REPORT FOR META

# ECONOMIC AND SOCIAL IMPACT OF META'S SUBMARINE CABLE INVESTMENTS IN APAC

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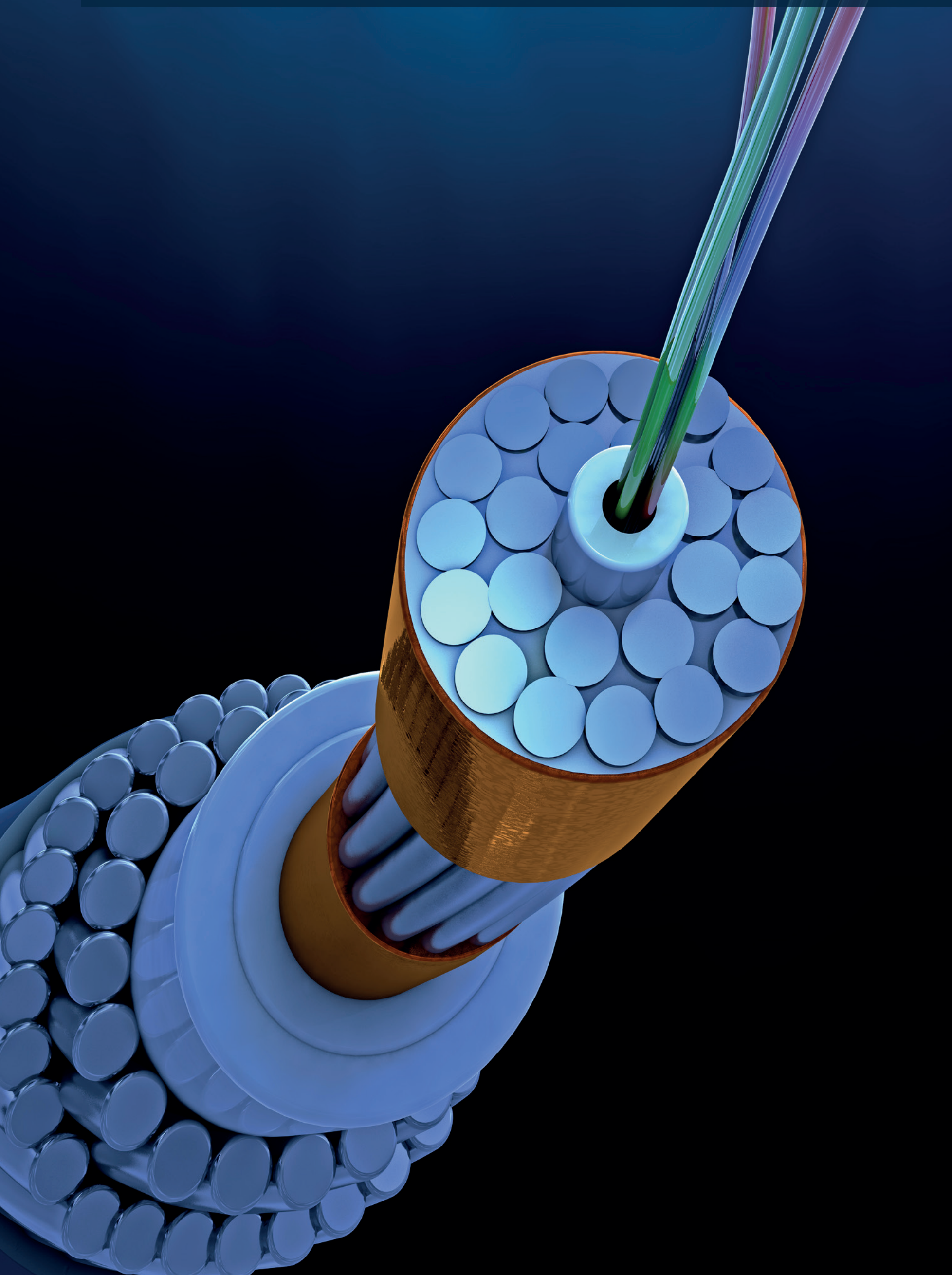
DECEMBER 2021



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This report was commissioned and sponsored by Meta, and prepared independently by Analysys Mason, a global consultancy specialising in telecoms, media and technology.

# 1 Executive summary

The Internet has become increasingly important for users, businesses, governments, and the social and economic welfare of countries. On top of this, the response to the Covid-19 pandemic has created a fundamental shift in how people conduct their daily lives, as remote working and remote schooling have resulted in many activities increasingly being conducted through online digital services. Access to the Internet is therefore more critical than ever to enable people and businesses throughout the world to communicate, learn, work, trade and participate fully in everyday life.

*Meta actively invests in connectivity infrastructure, including submarine cables, which are crucial to the delivery of Internet services to consumers and businesses around the world*

Meta is a major investor in digital infrastructure, including in the connectivity space. It contributes to enhancing global connectivity and Internet infrastructure by making investments in: submarine cables and data centres (i.e. Singapore data centre), edge network infrastructure in the form of points of presence (PoPs) and caches deployed in operator networks, backhaul fibre investments (e.g. domestic shared fibre-optic cables in Indonesia), and driving open industry standards in telecoms infrastructure (i.e. Telecom Infrastructure Project).

Submarine cables form a significant part of these investments globally and particularly in Asia–Pacific (APAC). In this region, most of the population live in island or coastal states, and submarine cables deliver the critical link between Internet service provider (ISP) networks in the region and content and services provided from data centres across the world.

Historically, submarine cables in Asia have landed at a small number of highly developed hubs: Japan, Singapore and Hong Kong. Approximately 60% of the international submarine cable systems in APAC land in at least one of Japan, Singapore or Hong Kong. This concentration has led to the emergence of two key bottlenecks on submarine cable routes, which represent potential points of failure:

- First, the Luzon Strait between the Philippines and Taiwan is a key waterway for most cables linking South-East Asia to North America. Given its position in the Pacific Ring of Fire,[1] earthquakes occur quite frequently, which can result in damage to submarine cables.
- Second, the South China Sea is one of the world's busiest waterways and the area where almost all intra-APAC submarine cables traverse. Deployment of new cables and the repair and maintenance of existing cables would require receiving approval permits from many jurisdictions in the region.

The risks associated with the two bottlenecks mentioned above have led Meta and other submarine cable investors, in close partnership with key players in the regional connectivity ecosystem including many

[1] The Ring of Fire is an area around the Pacific Ocean with significantly higher risk of earthquakes than other parts of the world.

telecoms operators, to develop and invest in new submarine cable systems. These systems seek to avoid the bottlenecks by diversifying the routes they follow under water, and connecting more communities and regions throughout APAC. These investments not only improve the reliability and performance of Meta's services, they also improve the overall resiliency, performance and cost-effectiveness of Internet infrastructure in the region. This positively impacts the connectivity ecosystem, supporting continued growth in the number of people who use the Internet and the amount of data that is consumed throughout the region. Better connectivity, in turn, supports economic and social benefits for consumers, businesses and governments.

*Meta has invested in two submarine cables that are in service in APAC as of 2020 and is expected to launch at least eight more cables in the region by 2025*

Two submarine cables in which Meta has invested are already in service in APAC: the Asia Pacific Gateway (APG) cable system went live in 2016, and the JUPITER cable system went live in 2020. These two submarine cables have been deployed across China, Japan, South Korea, Malaysia, the Philippines, Singapore, Taiwan, Thailand, the USA and Vietnam.

In addition, Meta has announced plans to invest in eight new submarine cables, which are expected to be ready for service (RFS) between 2021 and 2025.[2] Two of these cables, Echo (RFS planned for 2023) and Bifrost (RFS planned for 2024), will be the first cables to directly connect Jakarta (Indonesia) with the USA, and one of few APAC–NA[3] cables to avoid the Luzon Strait. Apricot (RFS planned for 2024) will be the first intra-Asia submarine cable that does not traverse the crowded part of the South China Sea. It will link up Singapore, Japan, Taiwan, Guam, Indonesia and the Philippines. These investments have all been conducted in the form of consortiums, to which Meta contributes both from a technological and financial perspective, along with other partners. The new cable systems will provide further route diversity and improve the resilience of the Internet infrastructure in APAC to the benefit of countries in which they land.

*Meta's APAC submarine cable investments are expected to drive additional economic benefits of approximately USD422 billion in GDP between 2021 and 2025*

Meta will continue to make investments in new submarine cables to respond to expected growth in Internet traffic. While new cables will continue to land in established submarine cable hubs in APAC (i.e. Singapore, Japan, Hong Kong), they will also increasingly reach other APAC countries such as Indonesia and the Philippines. We estimate that cables in which Meta is an investor could contribute over USD422 billion in additional GDP (in real terms) between 2021 to 2025 and support up to 3.7 million additional jobs by 2025.

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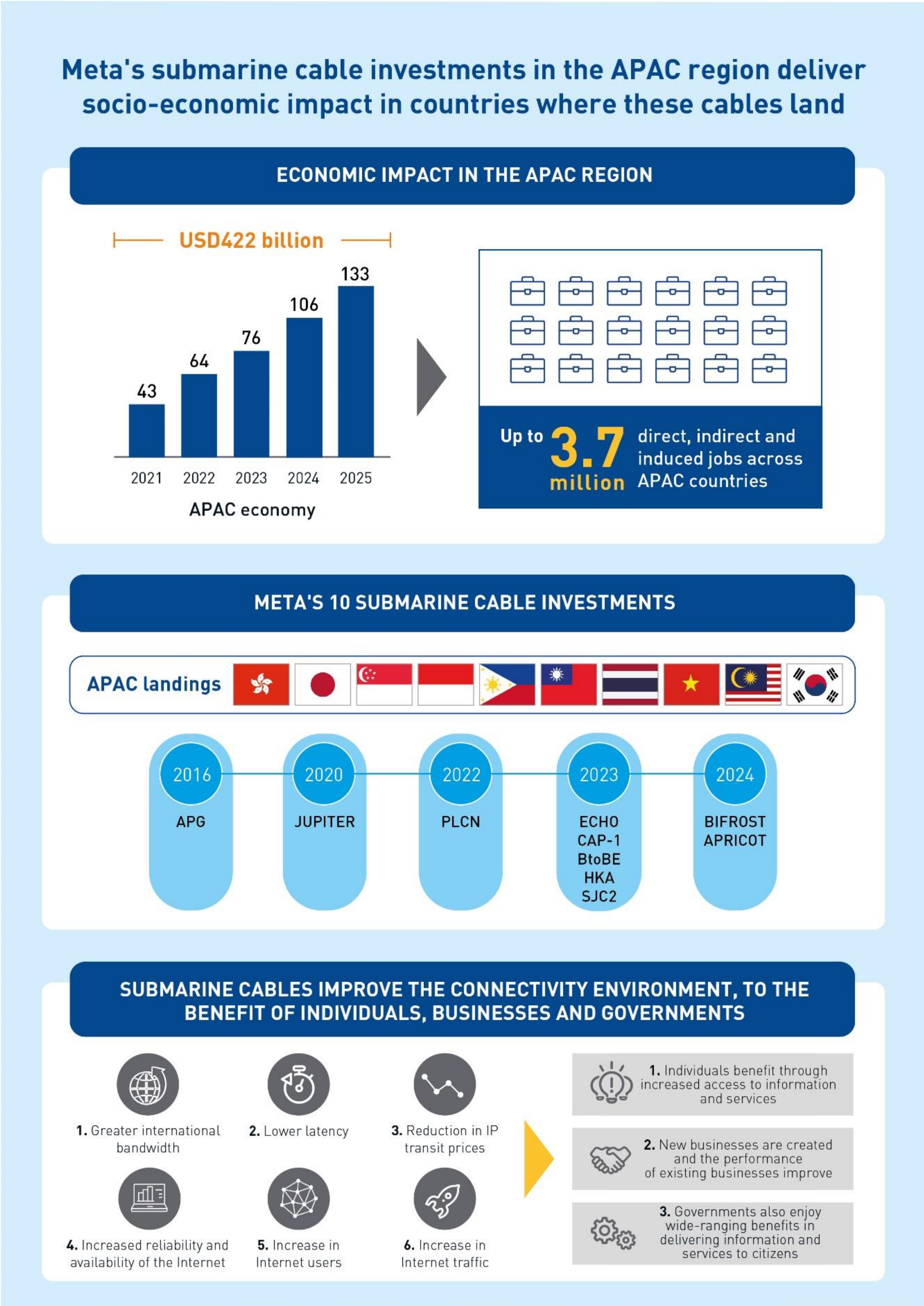
2 The eight new submarine cables are PLCN, SJC2, Echo, CAP-1, HKA, BtoBE, Bifrost and Apricot.

3 APAC–North America

*To fully unlock the forecast benefits of these cables, and attract yet more, governments, policy makers and regulators in APAC should consider adopting regulatory best practices and supportive investment regimes*

There are hurdles to submarine cable investments in the APAC region from a regulatory and investment regime standpoint, and more can be done to make the environment conducive to stimulating further investments. Countries such as Singapore, Japan and Australia have a good supply of submarine cables, brought about in part by policies that are supportive of submarine cable licensing and permitting, deployment, access and the protection and maintenance of submarine cables. These policies may serve as benchmarks for policy improvements in other markets across APAC. Policy makers should also seek to ensure that industry stakeholders, including ISPs and enterprises, have ease of access to the capacity that lands from these submarine cables – this is an area that Meta has been advocating for through the open cable design of the submarine cables in which it is investing.

As submarine cable owners (including Meta; other content, applications and service providers (CASPs); and APAC telecoms operators) look towards deployment of new open submarine cable systems through more diverse routes in the region, we expect that markets with policy environments conducive to the deployment and maintenance of submarine cables will stand to benefit greatly from such future investments. These policy changes will help to ensure full GDP and job benefits from the announced and future cables.


Meta's submarine cable investments in the APAC region deliver socio-economic impact in countries where these cables land
ECONOMIC IMPACT IN THE APAC REGION
USD422 billion
43
64
76
106
133
2021
2022
2023
2024
2025
APAC economy
Up to 3.7 million direct, indirect and induced jobs across APAC countries
META'S 10 SUBMARINE CABLE INVESTMENTS
APAC landings
2016
APG
2020
JUPITER
2022
PLCN
2023
ECHO
CAP-1
BtoBE
HKA
SJC2
2024
BIFROST
APRICOT
SUBMARINE CABLES IMPROVE THE CONNECTIVITY ENVIRONMENT, TO THE BENEFIT OF INDIVIDUALS, BUSINESSES AND GOVERNMENTS
1. Greater international bandwidth
2. Lower latency
3. Reduction in IP transit prices
4. Increased reliability and availability of the Internet
5. Increase in Internet users
6. Increase in Internet traffic
1. Individuals benefit through increased access to information and services
2. New businesses are created and the performance of existing businesses improve
3. Governments also enjoy wide-ranging benefits in delivering information and services to citizens

## Supportive regulatory and investment regimes are critical to support ongoing and future submarine cable investment

Submarine cable regulatory and investment regimes differ across APAC countries and play a critical role in influencing the supply of submarine cables in each country. Countries with a strong supply of submarine cables enjoy favourable conditions that enable straightforward licensing and permitting for cable consortiums, facilitate the efficient deployment of submarine cables on diverse routes, support open access to the international capacity that lands and enable timely repair and maintenance of submarine cables.

**BEST PRACTICES OBSERVED FROM LEADING COUNTRIES IN APAC REGION**

### 1 Can we own and land submarine cables?

- Full foreign ownership of submarine cable investments enables more such investments
- Procedures and criteria to obtain licences, approvals or permits for landing submarine cables should be transparent and accessible to all investors

### 2 Can we deploy submarine cables?

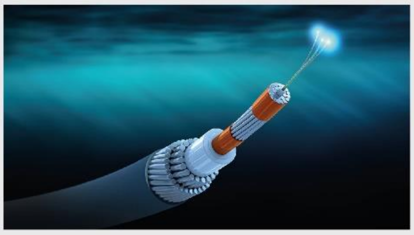
- Procedures to obtain licences, approvals or permits for deploying submarine cables within territorial waters should be transparent and streamlined
- Flexibility should be provided for cable owners to decide an optimal path and where to land within countries

### 3 Can we access capacity that lands?

- Liberalisation of international gateways and cable landing stations beyond domestic telecom operators
- Enable open access to international cables at non-discriminatory terms and at cost-based prices

### 4 Can we repair and maintain submarine cables?

- Cabotage provisions in relation to submarine cables to be removed
- Fast-tracked process to receive permits required for ships to perform works in territorial waters
- Cable protection zones to be established and enforced (applies to submarine cable corridors, if any)



# 2 Meta is actively investing in submarine cables in the APAC region

Meta commissioned Analysys Mason to conduct an independent study to review and forecast the socio-economic benefits of Meta's submarine cable investments in the Asia–Pacific region (hereafter referred to as APAC). We conducted our research between June and August 2021 and have used the most up-to-date information available as of 16 August 2021.

After providing an overview of the submarine cable investments made by Meta across APAC (this section), we explore the economic and social impact of these investments (Section 3), before discussing best practices in regulatory and investment regimes to enable more submarine cable investments (Section 4).[4] For the avoidance of doubt, the quantification of economic benefits across APAC excludes China and India.

In this section, we explore the complex infrastructure value chain that enables the exchange of information over the Internet, at high speed and on a massive scale (Section 2.1). Submarine cables are an important part of this value chain. They are designed to transport data across water bodies, using international fibre links laid along the seabed between and around continents. Meta, along with other content, applications and service providers (CASPs), is a major investor in submarine cables and purchaser of capacity on cables serving APAC countries. The importance of submarine cables to the APAC region is discussed in more detail in Section 2.2, and in Section 2.3 we review Meta's current and upcoming submarine cable investments.

## 2.1 Meta is actively involved across the connectivity value chain

Since the beginning of the Covid-19 pandemic, the Internet has established itself as a necessary requirement in the daily lives of people. Services have been forced to migrate online in their entirety, and this migration is expected to be permanent to a significant degree across many industries and activities. Education and work, and even socialising, have made this transition while demonstrating both the effectiveness and efficiency of Internet-based services. The current reliance on high-capacity, reliable access networks and cloud services also highlights the digital divide, however. In the context of APAC countries, it highlights the strong infrastructure investments required to connect the hundreds of millions of people currently unconnected to the Internet, and in turn to counteract the widening economic divide.

Video streaming (on platforms such as Netflix, YouTube and Facebook) and video conference services (Zoom, Microsoft Teams, Facetime) have seen a surge in demand. As consumer device technology improves, new technologies such as 5G is progressively rolled out and new use cases

4 The report also includes two annexes: Annex A describes the methodology used to estimate the economic impact of Meta's submarine cable investments and Annex B provides details of supporting research on the impact of improved connectivity outcomes on individuals and businesses.

such as augmented reality and virtual reality mature, the demand for high-bandwidth Internet services will increase. Video calling services, office collaboration services, and other real-time interactive services such as online/cloud gaming all require reliable connections with low latency, particularly when conducted internationally. These services also need to be usable from home, and reliable Internet connections are required to support online schooling and working from home.

The delivery of these services to end users rely on a complex chain of Internet infrastructure which can be split into the following parts, and are described in more detail below:

- data centres and edge infrastructure
- submarine cables
- backhaul and access networks.

**Data centres and edge network infrastructure** (i.e. caches and points of presence (PoPs)) store content in strategically chosen locations to minimise cost and travel time/latency for users. Instead of having to access content internationally, caches temporarily hold frequently used content locally instead. PoPs can then act as the entry point for direct communication to a company's network and content. Data-centre presence in the APAC region is largely concentrated in hubs such as Singapore, Hong Kong and Japan, and it remains essential to reliably connect other countries in APAC to these hubs as well as to other destinations outside APAC. Meta has deployed PoPs and caches widely across APAC countries and will service these edge infrastructure assets from its data centre, which is due to open in Singapore within the next few years.

**Submarine cables** act as the underpinning infrastructure for international and overseas connectivity, delivering content that reside in data centres across the world. This is an expensive part of the infrastructure value chain and has traditionally been reliant on investments from a limited group of incumbent telecoms operators. In recent years, CASPs including Meta have invested in submarine cables, often partnering with telecoms operators in APAC, and other CASPs. Meta has two submarine cables that are currently live and it will invest in at least eight more submarine cable systems in the APAC region by 2025. In particular, Meta will seek to connect more countries in APAC (such as Indonesia and the Philippines), thereby stimulating development of digital infrastructure in these countries and potentially enabling the emergence of new regional hubs over time depending on the regulatory settings supporting this.

**Backhaul and access networks** within countries are vital to enable all of this infrastructure to be interconnected. Backhaul networks generally form the national level of connectivity – taking data from submarine cables and linking it to localities across a country. This typically takes the form of high-capacity fibre cables and wireless technologies between masts. Access networks provide the final connection between backhaul networks and end users, most commonly in the form of mobile and fixed-wireless networks and fixed-line connections to premises. As this infrastructure often requires invasive construction, building a strong backhaul and access network can be an expensive and slow process. Meta is an active partner in developing new technologies, business models and partnership opportunities that help bring more people online to a faster Internet. It has invested in fibre-optic cables projects in Indonesia and Pakistan, partnered on Wi-Fi programs with Internet service providers (ISPs) in multiple APAC countries, and supported large-scale trials of fixed-wireless technologies, such as Terragraph. Meta was one of the founding members of Telecom Infrastructure Project (TIP) in 2016, partnering with hundreds of tech and telecoms companies to drive open industry standards in telecoms infrastructure in order to reduce costs of infrastructure roll-out and connect more of the world to the Internet.

All of these investments improve the availability of connectivity infrastructure and reduce costs to end users, thereby enabling an increase in Internet users and consumption of data across the APAC region. A summary of Meta's investments across the connectivity value chain is provided in Figure 2.1.

*Figure 2.1: Summary of Meta infrastructure investments [Source: Analysys Mason, 2021]*

| | Meta investments |
|---|---|
| | Meta invests in a small number of global hyperscale **data centres**, which are used to serve all world regions. In Singapore, Facebook is constructing one of the world's largest data centres, which is due to open in the next few years |
| | Meta invests in **international links**: this includes APG and JUPITER in APAC, which are already in service, as well as a further 8 announced intra-APAC/transpacific cable systems due to go live by 2025 |
| | Meta invests in **edge network infrastructure**: it has PoPs and caches deployed widely across APAC countries |
| | Meta has invested in fibre **backhaul infrastructure**. It is also supporting fibre-optic cable projects in Pakistan and Indonesia to improve affordability for end consumers and access in underserved and rural areas |
| | Meta was one of the founding members of the Telecom Infra Project (TIP) seeking to improve **access networks**, transport, and core and services technologies in collaboration with other global tech and telecoms companies |

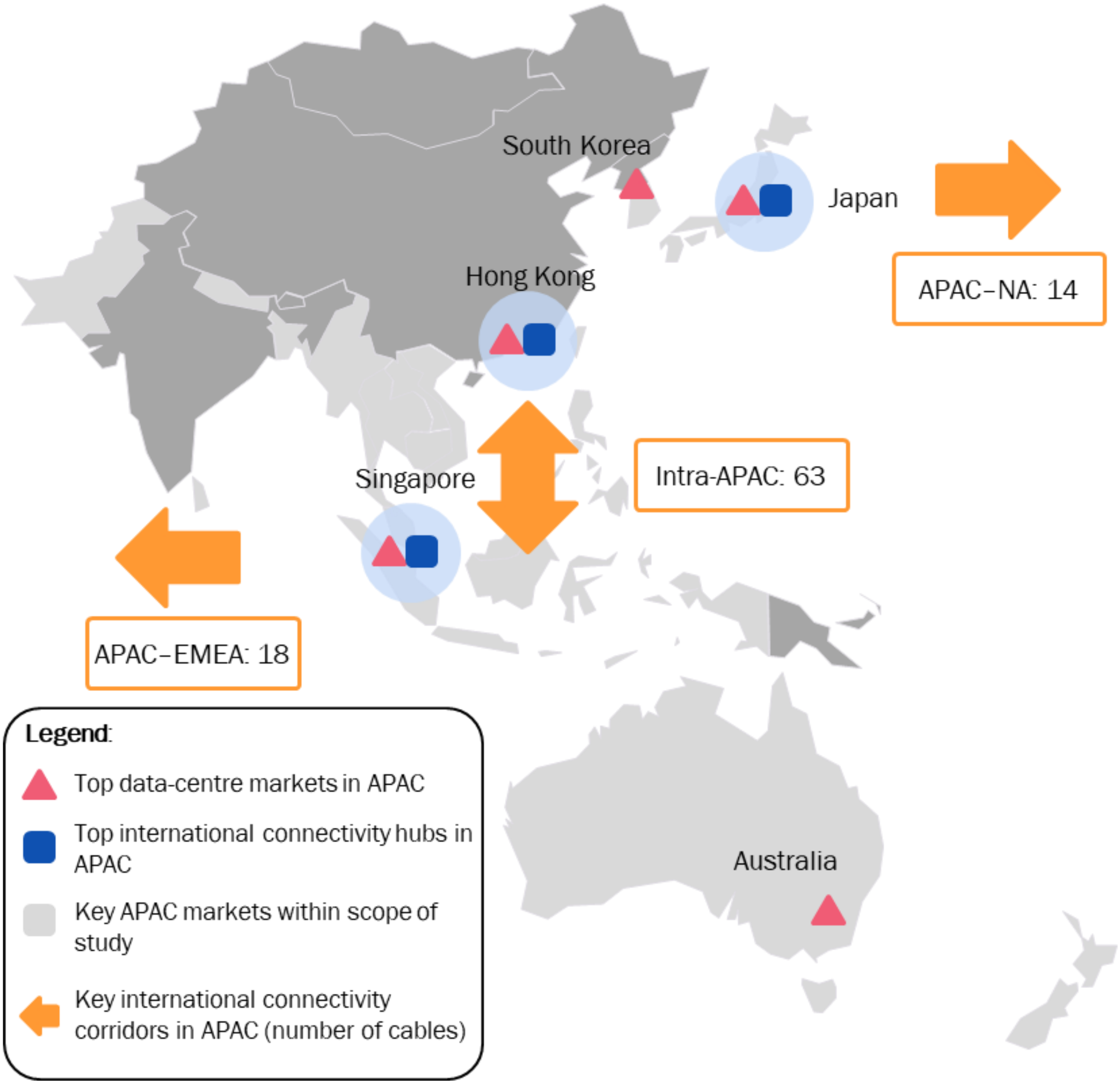
## 2.2 Submarine cables are especially important in APAC due to its geography

The APAC region has an abundance of island and archipelago nations, such as Indonesia, the Philippines, Japan, Singapore and Australia, as well as coastal nations including Malaysia, Thailand, Vietnam, Cambodia and South Korea. Increasing APAC submarine investments is critical to enable connectivity between these nations and ensure the future growth of digital economies in the region.

There are three main submarine cable routes connecting countries in APAC: intra-APAC, APAC–NA[5] and APAC–Europe, and the main submarine cable hubs are currently situated in Japan, Hong Kong and Singapore (see Figure 2.2). We note that Australia and South Korea are growing data-centre markets in the region and are also growing in importance as landing points for submarine cables.

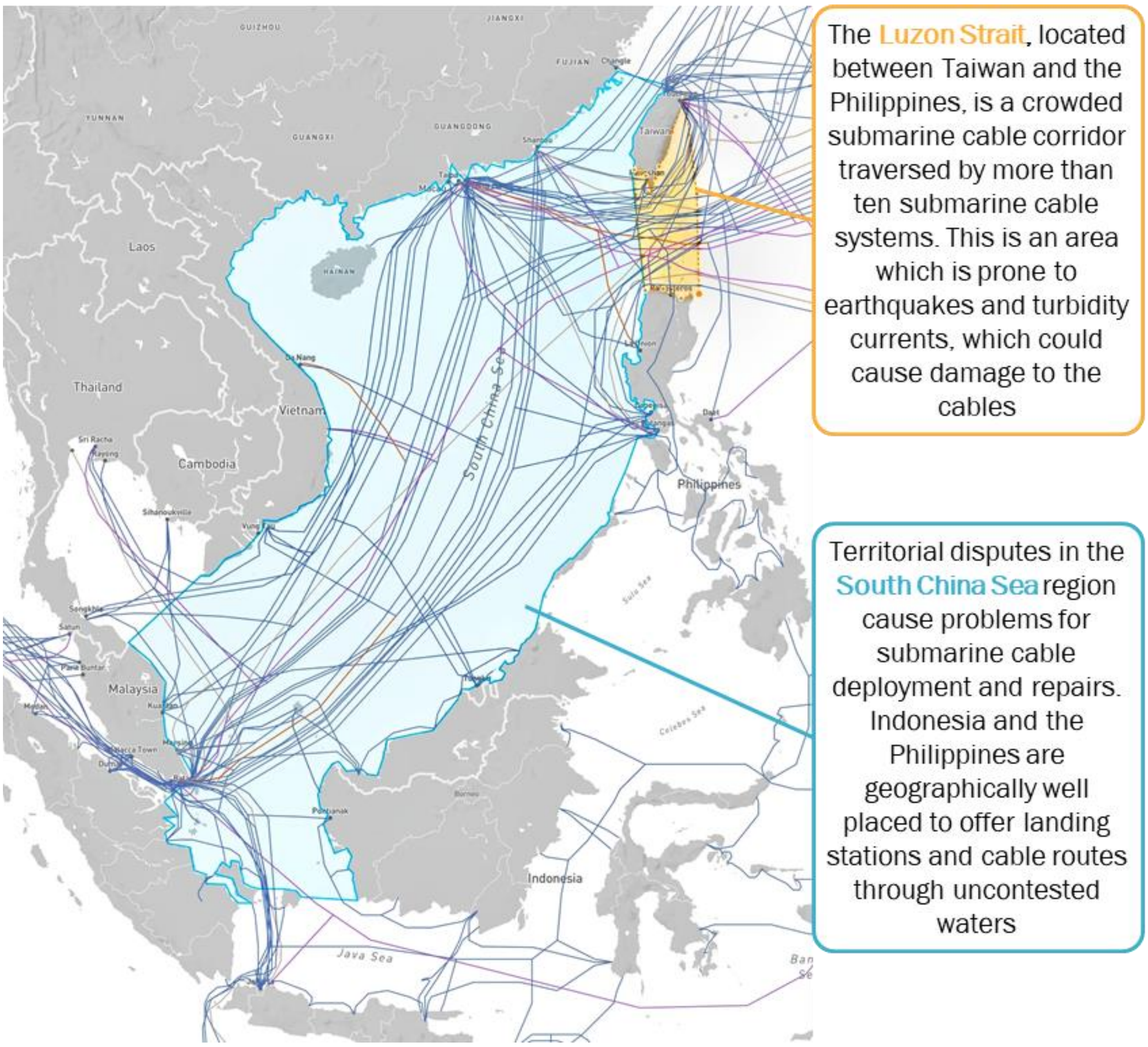
5 APAC–North America

*Figure 2.2: Map of key connectivity hubs in APAC with the number of international submarine cable systems connecting through each corridor [Source: Analysys Mason, TeleGeography, 2021]*




One major consequence of the concentration of submarine cable landings around the three primary hubs is significant overcrowding of cables deployed in traditional routes connecting the hubs – notably across the South China Sea and the Luzon Strait (see Figure 2.3).

*Figure 2.3: Mapped representation of the South China Sea, Luzon Strait and APAC submarine cables [Source: Analysys Mason, Infrapedia, 2021]*




Greater spatial separation of cables and geographical diversity in the context of physical cable routes are becoming ever more important, for three main reasons:

- Earthquakes and turbidity currents are a major cause of submarine cable damage. The Ring of Fire, located around the Pacific Ocean, has a significantly higher risk of earthquakes than other parts of the world. The Luzon Strait – one of the key corridors where there is overcrowding of APAC–NA submarine cables – is located in the Ring of Fire, specifically in areas surrounding the Philippine Sea Plate which experiences earthquakes and turbidity currents at an even higher frequency.[6] Overall network resilience can be improved by separating submarine cable routes, thus reducing the risk of multiple cables being damaged due to a single natural event.

6 See https://pubs.usgs.gov/of/2010/1083/m/pdf/of2010-1083m.pdf; https://www.sciencedirect.com/topics/earth-and-planetary-sciences/philippine-sea-plate

- Most of the intra-APAC cables pass through the South China Sea and require permits for deployment and cable repairs from multiple countries including China, Taiwan and various Association of South-East Asian Nations (ASEAN) countries.
- Marine activities such as fishing and anchorage continue to pose a substantial risk and cause damage to submarine cables. Beyond protective measures to the cables themselves and changes to policy regarding marine activity, deploying future submarine cables in areas of lower fishing activity/presence would reduce the frequency of cable damage. In this regard, separation of cables is also critical to protecting communications infrastructure. It is important that cables are sufficiently spaced to reduce the likelihood of a single anchor drag or fishing equipment damaging multiple cables at the same time.

Given the presence of potential points of failure due to the concentration of cables along traditional routes, the resiliency of the submarine cable infrastructure in APAC could be significantly improved through investments in new submarine cables that traverse alternative routes further east. New routes through Indonesia and the Philippines could circumvent these area-specific issues while also connecting geographically well-placed, high-growth markets that can act as alternative hubs for landing submarine cables.

However, regulatory and investment regimes governing submarine cable investments in the APAC region vary across countries, and there are barriers in some countries which may deter investments. Singapore, Australia and Japan are good examples of countries with policies conducive to submarine cable licensing, deployment, access, protection and maintenance that may serve as benchmarks for policy improvements by governments across the APAC region.

As route diversity is increasingly important, new routes and landing points should be explored. This would lead to investment supporting the formation of new hubs in APAC, in addition to growing capacity in traditional hubs. It is important that countries ensure their regulations are conducive to building and landing submarine cables in order to attract such investments. Policy best practices are discussed in more detail in Section 4 of the report.

## 2.3 Meta has already invested in two submarine cables in APAC, and has announced its commitment to a further eight systems to be deployed by 2025

As of 2020, the Asia Pacific Gateway (APG) and JUPITER cables, which Meta has invested in, are in service in the APAC region. Meta has announced eight more submarine cables in which it is an investor and that are currently in the process of deployment and are expected to be launched between 2022 to 2025 (see Figure 2.4).

| Submarine cable system | RFS year (*expected*) |
|---|---|
| APG | 2016 |
| JUPITER | 2020 |
| PLCN | *2022* |
| SJC2 | *2023* |
| Echo | *2023* |
| CAP-1 | *2023* |
| BtoBE | *2023* |
| HKA | *2023* |
| Bifrost | *2024* |
| Apricot | *2024* |

*Figure 2.4: Meta's submarine cable investments in APAC [Source: Meta]*

These deployments have all been conducted in the form of consortiums, to which Meta partners with other investors and contributes both from a technological and financial perspective. The submarine cables deployed by Meta are state of the art and deliver high capacity to the countries in which they land. Meta is willing and able to finance these projects as an anchor investor, which reduces financial risks and unit costs of capacity for other consortium members. As a result, other investors, including local APAC telecoms operators, are able to invest in these cables and jointly build out alongside Meta, where it may otherwise not be possible without Meta's contributions. For example, PLDT in the Philippines was seeking to increase its international capacity to help make the Philippines a connectivity hub in South-East Asia. Consequently, with the support of Meta and other global companies, such as Amazon and SoftBank, PLDT is investing to build the JUPITER Trans-Pacific cable system and the Apricot Intra-Asia Cable. JUPITER will connect the Philippines to the USA and Japan, while significantly increasing the country's international capacity.

"Besides contributing significant investments, Facebook (Meta) also supported in terms of technical and regulatory knowledge"

**Telecoms operator in Indonesia**
August 2021

These projects will create a very large amount of new capacity within APAC and between APAC and other regions. They illustrate Meta's investment strategy, focusing on infrastructure investments that improve the resilience and performance of connectivity infrastructure in the region. This is part of a global trend whereby Meta and other CASPs such as Google, Amazon and Microsoft are increasingly acting as major investors in new submarine cables alongside telecoms operators. From 2016 to 2020, large CASPs invested in six new submarine cables which provided close to 30% of potential incremental capacity in APAC.[7] Future cables, a number of which have already been

[7] We estimate that the six submarine cables invested in by CASPs provided 326Tbit/s in potential capacity from 2016 to 2020.

announced, will materially increase this impact, and ultimately contribute to continued improvements in connectivity throughout APAC.

# 3 Meta's submarine cable investments provide positive socio-economic impact across APAC

Meta's stated aims in investing in connectivity infrastructure are to reduce barriers to connectivity and make the Internet more widely available, accessible and affordable to more people.[8] Meta's investments in submarine cables not only support the delivery of its own services and associated content, but also create wider benefits to the APAC region, particularly in countries in which these cables land. This section explains how Meta's investments help drive socio-economic benefits through improved connectivity.

Meta's submarine cable investments, like investments by other entities, and in particular those of CASPs, improve connectivity for individuals, businesses and governments. In Section 3.1, we provide a qualitative overview of these effects. We also quantify these effects, by looking at the impact of new submarine cables on supply and demand connectivity metrics, and ultimately on GDP and jobs.

On the supply side, new cables lead to an increase in the bandwidth available in countries where they land. The new routes they enable can lead to noticeably lower latency, and increased supply accelerates the reduction in IP transit prices. On the demand side, these effects lead to increased Internet penetration and to greater data consumption from existing and new users, resulting in higher Internet traffic from end users which also benefit domestic telecoms operators. These effects are described in Section 3.2.

These effects, in turn, are statistically strongly correlated with GDP and job growth. Quantitatively, we estimate that Meta's cable investments could have an economic impact of USD422 billion in additional GDP over a five-year period between 2021 and 2025 and support up to an additional 3.7 million jobs (See Section 3.3).

Additional submarine cable investments are particularly significant for Indonesia and the Philippines. In Section 3.4 and 3.5, we examine why the landing of new cables is so important in these countries, the investments that Meta is making in these countries, and how the local economies and connectivity ecosystems will benefit from the planned investments.

## 3.1 Submarine cables improve the connectivity environment, to the benefit of individuals, businesses and governments

Improved connectivity has a well-documented impact on individuals, as consumers and citizens, and also has an impact on businesses and governments.[9]

8 See https://www.facebook.com/connectivity

9 World Development Report 2016: Digital Dividends; see https://www.worldbank.org/en/publication/wdr2016; OECD 2021: Bridging connectivity divides; available at https://www.oecd.org/sti/broadband/bridging-connectivity-divides-e38f5db7-en.htm

**Individuals** benefit through increased access to information and services online. Businesses can harness Internet connectivity to support broader digitalisation of their processes, leading to greater efficiency and effectiveness. Benefits include:

- Health, physical activity and community engagement[10] Direct health benefits related to Internet access can range from improved access to both urgent and general health information online, to telehealth and patient portal use. Research has shown that an increase in Internet take-up has an impact on overall reduction in the number of deaths, and particularly on reducing infant mortality.[11]

- Enhanced learning opportunities. Students have access to a broader range of resources, can save time and in the context of the Covid-19 pandemic, were able to access teaching in a way that would not have been possible without the Internet.

- Improved employment opportunities, through better information on the job market, and better financial inclusion through cheaper and more effective payment, savings platforms and insurance products.

The increased use of the Internet has created new business opportunities and benefits for enterprises. Research has shown that an increase in Internet penetration has a positive correlation to growth in businesses,.[12] has an impact on the types of business that are created, and ultimately affects economic growth and national income.[13]

New, digital-native **businesses** emerge in this context including e-commerce portals, digital payment applications and online education platforms. Existing businesses can find new, broader markets (as well as more competitors) beyond their physical reach, thanks to better, broader communication and advertising, and can improve their operational efficiency through connectivity and digital transformation.[14] These benefits are not limited to larger or digital native businesses:

- Meta's 'Global State of Small Business' report highlighted that the impact of Covid-19 led to both large declines in employment rates and increases in use of digital tools. Small and medium-sized businesses (SMBs) surveyed reported a rising use of digital tools from 81% of SMBs to

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10 BMC Public Health, 'Associations of Internet access with social integration, wellbeing and physical activity among adults in deprived communities: evidence from a household survey', July 2019; see https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-019-7199-x

11 Deloitte, 'Value of connectivity: Economic and social benefits of expanding Internet access', Feb 2014; see https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/technology-media-telecommunications/deloitte-uk-tmt-value-of-connectivity-tmt.pdf

12 Microsoft, 'Digital Transformation to Contribute US$8 Billion to The Philippines GDP by 2021', Feb 2018; see https://news.microsoft.com/en-ph/2018/02/14/digital-transformation-contribute-us8-billion-philippines-gdp-2021/

13 OECD, 'Southeast Asia Going Digital – Connecting SMEs', 2019; see https://www.oecd.org/going-digital/southeast-asia-connecting-SMEs.pdf

14 Deloitte, 'Value of connectivity: Economic and social benefits of expanding Internet access', Feb 2014; see: https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/technology-media-telecommunications/deloitte-uk-tmt-value-of-connectivity-tmt.pdf

88% in the months from February to July 2021.[15] The survey found that these businesses significantly increased their use of digital technologies for advertising and sales, mitigating the constraints in reaching their customers during the pandemic.

- Agriculture, a key industry across APAC countries, stands to achieve productivity gains with the introduction of technologies such as weather monitoring and live crop price services, artificial intelligence, autonomous machinery and smart sensors.

Finally, **governments** are pursuing ambitious digital strategies, which are dependent on a range of factors, including connectivity. Submarine cables contribute to this in ways that we explore further in the following sections of this chapter.

- Connectivity improvements can boost the efficiency and transparency of government service delivery, and can increase the reach and quality of e-government services. Information provision to citizens improves with better Internet access. The significance of this became clear in the context of the Covid-19 pandemic, when critical guidance issued by governments was made available over the Internet.
- Dedicated online portals are also available to improve transparency and tackle corruption, which remains an issue in the region.
- Other government services are also expected to benefit from digitalisation, primarily by enhancing operating efficiency and productivity. Lower waiting times for online applications (e.g. passport issuance) and wider service reach to the general public are two marked improvements that stem from higher Internet take-up rates.

In 2020, 40 million people gained access to the Internet in South-East Asia. One third of all digital service users in South-East Asia were new users, due to the changes brought about by Covid-19, and 94% of all users will continue using digital services post pandemic.[16] Despite these successes, challenges remain, which continued investments in connectivity are essential to progressively tackle:

- Smaller enterprises suffer the most from lack of access to connectivity in Asia. This digital divide can be seen across many avenues: significantly lower rates of using emails or messaging services to communicate, percentage of orders placed over the Internet, percentage of firms with a website, etc.
- The digital gender divide remains a notable issue, particularly in developing countries. The benefits brought about for women and girls through Internet access are vital in bridging the gap in digital skills, participation in STEM, tech sector, leadership and entrepreneurial roles, and many other areas as explained above.

15 Facebook, 'Global State of Small Business', Sep 2021; see https://dataforgood.fb.com/wp-content/uploads/2021/09/Global-State-of-Small-Business-Report-September-2021.pdf

16 Google, 'e-Conomy SEA 2020', 2020; see https://storage.googleapis.com/gweb-economy-sea.appspot.com/assets/pdf/e-Conomy_SEA_2020_Report.pdf

## 3.2 Submarine cables lead to greater bandwidth, lower latency and reductions in IP transit prices, which all contribute to greater demand for the Internet

Meta's involvement in submarine cable systems allows it to meet the growing demand for Meta services, in particular in the countries in which the cables land. These submarine cables are typically launched through partnering with local telecoms operators in APAC. Such investments not only contribute to lower latency and the improved reliability of Meta's own services, but also benefit its local partners and provide broader benefits to the connectivity ecosystem in APAC. The increased ability of Internet infrastructure in APAC to deliver services enables the realisation of benefits discussed in Section 3.1.

*The launch of new cables backed by Meta is increasing the supply of submarine capacity across APAC and enabling cost savings for ISPs and MNOs in APAC*

Landing new submarine cables in countries brings additional international bandwidth capacity and drives down the cost of international bandwidth, allowing ISPs and mobile network operators (MNOs) to achieve cost savings. The increase in supply of submarine cables has a visible correlation to the pricing of international bandwidth. This is shown in Figure 3.1 below, taking Singapore as an example: the average 10Gbit/s IP transit price decreased from USD21.75 to USD1.06 between 2010 and 2019 (a year-on-year average decrease of 28.5%).

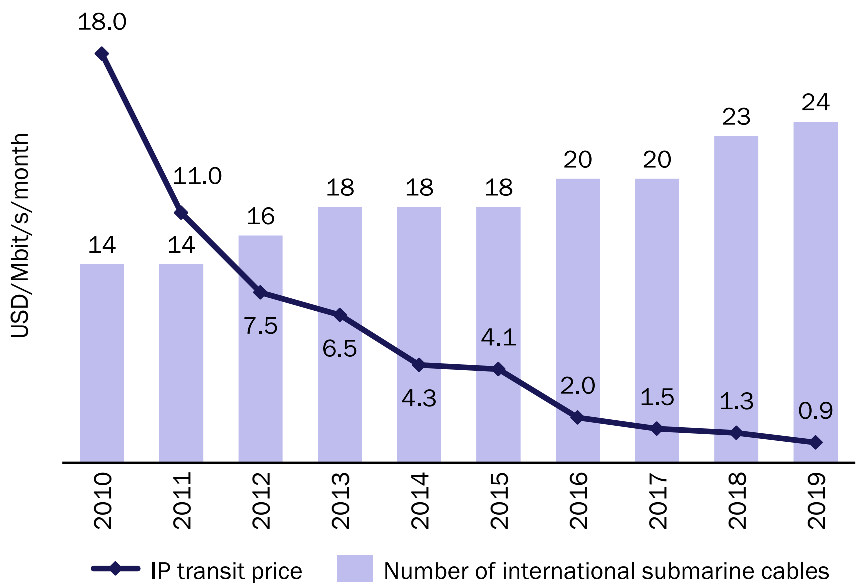


*Figure 3.1: 10Gbit/s IP transit price and number of international submarine cables in Singapore [Source: TeleGeography, Analysys Mason, 2021]*

Submarine cable investments are also supporting the expansion of Meta's edge infrastructure across APAC. As discussed in a previous report by Analysys Mason,[17] this enables ISPs and MNOs to access and exchange content within the region, rather than further afield. This in turn lowers the

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[17] Analysys Mason, 'The impact of Facebook's connectivity initiatives: sub-Saharan Africa and ASEAN'; July 2020; see: https://www.analysysmason.com/consulting-redirect/reports/impact_of_facebook_connectivity_ssa/

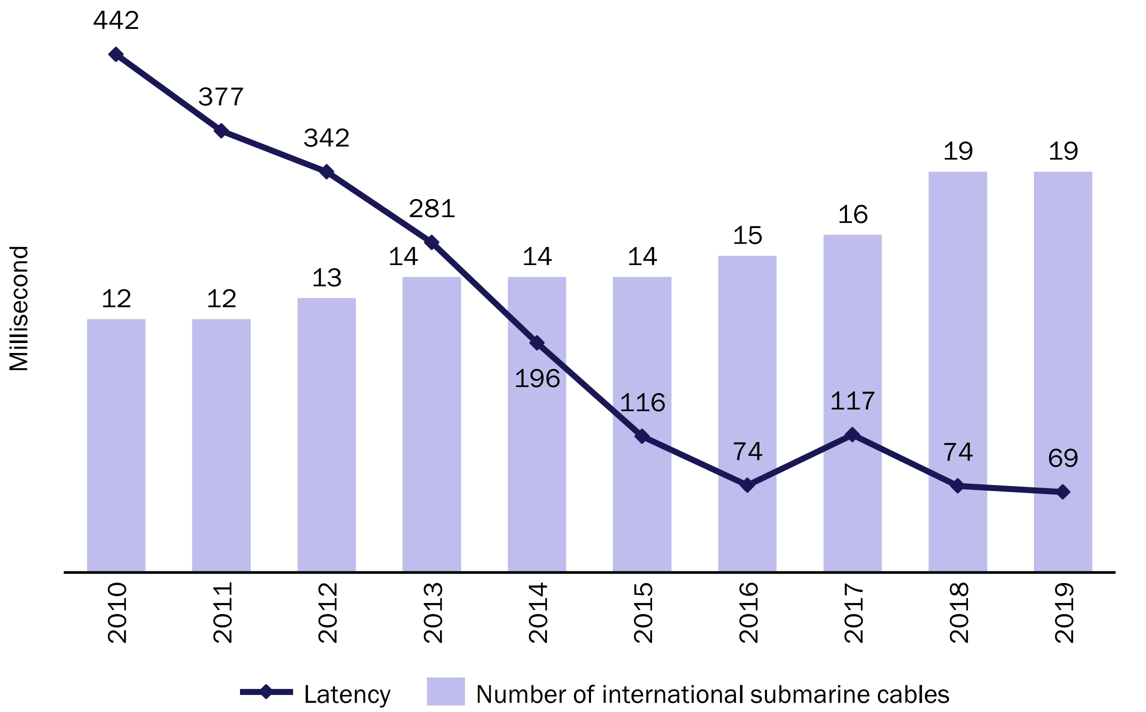
cost, for the MNOs and ISPs, of carrying rapidly increasing amounts of data, and improves the performance and user experience of Meta's applications, including Facebook, WhatsApp and Instagram. This is particularly beneficial to competitive ISPs in countries such as the Philippines where there are bottlenecks in access to international capacity.

*New cables improve the resilience and performance of the Internet in APAC by taking on new routes, landing at diverse locations and opening direct paths between countries*

Besides bringing additional significant capacity to the APAC region, the submarine cable investments from Meta also increase the resilience of the Internet and provide additional geographical diversity to existing areas where cables are concentrated (detailed in Section 2.2), specifically by avoiding the South China Sea and Luzon Strait. The Apricot cable system, invested in by Meta, Google, NTT, Chunghwa and PLDT, will be the first submarine cable to directly connect Japan and Taiwan to Singapore while avoiding the Luzon Strait and South China Sea.

The observed impact of deploying submarine cables to a given country is a decrease in the average latency experienced by users across their online usage (see Figure 3.2 below). More cables mean that route diversity improves, which can increase the directness of connections between countries, allowing traffic to be delivered through more direct, lower-latency routes. Greater route diversity also offers network resilience to combat downtime from cable damage – a common cause of long-term latency spikes. Furthermore, additional submarine cable deployment supports the expansion of edge infrastructure, which directly reduces latency by bringing data sources significantly closer to end users. Notably, the Echo and Bifrost cable systems will directly connect Indonesia and Singapore to North America, resulting in lower latency between the countries. Stimulating more submarine cable investments that traverse diverse paths and land at diverse locations will further strengthen the infrastructure within APAC, to the benefit of end users.

*Figure 3.2: Latency and number of submarine cables in Indonesia [Source: M-lab, Analysys Mason, 2021]*




**Case study: The Indochina region's vulnerability to submarine cable disruptions is expected to be alleviated by forthcoming high-capacity cables**

The Indochina region comprises Cambodia, Laos, Vietnam, Myanmar and Thailand. Within the Indochina region, Vietnam serves as the key international gateway and is connected to five international submarine cables, while Cambodia is connected to only two cables and Laos is landlocked. Historically, Vietnam has experienced frequent submarine cable breakage incidents due to "weather, seismic activity and marine activities".[18] The AAG cable in particular has been prone to cuts, causing intermittent issues since its debut in 2009, yet it is heavily relied upon and carries more than 60% of Vietnam's international Internet traffic.[19]

18 Saigoneer, 'Sharks, Anchors & Red Tape: Why It Takes Forever to Fix Vietnam's Broken Internet Cables', Nov 2017; see https://saigoneer.com/saigon-technology/11885-sharks,-anchors-red-tape-why-it-takes-forever-to-fix-vietnam-s-broken--cables

19 VNEspress, 'Vietnam to enjoy faster Internet as undersea cable repairs conclude', Jan 2020; see https://subtelforum.com/vietnam-cables-to-be-repaired-by-next-month/

In April and May 2020, two cables (AAG and APG) encountered concurrent disruptions, resulting in a significant degradation of Internet quality in Vietnam[20] and a cascading impact on Cambodia and Laos.[21] The impact was especially felt at a time when there was increased dependence on Internet-based services as social distancing measures were implemented due to Covid-19.

The region is expected to benefit from the upcoming high-capacity SJC2 and ADC cables (see **Error! Reference source not found.**), both in terms of connectivity via a third alternative landing p oint in Vietnam and reduced reliance on existing cables.

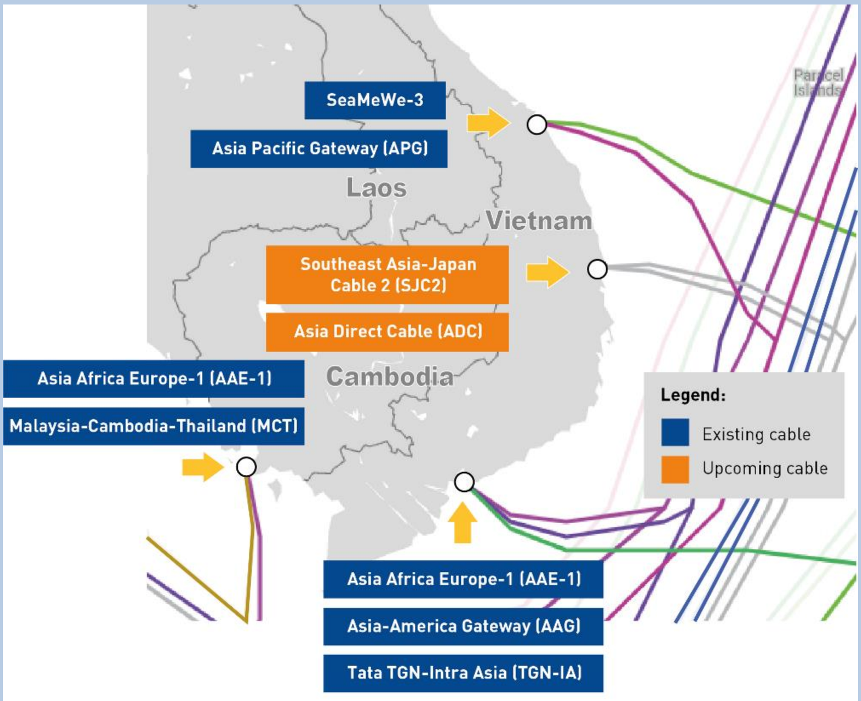



*Figure 3.3: Overview of submarine cables connecting to the Indochina region [Source: TeleGeography, Analysys Mason, 2021]*

*The above-mentioned factors improve the quality and affordability of broadband services, leading to an increase in Internet data traffic across APAC, and in the number of Internet users in lagging countries*

As discussed, Meta's investments in submarine cables improve the quality and performance of the Internet while reducing international bandwidth costs for ISPs and MNOs in APAC, which in turn enables them to provide more affordable services. Although affordability is not the only barrier to Internet take-up, it is a significant barrier across developing regions such as sub-Saharan Africa and

20 Vietnam+, 'AAG international undersea cable will be repaired before April 22', Apr 2020; see https://www.vietnamplus.vn/cap-quang-bien-quoc-te-aag-se-duoc-sua-chua-xong-truoc-224/633384.vnp

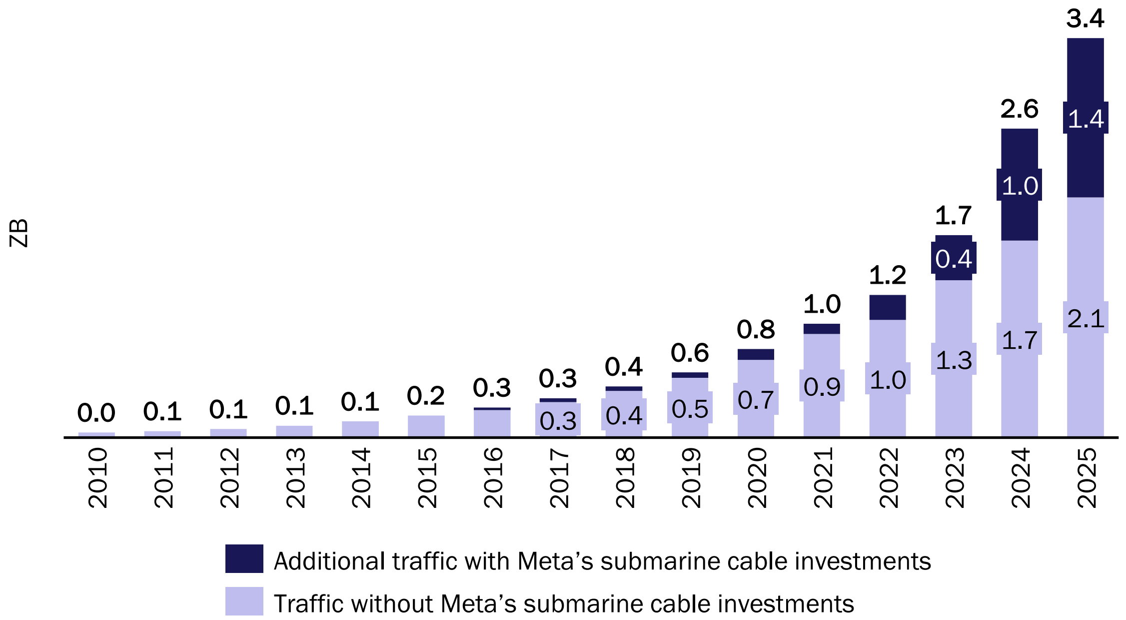
21 Submarine Telecoms Forum, 'Undersea Cable Faults Cause Internet Chaos in Vietnam, Cambodia & Lao PDR', June 2020; see https://subtelforum.com/cable-faults-impact-internet-in-vietnam-cambodia-laos/

developing APAC countries with lower penetration rates.[22] These factors help to enable more people to go online and stimulate more intense use of the Internet by every person connected.

Developing countries with low Internet penetration rates will benefit most from Meta and its partners' submarine cable investments. These investments in submarine connectivity will foundationally support network expansions and upgrades to greater shares of the population, primarily by providing additional capacity.

In addition, our analysis shows that new submarine cables are associated with greater data traffic delivered over the Internet across the board. This reflects an increase in Internet users as well as an increase in Internet use by existing users. We forecast that the overall data traffic impact of Meta's submarine cable investments in APAC will reach 1.4ZB[23] in 2025 – an estimated 40% of data traffic attributed to Meta's investments (see Figure 3.4). This will be the result of more people doing more things online, powering digital transformation in each country.

*Figure 3.4: Impact of Meta's submarine cable investments on annual data traffic in APAC [Source: Analysys Mason, 2021]*




The improvement of the connectivity ecosystem not only allows more people to go online and consume more services over the Internet, it also enables new businesses and drives the digital economy ambitions of countries across APAC. This in turn drives economic benefits in the form of higher economic growth, GDP and associated jobs.

22 EPS PEAKS, 'The impact of Internet connectivity on economic development in Sub-Saharan Africa', Jan 2015; see https://assets.publishing.service.gov.uk/media/57a0899b40f0b652dd0002f4/The-impact-of-internet-connectivity-on-economic-development-in-Sub-Saharan-Africa.pdf

23 Landing state-of-the-art submarine cables improves reliability, reduces latency, increases Internet bandwidth, and reduces pricing of international bandwidth, which results in an increase Internet data traffic generated by Internet users in total.

## 3.3 Meta's submarine cable investments are expected to enable USD422 billion in GDP growth between 2021 to 2025 and support 3.7 million jobs by 2025

Meta's infrastructure investments not only improve the reliability and resilience of the overall Internet; they also result in improvements to a connected country's Internet across three key metrics: lower latency, lower IP transit prices, and higher Internet bandwidth. Together, these improve both Internet affordability and performance for the end users, resulting in a greater proportion of Internet users overall. Data traffic also markedly increases due to the greater use of Internet-based applications, enabled by improved Internet performance.

Due to the enabling nature of the Internet, there is a strong correlation between connectivity outcomes and economic activity in areas such as education and healthcare. Past studies, including a report published by Deloitte in 2014, have supported and quantified this relationship.[24] The Deloitte study covers universal impacts of extending Internet access, ranging from innovation and productivity to labour enhancement and financial capital access, as well as estimates of the economic impacts on indicators such as employment, GDP growth and poverty. Another example of a supporting study, which was published by the World Bank in 2016,[25] estimates that a 100% increase in mobile data consumption raises GDP by 0.5%. Finally, a study from ITU, published in 2018, analyses the economic impact of broadband and digitisation, estimating that the impact on GDP caused by a 1% increase in Internet penetration can range up to 1.5%, depending mostly on the country's level of development and type of broadband assessed. The impact is higher in lower-income countries and more pronounced in the context of mobile broadband than fixed broadband.[26]

Analysys Mason's econometric assessment supports these conclusions (the methodology used is detailed in Annex A). We produced an endogenous growth model to link back to economic indicators by generating regressions fitted from historical data across APAC countries, building and modelling with equations relating new submarine cables to latency, bandwidth and IP transit prices, and in turn to Internet penetration and usage. As a result, Analysys Mason estimates that a 100% increase in mobile data traffic translates into a 0.98% impact on GDP. Based on this equation, we estimate that Meta's submarine cable investments will enable USD422 billion in GDP growth between 2021 to 2025 (see Figure 3.5).

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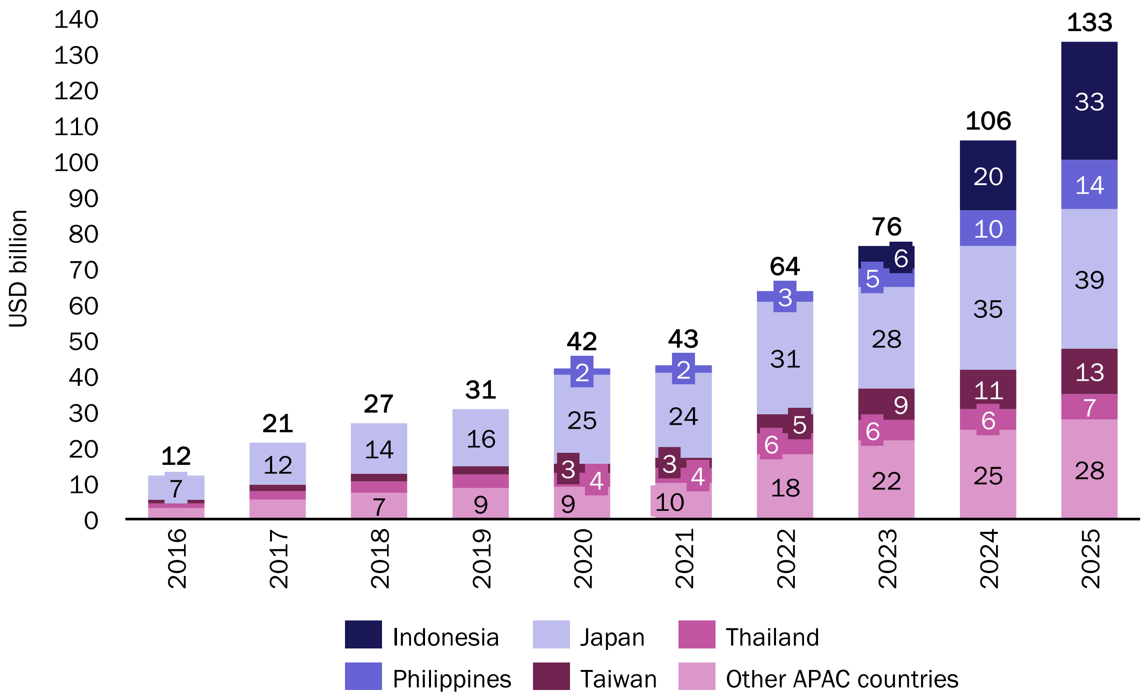
[24] Deloitte, 'Value of connectivity: Economic and social benefits of expanding Internet access', Feb 2014; see: https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/technology-media-telecommunications/deloitte-uk-tmt-value-of-connectivity-tmt.pdf

[25] The World Bank – 'Exploring the Relationship Between Broadband and Economic Growth', 2016; see https://documents1.worldbank.org/curated/en/178701467988875888/pdf/102955-WP-Box394845B-PUBLIC-WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf

[26] ITU – 'The economic contribution of broadband, digitization and ICT regulation', 2018; see https://www.itu.int/en/ITU-D/Regulatory-Market/Documents/FINAL_1d_18-00513_Broadband-and-Digital-Transformation-E.pdf

*Figure 3.5: GDP impact arising from Meta's submarine cable investments in APAC [Source: Analysys Mason, 2021]*

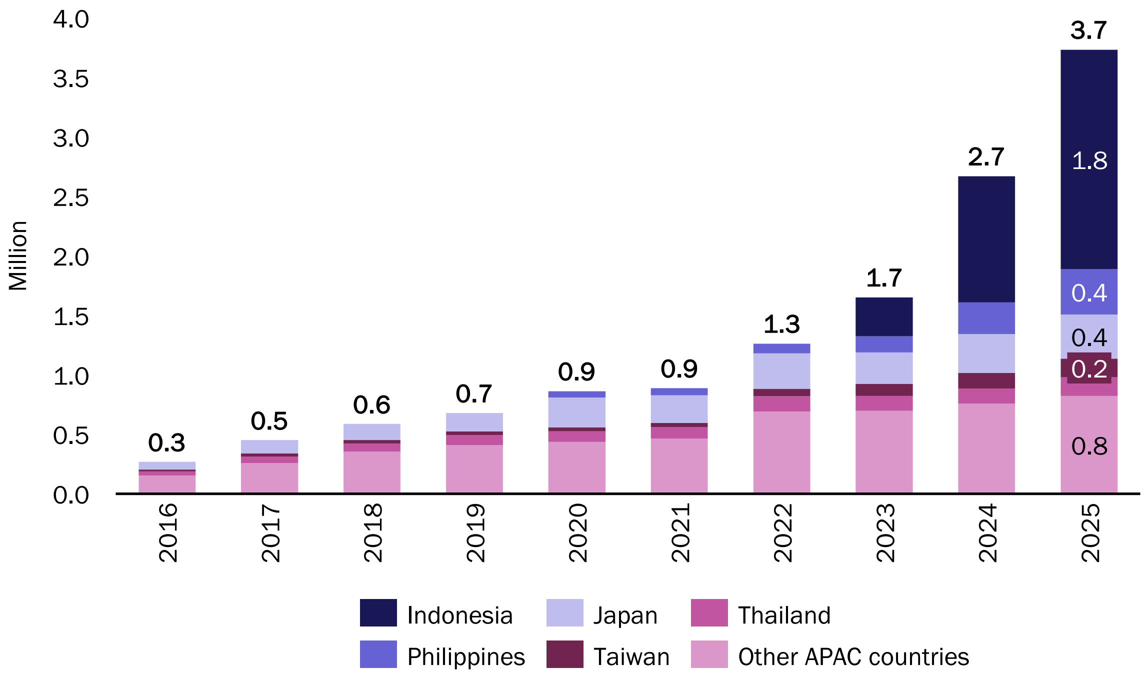



The development of this model has made it possible to estimate the impacts that Meta's submarine cables have had and will have on jobs in APAC. Jobs created directly from Meta's investments include those in construction and telecoms. However, the impact on job creation indirectly extends to other industries due to broadband improvements. This impact is expected to focus around service-oriented industries such as finance, healthcare, IT and education.[27]

Figure 3.6 provides an estimate of the number of additional jobs supported in 2025 in Indonesia, the Philippines, Japan, Taiwan, Thailand, and other APAC countries, supported through the increase in GDP attributable to Meta's submarine cable investments in APAC.

27 ITU, 'Impact of Broadband on the Economy' 2012; see https://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf

*Figure 3.6: Number of additional jobs supported through the increase in GDP attributable to Meta's submarine cable investments in APAC [Source: Analysys Mason, 2021]*




## 3.4 Indonesia could see USD59 billion in additional GDP between 2023 and 2025 linked to submarine cables in which Meta invests, supporting up to 1.8 million jobs by 2025

Indonesia is the world's fourth most populous nation and the largest economy in South-East Asia. The current and final five-year phase of the long-term economic plan for Indonesia, known as Rencana Pembangunan Jangka Menengah Nasional (RPJMN), aims to "further strengthen Indonesia's economy by improving the country's human capital and competitiveness in the global market".[28] In order to achieve the plan's overall goal of economic growth, a key area of focus for national connectivity and infrastructure development is information and communication technology and its associated regulations.[29]

Digital infrastructure development has therefore been a key focus for Indonesia. An example of a project supporting such development is the USD1.5 billion Palapa Ring project that was completed in 2019, providing a fibre-optic backbone network and 4G Internet access across Indonesia's archipelago. The government expects this project to improve digital literacy, reduce skill gaps and build tech talent, among other benefits. Further consequences of this investment will include growth in digital businesses, a higher rate of launching of new start-ups, and the development of smart cities.

28 World Bank, 'The World Bank in Indonesia'; see https://www.worldbank.org/en/country/indonesia/overview

29 Ministry of National Development Planning of the Republic of Indonesia, 'Masterplan for Acceleration and Expansion of Indonesia's Economic Development', July 2011; see https://www.bappenas.go.id/id/berita-dan-siaran-pers/kegiatan-utama/master-plan-percepatan-dan-perluasan-pembangunan-ekonomi-indonesia-mp3ei-2011-2025/

As discussed earlier in Section 2.2, submarine cables play an important role in connecting countries in APAC. Indonesia currently connects to 20 international cables, but most of them are connected to Singapore, and therefore Indonesia relies heavily on Singapore as the gateway for international connectivity. The strategic location of Indonesia adjacent to the Pacific Ocean, coupled with its archipelagic geography, allows for a multitude of landing station locations that could enable Indonesia to develop and become the next connectivity hub in South-East Asia, assuming enabling regulatory settings are in place to facilitate this. Improving the supply, resilience and availability of international capacity delivered through new submarine cables would further enable the government to realise Indonesia's ambition of digitalisation and becoming a digital hub in South-East Asia.[30]

*Meta has invested in the Echo, Bifrost and Apricot submarine cable systems that will be launched between 2023 and 2024*

Indonesia's reliance on Singapore for international connectivity will reduce with the launch of the Echo and Bifrost cables by 2023 and 2024 respectively, both of which received significant investments from Meta. These cables are designed to connect Indonesia directly to North America, bringing latency benefits which are essential for use cases such as e-commerce, cloud services and video services. Echo and Bifrost will also significantly increase the transpacific capacity and enhance Indonesia's network resiliency as the world's first two cable systems to traverse a new route through the Java Sea.[31]

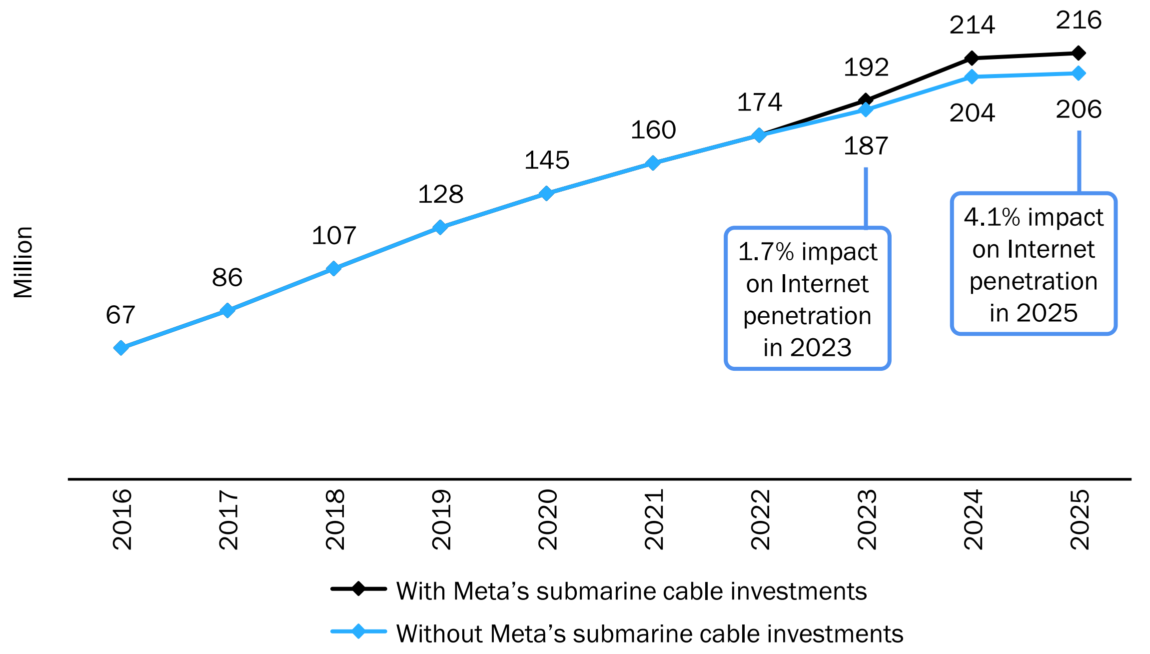
Apricot is the third submarine cable in which Meta has invested that connects to Indonesia and is also due to go live by 2024. It will connect countries within Asia (Indonesia, Japan, Taiwan, the Philippines, Singapore and Guam) and will provide additional resilience for international connectivity by introducing new cable routes in and out of the region. Along with Echo and Bifrost, APRICOT will also reduce Indonesia's international connectivity reliance on Singapore.

Indonesia's Internet penetration rate was at 53% of the population in 2020 and is expected to benefit from more submarine cables landing in the next few years. Meta's submarine cable investments are forecast to increase the number of Internet users in Indonesia by 10.2 million by 2025, corresponding to a 3.6% higher Internet penetration (see Figure 3.7).

30 CNBC Indonesia; see https://www.cnbcindonesia.com/news/20210322193443-4-232032/begini-penampakan-rumitnya-kabel-bawah-laut-yang-lewat-ri

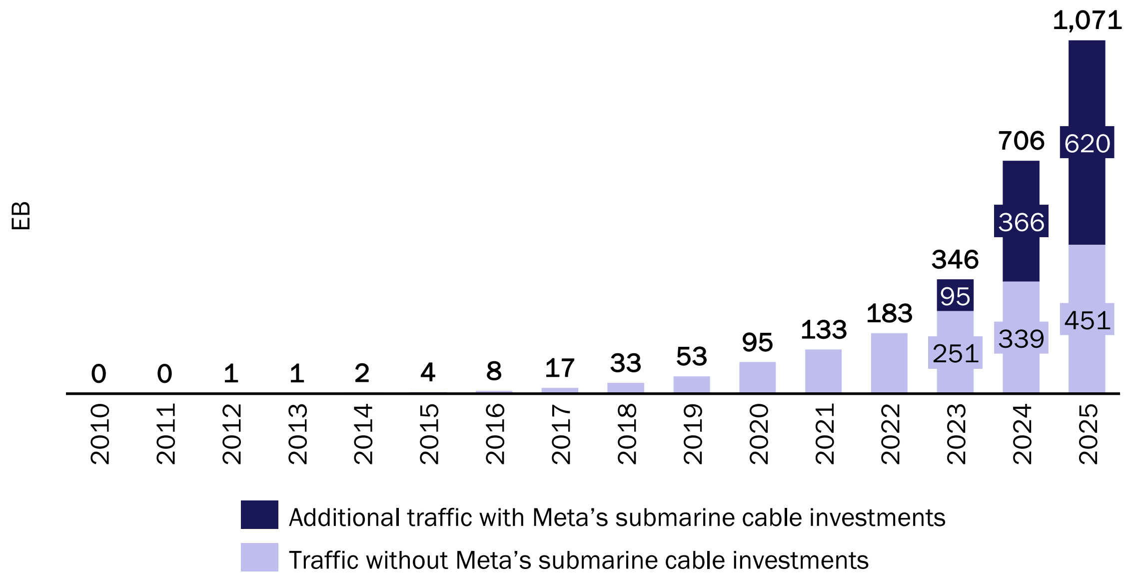
31 Echo and Bifrost cables: Facebook Engineering, 'Advancing connectivity between the Asia–Pacific region and North America' March 2021; https://engineering.fb.com/2021/03/28/connectivity/echo-bifrost/

*Figure 3.7: Impact of Meta's submarine cable investments on Internet users in Indonesia [Source: Analysys Mason, 2021]*




The impact on annual data traffic in Indonesia is primarily driven by an increase in the data traffic per Internet user, compounded by the increase in the number of Internet users. Analysys Mason forecasts an additional 620EB in annual data traffic by 2025 from Meta's submarine cable investments – 58% of the total forecast data traffic (see Figure 3.8).

*Figure 3.8: Impact of Meta's submarine cable investments on total annual data traffic in Indonesia [Source: Analysys Mason, 2021]*




The impact on data traffic (and usage) in Indonesia is expected to translate into improvements in productivity, digital literacy, education, manufacturing, human capital and many other areas. The total GDP impact between 2023 and 2025 is forecast to be USD59 billion (see Figure 3.9). This additional GDP growth is expected to support an additional 1.8 million jobs by 2025 (see Figure 3.10), with notable growth in employment in digital industries and entrepreneurial areas.

“70% of traffic in Indonesia goes international… without additional submarine cables, the current available international capacity will be exceeded by 2023 or 2024”

**Telecoms operator in Indonesia**
August 2021

*Figure 3.9: Annual GDP impact in Indonesia arising from Meta's submarine cable investments in APAC [Source: Analysys Mason, 2021]*

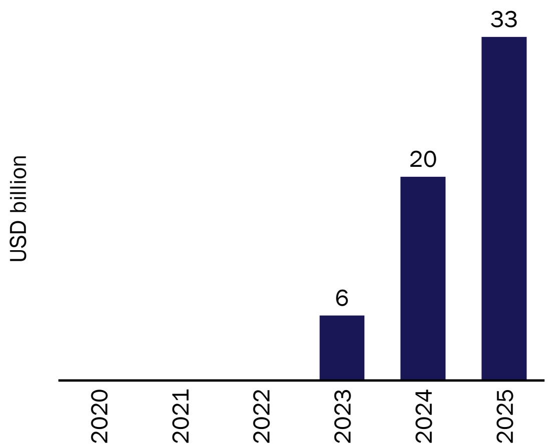
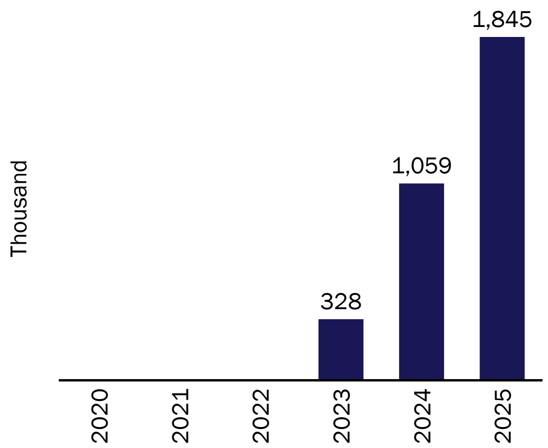



*Figure 3.10: Number of additional jobs supported in Indonesia through the increase in GDP attributable to Meta's submarine cable investments [Source: Analysys Mason, 2021]*




*Indonesia's digital economy is expected to benefit significantly from Meta's submarine cable investments*

Indonesia has the potential to be the leading start-up hub in ASEAN. It is home to the most vibrant tech ecosystems in South-East Asia. Of the 17 tech unicorns in the region, six are headquartered in Indonesia, five of these are placed in the top ten valuation, including household names GoTo and Traveloka. Venture capital investments in the two countries represent over 40% of the region's total.

In 2020, 115 million out of the 145 million Internet users in Indonesia are using OVO, a leading e-wallet application in Indonesia. OVO experienced a 267% increase in new users after the onset of Covid-19, and the Bank of Indonesia forecasts that this trend will continue to accelerate, with a 32% growth in e-payments in 2021.[32]

As shown in Figure 3.11, Indonesia has attracted an increasing share of investments in the region in the period 2018–20. With a large population of over 270 million and a fast-growing Internet economy, Indonesia is showing potential to become the primary location for tech unicorns in the ASEAN region. To realise this ambition, Indonesia needs to create an environment conducive to start-ups, enabling them to develop and scale. SMBs will also benefit from the ability to fully digitalise by extending their customer reach, improving efficiency in processes and communication, providing e-commerce, and so forth.

32 The Asian Banker, 'Indonesia e-wallet transaction to reach $18.5 billion in 2021 amid fierce competition', April 2021; see https://www.theasianbanker.com/updates-and-articles/big-tech-platforms-heat-up-competition-in-indonesias-digital-payments-landscape

The establishment of high-quality digital infrastructure will be a critically enabling factor, supported at the foundation by submarine cable capacity – the key area where Meta will provide state-of-the-art, high-capacity connections between the island nation and the global Internet.

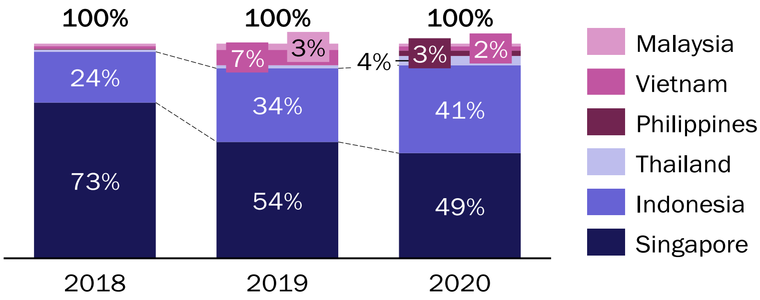



*Figure 3.11: Share of venture capital investment deal value in the six key South-East Asia countries [Source: Analysys Mason, Preqin, 2021]*

Cloud service providers such as Alibaba, Tencent and Google have either announced future data-centre plans in Indonesia or already have an established data-centre presence in the country. Others, notably Microsoft and AWS, have announced plans to enter the country in the coming years. We expect the improvement in international submarine cable supply to also stimulate further data-centre investments in Indonesia.

## 3.5 The Philippines could gain USD34 billion in additional GDP for 2021–25, linked to submarine cables in which Meta invests, supporting up to 380 000 jobs by 2025

The Philippines has the second largest population in South-East Asia after Indonesia. Overall, it has a relatively young and tech-savvy population, which could prove to be an advantage in the country's pursuit of digital economic growth. The president of the Philippines has backed the 'Free Wi-Fi for All' programme with a proposed 2021 budget of USD155 million, which is deploying over 12 000 Internet sites in educational institutions and more than 10 000 additional sites in government offices, hospitals and public places.[33] The aim is to bridge the digital divide and improve economic, social and education opportunities across the Philippines. Currently, there is only a small number of international submarine cables connected to the Philippines – additional submarine cable connectivity will be required to support the country's growth in Internet usage.

[33] OpenGov, 'Philippines government launches free Internet initiatives', July 2020; see https://opengovasia.com/philippines-government-launches-free-internet-initiatives/

The Philippine Digital Strategy sought to improve Internet access and opportunities on a national level by 2016, across schools, offices and other public institutions. Other goals included a 5% annual reduction in broadband prices and a 10% annual increase in infrastructure expansion investments. Building on this and the country's National Broadband Plan, in 2019 the Philippine government signed a deal to build a nationwide open-access fibre-optic network which will also connect underserved areas via DICT's Free Public Wi-Fi network.[34, 35] As part of the PLCN cable landing in the Philippines, Meta is providing 2Tbit/s to the Government which will support the National Broadband Plan.

The Philippines is heavily reliant on connectivity to regional hubs in Hong Kong, Japan and Singapore for international connectivity. However, it has the potential to become an alternative connectivity hub in the region given its strategic geographic location. Connecting new international submarine cables directly to the Philippines could reduce dependence on these hubs and improve network resilience. New submarine cables can also enable access to international capacity for smaller domestic telecoms operators in the Philippines.

*Meta has invested in the JUPITER, PLCN and Bifrost submarine cables connecting the Philippines to the USA, as well as Apricot for intra-APAC connectivity*

JUPITER connects the Philippines directly to North America, without reliance on regional connectivity hubs in Asia. PLCN, CAP-1 and Bifrost will further reduce the country's reliance on regional hubs in Asia by also connecting the Philippines directly to North America in 2022, 2023 and 2024 respectively. As the move towards more widespread digitalisation accelerates, the Philippines will benefit from lower latency times, higher international bandwidth, and stronger network resilience which supports investments in data centres and cloud adoption.

The Philippines has the potential to become an alternative connectivity hub for South-East Asia, with the right investment and regulatory settings, helped by the fact that it is the South-East Asian country in closest proximity to the USA. Submarine cables connecting to the Philippines can land on islands such as Luzon, avoiding the congested Luzon Strait (which, as mentioned previously, is prone to natural disasters that widely impact submarine connectivity), then connecting onwards to other APAC countries via other cable systems. One such system, the Apricot cable, is due to be RFS in 2024 and will help to boost the resilience of the Philippines' connectivity offering.

The Philippines' growing Internet penetration is expected to accelerate further due to Meta's investments in submarine cables. Analysys Mason forecasts that the number of Internet users will be 8.3 million higher by 2025 with these cables operating in the Philippines – a 7.1% increase on the forecast without Meta's investments (see Figure 3.12).

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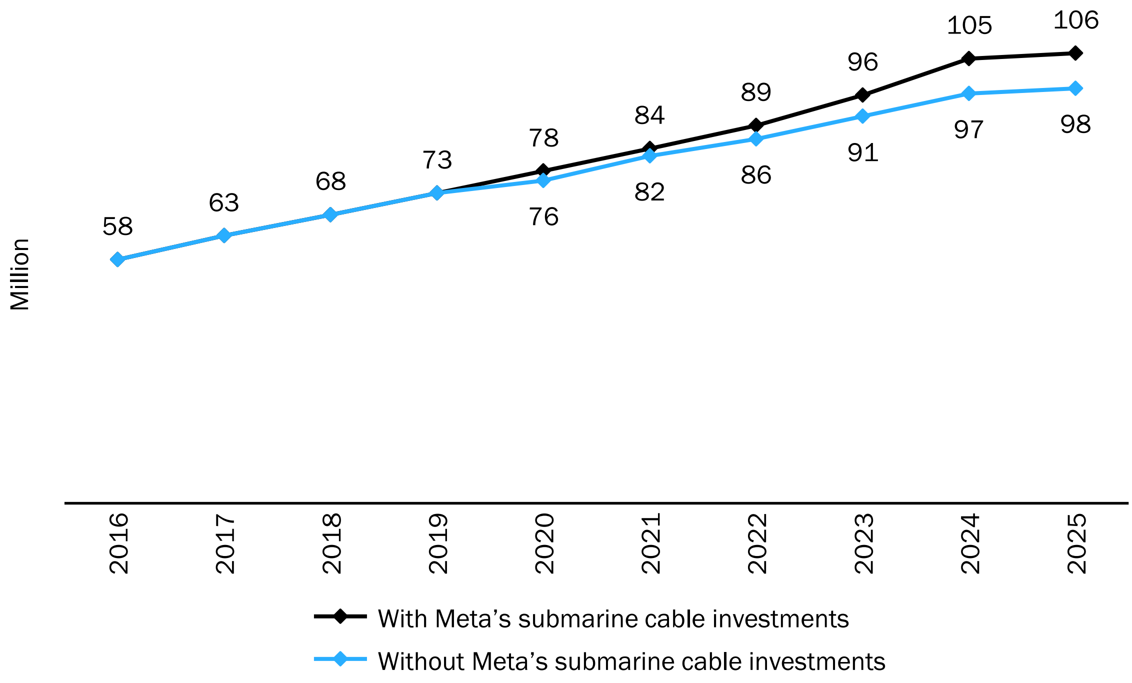
34 Optical Connections; see https://opticalconnectionsnews.com/2019/05/philippines-in-billion-dollar-fibre-partnership/

35 The Philippines National Government; see https://dict.gov.ph/data-says-ph-internet-improved-dict-says-it-could-do-better/

*Figure 3.12: Impact of Meta's submarine cable investments on Internet users in the Philippines [Source: Analysys Mason, 2021]*



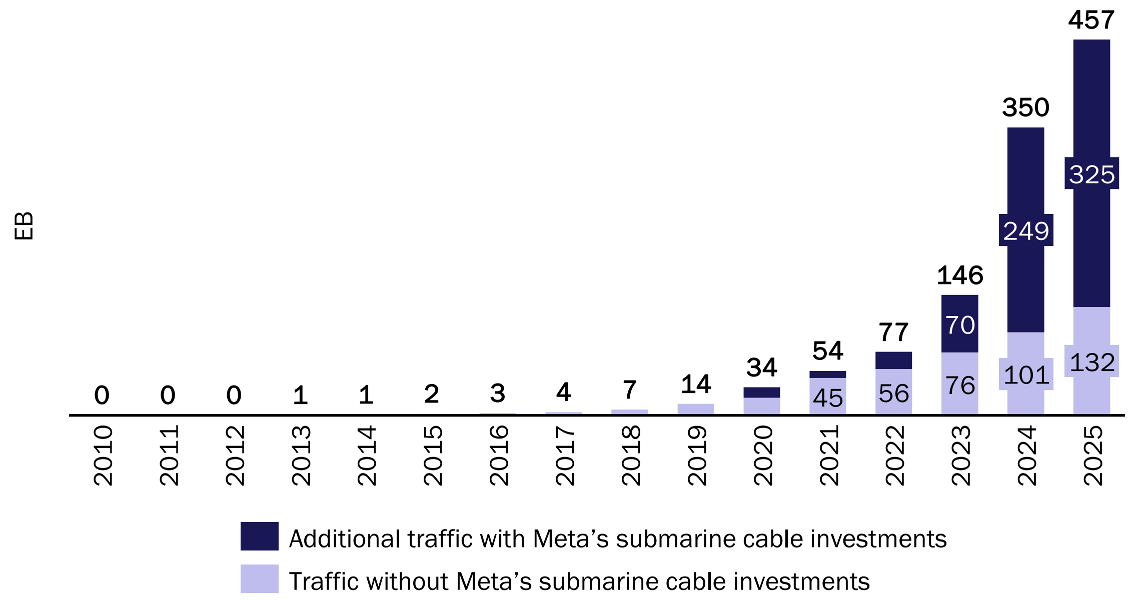

The impact of new submarine cables on annual data traffic is accentuated by the fact the Philippines only has eight non-Meta international submarine cables. The consequence of this is that Meta's investments will provide proportionally more international capacity in the Philippines than for other APAC countries.

In the Philippines, the average daily time spent using the Internet is almost 11 hours for Internet users aged 16 to 24 – the highest globally.[36] The majority of this time is spent on mobile devices, yet the Philippines ranks poorly in terms of average mobile Internet connection speeds (22.5Mbit/s). The Philippines also ranks as the top country globally in daily time spent using social media, with YouTube and Facebook the most used platforms. Meta's investments in new submarine cables will contribute to a continued improvement in the quality of Internet connections for Filipinos, enabling them to access more 'demanding' online services (higher-quality video, low-latency cloud gaming, better corporate cloud services).

Our model suggests that Meta's investments could drive an additional 325EB in annual data traffic by 2025 – 71% of the total forecast data traffic (see Figure 3.13).

36 DataReportal, 'Digital 2021: Global Overview Report', Jan 2021; see https://datareportal.com/reports/digital-2021-global-overview-report

*Figure 3.13: Impact of Meta's submarine cable investments on total annual data traffic in the Philippines [Source: Analysys Mason, 2021]*




The Philippines stands to benefit most from this connectivity improvement and resulting increase in data traffic in areas that can best harness digital technologies: online education, telemedicine, digital payments and e-commerce.

In the Philippines, the government is working to integrate ICT into the healthcare department as part of the eHealth Framework, covering services such as e-pharmacy, online consultations and standardised, electronic patient data aggregation. Other planned Internet-enabled use cases include telehealth/telemedicine systems, such as RxBox, which is funded by the Department of Science and Technology. RxBox links to the Philippines' most comprehensive electronic medical record database and is primarily used for monitoring and diagnostics – targeting disadvantaged and more geographically isolated communities.[37,38]

Analysys Mason forecasts the total GDP impact of Meta's submarine cable investments between 2021 and 2025 to be USD34 billion (see Figure 3.14). The additional GDP growth could support an additional 380 000 jobs by 2025 (see Figure 3.15), reducing poverty by increasing employment rates especially following the challenging employment context brought about by the Covid-19 pandemic.

37 Market Research Southeast Asia, 'The Philippines to Integrate e-Health in the Healthcare Industry', Oct 2019; see https://www.marketresearchsoutheastasia.com/insight/philippines-to-integrate-e-health-in-healthcare-industry

38 Oxford Business Group, "IT solutions helping more Filipinos access health care'; see https://oxfordbusinessgroup.com/analysis/your-fingertips-new-technologies-are-expanding-access-more-filipinos

*Figure 3.14: Annual GDP impact in the Philippines arising from Meta’s submarine cable investments in APAC [Source: Analysys Mason, 2021]*

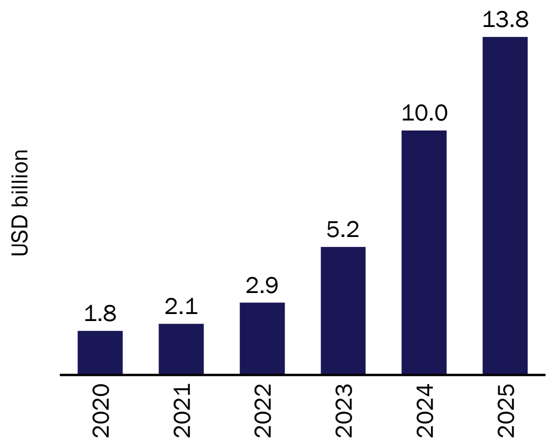
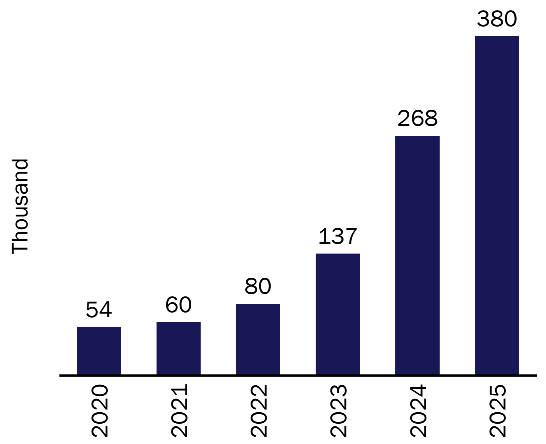



*Figure 3.15: Number of additional jobs supported in the Philippines through the increase in GDP attributable to Meta's submarine cable investments [Source: Analysys Mason, 2021]*




*The Philippines’ digital economy could receive a significant boost from Meta’s submarine cable investments*

Meta’s investments in new submarine cables, in partnership with other telecom operators and Internet companies, will increase competition in the telecoms landscape and support the digitalisation of public-sector services in the Philippines. The submarine cable investments will provide the foundation needed for broadening access to the Internet, improving the affordability of high-speed Internet services, and upgrading the quality of Internet connections – all of which are necessary steps towards the digital transformation of the Philippines.

Before 2020, international connectivity to the Philippines was largely supplied by PLDT and Globe: both of them owned six out of eight international cables connected to the Philippines and controlled seven CLSs, where the international cables terminate. This, together with the incumbents’ strength in the domestic terrestrial backhaul network, created bottlenecks in other ISPs’ access to international capacity.[39] Meta’s submarine cable investments will notably improve supply conditions, adding significant international capacity and new cable routes that improve both network resiliency and latency.

Competitive ISPs are set to benefit from greater access to international capacity: in 2021, Converge ICT managed to secure up to 15Tbit/s capacity on the upcoming Bifrost cable through an agreement with Keppel, a consortium member on the cable.[40] New entrant DITO is planning to launch a 5G

39 Arangkada Philippines, ‘Broadband Policy Brief No. 4’, Feb 2016; see http://www.investphilippines.info/arangkada/wp-content/uploads/2016/02/BROADBAND-POLICY-BRIEF-as-printed.pdf

40 Converge ICT, ‘Keppel and Converge enter into definitive agreements for Bifrost Cable System’, May 2021; see: https://corporate.convergeict.com/news/keppel-and-converge-enter-into-definitive-agreements-for-bifrost-cable-system/

network alongside its 4G network, as well as a commercial fixed broadband service in 2022.[41] DITO's ambitions extend to securing 30% of the domestic mobile market share within three years of launching its operations – posing a challenge to the current duopoly of PLDT and Globe. In order to achieve this, DITO has deployed more than 2000 mobile sites and over 14 000km of fibre-optic cabling. The average Internet speed offered is targeted to be 55Mbit/s by the fifth year of operations, over double the current national average. These targets would certainly be bottlenecked without additional submarine cable capacity, meaning Meta and its partner's cable investments are a necessary step towards enabling telecoms operators to provide superior connectivity to the country.

From the public-sector perspective, the E-Government Masterplan 2022 details how digital transformation of the government will improve four key areas that will result in more cost-effective and efficient public services for both business and citizens.[42] First, such transformation will optimise government operations: increasing efficiency of service delivery, integrating electronic systems and improving information and resource sharing through unified databases. Second, citizen engagement will be more direct, fast and accessible through digital public services. Next, business transaction processes, including licensing, permit acquisition and fee management processes, will be more streamlined. Finally, government employees are expected to benefit from productivity gains with respect to internal operations and public service delivery. Meta's 2Tbit/s of capacity provided to the Philippine government from the PLCN cable will support the government to achieve its ambitions.

Online education is another key area of focus for the Philippine government, and initiatives are in place to connect more educational institutions to the Internet. This is key for the country's recovery from the Covid-19 pandemic, and it will further facilitate the training of much needed tech talent. Attracting tech companies and investment from foreign countries is needed for digital economy growth: for example, local data centres are needed to improve the quality of digital services in the Philippines. Outsourcing of business and IT processes forms a large and quickly growing share of income generation in the Philippines, but it relies entirely on the Internet and tech talent to drive it.

41 TeleGeography, GlobalComms Database

42 DICT, 'E-Government Masterplan 2022'; see https://dict.gov.ph/ictstatistics/wp-content/uploads/2020/03/EGMP-2022.pdf

# 4 Supportive regulatory and investment regimes are critical to support ongoing and future submarine cable investment

Submarine cable regulatory and investment regimes differ across APAC countries and play a critical role in influencing the supply of submarine cables in each country. Countries with a strong supply of submarine cables enjoy favourable conditions that enable straightforward licensing and permitting for cable consortiums, facilitate the efficient deployment of submarine cables on diverse routes, support open access to the international capacity that lands and enable timely repair and maintenance of submarine cables. Providing a conducive policy and regulatory environment would not only provide confidence for Meta to continue investing in the APAC region, but other investors, including major CASPs and telecoms operators across the region, would also benefit from developing or improving an enabling environment.

Key barriers currently present in APAC countries include onerous licensing requirements for landing submarine cables that are similar to those required by domestic MNOs and ISPs and which may restrict foreign ownership in some instances. There are also policies in place preventing submarine cable owners from deploying cables through optimal routes and landing in optimal areas, which reduces the effectiveness and resilience of the submarine cable systems. The absence of open submarine CLSs in certain countries prevents MNOs, ISPs and enterprises from effectively accessing capacity. Lastly, the existence of some cabotage laws prevents specialised repair vessels from making timely repair on submarine cables.

On the other hand, countries with policies that are aligned with international treaties such as United Nations Convention on the Law of the Sea (UNCLOS) as well as implementing best practices from the International Cable Protection Committee (ICPC) are viewed favourably by cable investors and support future investments in submarine cables in these countries.

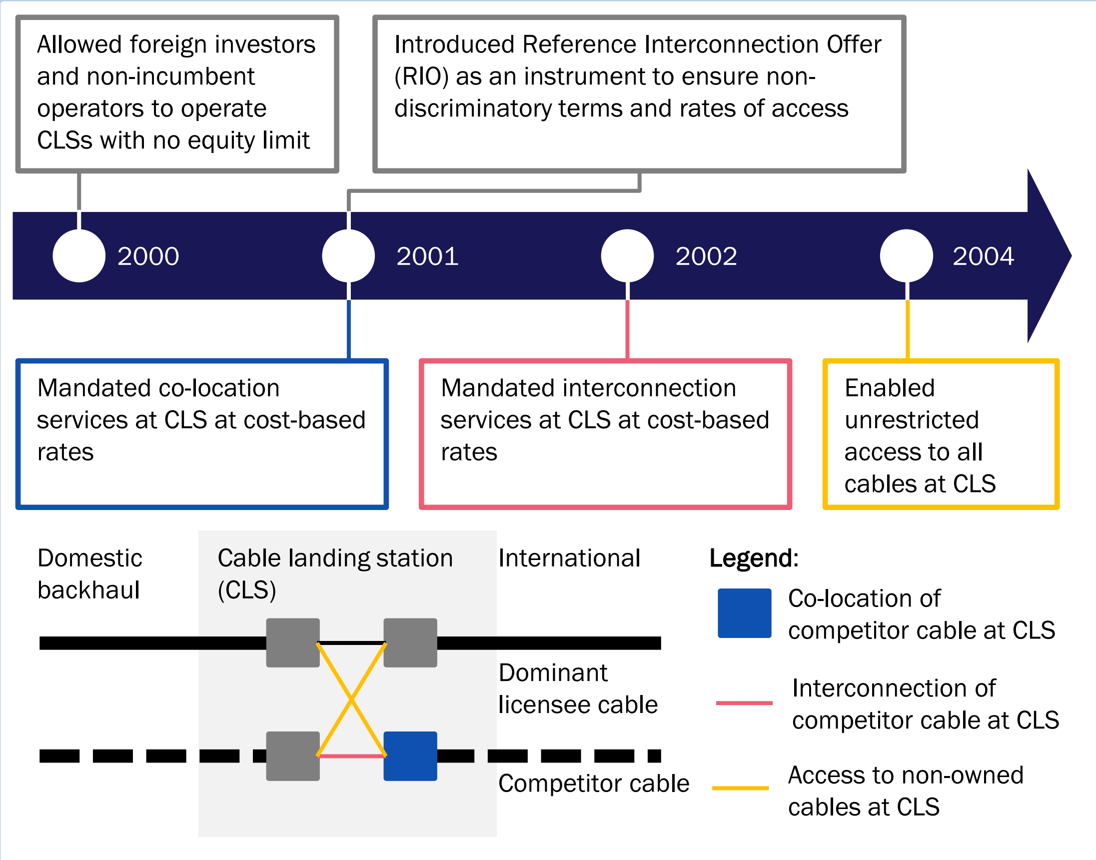
**Case study: How Singapore developed into a key digital connectivity hub for the APAC region**

Over the last two decades, Singapore has developed into a key digital connectivity hub serving the region. This has been enabled by its market-leading regulatory practices, supportive policies to encourage submarine cable investments, and forward-looking policies.

*Market-leading regulatory practices*

Since the early 2000s, the Infocomm Media Development Authority (IMDA) has progressively implemented a series of regulatory reforms that transformed the international connectivity landscape in Singapore. Unrestricted, non-discriminatory and cost-based access to international capacity was implemented, which resulted in the reduction of international interconnection service charges by more than 90%. The issues faced in the past included which entities were allowed to build a CLS, which entities could connect to the landing station on the domestic side, and the cost of the interconnection. These reforms catalysed Singapore's development into a connectivity hub, growing from 1 international cable in 2000 to 7 by 2005 and 23 by 2020, with more announced in the coming years. A summary of the regulations imposed by IMDA is provided in *Figure 4.1*.

*Figure 4.1: Key regulations implemented by IMDA in the early 2000s [Source: Analysys Mason, ITU, 2021]*



*Supportive policies to encourage submarine cable investments*

Apart from regulations, IMDA also provides strong procedural support that encourages new submarine cable investments in Singapore. Key steps and relevant stakeholders for the deployment of submarine cables are published in a single document to offer clear and easily accessible guidance to cable investors.[43] IMDA also acts as the lead agency to facilitate the process for application of licences and permits across multiple government agencies, thus reducing complexity for investors.

The Singapore government recognises the importance of submarine cables as the foundational infrastructure layer for its digital hub status, and thus it also provides for the protection and repair of the cables. It has established criminal penalties for submarine cable damage and has an expedited process to grant permits to repair ships in emergency situations.

*Forward-looking policies and regulations*

Following the regulatory reforms in the early 2000s that spurred the growth in the number of international cables in Singapore, IMDA continued to implement forward-looking policies to entrench its hub status. It launched a neutral Internet exchange, the Singapore Internet Exchange (SGIX), in 2009 to position itself as the international gateway for connected countries in the region, and attracted data-centre investments with enabling infrastructure to support facility launches. In recent years, IMDA has rolled out a domestic data protection and management framework and participates in international data protection fora to shape standards that facilitate cross-border data flows. IMDA has also been flexible in providing a policy environment that allows for ongoing innovations, such as enabling city PoPs where the submarine line terminal equipment (SLTE) is located in carrier-neutral data centres. This provides individual parties with control over their SLTE, allowing for faster upgrade cycles and mitigating the risk of anti-competitive behaviour by landing parties.

Barriers and best practices in APAC countries' regulatory and investment policies related to submarine cables are discussed further in the following sections:

- Licensing and foreign ownership of submarine cables (Section 4.1)
- Deployment and landing of submarine cables (Section 4.2)
- Access to capacity from submarine cables (Section 4.3)
- Repair and protection of submarine cables (Section 4.4).

## 4.1 Licensing and foreign ownership of submarine cables

The deployment of submarine cable systems is capital intensive, and historically it often relies on local telecoms operators, typically owned by governments, to shoulder the financial responsibility. Foreign investors, including major CASPs like Meta, are also willing to make investments, provided that a business-friendly policy environment is in place to provide confidence for such investors to

43 Infocomm Media Development Authority (IMDA), 'Guidelines on deployment of submarine cables into Singapore', Oct 2016; see https://www.imda.gov.sg/-/media/imda/files/regulation-licensing-and-consultations/codes-of-practice-and-guidelines/subcablelanding.pdf?la=en

commit in the long term. These investors would also need to have certainty on their ability to receive the required licences, permits and/or exemptions for landing submarine cables across countries in APAC. All consortium members would need to ensure that they are able to land in the countries where they need the capacity. The ability of submarine cable owners to secure the required right to land in every country is key to ensuring the financial viability of a new submarine cable project.

*Full foreign ownership on submarine cable investments enables more such investments*

In most developing APAC countries, there are limits on the share of equity that non-resident entities are allowed to hold for submarine cable assets. In these countries, submarine cable investors would have to weigh the operating risks and availability of suitable local partners against the benefits of landing cables there. In countries with greater local-majority ownership restrictions, investors would also need to consider the need to relinquish management control and transfer asset titles to the local partner which would make foreign investors more hesitant to invest. Without foreign investments, local investors would need to take on the burden and play the leading role to build and fund new submarine cables.

We note that APAC countries such as Singapore, Japan, Hong Kong and Australia have open investment policies and do not put in place foreign equity limits for submarine cable ownership.

*Procedures and criteria to obtain licences or permits for landing submarine cables should be transparent and accessible to all investors*

The ease with which submarine cable owners receive the necessary licences, approvals or permits to land submarine cables differs across APAC countries. In restrictive markets, onerous licensing requirements on domestic operators including MNOs and ISPs are extended to submarine cables. In some instances, the process requires approval from legislative bodies of the government which may be subject to political influence. This could mean that the submarine cable owners go through obscure and lengthy processes with great levels of uncertainty on both the outcome and the cost and time it would take to complete the process.

Countries can seek to reduce the level of regulatory complexity and shorten the approval process for submarine cable owners. In Singapore, for example, submarine cable owners only need to apply for a Facilities-Based Operations (FBO) licence, which typically takes around a month to be approved, with clear guidelines readily provided by the regulator. The Services-Based Operations (SBO) licence required by MNOs and ISPs to provide telecoms services is not required for landing submarine cables.

## 4.2 Deployment and landing of submarine cables

After receiving the necessary licences, approvals and/or permits to land submarine cables, submarine cable owners would need to receive permission for the laying of cables within territorial waters of the countries through which they traverse. Investors would additionally benefit from having flexibility in applying for diverse routes for the laying of cables and suitable locations for landing of cables. Diversity of cable landing stations is important in order to ensure that the failure of a single landing site or building does not impact too many cables. The procedures to obtain licences or permits for the laying of cables should also be transparent and streamlined.

*Procedures to obtain licences, approvals or permits for deploying submarine cables within territorial waters should be transparent and streamlined*

In the less streamlined regulatory environments in some APAC countries, submarine cable owners need to devote significant amounts of time and resources to identify appropriate parties to work with and receive the necessary approvals. Besides the telecoms regulator, submarine cable owners often have to seek permission from the relevant authorities governing maritime affairs, fisheries, and environment and urban planning. These authorities each have an important stake in their territorial waters, however a streamlined approach would benefit investors.

Countries in APAC should provide clear guidelines on the laying and landing of submarine cables and make such documents readily available in the public domain, as seen in Singapore[44] and Hong Kong.[45] Regulators in both of these best-practice markets also proactively assist investors by becoming the single point of contact to co-ordinate with other relevant government authorities and thus reduce complexity for submarine cable owners.

*Cable owners should be given the flexibility to decide on an optimal path, and where to land within countries*

While it is common for countries to have designated landing sites for submarine cables, cable owners should be given the flexibility to decide on the route and preferred landing locations. Submarine cable owners such as Meta, together with their suppliers and consortium members, have significant experience and collective knowledge and would be well placed to select appropriate submarine cable deployment paths, avoiding high-risk areas prone to natural disasters as well as those with high exposure to human activities (such as fishing and anchoring) that could damage submarine cables. Submarine cable owners would also need to have options regarding landing points and cable landing stations.

In the event of submarine cable corridors[46] being introduced (as has happened, for example, in Australia), we note that it is best practice to ensure that the corridors are sufficiently wide to provide ample space for future cable deployment and to prevent overcrowding, as the latter may lead to a single point of failure. Submarine cable corridors will also need to be frequently patrolled to ensure no human activities such as fishing, anchoring and sand dredging are occurring, as these can damage

44 IMDA, 'Guidelines on deployment of submarine cables into Singapore', Oct 2016; see https://www.imda.gov.sg/-/media/imda/files/regulation-licensing-and-consultations/codes-of-practice-and-guidelines/subcablelanding.pdf?la=en

45 Office of the Communications Authority (OFCA); see https://www.ofca.gov.hk/en/industry_focus/infrastructures/submarine_cables/index.html

46 Designated body of water where submarine cables can be deployed

the deployed cables. The underlying intent of creating the corridors is to protect critical communications infrastructure from damage.

The International Cable Protection Committee (ICPC) advises spatial separation of cables from other marine activities for effective submarine cable protection.[47] With adequate separation of cables themselves, operators are ensured unconstrained access for both installation and maintenance of submarine cables without risking damage to neighbouring cables.

Discretionary cable protection zones, rather than mandatory zones, provide active protection to submarine cables through air and sea patrols along with infringement penalties. Mandatory cable protection zones promote geographic clustering of cables and do not provide sufficient spatial separation of cables for installation and maintenance. This is because submarine cables must route through defined geographic areas as opposed to more flexible routing options in the discretionary case.

With these considerations in mind, ICPC recommends:

- Adopting *and* enforcing separation distances between cable ships and other vessels in the exclusive economic zone and the territorial sea, with a) distances of 500 metres in shallow water with a depth of 75 metres or less and b) in greater depths of water, the distances equal to the greater of 500 metres or two times the depth of the water.
- Adopting cable protection zones with the consultation and support of cable operators.
- Adopting an approach that maintains flexibility with respect to the number and size of cable protection zones.
- Implementing more rigorous approaches to nautical charting that ensure complete documentation of submarine cables and human activities that may pose risk to submarine cables.

In Singapore, the submission for permits to deploy submarine cables allows submarine cable owners to include details on the preferred route and landing location for the cables, and the regulators are known to provide flexibility and work out feasible solutions in collaboration with submarine cable owners. There are no restrictions on the buildings where a cable can terminate, resulting in a vibrant connectivity ecosystem.

## 4.3 Access to capacity from submarine cables

After submarine cable owners receive approvals from the regulatory authorities on the laying and landing of submarine cables, a branch from the main trunk of the cable will typically be deployed in the territorial waters of the country. This branch will then land at a beach manhole and terminate in the CLS. The CLS houses key equipment including the SLTE and power feed equipment (PFE), and allows the

47 ICPC – 'ICPC Government Best Practices for Cable Protection Resilience', July 2021; see https://www.iscpc.org/publications/icpc-best-practices/

interconnection with domestic networks to deliver bandwidth to MNOs/ISPs and other authorised parties in the market.

In order to benefit from the submarine cable capacity landing in their countries, governments would need to consider liberalisation of international gateways and CLSs to ensure that these are not under the control of a limited group of local players. It is also important for governments to facilitate open access to international cables,[48] and support non-discriminatory access at cost-based prices.

Singapore, Hong Kong and Japan are examples of best practice in this regard, allowing licensed foreign submarine cable owners to operate CLSs. To ensure that interconnection rates do not create a bottleneck, regulators in Singapore[49] and Hong Kong[50] take an active role in regulating terms and rates for interconnection.

In recent years, the concept of a city PoP has gained popularity. In this design, the SLTE of submarine cables will be located not at the CLS, but at a data centre in an inland location which facilitates the interconnection between submarine cables, and enterprises and telecoms operators,[51] and reduces the cost of backhaul for the customers in the country. It is important for governments to recognise this new deployment best practice and ensure that licence and permit conditions provide flexibility on the location of SLTEs. If widely adopted, city PoPs can also increase resilience and competition, by enabling enterprises and telecoms operators to easily change cables in case of a temporary break in service or in response to a better offer. It also allows cable operators to diversify their cables across multiple landing sites and buildings to ensure that the loss of a single building or landing site does not result in a catastrophic failure.

## 4.4 Protection and repair of submarine cables

Submarine cables take a relatively long period of time to be deployed. After deployment, they enter service, providing an increased amount of international bandwidth to consumers, businesses and governments in the countries in which they land. However, these cables are susceptible to damage from human activities such as fish aggregating devices (FADs),[52] stow nets, fishing, bottom-trawl fishing, sand dredging and anchoring. Submarine cables are an essential infrastructure supporting the Internet ecosystem. Governments need to protect submarine cables; if adequate protection is not available, and cable disruptions occur, governments would also need to allow submarine cable owners to send

48 Typical characteristics of an open CLS environment include no/minimal incumbent telecoms operator ownership, multi-provider backhaul connectivity to data centres, open optical interconnect platform, access to multiple beach manholes; see: https://www.submarinenetworks.com/en/insights/era-of-open-submarine-cable-systems-open-cls

49 IMDA; see https://www.imda.gov.sg/-/media/Imda/Files/Regulation-Licensing-and-Consultations/Frameworks-and-Policies/Interconnection-and-Access/RIO-Agreements-with-FBOs/Main.pdf

50 OFCA; see https://www.ofca.gov.hk/filemanager/ofca/en/content_757/traac4_2019.pdf

51 Submarine Cable Networks; see: https://www.submarinenetworks.com/en/insights/submarine-cable-networks-the-artery-connecting-the-internet-world

52 A man-made object used to attract ocean-going pelagic fish such as marlin, tuna and mahi-mahi (dolphin fish). These devices are usually buoys or floats tethered to the ocean floor with concrete blocks; see: https://en.wikipedia.org/wiki/Fish_aggregating_device

specialised ships into their waters to identify the location of the faults and conduct the necessary repairs in a timely manner. Spatial separation between cables is also important to ensure that, as far as possible, single incidents do not impact multiple cables.

*Cable protection zones should be established and enforced*

The existence of cable protection laws reduces the risk of cable damage caused by human activities within territorial waters of a country. Australia is an example of a best-practice market where cable protection zones are established in which activities such as fishing and anchoring are strictly prohibited. The cable protection zones are frequently patrolled to ensure compliance with the legislation. It should also be noted that damage to submarine cables are subject to criminal penalties in Singapore and Hong Kong.

*Ease of repair of submarine cables should be ensured*

When damage to submarine cables occurs, supply of international bandwidth to countries is affected and negatively impacts the end-user Internet experience. The economic cost increases with the time it takes to complete the repairs. When this happens, flexibility is required to enable the quickest possible repairs.

There are regulations present in some APAC countries which force the use of local ships for any maintenance activities, even when there is a lack of expertise from such local vessels or such vessels lack the physical capabilities required to carry out the repair and relay of the cable to a sufficient standard. This is due to the presence of cabotage laws that restrict the operation of sea transport services within the country to the country's own vessels. It should be noted that submarine cable repair ships are highly specialised, purpose-built vessels and typically serve multiple countries in a region. They should be allowed to access the territorial waters for repair purposes, subject to notification. The existence of cabotage laws can also potentially increase reliance on aged and less advanced ships for submarine cable repairs, often resulting in poor-quality work. These ships may also not meet the safety standards of global operators and could represent dangerous working conditions for the crew.

In some cases, submarine cable owners are required to go through a lengthy process to receive permits required for repair ships to perform work in territorial waters. Governments have the right to ensure that they have information on the ships engaged to perform the repair as well as the location and duration of repairs, but it is important to shorten the time it takes for submarine cable owners to receive the permits.

In Australia, the cabotage law in relation to submarine cables has been deregulated. Fast-track processes for cable repairs are also a welcome measure, and Taiwan is an example where 'approval in principle' can be provided that enables repairs to be performed by operators without requiring additional permits within a pre-approved time window. In ASEAN, member states have also identified seven to ten working days as the best-practice target for submarine cable repair works.[53]

53 See https://asean.org/wp-content/uploads/2012/05/ASEAN-Guidelines-for-Strengthening-Resilience-and-Repair-of-Submarine-Ca....pdf

# Annex A Economic impact assessment methodology

This annex details the quantitative, econometric approach Analysys Mason used to estimate the GDP and job impact resulting from Meta's submarine cable investments in APAC. This work was supported by experts Dr Michael Kende (Senior Adviser to Analysys Mason, Senior Fellow and Visiting Lecturer at the Graduate Institute in Geneva, Digital Development Specialist at the IFC) and Professor Neil Gandal (see bio below).

Prof. Neil Gandal is the "Henry Kaufman Professor in International Capital Markets" in the Berglas School of Economics at Tel Aviv University. He received his B.A. and B.S. degrees from Miami University (Ohio) in 1979, his M.S. degree from the University of Wisconsin in 1981, and his Ph.D. from the University of California-Berkeley in 1989. He is also a research fellow at the Centre for Economic Policy Research (CEPR).

Prof. Gandal has published numerous empirical papers using econometrics in industrial organisation, the economics of information technology, the economics of the software and Internet industries, and the economics of cybersecurity and cryptocurrencies. His papers have received more than 6000 citations at Google Scholar.

In his capacity as managing editor at the International Journal of Industrial Organization (IJIO) from 2005 to 2012, he edited many empirical papers using a wide range of econometric techniques. Following his editorship at the IJIO, he was named "Honorary Editor" of the journal. He is the only honorary editor in the history of the IJIO.

## A.1 Background

The core of our methodology rests on regressions – fitting a range of submarine cable related and economic variables against the number of submarine cables – to build equations that can be used to model different scenarios of Meta's involvement in APAC's submarine cable landscape.

In this report, our method includes two scenarios:

- Scenario 1 (With Meta investments): Meta involvement in all past, present, and planned submarine cables
- Scenario 2 (No Meta investments): No Meta involvement in all past, present and planned submarine cables

By simulating the difference between scenarios 1 and 2, we arrive at an estimate for the total impact of Meta's submarine cable investments in APAC. As the fundamental difference between the two scenarios is the number and type of submarine cable systems in which Meta has invested, we must carefully approach the difference in treatments of the cables in each scenario.

Firstly, we separate cables with Meta investments under Scenario 1 into *standard* cables and *premium* 'CASP-invested' cables. These cables in each country are generally classified as *premium* CASP cables. We recognise that some countries (including for example Japan and Singapore) already have very significant supply of submarine cables, and that several of those cables have CASP investors. Where cables land in these markets, we have considered their impact (in these markets only) to be similar to *standard* cables, rather than the greater impact of *premium* CASP cables. This is a conservative approach that leads to lower impacts of Meta cables in markets such as Singapore and Japan.

Secondly, we determine what would have happened to these cables if Meta did not invest in them. We have considered four possible outcomes:

- No change: cables in which Meta is not the primary or anchor investor, and where other CASPs play a major role, could be deployed regardless of Meta's involvement.
- Delayed deployment: some cables would be deployed even without Meta's involvement, but would have taken more time to get to completion (modelled as one year). This reflects Meta's capacity both financially and operationally to accelerate the funding and deployment process of new submarine cable systems.
- Deployment as *standard* submarine cables: for systems where a consortium of telecom operators are involved, we have considered that Meta's involvement would not be fundamental to the existence of the cable, but that without Meta it would have been deployed as a *standard* cable.
- No deployment: in this case, the submarine cable system would not have been built at all without Meta as an investor.

### A.1.1 Choice of supply, demand, and endogenous growth model equations

Before we delve into each part of the estimation process, we first provide a brief background on why we modelled the process in the way we did and then briefly discuss the data employed in the analysis.

It is well known that consumer demand for the Internet is essentially a demand for speed, that is, how fast web pages load. Speed itself depends on both latency and bandwidth. The following quotes are representative.

"While bandwidth plays a big role in how fast webpages load, the journey from one machine to another takes time to traverse. No matter how much data you can send and receive at once, it can only travel as fast as latency allows."[54]

54 See Understanding Network Bandwidth vs Latency, by Cody Arsenault, 3 August 2017; available at https://www.keycdn.com/blog/network-bandwidth

"True Internet speeds comes down to a combination of bandwidth and latency."[55]

Hence, on the supply side, we wanted to determine how investments in submarine cables affect latency and bandwidth by increasing the capacity for international connectivity.

Additionally, since demand also depends on retail prices to consumers and businesses, on the supply side, we estimate how investments in submarine cables affect IP transit prices. Despite the growing importance of direct peering relationships between ISPs and CASPs, IP transit remains an important component of retail Internet service, for which some price information is available, and where prices respond rapidly to the prevailing international connectivity environment. As a result, the price of IP transit is expected to impact retail prices to consumers and business. That is, a fall in IP transit prices typically leads to a fall in retail prices. We make this explicit in the model below.

On the demand side, we want to determine how (I) latency, (II) Internet bandwidth and (III) IP transit prices affect (IV) mobile data traffic[56] and (V) Internet penetration. The latter indicates the impact of these variables on new users choosing to go online, and the former indicates how the impact of these variables affect Internet data traffic, including from those already using it. This enables us to determine how investments effect demand.

Finally, we then wanted to examine how changes in demand – both the number of users and the corresponding data traffic - affect GDP. There are a number of existing models that have explored this relationship, which highlights the overall impact of Internet traffic on the economic performance of a country.

Thus we will estimate six equations: three supply equations, two demand equations, and an endogenous growth model equation.

### A.1.2 Data

The data for this analysis consists of panel data from countries in the APAC region from the 2010-2019 period. Panel data involves repeated observations over time for the countries in the analysis. For some countries, we do not have complete observations on all of the variables. Hence, we have what is referred to as an "unbalanced panel". Fortunately, we have a fairly large data set, which enables relatively precise estimates of the key effects.

Having a panel rather than cross-sectional data is advantageous, since a cross-section cannot control for time-invariant 'country' effects; they are included in the error term in cross-sectional analysis.[57] If these unobserved effects are correlated with the right-hand-side variables, the estimates from the

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55 What is Latency – How is Latency Different from Bandwidth, http://www.plugthingsin.com/internet/speed/latency/

56 We do not have enough data observations to estimate fixed data traffic. This is not a problem because (I) mobile data traffic is increasing much faster than fixed data traffic and (ii) there is a high positive correlation between these variables.

57 Cross-sectional data are the result of a data collection, carried out at a single point in time on a statistical unit. See: https://www.statista.com/statistics-glossary/definition/357/coss_sectional_data/

cross-sectional analysis will be biased; however, we eliminate this problem by using "fixed-effect models."

### A.1.3 Estimation

Our estimation covers three parts of the model.

- In section A.2, we estimate the supply-side impacts of an increase in submarine cable supply from investments in submarine cables on (I) latency, (II) Internet bandwidth and (III) IP transit prices.
- In section A.3, we then estimate the demand-side impact that latency, Internet bandwidth, and IP transit prices have on (IV) mobile data traffic and (V) Internet penetration.[58]
- In section A.4, we estimate equation (VI,) which measures the GDP per capita impact from an increase in mobile data traffic and an increase in Internet penetration using an endogenous growth model.

### A.1.4 Fixed Effects Models

We illustrate the importance of using a fixed-effect model by using as an example the demand model we employ for Internet penetration:

$$\textbf{(V)} \qquad \mathbf{R_{it} = \alpha_i + X_{it}\omega + \varepsilon_{it}.}$$

The variable $R_{it}$ is the penetration rate for mobile Internet service (denoted as penetration) in country *i* in year *t* – i.e. the percent of the population in country i in year t that has mobile Internet service.

The vector $\alpha_i \equiv \alpha + A_i'\delta$ is such that α is a constant and $A_i$ is a vector of unobserved time-invariant country factors. Given these unobserved time-invariant project factors, equation (V) should be estimated using a fixed effects model in which $\alpha_i \equiv \alpha + A_i'\delta$ are parameters to be estimated.[59] The δ parameters are typically not of interest, but rather are controls.

The variables in $X_{it}$ are observable time-varying country factors (like bandwidth and latency) and ω are parameters to be estimated. These parameters indicate the impact of the factors on penetration. Hence, the ω are parameters are the ones we are the interested in. Finally, $\varepsilon_{it}$ is an error term.

We employ these fixed effect models for equations I-V. In section A.4, we discuss the endogenous growth equations employed in equation (VI).

58 In the estimation equation for Internet penetration, we note that countries with lower Internet penetration rates will be more so. Thus we excluded countries in year *t* with Internet penetration rates above 75%.

59 As Angrist and Pischke note, treating $\alpha_i$ as parameters to be estimated is equivalent to estimating in deviations from the mean; see Angrist, J., and J. Pischke, 2009, 'Mostly Harmless Econometrics', Princeton University Press, Princeton, New Jersey.

## A.2 Supply side estimation: How submarine cable supply affects (I) latency, (II) Internet bandwidth, and (III) IP transit prices

The goal in this section is to examine how submarine cable supply affect latency, Internet bandwidth, and IP transit prices.

We have three supply equations:

(I) Latency
(II) Internet bandwidth
(III) IP transit prices

### A.2.1 Supply side: latency

We begin with equation I: latency. We use a log/log functional form which is typically employed in empirical work.[60]

$$\textbf{(I)} \qquad L_{it} = \alpha_i + \beta{*}C_{it} + \delta{*}P_{it} + \varepsilon_{it}.$$

Where

- $L_{it}$ is the natural logarithm of latency in milliseconds for round-trip time as of December of each year.
- $C_{it}$ is the natural logarithm of the total number of international submarine cables (SMC in the country at a point in time: $Cit=\ln(SMC_{it})$ )
- $P_{it}$ is the natural logarithm of the total number[61] of "premium" CASP international submarine cables (SMC in the country at a point in time: $P_{it}=\ln(PSMC_{it})$ )

Recall that the "it" subscript means "in country i, in year t".

The results of estimating equation (I) are shown in the first regression in Figure A.1. The negative coefficient on the number of submarine cables makes sense. Latency (time) falls when the number of submarine cables increases. Further, latency additionally falls if the marginal cable is a premium cable. The estimated coefficients in Figure A.1 are both statistically significant at the 99 percent level of confidence.

Since the variables are in (natural) logarithms, the coefficient is an elasticity and can easily be interpreted. For example, the –1.23 means that a one percent increase in the number of submarine cables reduces latency by 1.23 percent.

60 The coefficients (α β, δ etc.) in all of our equations are, of course, different. We use the same notation for simplification and clarity.

61 Note that we use the absolute number of submarine cables in these equations, differing from the *share* of total submarine cables as in our previous work estimating impacts of Google's infrastructure investments.

Further, even after controlling for the total number of cables, premium cables provide additional benefits. In particular, a one percent increase in the number of "premium" CASP submarine cables reduces latency by an additional 0.88 percent.

Adding the two coefficients together, a one percent increase in premium CASP cables reduces latency by 2.11 (1.23+0.88) percent.

### A.2.2 Supply side: Internet bandwidth

We now estimate equation (II), the Internet bandwidth equation. We do this (A) using total Internet bandwidth (IBW) and (B) using Internet bandwidth per user (IBW_per). The results are qualitatively similar.

$$\textbf{(IIA)} \quad \mathbf{IBW_{it} = \alpha_i + \beta{*}C_{it} + \delta{*}P_{it} + \varepsilon_{it}.}$$

$$\textbf{(IIB)} \quad \mathbf{IBW\_per_{it} = \alpha_i + \beta{*}C_{it} + \delta{*}P_{it} + \varepsilon_{it}.}$$

Where

$IBW_{it}$ = is the natural logarithm of the total used capacity of international Internet bandwidth as measured as the sum of capacity of all Internet exchanges offering international bandwidth.

$IBW\_per_{it}$ = is the natural logarithm of the total used capacity of international Internet bandwidth per user (as measured as the sum of capacity of all Internet exchanges offering international bandwidth divided by the number of users).

$C_{it}$ and $P_{it}$ are the same explanatory variables we used in equation (I).

The results of estimating equation (IIA) are shown in the second regression in Figure A.1. The positive coefficients on the number of submarine cables makes sense. Internet bandwidth increases when the number of submarine cables increases. Internet bandwidth further increases if the additional cable is a premium cable. The estimated coefficients are statistically significant at the 99 percent level of confidence.

The results show that a one percent increase in the number of submarine cables increases Internet bandwidth by 4.01 percent. Further, even after controlling for the total number of cables, premium cables provide additional benefits. In particular, a one percent increase in the number of "premium" submarine cables increases Internet bandwidth by an additional 0.83 percent.

Adding the two coefficients together, a one percent increase in premium cables premium cables increases Internet Bandwidth by 4.84 (4.01+0.83) percent.

The results of estimating equation (IIB) are shown in the third regression in Figure A.1. The positive coefficients on the number of submarine cables makes sense. Internet bandwidth per user increases when the number of submarine cables increases. Internet bandwidth per user further increases if the additional cable is a premium cable. The estimated coefficients are statistically significant at the 99 percent level of confidence.

The results show that a one percent increase in the number of submarine cables increases Internet bandwidth per user by 2.11 percent. Further, even after controlling for the total number of cables, premium cables provide additional benefits. In particular, a one percent increase in the number of "premium" submarine cables increases Internet Bandwidth by an additional 1.10 percent.

Adding the two coefficients together, a one percent increase in premium cables premium cables increases Internet bandwidth per user by 3.21 (2.11+1.10) percent.

### A.2.3 Supply side: IP transit price

We now estimate equation (III), the IP transit price equation.

$$\textbf{(IIIA)} \quad \mathbf{IP_{it} = \alpha_i + \beta^*C_{it} + \delta^*P_{it} + \varepsilon_{it}.}$$

Where

$IP_{it}$ = is the natural logarithm of the IP transit price. This is the price for a data rate of 10Gbit/s averaged over all four quarters of each year.

$C_{it}$ and $P_{it}$ are the same explanatory variables we used in equation (I).

The results from equation (IIIA) are shown in the fourth regression in Figure A.1. The negative coefficient on the number of submarine cables make sense. IP transit prices fall when the number of submarine cables increases. The results show that a one percent increase in the number of submarine cables decreases IP transit prices by 2.15 percent.

Further, even after controlling for the total number of cables, premium cables provide additional benefits. In particular, a one percent increase in the number of *premium* submarine cables reduces IP transit prices by an additional 0.69 percent.

Adding the two coefficients together, a one percent increase in premium cables premium cables reduces IP transit price by 2.84 (2.15+0.69) percent. The estimated coefficients are statistically significant at the 99 percent level of confidence.

We now repeat the estimation of the IP transit pricing equation (IIIB) using a log/linear functional form. This functional form is also common in empirical work. As we show below, the results using the two functional forms are very similar.

$$\textbf{(IIIB)} \quad \mathbf{IP_{it} = \alpha_i + \beta^*SMC_{it} + \delta^*PSMC_{it} + \varepsilon_{it}.}$$

Where

$IP_{it}$ = is the natural logarithm of the IP transit price we used in equation (IIIA)

$SMC_{it}$ is the total number of submarine cables in year t in country i.

$PSMC_{it}$ is the total number of premium cables in year t in country i.

The results of estimating equation (IIIB) are shown in the second regression in Figure A.1. The negative coefficient on the number of submarine cables makes sense. IP Transit Price falls when the number of submarine cables increases. Further, IP Transit Price falls additional if the additional cable is a premium cable. As the Table shows, the estimated coefficients are both statistically significant at the 99 percent level of confidence.

Since the right-hand side variables are in totals, the coefficients are best interpreted at the means of the variables. For example, in the data, the average number of cables is approximately 10. Hence, an additional cable (which is approximately a ten percent increase) leads to a 20% percent decrease in IP transit prices.[62]

Note that the effect is fairly similar to the effect measured in the log/log equation (IIIA). From that equation a 10% increase in the number of cables leads to a 21.5 percent decrease in IP transit prices.

Further, even after controlling for the total number of cables, premium cables provide additional benefits. Both of the estimated coefficients are statistically significant at the 99 percent level of confidence.

A table of the supply side regression results can be found below in Figure A.1. Note that all estimated coefficients are statistically significant at the 99% confidence interval

*Figure A.1: Fixed effects supply side regressions: Explaining Latency, Internet bandwidth, and IP transit prices [Source: Analysys Mason, 2021]*

| | Regression I: Latency (log/log)<br>Estimates (std. error) | Regression IIA: Internet bandwidth (log/log)<br>Estimates (std. error) | Regression IIB: Internet bandwidth per user (log/log)<br>Estimates (std. error) | Regression IIIA: IP transit prices (log/log)<br>Estimates (std. error) | Regression IIIB: IP transit prices (log/linear)<br>Estimates (std. error) |
|---|---|---|---|---|---|
| Standard SMC | –1.23 (0.15) | 4.01 (0.33) | 2.11 (0.31) | –2.15 (0.39) | -2.18 (0.035) |
| CASP SMC | –0.88 (0.10) | -0.83 (0.23) | 1.10 (0.19) | –0.69 (0.18) | -2.67 (0.084) |
| Observations | 179 | 167 | 159 | 118 | 118 |

62 This is calculated by exp(–0.22)=0.80 and 1–0.80=0.20

## A.3 Demand side estimation: How (I) latency, (II) Internet bandwidth, and (III) IP transit prices affect (IV) mobile data traffic and (V) Internet penetration

In this section, we estimate two demand side equations that depend on the three variables modelled with the supply side equations: latency, Internet bandwidth, and IP transit prices. We arrive at two demand side equations:

(IV) Mobile data traffic
(V) Internet penetration

### A.3.1 Demand side: mobile data traffic

We now estimate equation (IV), the demand side equation for mobile data traffic.

$$\textbf{(IV)} \qquad D_{it} = \alpha_i + \beta * IBW_{it} + \gamma L_{it} + \delta IP_{it} + \varepsilon_{it}.$$

All variables are in natural logarithms.

Where

$D_{it}$ is the total cellular data traffic (downstream and upstream) generated by all devices including fixed wireless devices in a given period. It includes both business and residential segments for country i at time t. We call this variable mobile Internet data traffic.

$IBW_{it}$ is Internet bandwidth as defined above.

$L_{it}$ is Latency as defined above.

$IP_{it}$ is the price of IP transit, as defined above.

We make the following assumptions in order to be able to estimate equation (IV):

1. There is monopolistic competition in the provision of IP transit data. This means that the price ($P_{it}$) in country i at time t is a multiple (greater than one) of the marginal cost (MC) of the provision of IP transit data in country i at time t. While international services may have more market power in some countries, policy and regulatory pressures may take the place of competition in restraining the price.

2. The marginal cost (MC) of the provision of Internet service to business or residential segments is a constant ($\tau$) multiplied by the price of IP transit data: $MC_{it} = \tau\ IP_{it}$,

3. We assume that there is also monopolistic competition in the provision of Internet service. Thus the price is a multiple of the marginal cost, where the multiple ($\xi$) is greater than one.

Taken together, these three assumptions mean that the price of the provision of Internet service $PIS_{it}$ is a multiple of the price of IP transit.

In other words, thus, $PIS_{it} = \xi * \tau * IP_{it}$ where the price of IP transit data itself is a function of its marginal cost.

We assume that the marginal costs are determined by technology, that is, marginal cost is exogenous to the equations we are estimating. This means that the retail price of the provision of Internet service is exogenous. This is important because it means that we do not have simultaneous equations bias. Such bias occurs when the price is endogenous.

Now, of course we do not know $\xi$ or $\tau$. But since equation (IV) above and equation (V) below are in logarithms, note that $\ln(PIS_{it}) = \ln[\xi * \tau * IP_{it})] = \ln(\xi) + \ln(\tau) + \ln(IP_{it})$. Since $\ln(\xi)$ and $\ln(\tau)$ are constant, they become part of the coefficient of the constant and are not necessary for our estimation. Hence, we can estimate equation (IV) above and equation (V) below without knowing $\xi$ or $\tau$.

The results of the estimation of equation (IV) are shown in the first column of Figure A.2. The coefficients on all of the explanatory variables make sense. Mobile Internet data traffic increases when Internet bandwidth increases. Controlling for this effect, mobile Internet data traffic increases when latency decreases. Finally, Mobile Internet data traffic increases when the price falls.

The estimated 0.62 coefficient on Internet bandwidth means that a one percent increase in Internet bandwidth per capita leads to a 0.62 percent increase in mobile Internet data traffic. This estimated coefficient is significant at the 99 percent level of confidence.

Similarly, the estimated –0.57 coefficient on latency means that a one percent decrease in latency leads to a 0.57 percent increase in mobile Internet data traffic. This estimated coefficient is significant at the 99 percent level of confidence.

Further, the –0.58 coefficient on IP transit price means that a one percent decrease in IP transit price leads to a 0.58 percent increase mobile Internet data traffic. This estimated coefficient is significant at the 99 percent level of confidence.

### A.3.2 Demand side: Internet penetration

We now estimate equation (V), the demand side equation for the penetration rate ($R_{it}$) which is the percent of the population who are Internet users in country i at time t.

$$\textbf{(V)} \qquad \mathbf{R_{it} = \alpha_i + \beta * IBW\_per\_{_{it}} + \gamma L_{it} + \delta P_{it} + \varepsilon_{it}.}$$

Again, all variables are in natural logarithms.

$R_{it}$ is the Internet penetration rate

$IBW\_per\_{_{it}}$ is the Internet Bandwidth per User as defined above.

$L_{it}$ is latency as defined before.

$PI_{it}$ is the price of IP transit as before.

We report our results in the second column on Figure A.2.

The coefficients on the explanatory variables make sense. The penetration rate increases when Internet bandwidth per user increases. Controlling for this effect, the penetration rate increases when latency decreases. Finally, the penetration rate increases when the price declines.

It should be noted that the coefficients on Internet bandwidth per capita and latency are significant at the 99 percent level of confidence. The coefficient on price is however not statistically significant.

Since all of the variables are in (natural) logarithms, the coefficients are elasticities and can easily be interpreted:

The estimated 0.15 coefficient on Internet bandwidth per user means that a one percent increase in Internet bandwidth leads to a 0.15 percent increase in the penetration rate.

Similarly, the estimated –0.27 coefficient on latency means that a one percent decrease in latency leads to a 0.27 percent increase in the penetration rate.

Finally, the estimated –0.0060 coefficient on price means that a one percent decrease in price leads to a 0.0060 percent increase in the penetration rate.

*Figure A.2: Demand side regressions: Explaining (IV) Mobile Internet data traffic and (V) Internet penetration [Source: Analysys Mason, 2021]*

| | Regression IV: Mobile Internet data traffic<br><br>Estimates (std. error) | Regression V: Internet penetration<br><br>Estimates (std. error) |
|---|---|---|
| Internet bandwidth | 0.62 (0.11) | |
| Internet bandwidth per user | | 0.15 (0.049) |
| Latency | –0.57 (0.18) | –0.27 (0.062) |
| IP transit price | –0.58 (0.15) | –0.0060 (0.058) |
| Observations | 100 | 50 |

## A.4 Endogenous growth model for estimating economic impact: GDP and job creation

### A.4.1 Impact on GDP from change in mobile data traffic

Endogenous growth models became popular in the 1980s. Such models are different from traditional (classical) growth models because endogenous growth models assume that growth is an endogenous outcome, not the result of (say) external technological progress. Paul Romer provides a survey in the Journal of Economic Perspectives.[63]

63 Paul Romer, 'The Origins of Endogenous Growth', 1994; see Journal of Economic Perspectives, Volume 8, Number 1, Winter 1994, pages 3–22.

In the telecommunications literature, endogenous growth models have been used to examine the relationship between changes in telecommunications use and economic growth.

The model we employ comes from an IMF paper by Andrianaivo and Kpodar (1994).[64] In that paper, they examined how ICT and financial inclusion affect economic growth in African countries. A modified version of the model used by Andrianaivo and Kpodar (2011) was also employed by in a Deloitte/GSMA study (2012)[65] in order to estimate the impact of mobile telephony on economic growth. Hence it seems natural to employ this model.

The model can be written

$$\textbf{(VI)}\ \mathbf{Y_{it} = \alpha_i + \rho^* y_{i,t-1} + \beta D_{it} + \delta R_{it} + \gamma X_{it} + \varepsilon_{it},}$$

Where

$Y_{it}$ is the GDP per capita in country i at time t

$Y_{i,t-1}$ is the GDP per capita in country i at time t-1

$D_{it}$ is the Internet data traffic from above.

$R_{it}$ is the penetration rate from above

For equation (VI), total cellular data traffic (downstream and upstream) generated by all cellular

The variables we employ in $X_{it}$ are:

Ratio_govt_gdp = the ratio of government expenses to GDP in country i at time t.

Ratio_trade_gdp = the ratio of international trade to GDP in country i at time t

The unemployment rate = the number of people looking for work, divided by the sum of the number of people employed and the number of people looking for work.

These variables were also used in the Deloitte/GSMA (2012) model. Deloitte/GSMA (2012) use a six-year horizon for the estimation of the endogenous growth model. Hence, we include data from 2014-2019, which is also a six-year time horizon.

All of the variables are in natural logarithms. Hence, the coefficients can be interpreted as elasticities.

64 Andrianaivo and Kpodar, 'ICT, Financial Inclusion, and Growth: Evidence from African Countries', 2011, see 'International Monetary Fund Working Paper'; https://www.imf.org/external/pubs/ft/wp/2011/wp1173.pdf

65 Deloitte/GSMA, 'What is the Impact of Mobile Telephony on Economic Growth', 2012; see https://www.gsma.com/publicpolicy/wp-content/uploads/2012/11/gsma-deloitte-impact-mobile-telephony-economic-growth.pdf

This is a dynamic panel data (DPD) model, since the lagged value of GDP ($Y_{i,t-1}$) appears on the right hand side. The empirical model we employ is due to Arellano and Bond (Rev. Ec. Stud., 1991)[66] and Holtz-Eakin, Newey and Rosen (Econometrica, 1988)[67]. It uses a Generalized Method of Moments (GMM) approach. It addresses the endogeneity problem of $y_{i,t-1}$.

By construction, the residuals of the differenced equation ($Y_{it} – Y_{i,t-1}$) should be auto-correlated of order one, i.e., an AR(1) process of serial correlation. But if the maintained assumption of serial independence in the original errors ($\varepsilon_{it}$) is true, the differenced residuals should not exhibit significant AR(2) behavior. If a significant AR(2) statistic is found, the second lags of the endogenous variable will not be appropriate instruments for their current values and we cannot use the model. This leads to a test, called the Arellano-Bond test, which we describe below.[68]

The results are shown in Figure A.3 below. For equation (VI), since all of the variables are in (natural) logarithms, the coefficients have an elasticity interpretation. The estimate of our coefficient of interest is the one on mobile data traffic. The value of 0.015, which is significant at the 99% level of confidence, means that a ten percent increase in mobile data use leads to a 0.15% increase in GDP per capita. Controlling for data traffic, additional penetration does not lead to a significant increase in GDP per capita.

*Figure A.3: Endogenous Growth Model: (VI, VII) coefficients for GDP per capita growth [Source: Analysys Mason, 2021]*

| | **Regression VI: GDP growth per capita**<br>Estimates (std. error) |
|---|---|
| GDP per capita (lagged) | 0.70 (0.13) |
| Mobile data traffic | 0.015 (0.0058) |
| Internet penetration | 0.0072 (0.0084) |
| Ratio_Govt_GDP | –0.018 (0.030) |
| Ratio_Trade_GDP | 0.021 (0.0092) |
| Employment rate | –0.055 (0.063) |
| Observations | 72 |

For equation (VI), the Arellano-Bond test for zero autocorrelation in first-differenced errors

66 Arellano and Bond, 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations', Apr 1991; see The Review of Economic Studies, Vol. 58, No. 2, pages 277–297.

67 Holtz-Eakin, Newey, and Rosen, 'Estimating Vector Autoregressions with Panel Data', 1988; see Econometrica, Vol. 56, Issue 6, pages 1371–95.

68 We employ the estimation procedure in Stata denoted "xtabond" to estimate the model and conduct the Arellano-Bond test. See https://blog.stata.com/2015/11/12/xtabond-cheat-sheet/

| Order | Z | Probability > Z |
|---|---|---|
| 1 | −1.89 | 0.059 |
| 2 | −1.34 | 0.18 |

*Figure 4.4: Equation (VI) – Arellano-Bond test for zero autocorrelation in first-differenced errors [Source: Analysys Mason, 2021]*

Since we cannot reject the null hypothesis that there is second order autocorrelation, the assumptions of the model hold.

### A.4.2 Impact on jobs supported by the increase in GDP

Our approach to estimating the impact of Meta's network infrastructure investments on jobs involves three key steps:

- Part A: We first translate the GDP impact into the gross-value-added (GVA) impact
- Part B: Next, we estimate the average GVA per job affected by Meta's investments in network infrastructure
- Part C: Lastly, we estimate the job impact by dividing the GVA impact by GVA-per-job assumptions.

### A.4.3 Part A: Estimation of GVA impact

We first estimate the GVA effect of the GDP impact calculated above, for each country/territory, using a GDP-to-GVA ratio.[69] This allows us to relate economic impact at national level to an industry-level metric which is more directly related to factors of production including labour and therefore jobs. For forecast years from 2021 to 2025, we use the 2020 GDP-to-GVA ratio.

### A.4.4 Part B: Estimation of GVA per job

Next, we estimate the GVA per job with weighting on industries likely to be most affected by developments in broadband connectivity, for each country/territory, in each year. Equinix's Global Interconnection Index[70] suggests that the primary beneficiaries of an increased consumption of Internet data traffic are likely to be the 'manufacturing', 'transport, storage and communications' and 'financial intermediation' industries.[71]

### A.4.5 Part C: Estimation of job impact

Lastly, we divide the GVA impact by the calculated GVA per job for each country to estimate the number of new jobs that have been created with the higher GVA. The GVA per job estimates at a

69 Gross value added (GVA) is a measure of contribution to GDP made by an individual industry; GDP-to-GVA ratio is derived from Euromonitor's database.

70 Equinix – "Global Interconnection Index"; see https://www.equinix.com/gxi-report/

71 Based on the list of industries available as part of Euromonitor's gross value-added dataset

country level account for general growth in productivity, in-line with overall economic growth. These country-level job impact estimates are then aggregated to form the overall job impact of Meta's submarine cable investments. We recognise that improving digital connectivity could result in a further increase workforce productivity and therefore additional increase in GVA per job. Without estimating the further increase in GVA per job caused by this productivity boost, we arrive at an upper bound of the number of jobs supported by the additional GDP enabled.

## A.5 Range of impact scenarios on GDP and job creation

Given that the equations derived from the econometric modelling are based on historical data from 2010 to 2020, we have elected to choose a more conservative value of the coefficients within the 95% confidence interval range for the various supple-side and demand-side equations to simulate the impact of Meta's submarine cable investments in future years. This is also driven by the fact that there will be other non-Meta cables launching in the future in similar countries which have yet to be announced. For the avoidance of doubt, the coefficients that we have used in our modelling are provided in Figure A.5 below and the range of GDP and job impact between the scenario adopting the most conservative coefficients and the average coefficients are provided in Figure A.6 below.

| Variables | Value of coefficients |
|---|---|
| *Supple-side model* | |
| CASP cable impact on Bandwidth | 0.3780273 |
| CASP cable impact on Latency | -0.6728224 |
| CASP cable impact on IP transit price | -0.3382115 |
| *Demand-side model* | |
| Bandwidth impact on mobile data traffic | 0.4025333 |
| Latency impact on mobile data traffic | -0.2032615 |
| IP transit price on mobile data traffic | -0.27969 |
| *Endogenous growth model* | |
| Mobile data traffic impact on GDP | 0.00979005 |

*Figure A.5: Co-efficient of variables in base case [Source: Analysys Mason, 2021]*

| Scenario | 2021-2025 GDP impact | Jobs supported in 2025 |
|---|---|---|
| Most conservative value for coefficients | 141 billion | 1.2 million |
| Analysys Mason base case coefficients | 422 billion | 3.7 million |
| Average value for coefficients | 1,711 billion | 15 million |

*Figure A.6: Range of output on GDP and job impact [Source: Analysys Mason, 2021]*

# Annex B Supporting research on the impact of improved connectivity outcomes on individuals, businesses, and governments

This annex provides details of supporting research on the impact of improved connectivity outcomes on individuals and businesses. Figure B.1, Figure B.2, and Figure B.3 focus on the benefits received by individuals, enterprises, and governments respectively.

*Figure B.1: Individuals benefit through increased access to information and services, which leads to improved quality of life, health, education, and income[72] [Source: Analysys Mason, 2021]*

| Impact metric | How connectivity affects outcomes | Examples of Internet-enabled service |
|---|---|---|
| Reduction in infant mortality | A 1 percentage point (pp) change in Internet take-up reduces infant mortality for the served communities by between 0.68pp and 1.43pp | • Although Vietnam's overall child mortality rate has dropped from 51.4 instances per 1000 live births in 1990 to 20.7 in 2018, a more detailed analysis shows that ethnic minority people have fertility rates and infant mortality rates that are much higher than the ethnic majority group. Ethnic minority women typically live in lower-income, more remote mountainous communities and are much less likely to attend antenatal or postnatal care or deliver their babies in a health facility. To address the problem, a research team from Vietnam's Institute of Population, Health and Development (PHAD) established a Maternal and Child Health Information Centre in 2015; the main mechanism of the PHAD was reaching out to pregnant women or recent mothers via mobile messages containing crucial information about pregnancy, prenatal care, birth and post-natal care. Around 900 pregnant women were reached in the trial project in Thai Nguyen province, with 90 000 messages sent that helped increase health knowledge and attitudes in the community; more informed behaviours are expected to contribute further to the child mortality reduction in the area and, if extended, in the whole country. |

72 Sources: Viswanath, V., Arun R. (2017), Sykes T. and Aljafari R.: 'Combating infant mortality in rural India: evidence from a field study of eHealth kiosk implementations'. The impact range taken is between the 4th and the 7th year; Deloitte: 'Value of connectivity, economic and social benefits of expanding Internet access', 2014; Lenka S. and Barik R.: 'Has expansion of mobile phone and Internet use spurred financial inclusion in the SAARC countries?', 2018; Cambridge Assessment International Education: 'Global Education Census Report', 2018; Online Recruitment Market in Vietnam, mid-year 2019, VietnamWorks; https://www.entrepreneur.com/article/330561; Bangkok Post: 'State launches telemedicine in rural areas', 2019; International Development Research Centre: 'Connecting Vietnam's isolated communities to improve healthcare', 2018.

| Impact metric | How connectivity affects outcomes | Examples of Internet-enabled service |
|---|---|---|
| Reduction in number of deaths | A 1% increase in Internet take-up should reduce deaths by 0.15% on an annual basis | • According to World Health Organisation standards, there should be at least one doctor for every 439 people in a given community. In Thailand today, one doctor has to serve 2065 people. The problem is primarily caused by low access to healthcare in remote regions, which are seen as too costly to be served through traditional means. To address the challenge, in 2019 the Public Health Ministry of Thailand partnered with the National Broadcasting and Telecommunications Commission and began development of the nationwide telemedicine programme. The programme first launched at 32 rural hospitals in eight provinces, with the aim to eventually cover 3920 remote villages and 600 000 households. In addition to enabling these households to receive healthcare that was previously unavailable or inefficient, the programme is expected to save patients and public hospitals USD1.2 billion annually within four years of implementation. |
| Improved learning outcomes | 14% of Internet users take at least one online course per year | • Improving broadband connectivity in Indonesia has enabled the increasing use of online resources by students and teachers; this is a step towards addressing the wide disparity between Java and the other outer islands when it comes to quality of education and training providers. Notably, Ruangguru, a start-up that provides an online platform for tutoring, has been used by over 15 million students and 400 000 teachers since its inception in 2014. In 2018, Cambridge International's Global Education Census also found that Indonesian students are among the world's highest users of technology in education, with more than two-thirds of Indonesian students using smartphones for studying in class and an even larger total using smartphones to do their homework (81%). |
| Increased number of online job applications | 26% of Internet users search or apply for a new job | • VietnamWorks is one of Vietnam's leading online recruitment platforms, with over 6.8 million monthly visits, and over 5.5 million job applications on 126 000 job postings on its platforms annually. Increased take-up of broadband has contributed to substantial growth in users for VietnamWorks – the number of applications on VietnamWorks' platforms increased by a compound annual growth rate (CAGR) of 14.3% between the first half of 2014 and 2019. |
| Improved financial inclusion | A 1% increase in Internet take-up should increase the number of banked people by 0.42% | • OVO, a standalone digital payments app backed by the ride-hailing giant, Grab, and local conglomerate Lippo Group, is the top e-wallet application in Indonesia. OVO's partner ecosystem includes more than 300 000 retailers, and leading Indonesia digital service providers (e.g. Grab and Tokopedia). In 2018, OVO announced that it had exceeded 1 billion annual transactions, a 75-fold increase from 2017. Over 110 million people, spread across 300 Indonesian cities, currently use OVO. CEO Jason Thomson estimates that OVO serves 98% of the adult population of the country and is a major contributor to financial inclusion in Indonesia. |

*Figure B.2: For enterprises, connectivity benefits result from increased organisational efficiency and ease of reaching and communicating with customers[73] [Source: Analysys Mason, 2021]*

| Impact metric | How connectivity affects outcomes | Examples of Internet-enabled service |
|---|---|---|
| New businesses created | A 1% increase in residential connectivity penetration should lead to 0.47% growth in the number of firms | • Thailand's nationwide programme, Thailand 4.0, was launched in 2016 with the aim to boost innovation and entrepreneurship in the country, helping aspiring or rising entrepreneurs through incubation programmes and policies supportive of emerging businesses. In order to promote cross-functional collaboration between different stakeholders, the government supported the creation of True Digital Park, whose key goal is to bring together start-ups, multinationals, small and medium-sized enterprises (SMEs), investors, universities and other digital economy players, to accelerate recognition of Thailand as a technology innovation hub in South-East Asia. |
| Development of e-commerce | Products purchased online are estimated to be 10% cheaper than their offline counterparts | • Vietnam's e-commerce market is experiencing a period of rapid growth, and online sales have increased from USD2.2 billion in 2013 to USD6.2 billion in 2017. It is estimated that the country's e-commerce market will reach USD15 billion by 2025. GlobalWebIndex estimates that, of the 59 million Internet users in Vietnam, 78% of those aged between 16 and 64 have purchased a product or service online. Together with regional e-commerce providers Lazada and Shoppee, the homegrown start-ups Tiki, Thegioididong and Sendo are amongst Vietnam's leading e-commerce players, each with more than 20 million web visits per month.[74] |
| Development of the agriculture sector | Agriculture is one of the key industries in ASEAN; the sector's productivity is expected to increase with the rise of technologies such as artificial intelligence, autonomous machinery and smart sensors | • The 'Green Way' app in Myanmar was developed to combat low productivity in the agriculture sector. The app provides farmers with up-to-date information on weather, crop prices and advice on pesticides and fertilisers. The founders initially set up a website with similar intentions in 2011 but it could not be sustained due to low Internet penetration. This has changed due to the liberalisation of the mobile sector, and the proliferation of smartphones since 2013. Today, with smartphone penetration at more than 80%, most farmers own a smartphone device. They have taken advantage of the mobile Internet to enhance agricultural productivity. More than 100 000 farmers across 329 townships had downloaded the app within |

73 Source: DIRSI, 'The Internet and Poverty: Opening the black box', July 2014; American Economic Review, 'Are Online and Offline Prices Similar? Evidence from Large Multi-Channel Retailers', January 2017; World Bank; ITU, 'The impact of broadband on the economy', 2012; Deloitte, 'Retail in Vietnam: Navigating the digital retail landscape', 2019; see https://datareportal.com/reports/digital-2019-ecommerce-in-vietnam; https://iprice.vn/insights/mapofecommerce/en/; https://www.nationthailand.com/Startup_and_IT/30339171; The ASEAN Post, 'Myanmar's farmers go hi-tech', 2019; Microsoft Philippines Communications Team, 'Digital Transformation to Contribute USD8 billion to the Philippines GDP by 2021', 2018; see https://www.techinasia.com/building-southeast-asias-startup-ecosystem-true-digital-park; Asia Outlook, 'Evaluating the role of technology in ASEAN-6'; see https://www.asioutlookmag.com/news/evaluating-the-role-of-technology-in-asean-6

74 Based on statistics gathered by iPrice in Oct 2019.

| Impact metric | How connectivity affects outcomes | Examples of Internet-enabled service |
|---|---|---|
| | | the first three years of its inception in 2016, and the founders' set of a goal of serving 2 million farmers in the following three years. |
| Business performance improvement | Enterprises connected to the Internet have higher productivity (10% higher in the services sector, 20% in information and 5% in manufacturing) | • A 2018 IDC study of 100 business leaders in the Philippines found that businesses undergoing digital transformation are expected to obtain more than 50% improvements in profit margin, productivity, revenue from new products and services, customer advocacy and cost reductions. The Microsoft-commissioned study also predicts that approximately 40% of the Philippines' GDP will be derived from digital products or services by 2021 – up from 3% of GDP in 2017. Digital transformation is also expected to add 0.4% CAGR to GDP growth annually by 2021. |

*Figure B.3: For governments, connectivity improvements can also boost efficiency and transparency, as well as increasing the reach and quality of e-government services[75] [Source: Analysys Mason, 2021]*

| Impact metric | Research-based relationship between the metric and connectivity | Examples of Internet-enabled service |
|---|---|---|
| Information provision | Internet connectivity should significantly increase the availability of high-quality, timely and reliable data, which can spur innovation and create opportunities for all stakeholders | • Digital Government Development Agency (DGA) was founded in 2018 under the Thai Office of the Prime Minister to provide services and support to all government agencies with regard to digital government transformation. Its initiatives include the e-government portal www.egov.go.th, a central information hub that helps people obtain public services provided by different Thai agencies. It also introduced the CITIZENinfo app in 2019 to provide information on the location of state agencies nationwide and the documents required for application of public services. The www.egov.go.th portal receives around 400 000 visits per month on desktop and mobile web applications. |
| Policing corruption | Meaningful Internet connectivity provides a way to overcome the most significant barrier in identifying corruption – the need to ensure anonymity for the information provider | • The ASEAN e-Government Strategic Plan 2020 recognises that using e-government systems, online platforms and mobile technologies to increase transparency is a key developmental objective. Anti-corruption agencies of Indonesia (KPK) and Malaysia (MACC) operate online portals and mobile applications for reporting corruption, which attract responses from a large number of citizens. |

75 Sources: The World Bank, The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution; Bangkok Post: 'State agencies to become digitalised by 2022', 2019; https://www.similarweb.com/website/egov.go.th; https://www.treasury.gov.my/index.php/en/gallery-activities/speech/item/5105-speech-unlocking-the-potential-of-the-digital-economy.html; https://www.malaysiakini.com/news/471812; UNODC, 'Embracing digitalization: how can anti-corruption agencies in ASEAN apply innovative tools in the fight against corruption?', 23 November 2018.

| Impact metric | Research-based relationship between the metric and connectivity | Examples of Internet-enabled service |
|---|---|---|
| Take-up of e-government service | About 84% of people receive payments in cash. The ability to receive digital non-cash payments from government should significantly reduce risks of money transit | • The improvement in connectivity infrastructure sets the foundation for the Malaysian government to rapidly modernise its systems and processes to simplify processes and improve the quality of life of its citizens. Examples of government services digitalisation include online applications for vehicle insurance and road tax, and shorter waiting times for passport issuance (currently a one-hour waiting time, compared to a one-day waiting time before digitalisation). The productivity initiatives provide users with easier access to information as well as wider and quicker service reach, increasing the level of satisfaction of using e-government services. These digitalisation successes have partly contributed to Malaysia ranking highly in the World Bank's Doing Business Report (15th out of 190 economies) and in Economic Intelligence Unit's Government E-Payments Adoption Ranking report (19th out of 73 countries) in 2019. |