox Notification)” in 2019. The Sandbox Notification allows participants to use certain frequencies and conduct frequency testing within the sandbox to develop and test equipment, networks or systems for pre-commercialisation purposes (NBTC, 2019[60]). Before, telecommunication operators could only receive a licence from NBTC for frequency testing. With this notification, a governmental entity or a juristic person registered under Thai law can apply for a sandbox licence to use frequency within the sandbox area (NBTC, 2019[60]).

ONDE has also developed an Action Plan for Promoting the Adoption of 5G Technology in Thailand, Phase 1. This plan aims to define the framework to support widespread adoption of 5G technology in various sectors and promote co-operation between the public and private sectors. Under this plan, Thailand introduced the "Thailand 5G Alliance" to drive 5G as the country’s key digital infrastructure. To that end, it will promote applications of 5G technology through business potential and commercial readiness.

In addition to these policies, Thailand supported deployment of next-generation networks by auctioning the spectrum needed to support 5G. NBTC auctioned three bands in 2020 – the 700 MHz, 2.6 GHz and 26 GHz bands – to support deployment of 5G networks. These 5G networks can, in turn, support innovative new use cases by providing higher speeds, lower latencies and improved capacity.

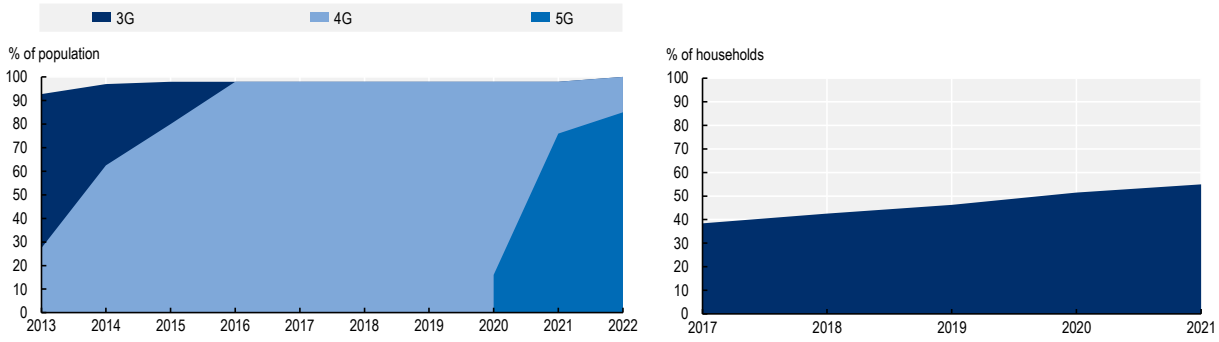
Thailand promptly set up the right enabling environment to promote 5G network deployment. This has included the 5G regulatory sandbox for operators to test frequency bands, policies to promote 5G applications and adoption, and assignment of sufficient spectrum in a variety of bands (low, medium and high). Indeed, Thailand was one of the first SEA countries to auction 5G spectrum. These actions seem to have paid off, considering Thailand’s early 5G rollout and its extensive 5G population coverage. By 2022, 5G networks covered 85% of the population, with 5G connections representing close to 13% of total mobile connections (GSMA Intelligence, 2023[11]).

5.5. Broadband deployment and digital divides

5.5.1. Broadband deployment

Over 2010-21, broadband deployment in Thailand sped up for both fixed and mobile broadband networks. In terms of mobile broadband networks, 3G and 4G networks have expanded rapidly in recent years, reaching virtually the entire population (98%) in 2015 and 2016, respectively (GSMA Intelligence, 2023[11]). Impressively, 5G network coverage by population reached 85% by 2022, just two years after operators began deploying in 2020 (GSMA Intelligence, 2023[11]). This increase in coverage has gone hand in hand with the aggressive investment strategy pursued by the dominant operator, True, over the last few years. However, the rollout of mobile networks would benefit from more investment by other competitors. They could be encouraged by a relaxation of restrictions on FDI and facilitation of mergers, subject to the relevant caveats (see section ‘Competition, investment and innovation in broadband markets’).

Figure 5.10. Broadband networks coverage



Note: The number of households covered by a fixed network is also referred to as cabled households or homes passed by a fixed wired network. The number of households covered by a fixed wired network, cabled households or homes passed denotes the availability of but not necessarily the subscription to or usage of fixed network services. Households should be classified as covered, cabled or passed if the network provider already provisions or could provision a connection to the fixed network within a short period of time (i.e., a few days) and without an extraordinary commitment of resources. An extraordinary commitment of resources involves any of the following: installing or extending cable from local switching centre, a DSLAM, CMTS, OLT, fibre node, optical splitter, FTTC cabinet, HFC node, building a duct, installing poles, leasing a line (ITU, 2020[13]).
Source: [Mobile broadband coverage] GSMA Intelligence (2023[11]), *Database,* www.gsmaintelligence.com/data/ (accessed on 9 November 2023). [Fixed broadband coverage] Data provided by national authorities, ONDE, Thailand.

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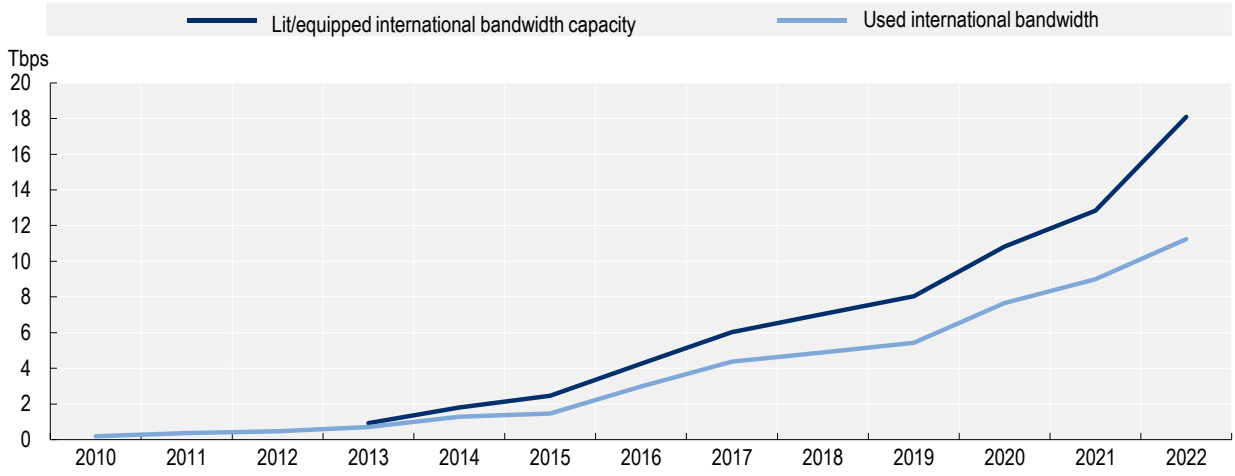
For fixed networks, the increase in coverage in recent years is notable. According to the ONDE (MDES), the number of households covered by a fixed broadband network in Thailand increased by 43% between 2017-21, reaching 54.9% of households (Figure 5.10). Further progress is needed to cover more households. The massive FTTH rollout between 2018 and 2021 is also noteworthy, resulting in good performance of fixed broadband services in Thailand, second only to Singapore in the region (see next section). This rollout has been mainly through aerial cables using existing electricity poles, although the government plans to consolidate this cabling in rural areas and move it underground in urban areas.

Operators report the burden of obtaining permits for network construction as a main barrier to network deployment. The process often includes different agencies across different jurisdictions (e.g. NBTC, the Metropolitan Electricity Authority, Provincial Electricity Authority). Dealing with several agencies is cumbersome and time-consuming, and often delays approvals. In some cases, operators reported lack of clarity regarding which authority has priority to give the permits. Removing such barriers can have a positive impact on network deployment in Thailand, particularly on the deployment of backhaul networks and national plans for fibre consolidation and undergrounding.

Moving up from the access networks to the backbone/long-haul transmission networks, Thailand has a terrestrial fibre network of 33 868 km (2020) connecting major urban centres through the five regions (ITU, 2023[61]).[8] However, only 19% of Thailand's population is within 10 km of a transmission node (2020) (ITU, 2023[61]), well below the SEA average (43%) (ITU, 2023[61]). This means that long distance backhaul networks will need to be built to connect broadband access networks and reach end-users. This can be a barrier to extending coverage in areas of low commercial interest, such as sparsely populated areas.

The equipped international bandwidth capacity in Thailand has been growing since 2013.[9] This growth coincides with the rollout of 4G networks, which anticipated increased demand that reached 11 terabits per second (Tbps) in 2022 (ITU, 2023[12]). As expected, used bandwidth followed the same trend, albeit at a slower pace, reaching 62% of equipped capacity in 2022 (ITU, 2023[12]) (Figure 5.11). Thailand ranks fourth in the region for equipped capacity (18 Tbps), after Singapore (220 Tbps), Malaysia (93 Tbps), Indonesia (47 Tbps), and Viet Nam (24 Tbps) (ITU, 2023[12]).

Figure 5.11. International bandwidth, 2010-22



Note: Lit/equipped international bandwidth capacity refers to the total lit capacity of international links, namely fibre-optic cables, international radio links and satellite uplinks to orbital satellites in the end of the reference year (expressed in Mbit/s). If the traffic is asymmetric (i.e., different incoming and outgoing traffic), then the highest value out of the two should be provided. Average usage of all international links, including optical fibre cables, radio links and traffic processed by satellite ground stations and teleports to orbital satellites (expressed in Mbit/s). The average is calculated over the twelve-month period of the reference year. If the traffic is asymmetric (i.e. different incoming and outgoing traffic), then the highest value out of the two should be provided. All international links used by all types of operators, namely fixed, mobile and satellite operators should be taken into account. The combined average usage of all international links can be reported as the sum of the average usage of each link (ITU, 2020[13]).
Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023),* www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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Thailand has 13 submarine cable landing stations to implement this international connectivity. Eleven of these cable landings connect the country to extra-regional cable systems. This includes some of the world's largest submarine cables, such as SeaMeWe-3 and 4, Asia-America Gateway (AAG), FLAG Europe-Asia (FEA) and Asia Africa Europe-1 (AAE-1) (TeleGeography, 2023[62]).

Among other SEA countries, Thailand and Indonesia rank fourth in extra-regional cable connections behind Singapore (28), Philippines (17) and Malaysia (15) (TeleGeography, 2023[62]). Thailand is also connected to two regional SEA cable systems: the Thailand-Indonesia-Singapore Cable (TIS) and the Malaysia-Cambodia-Thailand Cable (MCT) (TeleGeography, 2023[62]).

Taking all cables together, Thailand is connected to virtually all regions of the world. These connections are mostly through Singapore but also include direct connections to Asia and Europe (through Asia Africa Europe-1 cable system) (Table 3.4). At the SEA level, Thailand is connected to all other countries through submarine cable systems (except the landlocked Lao PDR) with 13 connections to Viet Nam; 10 to Singapore; 9 to Malaysia; 4 to the Philippines; 2 each to Brunei Darussalam, Cambodia, Myanmar; and Indonesia (Table 3.3).

Moreover, according to the ITU Broadband Map (ITU, 2023[61]), Thailand has international terrestrial connectivity to its neighbouring countries (Myanmar, Lao PDR, Cambodia). In addition to terrestrial fibre networks of several operators, it connects through the Greater Mekong Subregional Information Superhighway (GMS IS). The GMS IS provides international terrestrial fibre connectivity to link Cambodia, the People's Republic of China (Yunnan Province), Lao PDR, Myanmar, Thailand and Viet Nam (ADP, 2005[63]).

Its international connectivity infrastructure, both undersea cable and terrestrial, and the relatively large number of Internet Exchange Points (IXPs), positions Thailand as a gateway to the Internet for other less connected countries. For example, it could be a main or backup route to the Singapore or Hong Kong, China, hubs. It is also in a good position to host content and other services (CDN and cloud services nodes).

Table 5.2. Thailand's connections with other SEA countries via submarine cables

Cable System	Brunei Darussalam	Cambodia	Indonesia	Malaysia	Myanmar	Philippines	Singapore	Viet Nam
Asia Africa Europe-1 (AAE-1)		x		x	x			x
Asia Direct Cable (ADC)						x	x	x
Asia Pacific Gateway (APG)				x			x	x
Asia-America Gateway (AAG) Cable System	x			x		x	x	x
FLAG Europe-Asia (FEA)				x				x
India Asia Xpress (IAX)				x			x	x
Malaysia-Cambodia-Thailand (MCT) Cable		x		x				x
SEA-H2X				x		x	x	x
SeaMeWe-3	x		x	x	x	x	x	x
SeaMeWe-4				x			x	x
Singapore India Gateway (SING) Cable							x	x
Southeast Asia-Japan Cable 2 (SJC2)							x	x
Thailand-Indonesia-Singapore (TIS)			x				x	x

Source: OECD elaboration from TeleGeography (2023[62]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

Table 5.3. Thailand's connections with other regions via submarine cables

Cable System	Northern Africa	Sub-Saharan Africa	North America	Eastern Asia	Southern Asia	Western Asia	Northern Europe	Southern Europe	Western Europe	Australia and New Zealand	Micronesia
Asia Africa Europe-1 (AAE-1)	x			x	x	x		x	x		
Asia Direct Cable (ADC)				x							
Asia Pacific Gateway (APG)				x							
Asia-America Gateway (AAG) Cable System			x	x							x
FLAG Europe-Asia (FEA)	x			x	x	x	x	x	x		
India Asia Xpress (IAX)					x						
SEA-H2X				x							
SeaMeWe-3	x	x		x	x	x	x	x	x	x	
SeaMeWe-4	x				x	x		x	x		
Singapore India Gateway (SING) Cable					x	x					
Southeast Asia-Japan Cable 2 (SJC2)				x							

Source: OECD elaboration from TeleGeography (2023[62]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

Thailand has 7 IXPs (2023) (PCH, 2023[64]), the second highest number after Indonesia. All are located in the Bangkok area except for the BKNIX Chiang Mai IXP in Chiang Mai, in the north-west of the country (Table 3.5). This infrastructure appears to perform well in handling the growing Internet traffic in Thailand. Quality indicators such as median fixed broadband latency (5 ms) were among the best in the region, only surpassed by Singapore and Brunei Darussalam (4 ms) in July 2023 (Ookla, 2023[58]).[10]

Table 5.4. Internet exchange points, 2023

Name	City
Bangkok Neutral Internet Exchange	Bangkok
BKNIX Chiang Mai	Chiang Mai
BBIX Thailand	Bangkok
JasTel Internet Exchange	Nonthaburi
Thai-IX Bangkok by CS Loxinfo	Bangkok
Thailand IX	Bangkok and Nonthaburi
True International Gateway NIX	Bangkok

Source: PCH (2023[64]), *Internet Exchange Directory*, www.pch.net/ixp/dir (accessed 5 December 2023).

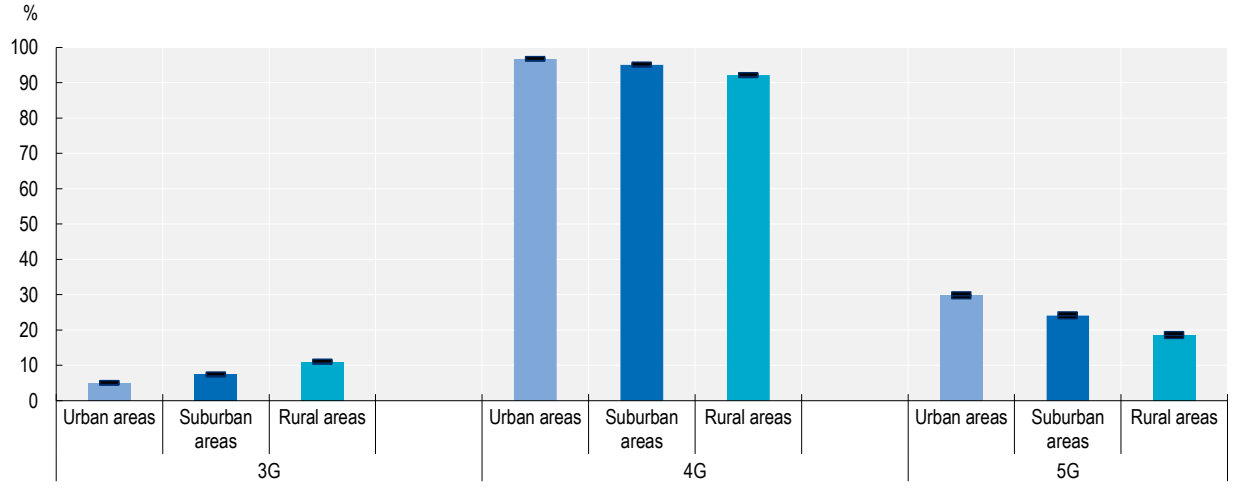
5.5.2. Digital divides

Despite the overall positive development of broadband penetration, there are significant divides when considering other factors, such as geography, age and gender. In 2021, 82% of individuals in rural areas used the Internet compared to 90% in urban areas (ITU, 2023[12]). In that same year, only 24% of those aged 75 and over use the Internet compared to 85% or more for other age groups (ITU, 2023[12]). With respect to gender, however, the differences are much less pronounced. There is a two percentage point gap favouring men, which has remained virtually unchanged over the last 20 years (ITU, 2023[12]).

There are several reasons behind these divides. Looking further at the supply-side reasons, mobile broadband mobile network availability, understood as the proportion of time users have a 3G, 4G and 5G connection (Opensignal, 2023[65]), shows high values and little difference between urban, suburban and rural areas. According to Opensignal the availability of 4G networks in rural areas was 92.1%, 4.6 percentage points lower than in urban areas (96.7%) (December 2022 – February 2023) (Figure 5.12) (Opensignal, 2023[66]).[11] Despite the high level of mobile network availability, the lower quality of mobile broadband services in rural areas may contribute to the geographical divide connections (Figure 5.14, Figure 5.15).

There appears to be a gap in fixed broadband coverage. While there is no disaggregated data by geography, Thai authorities recognise that lack of access to broadband networks in sparsely populated areas is a main barrier preventing take-up by residential users and small and medium-sized enterprises (SMEs) in these areas. In addition, initiatives such as Net Pracharat to extend fixed networks to rural areas (backhaul and Wi-Fi access points) seem to confirm that fixed broadband coverage can pose a problem in such parts of the country.

Figure 5.12. Network availability, percentage of time (3G, 4G, 5G), December 2022 – February 2023



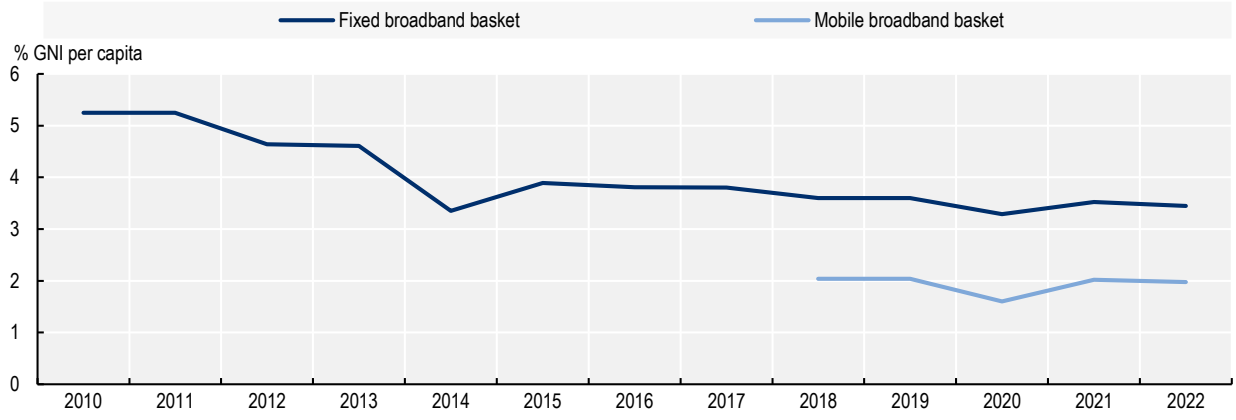
Notes:
1. Data was collected by Opensignal from its users over 90 days (1 December 2022–28 February 2023).
2. 3G availability shows the proportion of time that all Opensignal users had a 3G connection. 4G availability shows the proportion of time Opensignal users with a 4G device and a 4G subscription – but have never connected to 5G – had a 4G connection. 5G availability shows the proportion of time Opensignal users with a 5G device and a 5G subscription had an active 5G connection (Opensignal, 2023[65]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[67]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[68]).
Source: © Opensignal Limited - All rights reserved (2023[66]), http://www.opensignal.com.

StatLink https://stat.link/8wi1vx

Broadband prices in Thailand are relatively affordable in terms of purchasing power. They are around the target of 2% of GNI per capita or less for entry-level broadband services, established by the Broadband Commission in support of the Sustainable Development Goals (Broadband Commission for Sustainable Development, 2022[69]) (ITU, 2023[12]).[12] Prices for fixed broadband prices are higher than for mobile broadband, although they fell from 5.3% to 3.5% of monthly GNI per capita between 2010-22 (Figure 5.13) (ITU, 2023[12]). Mobile broadband prices have also decreased in recent years and stood at 2.0% of monthly GNI per capita in 2022 (ITU, 2023[12]). Given that prices do not differ significantly between fixed and mobile services, the dominance of mobile broadband subscriptions could be explained by their greater coverage, although the usage profile could also play a role.

However, affordability of devices can also influence adoption of communication services. According to Tarifica, mobile device prices are relatively high relative to income levels in Thailand. The benchmark price of entry-level internet-enabled handset reached 15.1% of average monthly income in 2022 (Tarifica, 2023[70]).[13] Moreover, operators in Thailand report the cost of a device can be a significant barrier to uptake of 5G services.

Figure 5.13. Prices for fixed and mobile broadband services (percentage GNI per capita), 2010-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2010 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[14]). Mobile basket prices are not available from 2010 to 2017.
Source: ITU (2023[12]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/kvgrcy

On the demand side, lack of digital skills is one of the biggest barriers to broadband take-up for all age groups. In Thailand, the proportion of individuals with the most widespread skill – "Using copy and paste tools within a document" – is only 15% in the 25-74 age group and close to zero (0.22%) in the older age group (2020) (ITU, 2023[12]). The situation improves for younger groups, although only about half have this basic skill (2020) (ITU, 2023[12]). Digital illiteracy is also behind the geographical divide, with a higher percentage of urban dwellers more proficient in all digital skills analysed (2020) (ITU, 2023[12]). However, this does not affect the gender gap, as women are ahead of men in virtually all the skills analysed (ITU, 2023[12]).

Lack of awareness of the benefits of broadband is the main hurdle to adoption. 90.2% of people who do not use the Internet in Thailand say this is because they do not need it (2021) (ITU, 2023[12]). Other reasons may be at play, such as concerns about the security of the Internet. According to Thai authorities, this is especially true for women. Lack of content in local languages would contribute to the age gap, according to national authorities.

5.5.3. Policies and regulation

Thai authorities have acted in several areas to facilitate network deployment and make sufficient spectrum available to the market. They have also launched several initiatives to narrow the gaps in broadband penetration, address supply- and demand-side hurdles, and bridge the digital divide. The main ones are described below.

Access to passive infrastructure

NBTC enacted a series of notifications in 2017 to regulate access to passive infrastructure. The "Notification Re: Rights of Way B.E. 2560 (2017)" concerned poles, usually from the Electricity Authority; the "Notification Re: Duct Access B.E. 2560 (2017)" concerned ducts, usually from another operator (NBTC, 2017[71]; NBTC, 2017[72]). These notifications establish a pricing method, and an oversight and dispute resolution role for the regulator.

Another priority for NBTC is aerial telecommunication and broadcasting cables nationwide. Since 2016, NBTC has promoted a co-ordinated approach towards aerial telecommunication and broadcasting cables (NBTC, 2021[73]). There are two main elements of its plans. First, it focuses on consolidating aerial fibre in rural areas so there will be one, or at least fewer, high-capacity fibre lines instead of multiple small-capacity lines strung overhead. Second, NBTC has been working with operators in major cities to encourage them to either consolidate their fibre cables or move them underground, depending on the area. This represents an investment for the operators, both in cost and in the time needed for administrative approvals.

Spectrum management

NTBC is the competent authority for spectrum management in Thailand. Under the NTBC Act, NBTC has released a Spectrum Management Master Plan since 2012. This Plan is the guideline for spectrum management, spectrum licensing and broadcasting, as well as telecommunication businesses licensing and regulation. It aims to encourage free and fair competition, efficient allocation, assignment and regulation of spectrum use. The Plan also defines the spectrum allocation strategy and the Table of Frequency Allocation. The latest plan is the Spectrum Management Master Plan No.2 B.E.2564 (2021) (NBTC, 2021[74]).

NBTC has the authority to assign spectrum In February 2020, NBTC auctioned the 700 MHz, 1 800 MHz, 2.6 GHz and 26 GHz bands to support 5G network deployment. The auction rules specified certain coverage requirements for both the 1 800 MHz and 2.6 GHz bands (NBTC, 2019[75]). However, blocks of the 1 800 MHz band were unsold (NBTC, 2020[76]). The band may be considered in future auctions, such as the one being considered by NBTC of the 3.5 GHz band. However, at the time of writing there has been low demand reported from operators. Before the merger of True and dtac, AWN (AIS) held 1 420 MHz of spectrum, True held 990 MHz, NT had 540 MHz and dtac had 270 MHz, according to national authorities. These spectrum holdings are higher than in other countries in the region. For example, in Cambodia, Smart Axiata holds the most spectrum with 232 MHz, while smaller players hold less than 50 MHz, according to national authorities. In Viet Nam, operators hold around 100 MHz of spectrum apiece. In addition, Thailand's spectrum assignments across low, mid and high bands, which have differing but complementary propagation characteristics, also support 5G network deployments.

Licences for mobile services are for 15 years, a somewhat short period. According to Thai authorities, a spectrum use fee applies to all operators or business entities using licensed spectrum, including mobile operators providing mobile communication services. Meanwhile, an auction fee applies in the case of auctioned spectrum (e.g. for mobile spectrum bands). If licensees fail to comply with conditions, NBTC may revoke the spectrum licence (Government of Thailand, 2010[18]). Spectrum licences can be transferred, but only with NBTC permission (Government of Thailand, 2010[18]).

Thailand's spectrum management approach has been a key factor to enable mobile network deployment. Ensuring that mobile operators have access to needed spectrum is key to support deployment next-generation networks, such as 5G. The auction of the 700 MHz, 1 800 MHz, 2.6 GHz and 26 GHz bands was integral to Thai operators' timely 5G network deployment, which reached 85% population coverage by 2022 (GSMA Intelligence, 2023[11]) (Figure 5.10).

Universal service obligation

NBTC adopted a framework policy for universal access to broadband services in 2005 (NBTC, 2017[77]). The Universal Service Obligation Master Plan No. 3 B.E 2565 (2022) aims to provide basic telecommunication services to all areas and population groups. In this plan, the definition of "Basic Telecommunications Services" means telephone services and broadband Internet services. The programme includes the deployment of Wi-Fi access points and computers, as well as improving the digital skills of target groups. The cost of projects for the universal service is covered by the "Universal Service Fund". Communication service licence holders contribute to the Fund through a fee, which is currently 2.5% of the licensee's total telecommunication revenue.

Public initiatives to extend networks in unserved areas

With the Village Broadband Internet Project (Net Pracharat), MDES has partnered with NBTC to extend broadband networks to approximately 45 000 villages in rural and border areas. To that end, the programme aims to deploy broadband backhaul networks in underserved areas, set up fibre optic networks in 24 700 of these villages, and establish a public Wi-Fi hotspot in each village. By July 2022, the Wi-Fi Net Pracharat service had approximately 11 million registered users. According to MDES, this initiative has helped bridge the digital divide and provide equitable and affordable access to information sources and services.

Price regulation

The Telecommunications Business Act authorises NBTC to set maximum fee thresholds depending on offered services (Section 55) (Government of Thailand, 2001[35]). NBTC has enacted certain retail tariff obligations under the Act. Two apply only to mobile communication services, while one applies to all licensees. Three Notifications detail these obligations: one on pricing approval, a second on reference rate regulation and the third on the maximum rate for excessive charges (Table 5.5).

Table 5.5. Main retail tariff regulations in Thailand for mobile communication services

	Pricing approval (2006)	Reference rate regulation (2019)	Maximum rate for excessive charge (2020)
Applies to	All telecom licensees, incl. mobile service providers.	Telecom licensees that offer mobile services, incl. those with their own network.	Telecom licensees owning their own network that provide post-paid mobile services.
Obligation	Filing for approval of pricing schemes involving advance payment such as, but not limited to, prepaid pricing schemes before commercialisation.	Average price of all plans/packages for each of specified mobile service, (voice, SMS, MMS and Internet) must be kept at or below the reference rates.	Maximum price of added charges (on top of contract monthly fee) for each of specified mobile service, (voice, SMS, MMS and Internet) must be kept at or below the regulated maximum rates.
Timeframe	Filing and approval carried out before public commercialisation of the specified pricing scheme.	Price report submission monthly.	Price report submission monthly.

Source: OECD elaboration based on Thai national responses to OECD questionnaire and NBTC (2006[78]), ประกาศ กทช. เรื่อง อัตราขั้นสูงของค่าบริการและการเรียกเก็บเงินค่าบริการล่วงหน้า ในกิจการโทรคมนาคม พ.ศ. 2549 [Announcement of the NTC regarding the maximum rate of service charges and the collection of advance service charges in the telecommunications business B.E. 2549], https://bit.ly/3DV7wH2; NBTC (2019[79]), ประกาศคณะกรรมการกิจการกระจายเสียง กิจการโทรทัศน์ และกิจการโทรคมนาคมแห่งชาติ เรื่อง การก าหนดและก ากับดูแลโครงสร้างอัตราค่าบริการโทรศัพท์เคลื่อนที่ภายในประเทศ [Notification of the NBTC Re: Setting and regulating structure of domestic mobile rate service], https://bit.ly/3DX1gOU; NBTC (2020[80]), เรื่อง การก าหนดและก ากับดูแลอัตราขั้นสูงของค่าบริการโทรศัพท์เคลื่อนที่ภายในประเทศ ในส่วนที่เกินกว่าสิทธิการใช้งานของรายการส่งเสริมการขายหลัก [NBTC Notification on Determination and Supervision of maximum rates of domestic mobile phone service charges in excess of the licence of the main promotion], https://bit.ly/3BQRtHt.

Digital skills programme

The "Second Universal Basic Telecommunications and Social Services Plan B.E.2560 – 2564 (2017-21)" supports and promotes development of information and communication technology (ICT) literacy skills. The project will include delivery of training courses on "Development of digital literacy skills towards digital society" for a minimum of 500 000 people during three years of operation 2021-24 (NBTC, 2021[73]). In addition, ONDE delivers the "Developing Digital Village Volunteering" training course. The course selects community representatives for their basic competence in digital volunteering. Through the training and skills certification process, they play a supporting role in digital activities that promote and develop digital literacy in local communities (ONDE, 2019[81]).

Consumer rights regulation

Based on the Notification on the Complaint Process and Consideration of Complaint for Telecommunication Services B.E. 2559 (2016), NBTC accepts consumer complaints regarding communication services and resolves disputes between consumers and providers. The main point of contact – "Call Center 1 200" – allows consumers to submit complaints in a variety of ways, such as direct phone call, fax, e-mail, website and social media (NBTC, 2019[82]).

Additionally, NBTC has created a "Pro check website/application". This provides information on promotions or services offered by mobile phone operators and high-speed Internet operators. It allows consumers to compare prices and select the right mobile/broadband plan (NBTC, 2019[83]).

Recommendations

7. **Reduce barriers to broadband deployment through simplified procedures for obtaining permits, access to public infrastructure and rights of way**. Measures for obtaining permits for network construction, access to public infrastructure and rights of way could be simplified and streamlined. In particular, co-ordination between authorities could be improved by breaking down potential silos and establishing a single point of contact or "one-stop shop" for operators. These measures would help accelerate both the migration of overhead cables underground and deployment of networks in other urban or inter-urban environments.
8. **Incentivise communication network operators to co-operate in network development activities**. Network operators could be encouraged to co-operate in civil works required for network deployment ("dig once") to minimise costs, disruption and environmental impact. Soft measures, such as providing digital tools to facilitate collaboration (e.g. a portal with information on planned civil works), have proved useful in the European Union and elsewhere. Such measures are included in EU best practices for the timely rollout of broadband networks following the European Commission Recommendation (European Commission, 2020[84]).
9. **Promote coordination of civil works and passive infrastructure sharing between networks to deploy high-capacity backbone and backhaul networks**. The coordination of civil works and passive infrastructure sharing between different types of infrastructure is encouraged to reduce costs, lead times and the environmental impact of backbone network deployment. In particular, using public works such as roads or railways for network deployment is highly recommended. Synergies should also be sought with measures to extend and modernise the electricity grid.
10. **Consider leveraging Internet and international connectivity infrastructure.** By leveraging its relatively large number of IXPs and its international connectivity through submarine and terrestrial cables, Thailand could serve as a gateway to the Internet for other less-connected countries (as a primary or backup route to hubs in Singapore or Hong Kong, China). It could also host content and other digital services (CDN nodes and cloud services) for the region.
11. **Promote and invest in the improvement of digital skills**. Initiatives to improve digital literacy and raise digital awareness of the population at large could be scaled up, focusing on older people and rural areas. This would go a long way to increasing demand and bridging the digital divide.
12. **Leverage synergies between programmes to promote provision and adoption of connectivity services.** Networks and infrastructures deployed by public initiative in rural and remote areas (Universal Service Obligations and Net Pracharat Project) could be leveraged. The public Wi-Fi hotspot in each village, for example, could support adoption of advanced broadband services, including online access to public services such as eHealth and education. This would encourage development of locally relevant and easy-to-use applications and content.

5.6. Quality of networks (resilience, reliability, security and capacity)

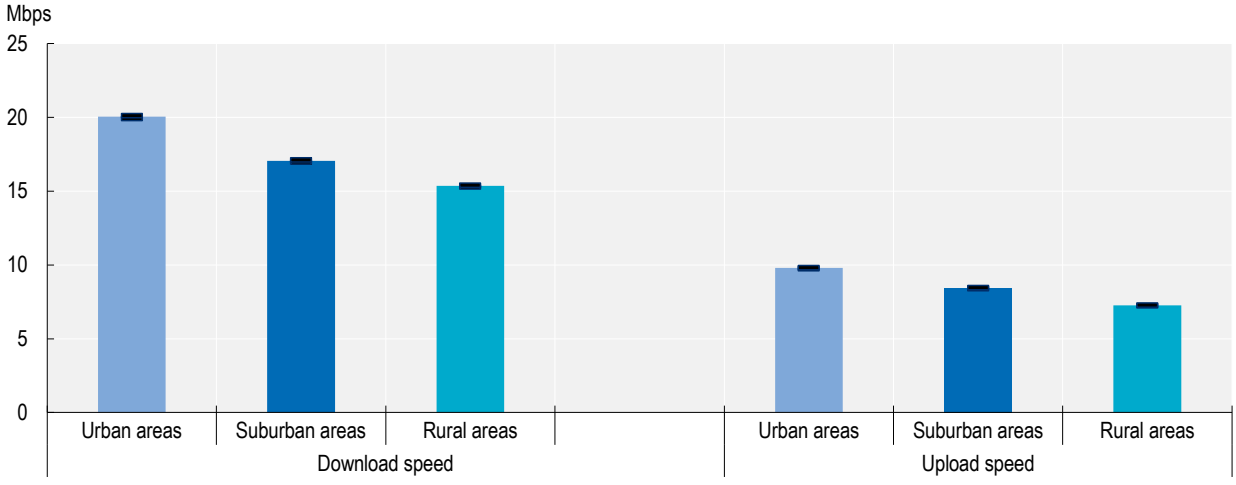
The quality of fixed broadband service in Thailand is high, both in the context of SEA and globally. In July 2023, the median speed for fixed broadband access was second only to Singapore and ranked fifth globally at 211.28 Mbps/180.2 Mbps (download/upload) – and well above the global performance (82.59Mbps/ 36.8Mbps) (Ookla, 2023[58]). Latency was also among the best in the region – 5 ms – in the same month

(Ookla, 2023[58]), below the global figure (9 ms). This good performance of the fixed networks goes hand in hand with growth in subscriptions to high-capacity access technologies, such as optical fibre and 4G, over the last few years (Figure 5.3, Figure 5.2).

The performance of mobile broadband connections is among the best in the region. For mobile broadband access, the median speed is 40.64Mbps/13.52Mbps (download/upload) (July 2023). This is fifth in the region (after Brunei Darussalam, Singapore, Malaysia and Viet Nam). It is also and just above the global performance (42.35 Mbps / 10.04Mbps) (July 2023) (Ookla, 2023[58]). Latency is 23 ms, below the global figure (28 ms) (Ookla, 2023[58]).

Measures of user experience reveal differences in access technology and user location. Over a 90-day period beginning in December 2022, the national average download/upload speed observed by users connected to 4G was 17.11 Mbps/8.32 Mbps (download/upload). Meanwhile, the observed speed reached 98.00 Mbps/21.13 Mbps (download/upload) for users with active 5G connections (Opensignal, 2023[66]). Rural users experienced 4G download speeds that were 23% lower than for urban users, and 5G download speeds were 24% lower (Opensignal, 2023[66]). Uploading speeds are also lower in rural areas, with 4G and 5G speeds 26% and 24% lower, respectively, than in urban areas (Figure 5.14, Figure 5.15) (Opensignal, 2023[66]) These results may indicate lower performance access networks in rural areas or an under-dimensioning of backbone and backhaul network capacity to connect them which would warrant further analyses.

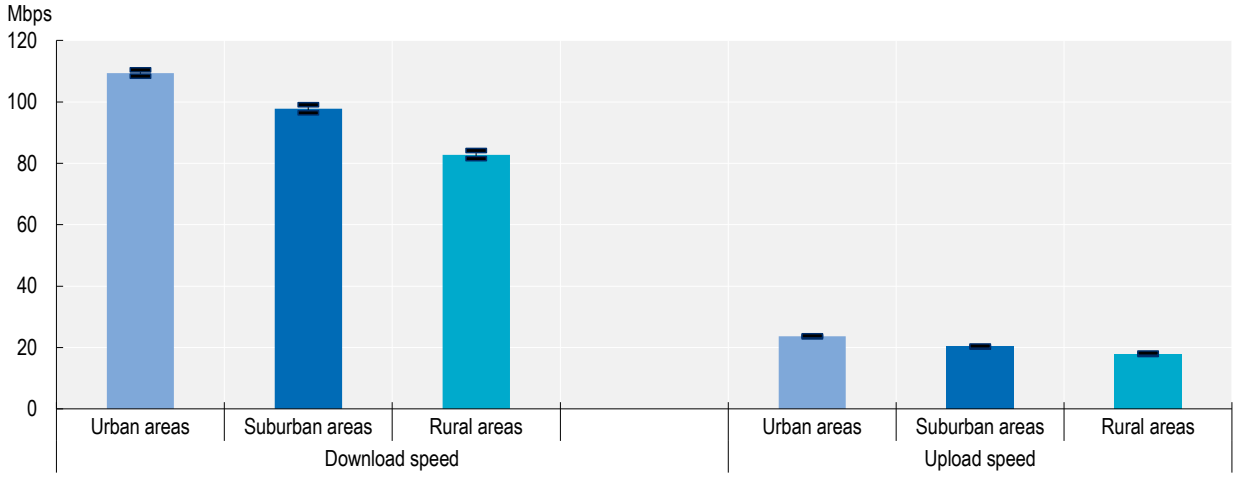
Figure 5.14. Download/upload speed experience 4G, December 2022 – February 2023



Notes:
1. Data were collected by Opensignal from its users, over 90-days period (1 December 2022–28 February 2023).
2. Opensignal download/upload speed experience represents the typical everyday speeds an Opensignal user experiences across an operator's mobile data networks. 4G download/upload speed is the average speed observed by Opensignal users when they were connected to 4G (Opensignal, 2023[65]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[67]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[68]).
Source: © Opensignal Limited - All rights reserved (2023[66]), http://www.opensignal.com.

StatLink https://stat.link/xnqsgd

Figure 5.15. Download/upload speed experience 5G, December 2022 – February 2023



Notes:
1. Data were collected by Opensignal from its users, over 90-days period (1 December 2022–28 February 2023).
2. Opensignal download/upload speed experience represents the typical everyday speeds an Opensignal user experiences across an operator's mobile data networks. 5G download/upload speed is the average speed observed by Opensignal users with active 5G connection. (Opensignal, 2023[65]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[67]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[68]).
Source: © Opensignal Limited - All rights reserved (2023[66]), http://www.opensignal.com.

StatLink https://stat.link/87163l

The topology of the national backbone terrestrial network, with a degree of meshing between the eastern and western branches, provides alternative routes for traffic that avoids the central node in Bangkok. In this way, it contributes to the resilience of the network. There is also some meshing between the east and south-east branches, which could provide alternative routes to Bangkok and the south-east nodes. However, parts of the peninsular branch of the backbone network have no alternative route by terrestrial cable (for geographical reasons) or submarine cable. Such configuration could result in a single point of failure for connectivity in the area. This is particularly relevant as some of the most populated cities in the country are on the peninsula, as well as 9 of the 13 landing stations of the submarine cables connecting Thailand to other regions of the world, in the cities of Satun and Songkhla.

Furthermore, almost all IXPs are in Bangkok (Table 3.5), which is usually associated with the colocation of servers of content providers (CDN, cloud services). This means that, regardless of the physical paths available, most traffic is likely to be routed to the Bangkok nodes, creating single points of failure for Internet traffic that might affect the whole country. In addition, the Chao Phraya delta is prone to flooding, which represents a natural high risk for network disruption.

5.6.1. Policies and regulation

The Thai authorities have taken several measures to improve the quality of networks. The main ones are described below.

Measurement and publication of quality of service data

NBTC monitors the quality of telecommunications service provision in accordance with its "Notification on Telecommunications Service Provision Quality Standards". Quality of service indicators must be measured and reported to NBTC each quarter. NBTC directly monitors the operators' quality of service both regularly and annually. It also does additional checks in response to consumer complaints. In addition, NBTC publishes information on communication success rates, speeds and prices.

Measures to improve network resilience

The ASEAN Digital Hub project aims to increase bandwidth on domestic terrestrial cables connecting to neighbour countries and on international submarine cable systems. It also plans a new submarine cable system connecting Thailand to countries in the Pacific Region. The first and second actions to increase bandwidth on domestic and international routes are under way, while the construction of a new submarine cable system is expected to finish in 2023.

Measures to improve network security

The Cybersecurity Act, B.E. 2562 (2019), published in May 2019 (MDES, 2019[85]), primarily regulates both public and private sector databases and information to ensure national security in cyberspace. The Act established the National Cyber Security Committee, which includes MDES as a member. The Prime Minister chairs the committee. The Act designates certain organisations as Critical Information Infrastructure Organisations, which include those providing ICTs and telecommunication services. These organisations must follow cyber threat procedures noted in the Act.

Recommendations

13. **Publish open, verifiable, granular and reliable subscription, coverage and quality-of-service data.** Building on the NBTC's Notification on Telecommunications Service Provision Quality Standards, Thai authorities should publish open, verifiable, granular and reliable subscription, coverage and quality-of-service data through periodic reporting, including on persistent network outages.
14. **Promote measures to improve the geographical diversification of communication infrastructures**. Measures could include encouraging the geographical diversification of IXPs, and construction of redundant backbone network solutions. Such solutions could be both geographic (alternative routes through meshed solutions) and technological (alternative technologies e.g. terrestrial fibre, submarine cable, radio link, satellite). The geographical diversification of connectivity to international links could also be expanded. For example, submarine cable stations could be set up in different locations or alternative terrestrial routes to landing stations could be established in other countries in the region.

5.7. Environmental impacts of networks

No information is available to assess the impact of telecommunication networks in Thailand. Nor is any information available on any measures by Thai authorities to minimise negative impacts of communication networks.

Recommendation

15. **Support and promote smart and sustainable networks and devices and encourage communication network operators to periodically report on their environmental impacts and initiatives.** Building on its regular collection of information for the publication of annual reports, NBTC could add indicators on environmental impacts on networks and connectivity. Accordingly, it could encourage communication network operators to periodically report on their environmental impacts and initiatives to improve them, as well as to report on the positive environmental effects of connectivity.

5.8. Regular assessment of broadband markets

NBTC periodically publishes annual reports based on Section 76 of the NBTC Act, which assesses broadcasting and communication markets. With regard to the assessment of the communication market, it collects and publishes figures on the number of subscribers and market share in fixed and mobile services. In addition, annual reports summarise the mergers in the communication sectors (NBTC, 2021[73]).

Recommendation

16. **Regularly assess the state of connectivity, and availability, performance and adoption of connectivity services and infrastructure deployment.** Building on its regular collection of information for annual reports, NBTC could add indicators to regularly assess the state of broadband connectivity. In particular, these should measure the availability, performance and adoption of connectivity services and infrastructure deployment to determine whether public policy initiatives are appropriate, and whether and how they should be adjusted. Disaggregating these indicators with sufficient geographical granularity could help differentiate data in areas with different degrees of urbanisation (rural, urban areas) and better understand trends in availability, performance and adoption of connectivity services. This information could be integrated into geographic information systems and published electronically.

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Notes

[1] Rural area (or mostly low-density cells) is defined as grid cells of 1 square kilometre with a density below 300 inhabitants per square kilometre and other grid cells outside urban clusters or centres (European Commission, Joint Research Centre, 2015[4]).

[2] Urban cluster (moderate-density cluster) is defined as contiguous grid cells with a density of at least 300 inhabitants per square kilometre and has a population of at least 5 000 in the cluster (European Commission, Joint Research Centre, 2015[4]).

[3] Urban centre (high-density cluster) is defined as contiguous grid cells with a density of at least 1 500 inhabitants per square kilometre. An urban centre has a population of at least 50 000 (European Commission, Joint Research Centre, 2015[4]).

[4] The previous NBTC Commissioners stayed in their positions until the first five NBTC Commissioners were royally endorsed (Bangkok Post, 2021[32]).

[5] An exchange rate of 35.011 THB/1 USD was used, as reported on 3 July 2023 (Bloomberg, 2023[89]).

[6] An exchange rate of 35.011 THB/1 USD was used, as reported on 3 July 2023 (Bloomberg, 2023[89]).

[7] Data collected and aggregated according to Ookla's Speedtest® Methodology (Ookla, 2023[87])

[8] The indicator of 'transmission network length', defined in the framework of the ITU Broadband Map (ITU, 2023[61]), refers to the physical length of fibre optic cable in a network irrespective of the number of optical fibres contained within the constituent cables of that network and can also be applied to microwave terrestrial networks. It is expressed in route kilometres (route-kms) (ITU, 2012[86]).

[9] 2013 is also the first year with available data (ITU, 2023[12]).

[10] Latency or ping is the reaction time of connection — that is, how quickly the user device gets a response after you've sent out a request. A fast ping means a more responsive connection, especially in applications where timing is everything (like video games). Ookla® measures several types of latency. The figures referenced in the text refer to 'minimum latency' that measures the best case latency for the user at the time they decide to take a Speedtest®. The lowest ping value is determined across one or more pings made before the download speed test – this represents the 'minimum latency' (Ookla, 2023[87]).

[11] Reproduced with permission of Opensignal, based on independent analysis of mobile measurements recorded from December 1, 2022 - February 28, 2023, © 2023 Opensignal Limited - All rights reserved.

[12] Specifically, "by 2025, entry-level broadband services should be made affordable in developing countries at less than 2% of monthly Gross National Income (GNI) per capita" (Broadband Commission for Sustainable Development, 2022[69]).

[13] The data source for handset price is Tarifica; the source for GNI per capita, USD, 2022 is GSMA Intelligence. The handset price is the price of the cheapest handset available in each market with Internet-browsing capability in USD (nominal prices), as gathered in 2022. The methodology for data collection can be found in the Mobile Connectivity Index Methodology (GSMA, 2022[88]).

6 Extending broadband connectivity in Viet Nam

Viet Nam stretches across the eastern part of mainland Southeast Asia. The country's economy continues to grow at a strong pace, and its level of human development, including income, life expectancy and education, is high. Population concentration and high fixed broadband penetration distinguish this country from its regional peers, which makes this report examine Viet Nam as a cluster of its own. The chapter outlines the geographic, economic and social conditions for broadband connectivity in Viet Nam. It proceeds by examining the performance and structure of the market and reviewing Viet Nam's communication policy and regulatory framework, including broadband strategies and plans. It then reviews competition, investment and innovation in broadband markets; broadband deployment and digital divides; the resilience, reliability, security and capacity of networks; and the country's assessment of broadband markets. It offers recommendations to improve in these areas.

Policy recommendations

1. Establish an independent regulatory body with remit over the communication sector.
2. Conduct regular competition assessments of relevant markets.
3. Implement reforms of state ownership in the communication sector and consider facilitating ownership by private entities.
4. Clarify co-ordination mechanisms between VNTA and VCC, where needed.
5. Consider lowering restrictions on private entities, both foreign and Vietnamese, to enter the market and invest to deploy networks, and eliminate FDI restrictions.
6. Reduce the administrative burdens associated with network deployment.
7. Facilitate co-ordination of civil works and joint use of passive infrastructure.
8. Facilitate spectrum assignment and increase spectrum availability, especially for mobile communication services.
9. Leverage synergies between programmes to promote provision and adoption of connectivity services.
10. Take actions to improve the affordability of access devices.
11. Promote and invest in the improvement of digital skills.
12. Publish open, verifiable, granular and reliable subscription, coverage and quality-of-service data.
13. Promote measures to improve the quality and resilience of international connectivity.
14. Support and promote smart and sustainable networks and devices and encourage communication network operators to periodically report on their environmental impacts and initiatives.
15. Assess the state of connectivity regularly to determine whether public policy initiatives are appropriate, and whether and how they should be adjusted.

Note: These tailored recommendations build on the OECD Council's Recommendation on Broadband Connectivity (OECD, 2021[1]), which sets out overarching principles for expanding connectivity and improving the quality of broadband networks. The number of recommendations is not an appropriate basis for comparison as they depend on several factors, including the depth of contributions and feedback received from national stakeholders. In addition, recommendations do not necessarily carry the same weight or importance.

6.1. Geographic, economic and social conditions for broadband connectivity

Viet Nam occupies the eastern part of mainland Southeast Asia, stretching about 1 650 km from north to south and about 50 km wide from east to west at its narrowest point. Viet Nam's main geographical features are the Nui Truong Son Ridge, which runs from northwest to southeast in central Viet Nam and dominates the interior, and two extensive deltas formed by the Hong (Red) River in the north and the Mekong (Cuu Long) River in the south. Between these two deltas is a long and relatively narrow coastal plain, although several spurs of the Nui Truong Son Ridge form sections of the coast.

This geography determines the distribution of the 98.5 million inhabitants (2021) (OECD, 2023[2]), who are mainly concentrated in the flat areas, especially in the two delta regions. Ha Noi and Hai Phong are the main urban centres in the north, Đà Nẵng City is the largest urban centre in the central region and Ho Chi Minh City is the country's main urban centre in the south. Urban centres account for the largest share of the population (41.6% in 2015) and 2.4% of the land mass (2015) (European Commission, Joint

Research Centre, 2015[3]). [1] Outside of these urban areas, 39.3% of the population live in areas classified as urban clusters (2015), which account for 6.5% of the land mass (2015) (European Commission, Joint Research Centre, 2015[3]).[2] 19.1% of the population live in the less densely populated or rural areas, which account for 91.1% of the land mass (2015) (European Commission, Joint Research Centre, 2015[3]).[3] These areas are located in the mountainous areas in the north and northwest, and along the central area of the country (European Commission, Joint Research Centre, 2015[3]).

In all regions, villages are usually located along rivers, canals and roads, forming a single elongated settlement. In the Hong River Delta and the central coastal plain, they tend to be densely clustered. In the Mekong Delta in the south, most settlements are loosely clustered farmsteads, some scattered among rice fields (Encyclopædia Britannica, Inc., 2023[4]).

Since the political and economic reforms (Đổi Mới) initiated in 1986, Viet Nam has undergone an economic transformation from a centrally planned economy to a "socialist-oriented" market economy. In the late 1990s, Viet Nam began to increase its participation in international fora such as the Association of Southeast Asian Nations (ASEAN), Asia Pacific Economic Cooperation (APEC) and the World Trade Organization (WTO). Commitments under the series of Free Trade and Economic Partnership Agreements (FTAs) with its major trading partners have reinforced this reform momentum.[4]

Viet Nam's development record over the past 30 years has been remarkable. Since the late 1990s, the country's economy has experienced a strong upturn, driven by tourism, manufacturing and export earnings. Sustained by robust growth over the past decades, Viet Nam has transitioned from an agrarian to industrial economy (OECD, 2023[2]). Viet Nam's average real gross domestic product (GDP) growth rate over 2017-21 was 5.4%, including over the COVID-19 crisis, compared to the OECD average of 1.5% (OECD, 2023[2]). Viet Nam's GDP per capita reached USD PPP 13 284 by 2022, placing it sixth in the region, just ahead of the Philippines (USD PPP 10 497) and behind Indonesia (USD PPP 14 687) (IMF, 2023[5]).

Following its economic growth, Viet Nam ranks as a lower-middle income country (World Bank, 2023[6]). In May 2021, the Congress of the National Assembly approved the Five-Year Socio-Economic Development Plan (SEDP) 2021-2025 and the Ten-Year Socio-Economic Development Strategy (National Assembly, Socialist Republic of Viet Nam, 2021[7]; Congress of Viet Nam, 2021[8]). These plans set long-term economic goals to achieve upper-middle income status by 2030 and high-income status by 2045.

Viet Nam has also made significant progress in other areas of human development. Between 1990 and 2021, life expectancy at birth , mean years of schooling and expected years of schooling all increased in Viet Nam (UNDP, 2023[9]). Viet Nam classifies as a country with a "high" level of human development (see Table 6.1), along with Indonesia in the region (UNDP, 2022[10]).

Considering the socio-economic and demographic conditions that are closely related to broadband development, Viet Nam is considered a cluster in itself for this publication (see Chapter 1). This is mainly due to its high concentration of population in urban centre and urban cluster areas (41.6% and 39.3% of the population, respectively) (European Commission, Joint Research Centre, 2015[3]) and high fixed broadband penetration (21.7 subscriptions per 100 inhabitants, 2022 (ITU, 2023[11]), second in the region after Singapore.

Table 6.1. Human development (2021) and degree of urbanisation (2015), Viet Nam

	Life expectancy (years, 2021)	Expected years of schooling (children, 2021)	Mean years of schooling (adults, 2021)	Gross domestic product per capita (current prices, PPP, 2022)	Population living in urban centres (%, 2015)	Population living in urban clusters (%, 2015)	Population living in rural areas (%, 2015)
Viet Nam	73.6 (5)	13.0 (7)	8.4 (7)	13 284 (6)	41.6	39.3	19.1
OECD average	80.0	17.1	12.3	53 957	48.8 (2022 data)	28.11 (2022 data)	23.11 (2022 data)

Note: The numbers in parentheses refer to the simple ranking (i.e. no weighting) of SEA countries for each indicator. The OECD average for human development indicators is a simple average across OECD member countries. The urbanisation indicators for SEA countries refer to the population percentage in urban centres, urban clusters and rural areas, respectively. For the OECD, figures are given for the rate of the population living in predominantly urban, intermediate, and rural regions, respectively.
Source: [Human development indicators] UNDP (2022[10]), *Human Development Report 2021/2022: Uncertain Times, Unsettled Lives: Shaping our Future in a Transforming World*, www.undp.org/egypt/publications/human-development-report-2021-22-uncertain-times-unsettled-lives-shaping-our-future-transforming-world. [GDP per capita, SEA countries] IMF (2023[5]), *World Economic Outlook Database, April 2023*, www.imf.org/en/Publications/WEO/weo-database/2023/April (accessed on 28 June 2023). [GDP per capita, OECD] OECD (2023[12]), *Gross domestic product (GDP)* (indicator), https://doi.org/10.1787/dc2f7aec-en (accessed on 30 June 2023). [Urbanisation indicators for SEA] European Commission, Joint Research Centre (2015[3]), *Global Human Settlement Layer (GHSL)*, https://ghsl.jrc.ec.europa.eu/CFS.php. [urbanisation indicators for OECD] OECD (2023[13]), *OECD.Stat* (database),*" Regions and cities: Regional statistics: Regional demography: Demographic indicators by rural/urban typology, Country level: OECD: share of national population by typology"*, https://stats.oecd.org/ (accessed on 28 August 2023).

6.2. Market landscape

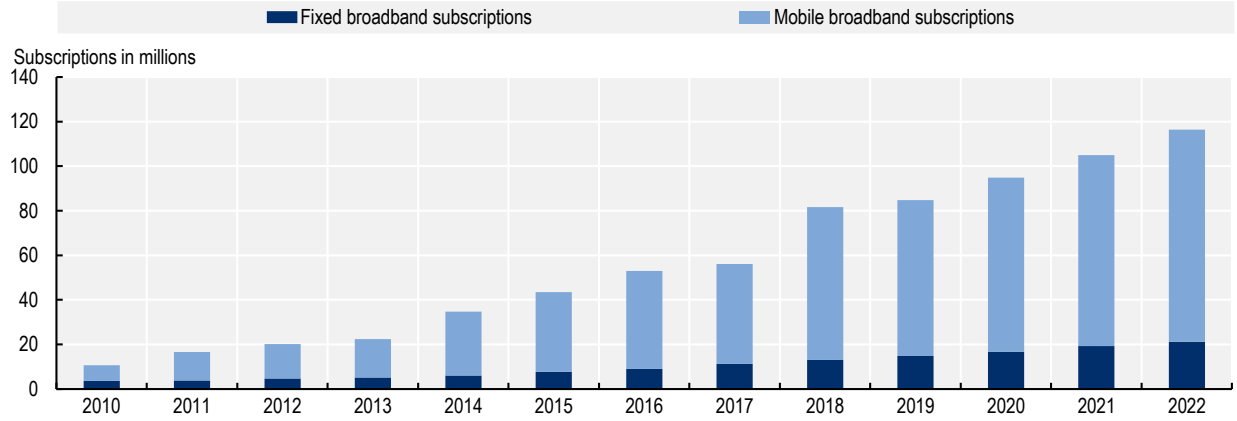
6.2.1. Market performance

The number of broadband subscriptions in Viet Nam has grown significantly over the past decade, mainly driven by mobile broadband. The total number of broadband subscriptions surpassed 116 million in 2022, with mobile broadband accounting for 82% of total subscriptions (ITU, 2023[11]) (Figure 6.1).

Mobile broadband subscriptions grew at a high pace over the past decade (2010-22), averaging a year-on-year growth rate of 26.5% and reaching 95.2 million subscriptions in 2022 (ITU, 2023[11]). From 2013-14, mobile broadband subscriptions jumped 66.9%. In 2017-18, they rose again by 53.1%, which roughly corresponds to the network rollout of 4G networks between 2016-17 (see Figure 6.9) (ITU, 2023[11]). Fixed broadband growth is more moderate, but still shows steady year-on-year growth, averaging 16% between 2010 and 2022 and reaching 21.3 million subscriptions in 2022 (ITU, 2023[11]).

In terms of penetration, Viet Nam's high fixed broadband subscription rate for the region stands out. Its 21.7 subscriptions per 100 inhabitants in 2022 is second in the region only to Singapore (27.4 subscriptions) and well above the regional average of 9.5 subscriptions (ITU, 2023[11]). Mobile broadband penetration in Viet Nam reaches 96.9 subscriptions per 100 inhabitants in 2022. It is, however, below the regional average of 103.7 subscriptions, ranking eighth in the region (ITU, 2023[11]).

Figure 6.1. Broadband subscriptions, 2010-22

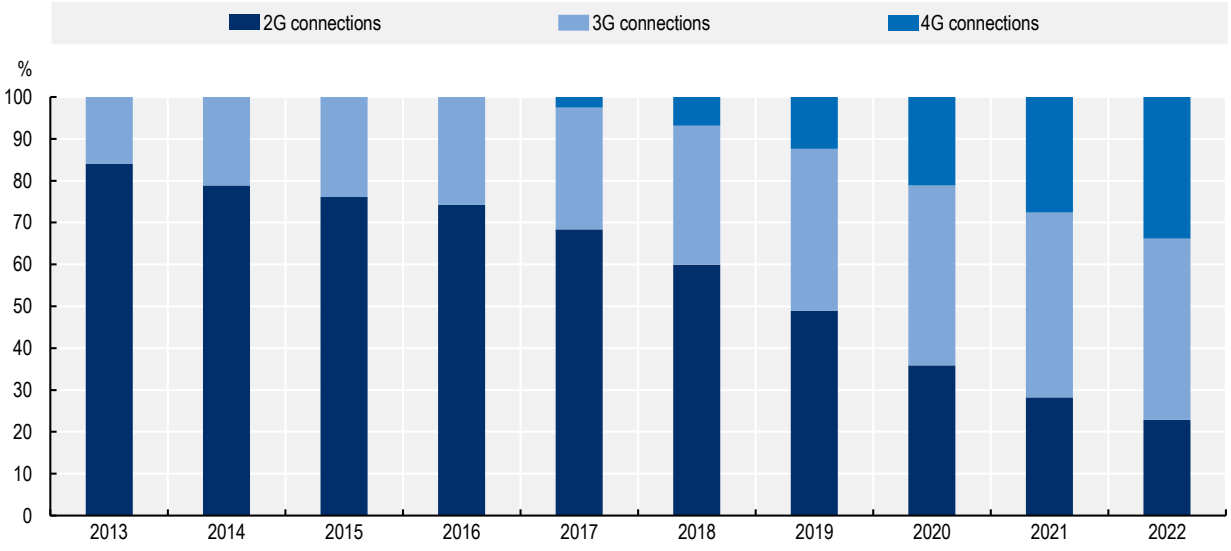


Note: Fixed broadband subscriptions refer to fixed subscriptions to high-speed access to the public Internet (TCP/IP connection) at downstream speeds equal to, or greater than, 256 kbit/s. This includes cable modem, DSL, fibre-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. It includes fixed WiMAX and any other fixed wireless technologies. This total is measured irrespective of the method of payment. It excludes subscriptions with access to data communications (including the Internet) via mobile-cellular networks. It includes both residential subscriptions and subscriptions for organisations. Mobile broadband subscriptions (active mobile-broadband subscriptions in ITU Database) refer to the sum of active handset-based and computer-based (USB/dongles) mobile-broadband subscriptions that allow access to the Internet. It covers actual subscribers, not potential subscribers, even though the latter may have broadband-enabled handsets. Subscriptions must include a recurring subscription fee or pass a usage requirement if in the prepayment modality – users must have accessed the Internet in the last three months (ITU, 2020[14]).
Source: ITU (2023[11]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/q6md9t

The most common mobile technology in 2022 remains 3G, accounting for 43.3% of mobile connections, followed by 4G with 33.9% and 2G with 22.9% (Figure 6.2) (GSMA Intelligence, 2023[15]). 4G connections have been growing steadily since 2017, while 2G connections have decreased since 2013 (GSMA Intelligence, 2023[15]). Viet Nam differs from its regional neighbours with 3G as the most common mobile technology. 4G is most prevalent in seven of the ten Southeast Asian countries, with 3G the most prevalent in only Brunei Darussalam, Lao People's Democratic Republic (Lao PDR) and Viet Nam (GSMA Intelligence, 2023[15]). 5G in Viet Nam is at a nascent stage, mainly confined to trials in urban areas, which explains why Figure 6.2 does not show 5G connections. Viet Nam trails other countries in the region that have already deployed 5G, such as Singapore, Thailand and Philippines.

Figure 6.2. Percentage of mobile connections per technology, 2013-22



Source: GSMA Intelligence (2023[15]), *Database*, www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

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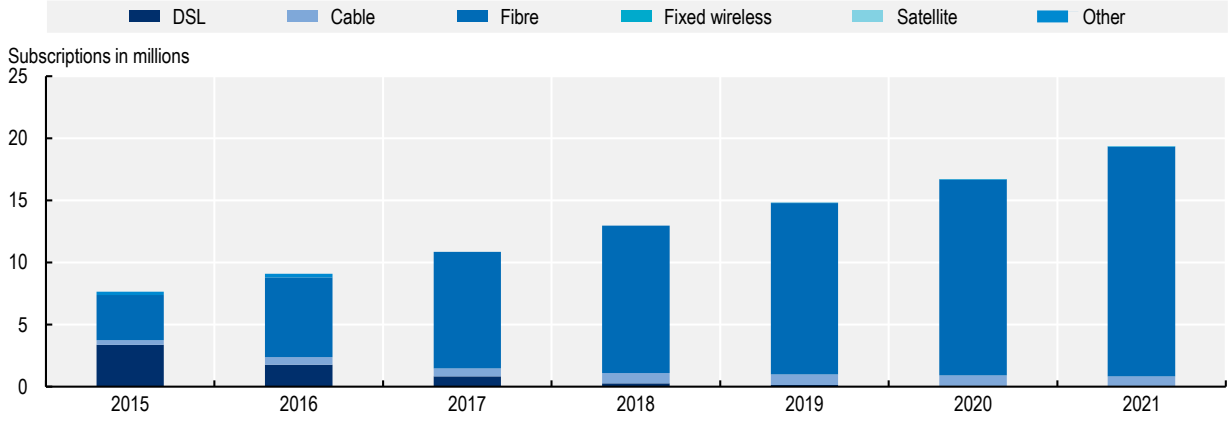
Fixed broadband in Viet Nam is dominated by fibre-to-the-home (FTTH), which is by far the most common technology in the country. Fibre accounted for an impressive 95.5% of fixed broadband subscriptions in 2021 and has grown rapidly in recent years (ITU, 2023[11]). In 2015, fibre accounted for around half of fixed broadband subscriptions (47%), with digital subscriber line (DSL) accounting for roughly the other half (44%) (ITU, 2023[11]). DSL fell sharply to represent only 0.3% of subscriptions in 2021, illustrating how Viet Nam leap-frogged technology by investing in fibre (ITU, 2023[11]). Cable modem technology, although in the minority, grew until 2019 then remained relatively stable, accounting for around 4% of subscriptions in 2019 (ITU, 2023[11]) (Figure 6.3).

Figure 6.3. Fixed broadband subscriptions by technology, 2010-21



Source: ITU (2023[11]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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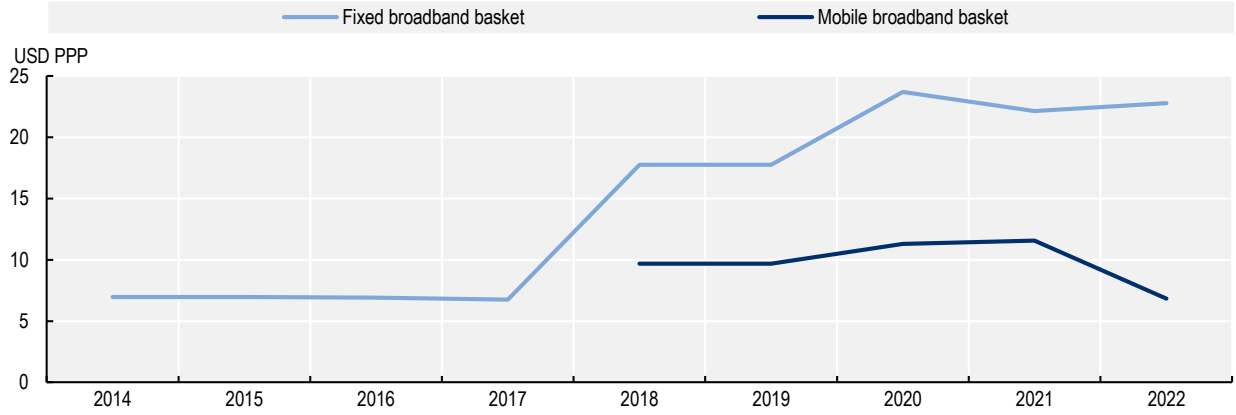
Viet Nam's prices for entry-level fixed communication service baskets (5 GB) are higher than entry-level mobile service baskets (70 min + 20 SMS + 500 MB), as is the case in other SEA countries (Figure 6.4). From 2014-17, fixed prices were around USD PPP 7.0, before rising to USD PPP 17.8 in 2018 and reaching USD PPP 22.8 in 2022 (ITU, 2023[11]).

Despite this increase in price, fixed prices for Viet Nam were the lowest in the region in 2022, by a wide margin. Cambodia had the second lowest fixed prices USD PPP 41.1 (ITU, 2023[11]). They also appear to be affordable, as in 2022 they represented only 2.6% of gross national income (GNI) per capita (Figure 6.4) (ITU, 2023[11]).

Mobile communication prices for a basic package have also been relatively stable. From 2018 to 2021, they rose from around USD PPP 9.7 to USD PPP 11.6, before dropping to USD PPP 6.8 in 2022 (Figure 6.4) (ITU, 2023[11]). In 2022, Viet Nam had the second lowest mobile prices in the region (USD PPP 6.8), behind Myanmar (USD PPP 5.2) (ITU, 2023[11]). Mobile prices are also affordable. They represented around 2% of GNI per capita from 2018 to 2021, falling to 0.8% of GNI per capita in 2022 (Figure 6.12) (ITU, 2023[11]).

Figure 6.4. Prices for entry-level fixed and mobile communication services, USD PPP, 2014-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2014 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[16]). Mobile basket prices are not available from 2014 to 2017.
Source: ITU (2023[11]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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6.2.2. Market structure

In the 1990s, Viet Nam began liberalising the communication sector as part of the political and economic reforms towards a "socialist-oriented" market economy (Đổi Mới). The country gradually became more open and integrated internationally, becoming a member of ASEAN in 1995, APEC in 1998 and acceding to the WTO in 2007. Legislative changes also supported this shift. The Ordinance on Post and

Telecommunications was passed in 2002 (and later replaced by the 2009 Law on Telecommunications (No. 41/2009/QH12), hereafter "Telecom Law"). This regulated the licensing of communication infrastructure and service providers and allowed the entry of private companies. Subsequently, the Competition Law of 2004 (replaced in 2018) introduced pro-competitive provisions such as *ex ante* regulation of operators with significant market power.

Notwithstanding these efforts to open the market, state-owned enterprises in the country remain important players in both the fixed and mobile communication markets. Article 17 of the 2009 Telecom Law notes the state holds controlling shares in operators providing communication services, "whose network infrastructure is of particular importance to the operation of the entire national telecommunications infrastructure and directly affects economic development and the society, ensuring national defence and security" [unofficial translation] (Government of Viet Nam, 2009[17]).

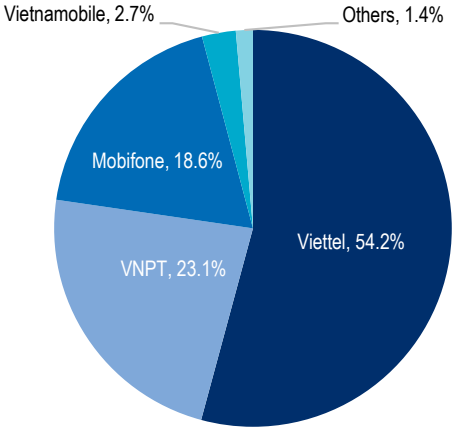
State-owned enterprises (SOEs) in the communication sector include the Viet Nam Posts and Telecommunications Group (VNPT), the Military Industry-Telecoms Group (Viettel) and Mobifone Telecommunications Corporation. The Department of Technology and Infrastructure unit of the Commission for the Management of State-owned Capital in Enterprises manages Mobifone and VNPT (CMSC) (CMSC, n.d.[18]). The state owns 100% of shares in both companies (OECD, 2022[19]). Viettel is also 100% state-owned, under the Ministry of Defence (Art. 1) (Government of Viet Nam, 2018[20]).[5] The State Capital Investment Corporation (SCIC) owns just over 50% of shares in the FPT Telecom Joint Stock Company, another player in the fixed market (OECD, 2022[19]). The SCIC is a state-owned holding company that acts as a shareholder to invest in enterprises in key sectors that are usually privatised to some degree (OECD, 2022[19]). Of the operators with state ownership, Viettel has a high economic importance to the country. Viettel's revenues, along with those of Electricity of Viet Nam and Petro Viet Nam, make up half of the total revenues brought in by Viet Nam's more than 2 000 state-owned (fully or majority-owned) enterprises (OECD, 2022[19]).

In recent years, Viet Nam has taken steps to improve the governance of SOEs. In 2018, for example, it established the CMSC with the objective of "enhancing efficiency, facilitating equitization and separating ownership of the country's largest 19 SOEs and state corporate groups from the state's regulatory function" (OECD, 2022[19]). Overall, the total number of SOEs has decreased from 12 000 in the 1990s to around 2 100 in 2022 (OECD, 2022[19]).

The government has also put in place regulation to further streamline the SOE sector. For example, Decision No 22/2021/QD-TTg defines which SOEs should undergo ownership conversion and divestment over 2021-25. It also determines the level of state holdings following the proceedings according to certain classification criteria (Government of Viet Nam, 2021[21]). According to Decision No. 22/2021/QD-TTg, the state will own between 50-65% of SOEs providing communication services with network infrastructure that are critical to national communication infrastructure and that impact socio-economic development and national security (Government of Viet Nam, 2021[21]). In April 2023, the government directed the Ministry of Planning and Investment to assist relevant stakeholders to implement Decision No. 22/2021 (Government of Viet Nam, 2023[22]). However, the specific details regarding divestment plans of communication operators were unclear at the time of writing.

These changes may affect how SOEs operate. This may, in turn, impact Viet Nam's mobile market, which is characterised by operators with state ownership. Of the four main players in the mobile market, (Viettel, VNPT, Mobifone and Vietnamobile), only Vietnamobile is privately owned.[6] As shown in Figure 6.5, Viettel is the leader with over half the market (54.2%) based on mobile broadband subscriptions, followed by VNPT (23.1%), Mobifone (18.6%) and Vietnamobile (2.7%) in 2021. A few other operators collectively hold the remaining 1.4% of the market. Together, state-owned operators account for around 96% of mobile market shares.

Figure 6.5. Mobile market shares based on mobile broadband subscriptions, Q4 2021

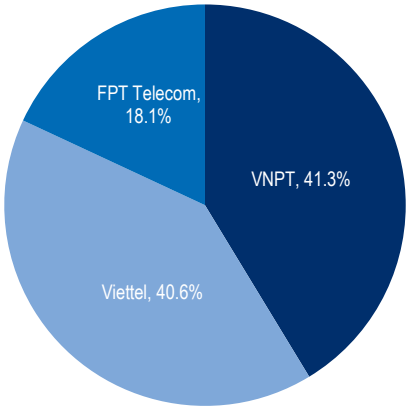


Note: Included in the "Others" category are I-Telecom, ASIM, Gtel and Mobicast.
Source: OECD elaboration based on data from Vietnamese authorities.

StatLink https://stat.link/s2tw9m

In the fixed market, the state owns shares in all three operators: VNPT, Viettel and FPT Telecom. VNPT leads the market with 41.3%, followed closely by Viettel with 40.6%, based on fixed broadband subscriptions in 2021. FPT Telecom holds the remaining proportion (18.1%) (Figure 6.6).

Figure 6.6. Fixed market shares based on fixed broadband subscriptions, Q4 2021



Source: OECD elaboration based on data from Vietnamese authorities.

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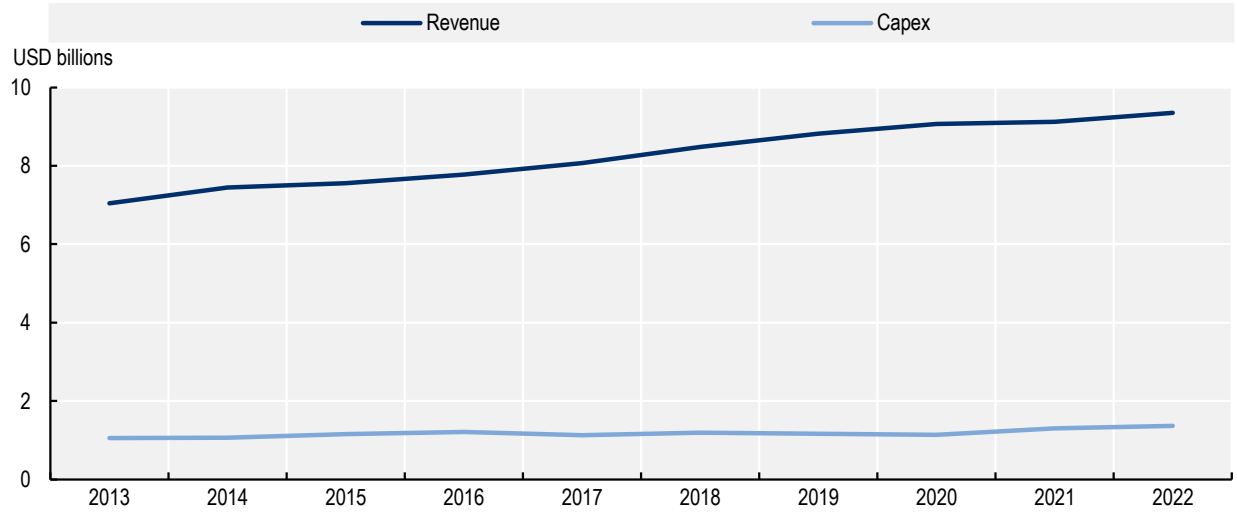
Viet Nam's communication markets seem to be growing at a healthy pace, considering the growth of broadband subscriptions in the last decade. While data on revenues and investment are unavailable for the fixed market, estimates for the mobile market show steady growth. Total revenues, in nominal terms, of the mobile sector have been steadily increasing from USD 7.04 billion in 2013 to around USD 9.35 billion in 2022, a growth rate of 33% over that period (Figure 6.7) (GSMA Intelligence, 2023[15]). Total investment

(Capex) in mobile networks, in nominal terms, kept pace, growing 29% over 2013-22, from USD 1.05 billion to USD 1.36 billion in 2022 (Figure 6.7) (GSMA Intelligence, 2023[15]). Revenue and investment figures for three of the four main mobile operators were unavailable (Viettel, VNPT and Mobifone, which all have state ownership), making comparisons by operator impossible. At the regional level, Viet Nam's mobile sector compared to SEA peers places Viet Nam third in terms of revenues and fourth in total Capex spent in nominal terms in 2022 (GSMA Intelligence, 2023[15]).

Figure 6.7. Mobile revenues and investment (total Capex), 2013-22



Note: Breakdown by operator is not included due to data availability.
Source: GSMA Intelligence (2023[15]), *Database,* www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

StatLink https://stat.link/v2ibre

The remarkable expansion of broadband networks in Viet Nam, coupled with the high quality of fixed networks and relative affordability of broadband services, suggests the Vietnamese market has generally performed well. This has taken place in a relatively concentrated market, where most of the main players have state ownership. However, the large investments needed for deployment of 5G, which is still in its infancy in Viet Nam, and the extension of fibre networks beyond urban areas, could benefit from the entry of private capital to complement public sector investment.

6.3. Communication policy and regulatory framework

6.3.1. Institutional framework

The Ministry of Information and Communications (MIC) is the main body responsible for the communication sector in Viet Nam. As set out in Decree No. 48/2022/ND-CP, its duties include drafting and implementing policies to develop the Vietnamese communication market; issuing communication licences, rules and regulations; and assigning spectrum (Government of Viet Nam, 2022[23]). It also has the remit to regulate the communication sector, including the competition thereof (Government of Viet Nam, 2022[23]). The decree lists several units affiliated with MIC, including the Authority of Telecommunications (VNTA) and the Authority of Radio Frequency (ARFM), whose powers, function and structure are defined by the Minister of Information and Communications (Government of Viet Nam, 2022[23]). VNTA helps MIC monitor and regulate the communication sector, including on competition matters (VNTA, 2020[24]). For its part,

ARFM assists MIC in its duties related to radio frequency, including allocation, assignment and use (ARFM, 2022[25]). MIC is also responsible for the broadcasting sector, with support from the Authority of Broadcasting and Electronic Information (Government of Viet Nam, 2022[23]).

The institutional framework of Viet Nam establishes MIC as both the policy-making entity and regulator, as VNTA is an affiliated unit of the ministry. This is problematic given the prevalence of state ownership of communication operators, with the government having full ownership in several fixed and mobile operators. To avoid conflict of interest, the government should not be both a regulator and a regulated entity. This was outlined in Recommendation 2.7 of the *OECD Peer Reviews of Competition Law and Policy: Viet Nam* (OECD, 2018[26]):

> *Policy and line agencies (e.g. the Ministries responsible for making policy in telecommunications, energy and transport or the agencies responsible for enforcing laws in those areas) should perform their functions without favour or discrimination between businesses that are state owned or privately owned.*

Operators with state ownership, especially those with 100% state ownership (Mobifone, VNPT, Viettel), seem to largely enact policies set by the government. The government also appoints key leadership positions, for instance at VNPT, meaning there is governmental influence in these companies.

In addition, the lack of an independent regulator and the prevalence of operators with state ownership in both markets introduce a risk that public and private entities may receive different regulatory treatment. The existence of only one main privately-owned player in the mobile market (which even then only has around 3% market share) may create the perception of discrepancy in the treatment of private companies, although there is no formal evidence of this. As one concrete example of how this may play out, the state both assigns licences for the use of spectrum – a critical but scarce resource – and receives them through its SOEs. This can result in a potential conflict of interest where other private operators are vying for the right to use spectrum.

In addition, the 2021 OECD Broadband Recommendation calls for regulatory decisions in the communication sector to be made, “in an independent, impartial, objective (evidence- and knowledge-based), proportionate, and consistent manner” (OECD, 2021[1]). Similarly, the 2012 Recommendation of the OECD Council on the Regulatory Policy and Governance advocates for regulators to make objective, impartial and consistent decisions, avoiding conflicts of interest (OECD, 2012[27]). The Annex to the Recommendation suggests considering independent regulators where regulatory decisions can have a significant economic impact on the regulated parties (OECD, 2012[27]). This clearly applies to the communication sector.

Separating regulatory functions from policy-making functions helps promote independent, impartial and objective regulatory decisions, based on evidence and insulated from political influence. Indeed, 84% of communication regulators in the OECD member countries are independent, as established by legislation (OECD, 2022[28]).

Recommendation

1. **Establish an independent regulatory body with remit over the communication sector.** As MIC acts as both the policy-making entity and regulator through its affiliated unit (VNTA), there is no independent regulator in the country. An independent regulator, equipped with the tools to monitor and enforce regulation over the communication sector, is considered good practice across the OECD. Especially given the prevalence of state ownership of important players in the communication sector, Viet Nam should establish an independent regulatory body with remit over the communication sector to strengthen its institutional framework, in line with OECD Recommendations (OECD, 2021[1]; OECD, 2012[27]).

6.3.2. Regulatory framework

The 2009 Law on Telecommunications (No. 41/2009/QH12) (Telecom Law) and the Law on Radio Frequencies (No. 42/2009/QH12) provide the backbone of Viet Nam's regulatory framework governing the communication sector. As the broad legislation over the communication sector in Viet Nam, the Telecom Law covers several areas. These include MIC's responsibilities and powers, licensing, interconnection and infrastructure sharing, technical standards and network deployment planning (Government of Viet Nam, 2009[17]). Secondary legislation ("decrees") define further provisions to implement the Telecom Law, such as Decree 25/2011/ND-CP (Government of Viet Nam, 2011[29]) and the amending Decree 81/2016/ND-CP (Government of Viet Nam, 2016[30]). At the time of writing, revisions to the Telecom Law are currently being discussed (MIC, 2023[31]). Some of the proposed amendments currently under discussion pertain to competition management.

According to the licensing framework outlined in the Telecom Law, there are two types of administrative licences: one for the commercial provision of communication services in Viet Nam ("commercial licence") and one for communication operations ("operations licence") [unofficial translation] (Government of Viet Nam, 2009[17]). The "commercial" licence is given to operators, either with or without their own network infrastructure. Meanwhile, the "operations" licence covers firms wishing to either install submarine cables, operate a private network or test communication networks and services (Government of Viet Nam, 2009[17]). Operators applying for a commercial licence to establish a fixed or mobile terrestrial communication network, or a satellite fixed or mobile communication network, must meet capital and investment thresholds, among other licence conditions (Government of Viet Nam, 2011[29]).

Fees apply for the right to both operate a public telecommunication network and provide telecommunication services to the public, according to Art. 41 of the Telecom Law and Art. 30 of the implementing Decree 25/2011/ND-CP. The right to operate a public network requires a fixed annual fee, set on a case-by-case basis depending on the type, scope and scale of the network (Government of Viet Nam, 2011[29]). The annual fee for the right to provide communication services is set as 0.5% of annual revenues from the services included in the licence (Government of Viet Nam, 2018[32]). However, this annual fee cannot be lower than a fixed rate that is set for each type of service. Operators must also contribute to the Viet Nam Public-Utility Telecommunication Service Fund, depending on the service (Government of Viet Nam, 2011[29]). For communication services, operators must contribute 1.5% of revenues accrued from providing these services to the Fund, according to the Prime Minister's Decision 2269/2021/QD-TTg (Government of Viet Nam, 2021[33]).

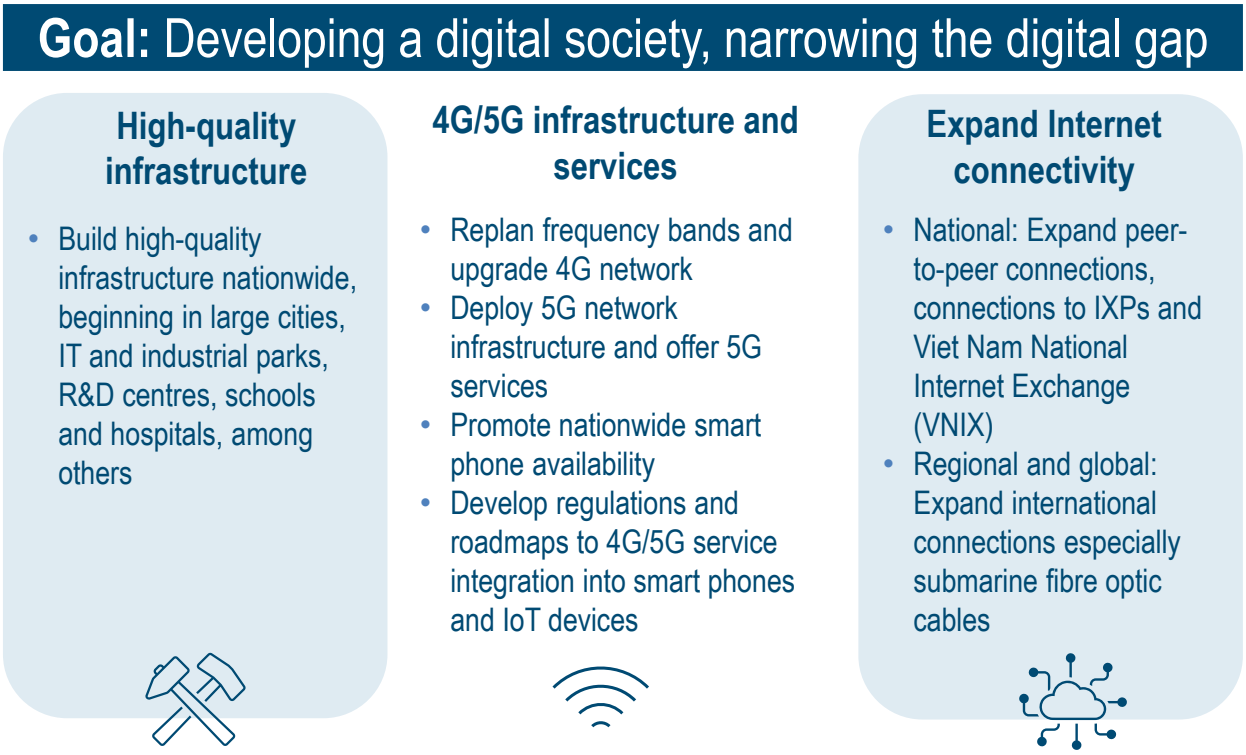
The Law on Radio Frequencies is another key text defining the communication framework in the country. It empowers MIC to manage spectrum resources in the country, including to allocate frequency bands nationally, assign spectrum, define technical standards for radio equipment and restrict harmful interference (Government of Viet Nam, 2009[34]).

6.3.3. Broadband strategies and plans

Developing the communication industry is included in the government's broad Five-Year (2021-2025) and Ten-Year (2021-2030) Plans, underscoring its importance to foster digital transformation (National Assembly, Socialist Republic of Viet Nam, 2021[7]; Congress of Viet Nam, 2021[8]). Furthermore, the "National digital transformation programme to 2025, orientation to 2030", approved in June 2020, includes goals under three main policy objectives: i) developing digital government and improving operational efficiency; ii) developing the digital economy and improving global competitiveness; and iii) developing a digital society and closing digital divides (Government of Viet Nam, 2020[35]). This programme builds on past strategies, such as the strategy articulated in the Prime Minister's 2010 Decision 1755/2010/QD-TTg, which included goals related to broadband communication infrastructure (Government of Viet Nam, 2010[36]).

Under the last objective, to develop a digital society and close digital divides, the programme has set specific targets for communication infrastructure. By 2025, 80% of households and 100% of municipalities should be connected to the Internet via fibre, and 4G or 5G services and smartphones should be universally available. By 2030, fibre and 5G should be universally available. Compared to countries in the region, but also OECD countries, these targets are ambitious. The programme also includes specific actions to achieve these targets, such as building high quality infrastructure, improving 4G/5G networks and services, and expanding Internet connectivity, as outlined in Figure 6.8.

Figure 6.8. Actions to achieve communication infrastructure targets under Viet Nam's National Digital Transformation Programme to 2025, orientation to 2030



Note: The graphic focuses on those actions related to communication infrastructure and connectivity goals and does not represent all actions and targets included under the programme.
Source: OECD elaboration based on Viet Nam (2020[35]), *Quyết định số 749/QĐ-TTg của Thủ tướng Chính phủ: Phê duyệt "Chương trình Chuyển đổi số quốc gia đến năm 2025, định hướng đến năm 2030"* [Decision No. 749/QD-TTg of the Prime Minister: Approving the "National Digital Transformation Programme to 2025, with orientation to 2030"], https://chinhphu.vn/default.aspx?pageid=27160&docid=200163.

6.4. Competition, investment and innovation in broadband markets

6.4.1. Competition

Considering the level of competition in Viet Nam's communication markets, as noted above, both the fixed and mobile market are characterised by a few strong players, most of which have state ownership. In the mobile market, Viettel leads with 54.2% of total mobile broadband subscriptions, followed by VNPT (23.1%), Mobifone (18.6%) and Vietnamobile (2.7%) in 2021. The remaining 1.4% is shared among a few small operators (Figure 6.5). This results in a Herfindahl–Hirschman Index (HHI) rating of 3 825, calculated based on these market shares. As Viettel holds over half of the market and VNPT, the next closest

competitor, has only half of that (23.1%), competitive pressure from other operators may be limited. This poses a risk that Viettel may leverage its position, which Vietnamese authorities have acknowledged. In 2015, Circular 15/2015/TT-BTTTT revised the 2012 designation of providers of mobile communication services (voice, messaging and Internet access) with a "dominant" market position from Viettel, Mobifone and VNPT to only Viettel (MIC, 2015[37]; Government of Viet Nam, 2012[38]). This designation remains today. If the revisions to the Telecom Law on competition are passed according to expectations, this designation will be subject to a more comprehensive and systematic re-evaluation according to national authorities. Despite this relative concentration, mobile broadband prices are affordable, around 0.8% of GNI per capita in 2022 (Figure 6.12) (ITU, 2023[11]).

In the fixed market, three players split the total number of fixed broadband subscriptions: VNPT, Viettel and FPT Telecom. VNPT and Viettel both hold around 40% of the market each, with FPT Telecom holding the remainder (18.1%) in 2021 (Figure 6.6). The HHI for the fixed market, considering these market shares, is 3 683. This could be classified as a highly concentrated market according to certain classifications, such as those put forward by US Department of Justice (2010[39]). In 2012, Circular 18/2012/TT-BTTTT defined all three players as having a dominant position in the fixed broadband Internet access market, a classification still in effect (Government of Viet Nam, 2012[38]). Naming all three operators in the fixed market as having a "dominant" position is counter intuitive. As in the mobile market, the prevailing designation in the fixed market will undergo reassessment following the revised Telecom Law's expected enactment, according to national authorities.

Despite the market's concentration around three main players, prices for fixed broadband seem to be affordable. In 2022, entry-level fixed broadband prices represented only 2.6% of gross national income (GNI) per capita (Figure 6.12) (ITU, 2023[11]). This has likely driven the strong fixed broadband penetration in the country, as discussed below.

When considering overall competition in the communication sector, the question of state ownership is important to note. While enterprises with state ownership dominate the market, there is not just *one* state-owned operator. Rather, there are three in each market (fixed and mobile), whose very presence applies a degree of competitive pressure compared to a monopoly market structure. Therefore, the Vietnamese framework seems to encourage competition *among* the SOEs. The competing operators with state ownership is an important distinction in the Vietnamese market, setting it apart from traditional thinking surrounding state-run communication markets.

However, Viet Nam does not seem to be particularly conducive to privately owned operators. This is likely due in part to Article 17 in the Telecom Law regarding the state holding controlling shares in operators of particular importance (Government of Viet Nam, 2009[17]). A related question is how Article 17 would be applied if a private operator becomes an important player in the market and whether there is a risk of discriminatory treatment to avoid such a scenario, although there is no evidence of this to date. Some degree of preference for state-owned operators may occur in practice and even this perception may deter the entry of new private operators into the market. This is supported by findings in the 2022 *OECD Review of the Corporate Governance of State-Owned Enterprises in Viet Nam* (OECD, 2022[19]):

> *On the issue of competitive neutrality, no formal statutory discrimination between SOEs and private firms is detected. However, the proximity of SOEs to policy makers, continued conflation of the exercise of ownership rights, the government's explicit use of SOEs as a main vehicle for the implementation of the State's industrial or sectoral policies, policy formulation and regulatory responsibilities within the same government ministries/agencies have led to a perception of discrimination and discrepancy while distorting the playing field.*

Thus, introducing an independent communication regulator, continuing planned reforms of the SOE sector and potentially revising Article 17, may make Viet Nam's communication markets more conducive to private entities. This, in turn, may also stimulate further competition in the market and spur private investment in communication networks.

Underpinning this landscape, the 2018 Competition Law (No. 23/2018/QH14) establishes the general competition regulatory framework across industries in Viet Nam. Namely, it legally establishes companies' right to freely compete (Government of Viet Nam, 2018[40]). Importantly, Article 8 explicitly prohibits state agencies from hindering market competition, including to discriminate between enterprises, giving the legal basis for competitive neutrality (Government of Viet Nam, 2018[40]). This is important as the government – driven by national interests – owns shares in all three main fixed operators and three of the four main mobile operators.

Enterprises may be considered to have dominant market position if they have significant market power (SMP), as defined in Art. 26 of the Competition Law, or have a market share of 30% or more (Government of Viet Nam, 2018[40]). An entity may be determined to have SMP based on several characteristics, such as the market landscape and respective market share, barriers to entry, and the financial position of the firm and its competitors, among others (Government of Viet Nam, 2018[40]).

Under this broad framework, the Telecom Law prohibits communication companies from conducting anti-competitive behaviour, as defined under the Competition Law. The Telecom Law further bans operators with either a dominant market position or those with essential facilities from conducting specific anti-competitive acts. Such acts include withholding technical information on essential facilities or other necessary information for a competitor to offer communication services (Government of Viet Nam, 2009[17]). The law further defines MIC as the lead agency for competition matters in the sector. MIC co-ordinates with the Ministry of Industry and Trade (MoIT) to uphold the competition provisions of the Telecom Law. Under MIC, VNTA is the "specialised management agency in telecommunications" with the remit to manage and regulate competition related to establishment of communication networks and provision of services (Government of Viet Nam, 2011[29]).

In case of proceedings such as mergers, acquisitions or joint ventures that would result in a combined market share of between 30-50%, the firms must notify VNTA and the competition authorities prior to undertaking the venture (Government of Viet Nam, 2011[29]). Where the combined market share would be greater than 50%, the Minister of Industry and Trade must approve the proceeding, after receiving the approval from the Minister of Information and Communications (Government of Viet Nam, 2011[29]).

The Competition Law establishes MoIT as the lead government agency on competition matters. It also creates the "Viet Nam Competition Commission" (VCC) [English translation], which conducts competition assessments (Government of Viet Nam, 2018[40]). In February 2023, five years after the Competition Law's passing, Decree No. 03/2023/ND-CP established the powers, structure and mandate of the VCC under MoIT (Government of Viet Nam, 2023[41]). The decree allows VCC to properly assume its functions and issue decisions. Accordingly, in March 2023, the prime minister appointed the chair and seven members to the VCC (VCC, 2023[42]). As one of its duties, VCC monitors violations of the competition framework, including by "state agencies" [unofficial translation of Art. 2(4)] (Government of Viet Nam, 2023[41]). VCC replaces the Viet Nam Competition and Consumer Authority.

Regulatory oversight is key to upholding the competition framework outlined above. The Telecom Law defines MIC, through VNTA, as the responsible body to manage competition in the communication sector. VCC has a broader remit to manage competition in the country and enforces violations of the competition framework by other government agencies, which is of particular importance to the communication sector. According to national authorities, VNTA manages competition through a "pre-inspection" approach in the communication sector (defined under the Telecom Law), while VCC manages competition through a "post-inspection" approach in the communication sector as well as all other sectors (defined under the Competition Law). As VNTA and VCC carry out their respective mandates in the communication sector, Viet Nam should monitor and clarify in case any uncertainties arise.

Further, the Telecom Law notes that MIC and MoIT should co-ordinate on competition matters in the communication sector (Art 19(7)) (Government of Viet Nam, 2009[17]). This co-ordination would likely occur through their respective bodies (e.g. VNTA and VCC). However, the nature of this co-ordination is not

defined in the Law and may require further clarification. Ensuring appropriate co-ordination mechanisms on cross-cutting issues like competition to promote regulatory coherence is a key tenet of the 2012 OECD Recommendation on Regulatory Policy and Governance (OECD, 2012[27]). Enacting this regulatory framework depends on the ability of VNTA to co-ordinate with VCC and enforce it effectively to promote fair competition in the market.

Recommendations

2. **Conduct regular competition assessments of relevant markets.** The last classifications of dominance in the mobile and fixed markets were conducted in 2015 and 2012, respectively. Viet Nam could consider reassessing these markets, and other relevant markets as needed, taking into account the planned amendments to the Telecom Law that are currently being discussed. Based on these assessments, regulatory measures could be enacted as necessary (e.g. asymmetric regulation on dominant operators) to increase the level of competition.
3. **Implement reforms of state ownership in the communication sector and consider facilitating ownership by private entities.** Viet Nam's plans regarding SOE ownership conversion and divestment over 2021-25 are welcome and should be implemented in a timely manner. In particular, Viet Nam could consider further reform of state ownership in the communication sector. Further, Viet Nam could consider amendments to Article 17 of the Telecom Law regarding state ownership of communication operators of particular importance, to open the communication sector to wider participation by private entities. These actions could help make Viet Nam's communication sector more conducive to private actors, lowering barriers to entry and participation to stimulate further competition in the market.
4. **Clarify co-ordination mechanisms between VNTA and VCC, where needed.** The Telecom Law notes that MIC and MoIT should co-ordinate on competition matters in the communication sector, which would occur through their respective bodies (e.g. VNTA and VCC). However, the co-ordination mechanism does not seem to be explicitly defined and may require further clarification in case issues arise as VNTA and VCC carry out their respective mandates governing competition in the communication sector.

6.4.2. Investment

Viet Nam's policies influence how much operators invest to expand and upgrade their networks. This influence may be even more pronounced as the state holds shares in several large players and may shape operators' investment strategies. As a key policy objective in Art. 4(1), the Telecom Law promotes investment to deploy communication infrastructure to support socio-economic development (Government of Viet Nam, 2009[17]). As part of the criteria to obtain a licence to establish a network in the country, prospective operators must meet certain capital thresholds and agree to investment commitments depending on the type of network (Government of Viet Nam, 2011[29]). For example, operators of a nationwide fixed terrestrial communication network using frequency bands and numbering must have VND 300 billion (USD 12.7 million) as capital (Government of Viet Nam, 2011[29]). They must also commit to investing at least VND 1 trillion (USD 42.3 million) in the first 3 years of the licence and at least VND 3 trillion (USD 126.9 million) over 15 years (Government of Viet Nam, 2011[29]).[7] For a mobile terrestrial communication network using spectrum bands, operators must have a legal capital of VND 500 billion (USD 21.1 million). They must also commit to invest at least VND 2.5 trillion (USD 105.7 million) for the first 3 years and at least VND 7.5 trillion (USD 317.2 million) over 15 years (Government of Viet Nam, 2011[29]).[8] These requirements seek to verify that a prospective operator has the financial means to deploy networks, given the capital-intensive nature of operating and maintaining communication networks.

Mobile operators seem to be investing above the legal thresholds set in their licensing conditions. For example, Vietnamese operators had a Capex of USD 1.36 billion in 2022 (nominal terms) (Figure 6.7), spending more in a year (albeit together) than the required investment commitment per operator over 15 years (USD 317.2 million) (GSMA Intelligence, 2023[15]). With respect to regional peers, Thailand and Indonesia lead in terms of overall Capex in 2022, followed by the Philippines and Viet Nam in fourth place (GSMA Intelligence, 2023[15]).

The Telecom Law further allows the shared use of communication infrastructure under Article 45 (Government of Viet Nam, 2009[17]). Network operators can form contractual sharing agreements directly. The VNTA will only intervene in certain instances. These include cases where parties cannot reach an agreement to share essential facilities, where the shared use of passive infrastructure is required to meet planning rules, or where the shared infrastructure will be used to provide "public-utility" (e.g. universal service) communication services (Government of Viet Nam, 2009[17]).

From informational interviews, Vietnamese mobile operators seem primarily to share passive infrastructure (e.g. towers, base stations). However, MIC has recently encouraged greater sharing, including of active infrastructure. While operators note certain technical challenges to sharing of active elements, they have taken some early action. In 2021, the three largest mobile operators, Viettel, VNPT and Mobifone, signed a 5G network-sharing agreement during their 5G trials. This included the sharing of active elements, such as multi-network radio access (MIC, 2021[43]; MIC, 2021[44]). MIC announced plans to issue regulations on sharing 5G infrastructure to further support these sharing activities (MIC, 2021[43]). Promoting network sharing can help foster investment and promote quicker network deployment. At the same time, attention should be paid to ensure that active infrastructure sharing does not lead to less competition in the market.

Viet Nam's regulatory framework related to foreign direct investment (FDI) is governed by the Telecom Law, the Law on Investment and by the international or regional treaties to which Viet Nam has adhered. The Telecom Law requires foreign investors to register their business and obtain an "investment certificate", in addition to applying for the relevant telecommunication licences (Government of Viet Nam, 2009[17]). Both direct and indirect investment in communication services is allowed (Government of Viet Nam, 2011[29]).

Certain restrictions apply to investment in communication services. Article 17 of the Telecom Law asserts that the state holds a controlling number of shares in communication network service providers of particular importance. This effectively limits the market's openness to private entities, foreign or Vietnamese. In addition, Viet Nam's commitments to the WTO Agreement for Trade in Services specifies that foreign capital (investment) must not exceed 65% for non-facilities-based service providers and 49% for facilities-based service providers (WTO, 2007[45]). Joint ventures with communication service suppliers duly licensed in Viet Nam are allowed for both types (non-facilities-based and facilities-based operators) (WTO, 2007[45]). Therefore, foreign operators that either own their own networks (facilities-based) or only rent capacity (non-facilities based) are not allowed to operate in the country without a Vietnamese partner.

In addition to its WTO commitments, Viet Nam also adheres to regional trade agreements, which may allow less restrictive thresholds for signing countries. For example, the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), to which Viet Nam is a signatory, allows slightly lower restrictions. Under the CPTPP, foreign investment for non-facilities-based services is permitted via purchase of shares in a Vietnamese company or through a joint venture up to 65% (up to 70% for virtual private networks) (Government of Viet Nam, n.d.[46]).

The limitation in the CPTPP on non-facilities-based services ends for signatories five years after the agreement entered into force, presumably 5 years after Viet Nam signed the agreement in 2019 (Government of Viet Nam, n.d.[46]; WTO, 2023[47]).[9] Thus, no foreign investment or joint venture requirement should remain for CPTPP parties for non-facilities-based services after 2024.

However, restrictions remain for CPTPP signatories for facilities-based services, even after five years. Foreign investment for facilities-based services must occur through a joint venture or via purchase of shares in a Vietnamese firm. It is capped at 49% for basic services, or 51% for value-added services (VAS) (Government of Viet Nam, n.d.[46]). This 51% limit for VAS facilities-based services will increase to 65% in 2024 for CPTPP signatories (Government of Viet Nam, n.d.[46]). Foreign service suppliers under the CPTPP may fully own submarine cable transmission capacity that lands in Viet Nam and are permitted to sell capacity to any licensed operator in Viet Nam (Government of Viet Nam, n.d.[46]).

Viet Nam's legal framework restricts FDI and limits the entry of private players, both foreign and Vietnamese, also evident given the dominance and prevalence of operators with state ownership. Nevertheless, the information and communication sector has more broadly attracted FDI, close to USD 655 million in 2022 (Ministry of Planning and Investment, 2022[48]). Considering inward FDI stock across all economic sectors, Viet Nam ranks fourth among ASEAN countries in 2021, behind Singapore, Thailand and Indonesia (UNCTAD, 2022[49]).[10]

Similar ownership restrictions exist in other SEA countries. Thailand, for example, has similar caps although several operators in both the fixed and mobile markets have foreign investors. Viet Nam's case differs from Thailand due to the prevalence of SOEs and given legal restrictions. These facts may hinder the ability of foreign firms to participate in the market more than the FDI restrictions themselves. However, the removal of FDI restrictions would help further open the market to foreign players and provide additional investment incentives. Mexico, for example, eliminated restrictions on FDI in telecommunication and satellite communication services, allowing the entry of foreign companies. Subsequently, companies such as AT&T and Eutelsat, have made important investments in the country (OECD, 2017[50]).

Annual fees for communication operators may also affect investment. Operators must pay a licence fee as well as an operating fee, according to the Telecom Law (Art. 35) (Government of Viet Nam, 2009[34]). In addition, they must contribute to the Viet Nam Public-Utility Telecommunication Service Fund. In addition to these, operators must pay an annual fee for spectrum usage, as well as a one-time fee to obtain the spectrum rights (e.g. auction price, in cases where spectrum rights are auctioned).

Fees to obtain a telecommunication licence and to contribute to a universal service fund are common across OECD countries. However, annual spectrum usage fees, on top of one-time fees to obtain spectrum rights increases financial burden and may risk hindering investment. While some OECD countries have an annual spectrum fee, these are most often set to recover costs (OECD, 2022[51]).

The level of total fees levied on network operators should be carefully assessed to determine their impact on operators' long-term financial health and their ability to invest in network deployment. However, during informational calls with Vietnamese operators for this report, the level of fees did not seem to pose a problem or impact their propensity to invest. In addition, current levels of investment seem to be sufficient, with Viet Nam ranking fourth in the region in terms of overall Capex in 2022 (nominal terms).

Recommendation

5. **Consider lowering restrictions on private entities, both foreign and Vietnamese, to enter the market and invest to deploy networks, and eliminate FDI restrictions**. As Viet Nam's framework limits FDI and the entry and participation of private firms, both foreign and national, in the market, authorities could consider lowering these barriers. To that end, they could remove FDI restrictions and encourage private sector capital for investment in communication networks. Such actions can support the deployment of new 5G networks and extension of FTTH networks beyond urban areas, which will require substantial investments.

6.4.3. Innovation

To establish an enabling environment to support innovation, the Telecom Law established a one-year trial licence for entities wishing to test their networks and services (Government of Viet Nam, 2009[17]). To obtain the trial licence, applicants must test services not already included in their licence or that use resources already allocated. In addition, tests must adhere to relevant regulations and standards (Government of Viet Nam, 2009[17]).

This trial licence, which has relatively low requirements to obtain it, has helped support development of new technologies and services, such as 5G. In 2019, MIC issued trial licences to Viettel, VNPT and Mobifone to trial 5G services (MIC, 2019[52]). In 2023, MIC reported the operators had trialed 5G in 40 cities or provinces (MIC, 2023[53]). Despite these trials, 5G network deployment remains at a limited scale in the country. To foster 5G, MIC has called on operators to develop 5G (MIC, 2021[44]). However, the government's slow release of additional mobile spectrum seems to have delayed 5G network deployment. Thus, the expedient assignment of additional spectrum is needed to ensure operators can deliver on 5G plans, as noted in the section on "spectrum management" below.

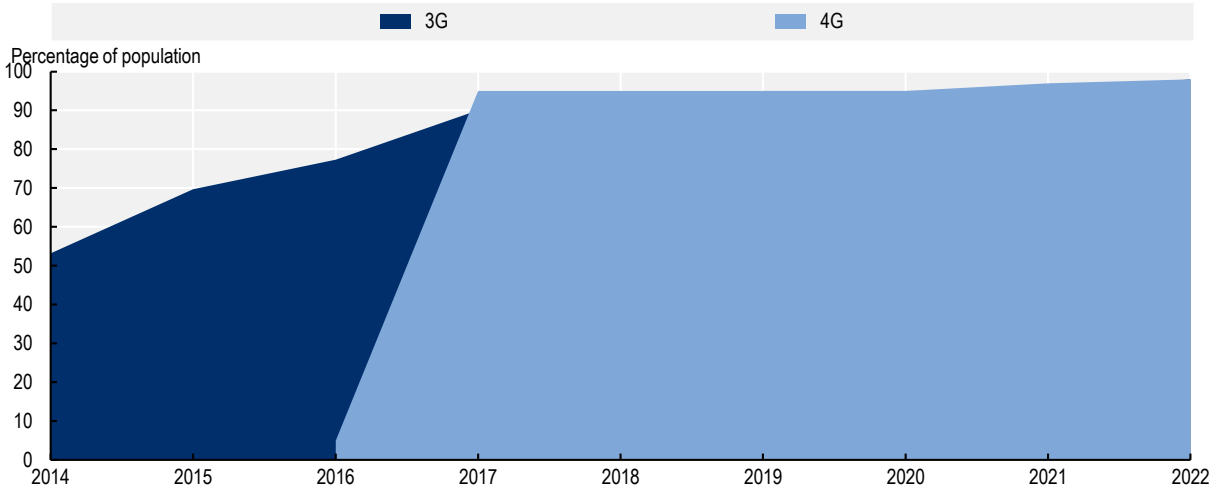
The government has also established strategies to target certain technologies for further development. Similarly, in December 2020, the prime minister issued Decision No. 38/2020/QD-TTg, setting forth a list of advanced technologies and high-tech products that are prioritised for investment and development (Government of Viet Nam, 2020[54]). The list includes several technologies related to communication, such as next-generation network technology, virtualisation and computing technology, and technology for integration and optimisation of telecommunication systems (Government of Viet Nam, 2020[54]). The Decision does not specify how these technologies will be prioritised, allowing relevant ministries to implement them through their own policies in support of these goals.

6.5. Broadband deployment and digital divides

6.5.1. Broadband deployment

Viet Nam has made significant progress in broadband development, especially in the second half of the last decade. Mobile broadband (3G, 4G) coverage reaches almost the entire population (98% by 2022) (GSMA Intelligence, 2023[15]). 3G networks have been progressively deployed over the last decade, reaching 95% of the population by 2020. They continued at a slower pace to reach the current level of 98% (GSMA Intelligence, 2023[15]). 4G networks, on the other hand, have had a much more rapid rollout since 2016, with 95% population coverage already in 2017 (GSMA Intelligence, 2023[15]) (Figure 6.9). The rollout of 5G, however, is still in a trial phase, with connectivity only available in urban areas (December 2022) (Opensignal, 2023[55]).[11] Viet Nam lags its regional peers in 5G deployment, with Indonesia, Lao PDR, Malaysia, the Philippines, Singapore and Thailand already having commercial 5G deployments (GSMA, 2022[56]).

Figure 6.9. Mobile broadband coverage, 2014-22



Source: GSMA Intelligence, (2023[15]), *Database,* www.gsmaintelligence.com/data/ (accessed on 9 November 2023).

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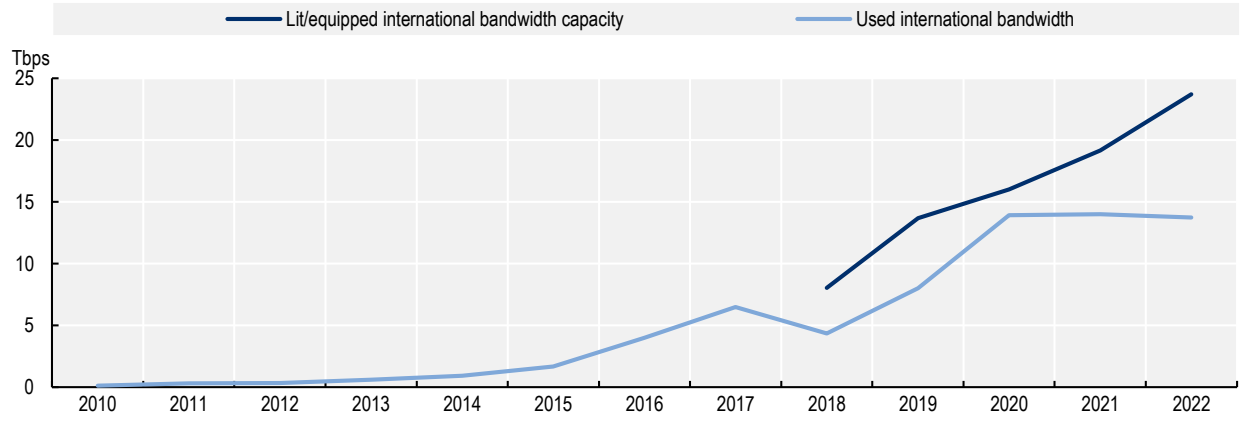
Although no coverage data are available, Viet Nam has relatively high fixed penetration, second in the region with 21.7 subscriptions per 100 inhabitants. This indicates a considerable percentage of the population has access to such networks (Figure 6.1). Moreover, data on fixed subscriptions by technology show a leap towards FTTH/B in recent years (Figure 6.3).

Several factors favour achievement of a high population coverage (households passed) for a given wireline network rollout. First, most people live in highly concentrated in urban and suburban areas (81% of the population) (2015) (European Commission, Joint Research Centre, 2015[3]). Second, people are typically settled along rivers, canals and roads. The opposite is true for low density areas, where 19% of Viet Nam's population live (2015) (European Commission, Joint Research Centre, 2015[3]), making investment in these areas much less profitable and resulting in a coverage gap.

In terms of backbone networks, there are three major fibre networks according to the ITU Broadband Map. Two are operated by the dominant fixed and mobile network operators, VNPT and Viettel respectively, and the Greater Mekong Subregional Information Superhighway operates the third (ITU, 2023[57]). They have a total route length of 264 389 route kilometres (2020) (ITU, 2023[57]).[12] The network has a relatively high coverage area, with 44% of the population within 10 km of a transmission network node, above the SEA average (43%); 90% are within 25 km (2020) (ITU, 2023[57]). These networks are complemented by Viet Nam's own satellite, VINASAT, which provides connectivity to mountainous areas, islands and border areas (as well as maritime communications).

In terms of international connectivity, Viet Nam has an equipped capacity of 23.7 terabits per second (Tbps) (2022) (ITU, 2023[11]). This represents 6% of the region's capacity, fourth behind the 54% provided by Singapore, the 23% by Malaysia and the 12% by Indonesia (2022) (ITU, 2023[11]). The data show a significant increase in Viet Nam's used international bandwidth in recent years (Figure 6.10). This coincides with the rollout of 4G networks and the surge in mobile broadband subscriptions, reaching 14 Tbps in 2022, 58% of installed capacity (ITU, 2023[11]).

Figure 6.10. International bandwidth, 2010-22



Note: Lit/equipped international bandwidth capacity refers to the total lit capacity of international links, namely fibre-optic cables, international radio links and satellite uplinks to orbital satellites in the end of the reference year (expressed in Mbit/s). If the traffic is asymmetric (i.e., different incoming and outgoing traffic), then the highest value out of the two should be provided. Average usage of all international links, including optical fibre cables, radio links and traffic processed by satellite ground stations and teleports to orbital satellites (expressed in Mbit/s). The average is calculated over the twelve-month period of the reference year. If the traffic is asymmetric (i.e. different incoming and outgoing traffic), then the highest value out of the two should be provided. All international links used by all types of operators, namely fixed, mobile and satellite operators should be taken into account. The combined average usage of all international links can be reported as the sum of the average usage of each link (ITU, 2020[14]).
Source: ITU (2023[11]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

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Viet Nam's international connectivity is provided by terrestrial and submarine cables and its satellite system, VINASAT. The country has seven submarine cable landing stations, a relatively low number for the region despite its long coastline (e.g. Thailand has 11 landing stations). The seven stations connect Viet Nam to some of the longest cable systems, including the SeaMeWe-3 cable, the Asia Africa Europe-1 (AAE-1) cable (bypassing Singapore) and the Asia-America Gateway (AAG) cable system. It is also part of two systems connecting countries within the Eastern Asia region: the Southeast Asia-Japan Cable 2 (SJC2) and the Tata TGN-Intra Asia (TGN-IA) cable (TeleGeography, 2023[58]). This submarine cable system connects Viet Nam to several regions of the world, including in Africa, Europe, Oceania and other Asian regions (Table 3.4).

At the intra-SEA level, Viet Nam is not connected to any regional cable systems, unlike other countries in the region (e.g. Malaysia-Cambodia-Thailand cable, Thailand-Indonesia-Singapore cable). However, the long-distance cable systems provide Viet Nam with connectivity to all SEA countries (except the landlocked Lao PDR). Six of the seven cables connect Viet Nam to Singapore and Thailand, four to Malaysia and the Philippines, two to Myanmar and Brunei Darussalam, and one each to Cambodia and Indonesia (Table 3.3).

Table 6.2. Viet Nam's connections with other SEA countries via submarine cables

Cable system	Brunei Darussalam	Cambodia	Indonesia	Lao People's Democratic Republic	Malaysia	Myanmar	Philippines	Singapore	Thailand
Asia Africa Europe-1 (AAE-1)		x			x	x			x
Asia Direct Cable (ADC)							x	x	x
Asia Pacific Gateway (APG)					x			x	x
Asia-America Gateway (AAG) Cable System	x				x		x	x	x
SeaMeWe-3	x		x		x	x	x	x	x
Southeast Asia-Japan Cable 2 (SJC2)								x	x
Tata TGN-Intra Asia (TGN-IA)							x	x	

Source: OECD elaboration from TeleGeography (2023[58]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

Table 6.3. Viet Nam's connections with other regions via submarine cables

Cable system	Northern Africa	Sub-Saharan Africa	North America	Eastern Asia	Southern Asia	Western Asia	Northern Europe	Southern Europe	Western Europe	Australia and New Zealand	Micronesia
Asia Africa Europe-1 (AAE-1)	x			x	x	x		x	x		
Asia Direct Cable (ADC)				x							
Asia Pacific Gateway (APG)				x							
Asia-America Gateway (AAG) Cable System			x	x							x
SeaMeWe-3	x	x		x	x	x	x	x	x	x	
Southeast Asia-Japan Cable 2 (SJC2)				x							
Tata TGN-Intra Asia (TGN-IA)				x							

Source: OECD elaboration from TeleGeography (2023[58]), *Submarine Cable Map*, www.submarinecablemap.com/ (accessed on 22 February 2023).

An international terrestrial cable network called the Greater Mekong Subregional Information Superhighway (GMS IS) connects Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam and Yunnan Province in the People's Republic of China (hereafter "China") (ADB, 2005[59]). The GMS IS in Viet Nam is deployed along the coastal route between Ha Noi and Ho Chi Minh City, with direct links to Cambodia, Lao PDR and China (ITU, 2023[57]). Finally, Viet Nam also has its own satellite system, VINASAT-1 and VINASAT-2, operated by VPNT. The satellites provide connectivity to remote areas, border areas and islands, and improve international connectivity. They are also used for national security and defence. MIC recently announced a plan to replace VINASAT-1 and VINASAT-2 in 2023 (Khang, 2022[60]).

The Viet Nam National Internet Exchange (VNIX), created in 2003, is managed and operated by the Viet Nam Internet Centre (VNNIC), a unit under MIC. VNIX operates under the principle of non-profit neutrality for peering services between agencies, organisations and enterprises. However, in parallel, VNIX operates as a commercial platform, allowing connected organisations to buy or sell services to each other, including Internet access and cloud services (VNNIC, 2023[61]). VNIX has five nodes distributed throughout the country, two in Ha Noi (north), two in Ho Chi Minh City (south) and one in Đà Nẵng (central). The distributed nodes of the VNIX have performed well in handling this growing Internet traffic. Quality indicators, such as fixed broadband latency and jitter, are among the lowest in the region, along with Singapore and Brunei Darussalam.

Table 6.4. Internet exchange points, 2023

Name	City
Viet Nam National Internet Exchange	Ho Chi Minh City
Viet Nam National Internet Exchange	Hanoi
Viet Nam National Internet Exchange	Da Nang city

Source: PCH (2023[62]), *Internet Exchange Directory*, www.pch.net/ixp/dir (accessed 5 December 2023).

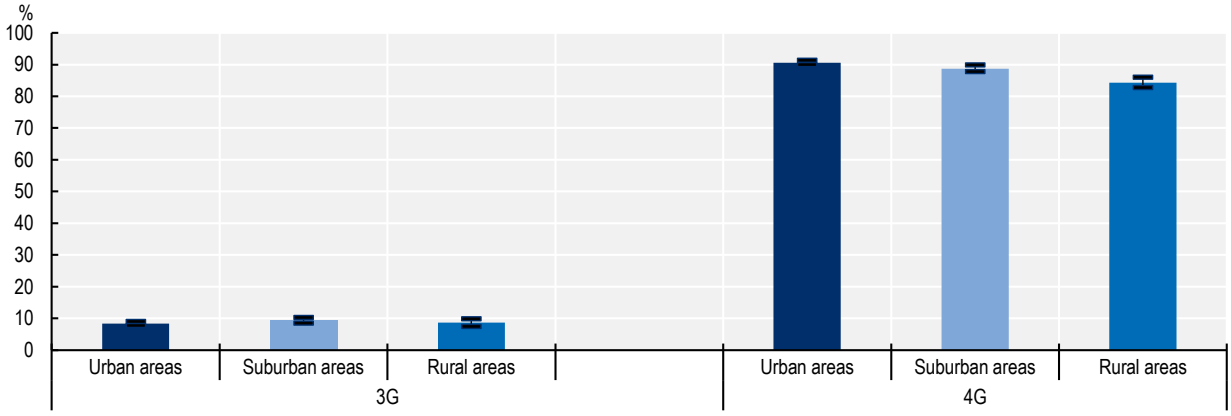
6.5.2. Digital divides

Despite the major development of broadband in Viet Nam over the last decade, there are marked differences in Internet usage depending on several factors. Although the Internet usage rate in Viet Nam is relatively high (79% of the population) (2022) (ITU, 2023[11]), there is a pronounced geographical gap between urban and rural areas. As of 2020, the gap reached 18 percentage points (64% of individuals in rural areas use the Internet vs. 82% in urban areas) (ITU, 2023[11]). There is also a significant gender gap of six percentage points in favour of men (2022) (ITU, 2023[11]). There are no publicly available data to determine whether the country has an age-related divide.

Several causes on both the supply and demand sides may explain these gaps. Looking in more detail at supply-side reasons, mobile network availability, understood as the proportion of time users have a 3G and 4G connection (Opensignal, 2023[63]), shows some differences between urban, suburban and rural areas (Figure 6.11). According to Opensignal, 4G network availability is 6.3 percentage points lower in rural areas than in urban areas, although still relatively high at 84.3% of the time (December 2022 - February 2023) (Figure 6.11) (Opensignal, 2023[55]). Despite the high level of mobile network availability, the lower quality of mobile broadband services in rural areas may contribute to the geographical divide (Figure 6.13).

With regard to fixed broadband, data disaggregated by degree of urbanisation are not available. However, interviews with local stakeholders indicate that coverage seems to be concentrated in densely populated areas. This may limit connectivity for some users who need the performance generally offered by these networks (e.g. higher upload speed and reliability), such as business users (small and medium-sized enterprises) and public administrations.

Figure 6.11. Network availability, percentage of time (3G, 4G), December 2022 – February 2023



Notes:
1. Data was collected by Opensignal from its users over 90 days (1 December 2022–28 February 2023).
2. 3G availability shows the proportion of time that all Opensignal users had a 3G connection. 4G availability shows the proportion of time Opensignal users with a 4G device and a 4G subscription – but have never connected to 5G – had a 4G connection. 5G availability shows the proportion of time Opensignal users with a 5G device and a 5G subscription had an active 5G connection (Opensignal, 2023[63]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[64]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[65]).
Source: © Opensignal Limited - All rights reserved (2023[55]), http://www.opensignal.com.

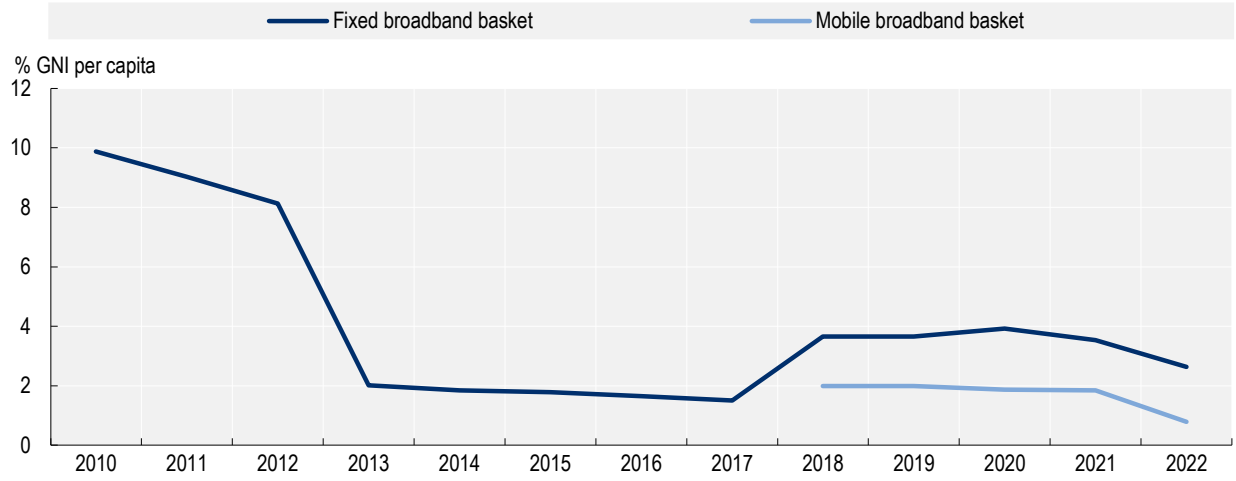
StatLink https://stat.link/mt0p6x

Informational interviews identified two main barriers to deploying networks in rural areas to address the coverage and speed gaps. First, the high cost of network deployment and low demand undermined the business case. Second, there were long delays and administrative burdens in obtaining construction permits, especially at the local level. This situation seems to indicate the limited practical effectiveness of government measures to facilitate permits for network construction (see section on policy and regulation).

Broadband prices in Viet Nam are relatively affordable in terms of purchasing power. They are close to the target of less than 2% of GNI per capita for entry-level broadband services set by the Broadband Commission in support of the SDGs (Broadband Commission for Sustainable Development, 2022[66]).[13] Fixed broadband prices fell dramatically from 2012 to 2013, from 8.1% of GNI per capita to 2.0%. In the following years, they stayed below 4%, falling to 2.6% in 2022 (Figure 6.12) (ITU, 2023[11]). Mobile broadband prices are also relatively affordable. They remained at around 2% of GNI per capita between 2018 and 2021, falling to 0.8% of GNI per capita in 2022 (ITU, 2023[11]) (Figure 6.12). These data suggest the price of broadband connectivity does not appear to be a determining factor in the digital divide between different socio-economic groups.

However, affordability for devices can also influence adoption of communication services. According to Tarifica, mobile device prices are relatively high relative to income levels in Viet Nam, with the benchmark price of entry-level internet-enabled handset reaching 19.49% of average monthly income (2022) (Tarifica, 2023[67]).[14] This value is above the price in countries with similar GDP, such as Indonesia (7.74 %), and well above countries such as Singapore (0.39%).

Figure 6.12. Prices for fixed and mobile broadband services (percentage GNI per capita), 2010-22



Note: The fixed broadband basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan. For comparability reasons, the fixed-broadband basket is based on a monthly data usage of a minimum of 1 GB from 2010 to 2017, and 5 GB from 2018 to 2022. For plans that limit the monthly amount of data transferred by including data volume caps below 1GB or 5 GB, the cost for the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s. The mobile broadband basket is based on a monthly data usage of a minimum of 500 MB of data, 70 voice minutes, and 20 SMSs. For plans that limit the monthly amount of data transferred by including data volume caps below 500 MB (low-consumption), the cost of the additional bytes is added to the basket. The minimum speed of a broadband connection is 256 kbit/s, relying on 3G technologies or above. The data-and-voice price basket is chosen without regard to the plan's modality, while at the same time, early termination fees for post-paid plans with annual or longer commitment periods are also taken into consideration (ITU, 2020[16]). Mobile basket prices are not available from 2010 to 2017.
Source: ITU (2023[11]), *World Telecommunication/ICT Indicators Database 2023 (27th edition/July 2023)*, www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed on 22 August 2023).

StatLink https://stat.link/eyp2b3

On the demand side, data reveal that a lack of digital skills can be a barrier to Internet usage. Only 26% of the population reported having the most widespread skill, "using copy and paste tools within a document" (2021) (ITU, 2023[11]). This was one of the lowest percentages of the countries examined in this report, along with Thailand (23% of the population for the same skill) (2020) (ITU, 2023[11]). The remaining digital skills covered by the ITU survey, such as "sending e-mails with attached files" or "creating electronic presentations with presentation software" have lower percentages (ITU, 2023[11]). Data on digital literacy by age or location are not available, preventing conclusions on their influence on the age and geographical divide. The national authorities consulted also point to the lack of digital skills as a key constraint to broadband adoption.

6.5.3. Policies and regulation

The Vietnamese authorities have acted in several areas to facilitate network deployment, make sufficient spectrum available to the market, and bridge the digital divide. The main ones are described below.

Permits for network construction and rights of way

The Telecom Law (Chapter IX) (Government of Viet Nam, 2009[17]) and its implementing Decree No. 25/2011/ND-CP (Art. 40-43) (Government of Viet Nam, 2011[29]) contain specific provisions to facilitate construction of passive telecommunication infrastructure for network deployment. These measures are largely based on prior planning for passive infrastructure. National plans define the requirements and conditions for the construction and installation of passive infrastructure. This is followed by passive infrastructure planning at the local level by the Provincial People's Committee. On the basis of these local

plans, companies (operators) submit their telecommunication infrastructure plans to the committee for approval.

This planning and prior approval makes it possible to streamline the administrative burden associated with the construction of passive infrastructure. The process eliminates the need for a permit if such construction is consistent with the operator's approved telecommunication infrastructure plan. In addition, the committee has authority to review, amend or even repeal local regulation for granting a permit to build passive infrastructure if it is no longer appropriate. This avoids disputes between authorities involved in permitting.

In terms of rights of way, the Telecom Law (Art. 57) states that "public telecommunication projects" shall have priority in the use of space, soil, subsoil, riverbed and seabed, and that "public telecommunications service points" shall have priority at railway stations, bus stations, seaports, airports, border gates and other public places (Government of Viet Nam, 2009[17]).

Co-ordination of civil works and joint use of passive infrastructure

According to the Telecom Law (Art. 58) (Government of Viet Nam, 2009[17]) and its implementing Decree No. 25/2011/ND-CP (Art. 43) (Government of Viet Nam, 2011[29]), investors in passive infrastructure must ensure its joint use for the installation of equipment in accordance with passive infrastructure planning. They also oblige investors to allow installation of communication cables and equipment on infrastructure of other sectors, namely on electricity poles (if cables cannot be buried or if separate poles cannot be built); on underground public works (e.g. water supply, street lighting, sewerage); and along roads, streets, pavements and bridges, among others. It also stipulates that installation of communication equipment and cables should be rented on a cost basis.

Each infrastructure is managed by a separate authority. For example, the Ministry of Commerce manages electricity poles, the Ministry of Construction manages underground works and the Ministry of Transport oversees roads and streets. These authorities jointly manage passive infrastructure. In addition, the Provincial People's Committees manage the sharing of passive infrastructure at the local level.

When laying underground cable, operators must co-ordinate and provide funding, while the Provincial People's Committee co-ordinates local implementation of the plan.

Licensing procedures

The Telecom Law (Chapter V) (Government of Viet Nam, 2009[17]) and its implementing Decree No. 25/2011/ND-CP (Art. 23) (Government of Viet Nam, 2011[29]) detail procedures for granting licences for communication services in Viet Nam. It sets relatively short deadlines to process a dossier (45 working days) and also requires co-ordination between relevant agencies in evaluating the dossier. Subsequently, Decree 81/2016/ND-CP (Government of Viet Nam, 2016[30]) of 1 July 2016 established a maximum period of 15 working days for the processing of applications.

Spectrum management

MIC is responsible for spectrum management and proposes the country's frequency allocation table to the prime minister who has the ultimate decision (Government of Viet Nam, 2013[68]). The latest frequency allocation plan was issued in 2021 (Government of Viet Nam, 2021[69]). MIC also assigns spectrum licences, according to the Law on Radio Frequencies and subsequent amendments outlined in Law No. 9/2022/QH15, which came into effect in July 2023 (Government of Viet Nam, 2009[34]; Government of Viet Nam, 2022[70]). Radio frequency may be assigned in three possible ways: direct assignment, administrative selection ("beauty contest") and auction. Auctions are used to assign bands intended to establish public mobile communication networks, or other public terrestrial communication networks considering the domestic communication market and international practice to license the frequency band in question (Art. 1) (Government of Viet Nam, 2022[70]).

Beauty contests are employed in the same cases as specified for auctions, however with the intent to spur deployment of a new technology at a large scale within a given timeframe, or to encourage new entrants to the market (Art. 1) (Government of Viet Nam, 2022[70]). Direct assignment is on a first-come, first-served basis and applies to cases not specified for auctions and beauty contests, as well as other specific cases (e.g. to support trials and testing or in emergency cases) (Government of Viet Nam, 2009[34]; Government of Viet Nam, 2022[70]).

The maximum duration is 15 years for licences that allow the use of a frequency band, or channels thereof (Government of Viet Nam, 2009[34]; Government of Viet Nam, 2022[70]). Spectrum licences assigned by auction may be transferred to other eligible entities after five years from the licence's issuance, upon MIC's approval (Government of Viet Nam, 2009[34]; Government of Viet Nam, 2022[70]). However, spectrum licences assigned directly or by beauty contest are not allowed to transfer their right to use spectrum (Government of Viet Nam, 2022[70]). Licences may be revoked if the licensee fails to implement provisions of the licence within two years of its issuance (Government of Viet Nam, 2009[34]). The current maximum licence validity of 15 years is somewhat short and may hinder investment if operators are unsure whether they will have continued access to the spectrum they need.

Article 31 of the Law on Radio Frequencies, as amended by Law No. 9/2022/QH15, states that spectrum licensees must pay a fee for: i) using the spectrum; and ii) for being issued the spectrum licence (Government of Viet Nam, 2009[34]; Government of Viet Nam, 2022[70]). Therefore, mobile network operators must pay two types of spectrum fees: an annual usage fee and a one-time fee to obtain the frequency licence (e.g. through an auction). Annual usage fees, on top of one-time fees for the licence, increase the cost of spectrum and may pose an additional financial burden and risk curbing investment. Across the OECD, some countries have annual spectrum fees, or another form of annual regulatory fee. However, these are mostly set to recover costs (OECD, 2022[51]). When an auction procedure is in place, most OECD countries do not usually set annual fees above cost recovery (OECD, 2022[51]). Law No. 9/2022/QH15, amending Art. 31 of Law on Radio Frequencies, establishes that frequency usage fees should be set based on the principle of cost recovery (Government of Viet Nam, 2022[70]).

To assign spectrum through an auction procedure, auctions must adhere to sectoral regulation (e.g. the Telecom Law and the Law on Radio Frequencies) and supporting regulation. General regulation also applies to spectrum auctions, in particular the Law on Property Auction and the Law on the Management and Use of Public Property (Government of Viet Nam, 2016[71]; Government of Viet Nam, 2017[72]). In August 2023, the government issued Decree No. 63/2023/NĐ-CP, which details provisions of the Law on Radio Frequencies and subsequent Law No. 09/2022/QH15 (Government of Viet Nam, 2023[73]). Importantly, Decree No. 63/2023/NĐ-CP defines aspects of auction assignment procedures, including to define an auction's reserve price using a benchmark method. The decree also provides further details regarding application and licensing procedures by beauty contest or direct assignment (Government of Viet Nam, 2023[73]).

There have been several delays to auction spectrum in the past ten years (MIC, 2022[74]). Some delays may have been due to the legal complexity governing spectrum assignment across sectoral and broader regulation. However, MIC has acted to clarify this uncertainty in recent years. Decree No. 63/2023/NĐ-CP, for example, may help to facilitate the organisation of spectrum auctions.

According to national authorities, each mobile network operator is licensed to use around 100 MHz of spectrum across the 900 MHz, 1800 MHz and 2100 MHz bands. MIC also plans to assign spectrum in the 700 MHz, 2.3 GHz, 2.6 GHz and 3.5 GHz bands. After carrying out these plans, national authorities predict that each of the main operators will hold between 200-300 MHz of spectrum, not including mmWave spectrum.

In February 2023, MIC issued rules to auction spectrum in the 2.3-2.4 GHz band (Government of Viet Nam, 2023[75]). While Mobifone, Viettel, Vietnamobile and VNPT all applied to participate in the auction and received approvals from MIC, none registered for the auction. Ultimately, the three available 30 MHz

spectrum blocks went unsold (MIC, 2023[53]). The lack of participation despite the purported demand from operators may be due to several reasons, one of which could be the reserve price set in the auction. The benchmarking approach outlined in Decree No. 63/2023/NĐ-CP may assist MIC to set reserve prices. Reserve prices should be set at a level that allows market players to express their valuations of the spectrum (OECD, 2022[51]). It is unclear whether MIC plans to host another auction for the 2.3 GHz band. Among the other spectrum bands planned for assignment, MIC has reported plans to auction the 700 MHz band in the near future (MIC, 2023[53]). In October 2023, MIC announced its auction rules for the auction of spectrum in the 2.5-2.6 GHz band (MIC, 2023[76]).

Viet Nam seems to be lagging in the amount of spectrum assigned to operators to support mobile communication services compared to other SEA countries. In Thailand, before the True-Dtac merger, market leader AWN(AIS) held 1 420 MHz in total across all bands, True held 990 MHz, NT had 540 MHz and Dtac had 270 MHz. Similarly, in Singapore, operators on average hold around 1 000 MHz each (although new entrants hold less). Cambodia's three main mobile operators also hold more than 100 MHz each, varying from around 132 MHz for CamGSM to 230 MHz for Smart Axiata, although this is more comparable to Viet Nam's spectrum assignments. During informational interviews for this report, Vietnamese operators noted that delays to assign spectrum was a key challenge to deploying 5G networks. Nevertheless, MIC's recent actions (e.g. plans to assign the 2.5-2.6 GHz band) suggest some momentum to assign additional spectrum in the near term.

However, even if MIC assigned mobile spectrum as planned, the total amount of spectrum available for public communication services may continue to be insufficient. According to MIC reports, only 15% of Viet Nam's total spectrum holdings are available for public communication services, while the other 85% is reserved for "specialised" networks, including national defence and public security purposes (MIC, 2022[74]). Yet only 4% of the spectrum is in use to support national defence and security; the remaining 81% was reportedly unused as of 2022 (MIC, 2022[74]). Overall, the amount of spectrum available for mobile operators to provide public communication services in Viet Nam is limited. If more spectrum were made available, mobile operators might be better equipped to upgrade and expand their networks and provide high quality connectivity.

Universal Service Obligation

The "universal telecommunications service" is set forth in Chapter III of the Telecom Law (Government of Viet Nam, 2009[17]) and in Art. 14 of its implementing Decree No. 25/2011/ND-CP (Government of Viet Nam, 2011[29]). The decree defines several principles for provision of public communication services, including priority to remote areas, border and island areas. Difficult areas where communication companies cannot afford to operate effectively using market mechanisms are also prioritised. These services also aim to ensure the right to equal and reasonable access for all. To that end, they provide or finance communication equipment and services to "poor" or "near-poor" households or other users through preferential treatment (Government of Viet Nam, 2011[29]) .

Providers of public utility communication services are private companies, selected through order placement, bidding or plan assignment. The Viet Nam Fund for Public Utility Telecommunications Services is the instrument for financing these services, but operators fund the services (Government of Viet Nam, 2011[29]). For communication services, operators must contribute 1.5% of revenues accrued from provision of these services (Government of Viet Nam, 2021[33]).

Universal service has been implemented through various initiatives since 2005, up to the current "Programme on the provision of public telecommunications services until 2025" (Government of Viet Nam, 2021[77]). This programme includes support measures for both service provision and take-up. To support service provisions, the programme finances part of the costs of deploying fixed and mobile networks in targeted areas; the operational costs of connecting islands to the mainland; and deployment of public Internet access points. To stimulate demand and take-up of services, it subsidises terminals (tablets and

smartphones for 400 000 households) and the cost of connecting to broadband services, as well as to enact certain promotional and training measures. The programme has a budget of VND 12.5 trillion (USD 528.6 million).[15]

Price regulation

The Telecom Law allows communication operators to determine their own tariffs (Government of Viet Nam, 2009[17]), but the MIC may control prices in certain situations. These include where communication service charges increase or decrease unreasonably compared to the cost of offering services or average rates, and where this results in instability in the communication market, causing damage to the legal rights and interests of consumers, other operators or the state. Such measures could include the imposition of maximum or minimum prices (Telecom Law, Art. 53-56 (Government of Viet Nam, 2009[17]) and Decree No. 25/2011/ND-CP, Art. 38) (Government of Viet Nam, 2011[29]).

Digital skills programme

Education and training are the first priority of the National Digital Transformation Plan until 2025, with a vision until 2030. In April 2022, the MIC launched an e-learning platform called “ONE TOUCH”, as well as several community digital technology groups to help residents learn digital skills. Between March and October 2022, more than 61 500 such groups with nearly 284 000 members were established in 55 of 63 provinces and central cities. As a result, 13.4 million people have accessed the platform to learn basic digital skills.

In addition, VNNIC has built and developed the VNNIC Internet Academy platform to teach basic and essential Internet skills. The platform's content and lectures are developed according to the digital skills of each audience in the online environment. This ranges from children, the elderly and beginners to professionals, experts and managers in the Internet sector.

Consumer rights regulation

Decision No. 05/2007/QD-BBCVT (Government of Viet Nam, 2007[78]) regulates the handling of complaints and provides guidance on dispute resolution between users and postal, communication and Internet service providers. The Telecom Law also outlines provisions on consumer rights in Art. 16, which includes users’ right to complain about tariffs and quality of service, and to receive refunds and compensation (Government of Viet Nam, 2009[17]).

Recommendations

6. **Reduce the administrative burdens associated with network deployment**. Leverage existing legislation to facilitate construction of passive communication infrastructure for network deployment. This includes provisions in the Telecom Law (Chapter IX) (Government of Viet Nam, 2009[17]) and its implementing Decree No. 25/2011/ND-CP (Art. 40-43) (Government of Viet Nam, 2011[29]) to reduce the administrative burden associated with the construction of passive infrastructure. Pay attention to local co-ordination mechanisms to ensure that permits and rights of way are expedited in a timely manner. Also ensure that any disputes over permits and rights of way are resolved promptly.
7. **Facilitate co-ordination of civil works and joint use of passive infrastructure**. Ensure proper implementation of provisions of the Telecom Law (Art. 58) (Government of Viet Nam, 2009[17]) and the Decree No. 25/2011/ND-CP (Art. 43)) (Government of Viet Nam, 2011[29]) that regulate the sharing of passive infrastructure of other sectors (e.g. electricity grids) and public

works (e.g. water supply, street lighting, roads, pavements, bridges) for installation of communication cables and equipment. Ensure competent authorities for each infrastructure act diligently and co-ordinate among themselves and with the local administration.

8. **Facilitate spectrum assignment and increase spectrum availability, especially for mobile communication services**. To spur 5G deployment, Vietnamese authorities should speed up efforts to auction spectrum to support next-generation mobile spectrum (e.g. in the 700 MHz, 2.3 GHz, 2.6 GHz and 3.5 GHz bands). To that end, they should avoid discouraging participation through, for instance, high reserve prices. Auctions for in-demand spectrum bands, such as to support mobile communication, are the most efficient way of allocating spectrum (OECD, 2022[51]). In addition, as a small portion of spectrum is available for public use (approximately 15% according to MIC estimates) (MIC, 2022[74]), Viet Nam could consider making a greater amount of spectrum available to support public communication services.
9. **Leverage synergies between programmes to promote provision and adoption of connectivity services**. To close gaps in unserved and underserved rural areas, measures should promote network deployment, such as the Universal Service Fund, complemented by measures to promote use of connectivity services by citizens and local businesses. In this sense, the approach of the current universal service programme "Programme on the provision of public telecommunications services until 2025" (Government of Viet Nam, 2021[77]), which considers both aspects, is considered appropriate. It is also highly recommended to find synergies with other programmes, such as those dedicated to improving the digital literacy of the population, including the "ONE TOUCH" or the VNNIC Internet Academy platform.

   Furthermore, government purchasing power could be used as an anchor tenant for demand in semi-urban and rural areas. For example, it could provide connectivity to schools, health centres or other types of public service infrastructure. Community centres with high quality connectivity could also be used to raise demand in these areas. To that end, they could provide training and other types of digital services to citizens and businesses in rural areas.
10. **Take actions to improve the affordability of access devices**. Vietnamese authorities could consider implementing support programmes for low-income and other non-adopting households and small and medium-sized enterprises (SMEs) to purchase access devices such as mobile handsets, tablets or computers.
11. **Promote and invest in the improvement of digital skills**. Initiatives to improve digital literacy and raise digital awareness of the population at large could be scaled up, focusing on older people and rural areas. This would go a long way to increasing demand and bridging the digital divide.

6.6. Quality of networks (resilience, reliability, security and capacity)

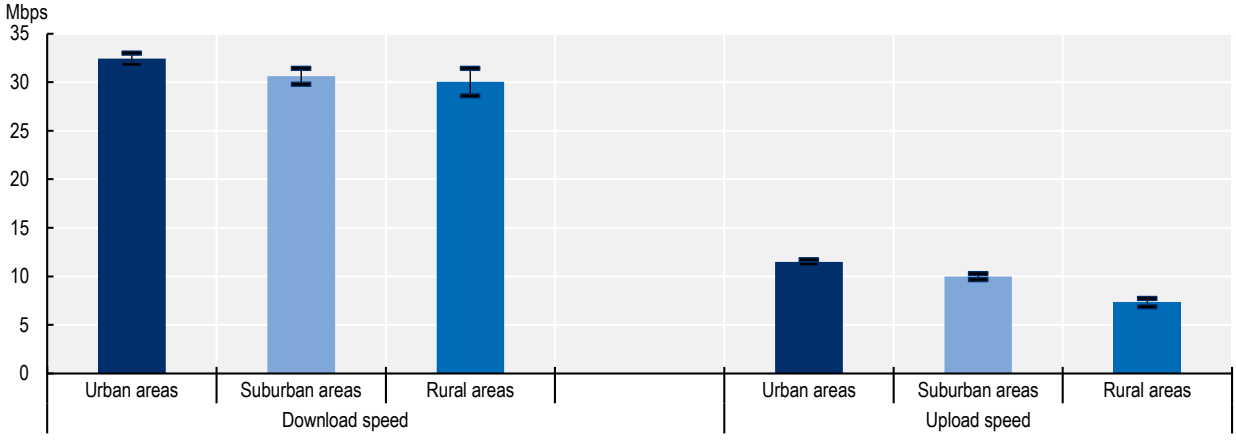
Viet Nam's end-user broadband performance is among the best in the region. Fixed connectivity stands out not only for its speed, but also for its symmetry (similar upload and download speeds). In July 2023, Viet Nam's median fixed broadband connection speed was symmetrical at 93.7 megabits per second (Mbps), third in the region behind Singapore and Thailand in terms of upload speeds (fourth by download speed) (Ookla, 2023[79]).[16] During the same month, median fixed broadband latency was among the lowest in the region at 5 milliseconds (ms), just above Singapore and Brunei Darussalam (4 ms) (Ookla, 2023[79]).[17] The speed data do not vary much from those reported by Vietnamese authorities (VNNIC) (July 2023), 93 Mbps/91.6 Mbps. However, latency data do vary, rising to 9.2 ms (VNNIC, 2023[80]). Viet Nam's strong performance likely stems from use of symmetrical and high-capacity access networks such as FTTH

for almost all fixed broadband subscriptions, as well as adequate capacity dimensioning of the backhaul and backbone network.

The quality of mobile broadband connections is also relatively good in Viet Nam. In July 2023, the median mobile download speed was 48.3 Mbps, fourth best in the region (after Brunei Darussalam, Singapore and Malaysia), and the median upload speed was 19.9 Mbps, second best in the region (after Brunei Darussalam) (Ookla, 2023[79]). In the same month, the median latency was 23 ms, the median in the region (Ookla, 2023[79]) (see Chapter 1). According to VNNIC data in July 2023, median mobile broadband connection speed was 39.7 Mbps/16.6 Mbps and median latency 35.9 ms (VNNIC, 2023[80]). This is particularly relevant given the low 5G coverage, indicating a high performance of deployed 4G networks.

Despite the excellent quality-of-service data at the country level, the measures of user experience reveal some differences according to access technology and user location. 4G users in rural areas experienced 7% lower download speeds than in urban areas, and a remarkable 36% lower upload speeds (Figure 6.13) (Opensignal, 2023[55]). These results may indicate lower performance access networks in rural areas or under-dimensioning backbone and backhaul networks capacity.

Figure 6.13. Download/upload speed experience 4G, December 2022 – February 2023



Notes:
1. Data were collected by Opensignal from its users, over 90-days period (1 December 2022–28 February 2023).
2. Opensignal download/upload speed experience represents the typical everyday speeds an Opensignal user experiences across an operator's mobile data networks. 4G download/upload speed is the average speed observed by Opensignal users when they were connected to 4G (Opensignal, 2023[63]).
3. Confidence intervals (as represented by error bars) provide information on the margins of error or the precision in the metric calculations. They represent the range in which the true value is likely to be, considering the entire range of data measurements.
4. The results for urban areas, suburban areas and rural areas have been obtained by averaging, in each of these categories, the results of the users' tests in geographical locations classified as "urban centres" for urban areas, "dense urban areas", "semi-dense urban areas" and "suburban areas" for suburban areas, and "low density rural areas", "rural areas" and "very low density rural areas" for rural areas. This territory classification has been taken from the Global Human Settlement Layer Dataset (European Commission, Joint Research Centre, 2022[64]). This applies the definitions of degree or urbanisation established in the methodology developed by the European Commission, Food and Agriculture Organization, UN-Habitat, International Labour Organization, OECD and World Bank (European Commission, Eurostat, 2021[65]).
Source: © Opensignal Limited - All rights reserved (2023[55]), http://www.opensignal.com.

StatLink https://stat.link/dyglwc

The topology of national backbone networks, IXPs and international connectivity, contribute to the resilience of Viet Nam's broadband services. The topology of the national backbone terrestrial network has a relatively high level of meshing along the central region, as well as in the northern and southern regions,

which offers alternative routes for traffic in case of network failures (ITU, 2023[57]). In addition, five VNIX nodes are distributed throughout the territory. This means that traffic exchange between providers and access to content providers is also geographically redundant, which increases the resiliency of the transport network.

Viet Nam's international connectivity is also geographically diversified. The submarine cable landing stations are distributed in three different locations, taking advantage of Viet Nam's long coastline: two in the central region (Danang and Quy Nhon), and one in the southern region (Vung Tau) (TeleGeography, 2023[58]). In addition, Viet Nam is integrated into the Greater Mekong Subregional Information Superhighway (GMS IS), an international terrestrial cable system, which provides alternative routes for international traffic via neighbouring countries. Finally, international connectivity is also diversified in terms of technology, namely submarine and terrestrial fibre networks and satellite connectivity, as described above.

6.6.1. Policy measures and regulation

The Vietnamese authorities have taken several measures to improve the quality of networks. The main ones are described below.

Measurement and publication of quality-of-service data

VNTA measures the quality of connectivity services (Internet connection) through user experience via crowdsourced data. The measurement tool, i-Speed, is similar to that offered by some commercial products, but developed and maintained by VNNIC and VNTA. This approach allows Vietnamese authorities to set quality-of service indicators and collect data independently of operators and third-party measurement companies. I-Speed is made available to users through the speedtest.vn and i-speed.vn websites. The i-Speed application can be installed on mobile devices to enable self-assessment of connection quality. The results of the Internet speed measurement in VNNIC Internet Speed show the parameters of speed (download and upload), latency (ping, jitter) and Internet connection protocol (IPv4/IPv6). When using the i-Speed application on mobile devices, users will also be aware of other connection parameters (VNNIC, 2023[81]). Based on these measurement data, VNNIC produces aggregated statistics on quality-of-service indicators at country level (VNNIC, 2023[82]).

Measures to improve network security

Viet Nam has broad regulation on network security, the Law on Network Information Safety (Law no.86/2015/QH13), amended by Law No. 35/2018/QH14 (Government of Viet Nam, 2015[83]; Government of Viet Nam, 2018[84]). The law covers several aspects of network security, including protection of personal information. It also sets out certain specific actions to which communication operators must comply (Government of Viet Nam, 2015[83]). Furthermore, MIC develops strategies, legislation, standards or technical regulation to uphold network security of information and communication infrastructure (Art. 52, amended by Art. 18 of Law No. 35/2018/QH14). According to this law, ministries and equivalent government agencies, including at the provincial and municipal level, as well as communication companies and owners of information systems of national importance, must establish or designate specialised departments to respond to network information security incidents (Government of Viet Nam, 2015[83]). MIC co-ordinates and documents the nationwide responses to network information security incidents.

Recommendations

12. **Publish open, verifiable, granular and reliable subscription, coverage and quality-of-service data.** Building on the data collection procedures to inform MIC's annual "White Book" on the availability, performance and take-up of connectivity services and infrastructure deployment, open, verifiable, granular, and reliable subscription and coverage data should be published. In terms of quality-of-service data, Vietnamese authorities could consider collecting and publishing indicators related to network resilience, in particular persistent outages.
13. **Promote measures to improve the quality and resilience of international connectivity**. Viet Nam could consider exploiting the geographical and technological diversification of its international connections (terrestrial and submarine cables and satellite), as well as its distributed Internet traffic exchange infrastructure (VNIX), to improve the quality and resilience of its international connectivity. To this end, Viet Nam could consider promoting cross-border connectivity with IXP peers and harmonising Internet traffic management policies and practices (BGP configuration). This would allow for diversification of routes for international traffic that could be routed to the international connections of any of the connected countries, while optimising the available equipped bandwidth in all of them. Ultimately, this would improve the quality and resilience of international connectivity in Viet Nam (as in the rest of the interconnected countries). This, in turn, could be used to encourage local deployment of content and other service providers (e.g. CDN, cloud services), resulting in improved quality experienced by end-users in Viet Nam. The improved regional integration, in this case digital, would have a positive impact on the economy by facilitating the integration of firms (especially SMEs) into regional and global value chains, one of the key drivers of growth in Viet Nam.

6.7. Environmental impacts of networks

No information is available to assess the impact of telecommunication networks in Viet Nam. However, policies and measures are in place at different levels to mitigate the environmental impacts of digital technologies, including connectivity, and to help reduce the environmental impacts of other sectors.

In 2021, Viet Nam adopted the National Strategy on Green Growth for the period of 2021-2030, with a vision to 2050 (Government of Viet Nam, 2021[85]). The strategy aims to accelerate restructuring of the economy to achieve economic prosperity, environmental sustainability and social equity. It also aims to facilitate the transition to a green and carbon-neutral economy and contribute to reducing global warming. Actions under the strategy include the National Digital Transformation Programme 2025, with a vision for 2030 (issued together with Prime Minister's Decision No. 749/QD-TTg of 3 June 2020) to create momentum for green growth, which is managed by MIC. MIC is also part of the National Steering Committee on Green Growth, which helps the government and the prime minister co-ordinate implementation of the strategy (Government of Viet Nam, 2022[86]).

Infrastructure sharing, allowed under the Telecom Law (Art. 45), may also serve the dual purpose of reducing both Capex and environmental impact (Government of Viet Nam, 2009[17]). MIC estimates that sharing 4G base stations would save VND 16 trillion and reduce the equivalent of 1.1 tonnes of CO_2 emissions, or 3.9 billion kWh of electricity consumed, each year (MIC, 2020[87]).

Recommendation

14. **Support and promote smart and sustainable networks and devices and encourage communication network operators to periodically report on their environmental impacts and initiatives.** The Vietnamese authorities could consider designing a plan to support and promote smart and sustainable networks and devices under the National Digital Transformation Programme 2025, with a vision for 2030, within the framework of the National Green Growth Strategy (Government of Viet Nam, 2021[85]). This plan could also encourage communication network operators to report periodically on their environmental impacts and initiatives to improve them, and to report on the positive environmental effects of connectivity.

6.8. Regular assessment of broadband markets

The Telecom Law implicitly provides for market assessment for various purposes. This includes for publication of the list of communication undertakings with a dominant market position (Article 19) and for the definition of the scope of universal service. However, neither the law nor its implementing regulations establish a procedure for collecting information, nor do they define the periodicity or methodology for market assessment.

On the other hand, MIC produces an annual report or "White Book" with quantitative information on all areas under its remit, including communication services (MIC, 2022[88]). The report includes information on the structure of the fixed and mobile broadband market by revenue and number of subscribers, international Internet connectivity, mobile network coverage (2G, 3G and 4G) and employment in the communication sector, together with a descriptive summary. MIC compiles this report with information from other government ministries and agencies, as well as from external organisations.

Finally, VNTA measures the quality of connectivity services (Internet connection) through user experience, via crowdsourced data with its own measurement tool as described above (VNNIC, 2023[81]). Based on these measurement data, VNNIC produces aggregated statistics on quality-of-service indicators at country level (VNNIC, 2023[82]), and publishes the results on a weekly and monthly basis on its website. It also publishes territorialised information in map format with subregional disaggregation (VNNIC, 2023[80]).

The high quality of broadband services in Viet Nam may have benefited from the thorough monitoring and publication of quality-of-service indicators based on its own quality measurement tool. This system puts a tool in the hands of end-users to make a more informed choice, thereby stimulating competition. Moreover, it also provides the data that allow Vietnamese authorities to evaluate public policies on a geographical basis and thus fine-tune future policies. In this respect, Viet Nam is on par with leading OECD countries in terms of broadband speed measurement.

Recommendation

15. **Assess the state of connectivity regularly to determine whether public policy initiatives are appropriate, and whether and how they should be adjusted**. Building on the data collected for MIC's annual "White Book" on the availability, performance and take-up of connectivity services and infrastructure deployment, it is recommended to establish a system for regular assessment of the state of connectivity to determine whether and how public policy initiatives are appropriate. Disaggregating these indicators with sufficient geographical granularity could help differentiate data in areas with different degrees of urbanisation (rural, urban areas) and better understand trends in availability, performance and adoption of connectivity services. This information could be integrated into geographic information systems and published electronically.

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Notes

[1] Urban centre (high-density cluster) is defined as contiguous grid cells with a density of at least 1 500 inhabitants per square kilometre. An urban centre has a population of at least 50 000 (European Commission, Joint Research Centre, 2015[3]).

[2] Urban cluster (moderate-density cluster) is defined as contiguous grid cells with a density of at least 300 inhabitants per square kilometre and has a population of at least 5 000 in the cluster (European Commission, Joint Research Centre, 2015[3]).

[3] Rural area (or mostly low-density cells) is defined as grid cells of 1 square kilometre with a density below 300 inhabitants per square kilometre and other grid cells outside urban clusters or centres (European Commission, Joint Research Centre, 2015[3]).

[4] For example, recent trade agreements include the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), which came into effect on 14 January 2019; the EU-Viet Nam Free Trade Agreement, signed in June 2019 and entered into force in August 2021; and the UK-Viet Nam Free Trade Agreement, effective in May 2021. In addition, the Regional Comprehensive Economic Partnership (RCEP) Agreement was signed in November 2020 and entered into force on 1 January 2022.

[5] Under Decree No. 05/2018/ND-CP, the official name is “Military Industry and Telecommunications Group” [unofficial translation]; article 2 notes it may be referred to as “Viettel” (Government of Viet Nam, 2018[20]).

[6] Vietnamobile has two majority shareholders, Hanoi Telecom JSC and Hutchison Asia Telecom, which is part of CK Hutchison Holdings (Vietnamobile, 2021[90]). Hanoi Telecom JSC declares itself as “the only private telecommunications company in Viet Nam” [unofficial translation] (Vietnamobile, 2021[90]). The substantial shareholders of CK Hutchison Holdings are: Li Ka-Shing Trustee Company Limited, Li Ka-Shing Unity Trustee Corporation Limited, Li Ka-Shing Unity Trustcorp Limited (26.26%), and Li Ka-shing (30.36%) (CK Hutchison Holdings Limited, 2023, p. 35[89]).

[7] An exchange rate of USD 1 = VND 23 645.80 was used, as of the quoted rate on 16 July 2023 by Bloomberg at www.bloomberg.com/quote/USDVND:CUR. This exchange rate was used in the absence of an exchange rate for VND from the OECD (https://data.oecd.org/conversion/exchange-rates.htm).

[8] An exchange rate of USD 1 = VND 23 645.80 was used, as of the quoted rate on 16 July 2023 by Bloomberg at www.bloomberg.com/quote/USDVND:CUR. This exchange rate was used in the absence of an exchange rate for VND from the OECD (https://data.oecd.org/conversion/exchange-rates.htm).

[9] Current signatories of the CPTPP include Australia, Brunei Darussalam, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore and Viet Nam (WTO, 2023[47]).

[10] Figures refer to values as calculated from 1 January 2022 to 20 December 2022.

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[12] The indicator of ’transmission network length’, defined in the framework of the ITU Broadband Map (ITU, 2023[57]), refers to the physical length of fibre optic cable in a network irrespective of the number of optical

fibres contained within the constituent cables of that network and can also be applied to microwave terrestrial networks. It is expressed in route kilometres (route-kms) (ITU, 2012[92]).

[13] Specifically, "by 2025, entry-level broadband services should be made affordable in developing countries at less than 2% of monthly gross national income (GNI) per capita" (Broadband Commission for Sustainable Development, 2022[66]).

[14] The data source for handset price is Tarifica; the source for GNI per capita, USD, 2022 is GSMA Intelligence. The handset price is the price of the cheapest handset available in each market with Internet-browsing capability in USD (nominal prices), as gathered in 2022. The methodology for data collection can be found in the Mobile Connectivity Index Methodology (GSMA, 2022[93]).

[15] An exchange rate of USD 1 = VND 23 645.80 was used, as of the quoted rate on 16 July 2023 by Bloomberg at www.bloomberg.com/quote/USDVND:CUR. This exchange rate was used in the absence of an exchange rate for VND from the OECD (https://data.oecd.org/conversion/exchange-rates.htm).

[16] Data collected and aggregated according to Ookla's Speedtest® Methodology (Ookla, 2023[91]).

[17] Latency or ping is the reaction time of connection — that is, how quickly the user device gets a response after you've sent out a request. A fast ping means a more responsive connection, especially in applications where timing is everything (like video games). Ookla® measures several types of latency. The figures referenced in the text refer to 'minimum latency' that measures the best case latency for the user at the time they decide to take a Speedtest®. The lowest ping value is determined across one or more pings made before the download speed test – this represents the 'minimum latency' (Ookla, 2023[91]).

Extending Broadband Connectivity in Southeast Asia

This report assesses the current state of connectivity in Southeast Asia and provides tailored recommendations for extending broadband access, focusing on five countries: Cambodia, Indonesia, Singapore, Thailand and Viet Nam. The analysis builds upon the OECD Recommendation on Broadband Connectivity, which provides a reference for policy makers and regulatory authorities within and outside of the OECD. Using the principles of the Recommendation as a roadmap, countries may be better able to unleash the full potential of connectivity for the digital transformation and to ensure equal access to connectivity for all users.

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