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REPORT FOR FACEBOOK

THE IMPACT OF FACEBOOK'S CONNECTIVITY INITIATIVES IN THE ASEAN REGION

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1 Executive summary

Facebook has launched a range of initiatives aimed at tackling the barriers to connectivity, by investing directly in infrastructure and partnering with telecoms operators and Internet service providers to improve connectivity. We estimate that the economic benefits to ASEAN countries stemming from Facebook's connectivity initiatives may reach USD70 billion over the next five years.

Access to the Internet is increasingly important throughout the world as a means for people to communicate, learn, work, trade and participate fully in everyday life. People use the Internet to access content and services that can be provided from anywhere in the world, allowing connections between friends, strangers, businesses and customers that were unimaginable a generation ago. These connections are achieved through an interconnected web of networks that enable information to be exchanged between a shopkeeper in Bangkok, a supplier in Jakarta and a customer in Kuala Lumpur.

In recent years, the infrastructure required to provide this connectivity has seen rapid development across the countries of the Association of Southeast Asian Nations (ASEAN), but more than half of the region's population remains unconnected. This reflects the connectivity gap between urban centres and rural areas and the difficulty of making a return on investment in places where incomes are low, where people may be unaware of the benefits the Internet could bring them, or may lack the skills to use online services. The challenge of infrastructure deployment in difficult-to-reach areas is therefore compounded by issues related to affordability and perceived relevance of services, and the readiness of people to get online.

In response, **Facebook has launched a range of connectivity initiatives aimed at tackling these barriers,** by providing financial and technical inputs that can make infrastructure easier and cheaper to deploy. These initiatives contribute to Facebook's mission "to give people the power to build community and bring the world closer together", by using applications and online services provided by Facebook and other providers, accessing the wealth of content available on the Internet, and creating their own content and services. These initiatives fall broadly into two categories.

First, **Facebook invests in network infrastructure,** either directly or through long-term contracts. These investments include **fibre investment under the OTNx umbrella** (currently deployed in Indonesia), **edge network infrastructure** including four points of presence in the region, and caches in operators' networks in all ten ASEAN countries, and **investment in submarine cables** and data centres (Facebook is an investor in five current and multiple planned cables landing in ASEAN countries and is building a data centre in Singapore).

Second, **Facebook has developed programmes through which it works closely with telecoms operators and Internet service providers to improve connectivity,** typically using innovative platforms and technologies that can improve the economics of network deployment and operation. These initiatives are primarily focused on access network infrastructure and aim to support operators and service providers in bringing more people online by extending network coverage and improving service affordability. In ASEAN countries, these initiatives include **Express Wi-Fi,** an end-to-end SaaS platform for launching and operating a sustainable, high-quality Wi-Fi network, through a Facebook-designed interface and workflow, onto an operator's public Wi-Fi network. It is available in Indonesia, the Philippines and Thailand, helping to bring more people online and stimulating data usage and Internet traffic overall. Facebook is also working on improving the economics of network equipment through the **Telecom Infra Project,** or TIP, which underpins a number of initiatives. These include

Terragraph, which uses high-capacity wireless networking approach to provide high-speed Internet service at a lower cost than trenched fibre infrastructure. Whilst these initiatives are not yet widespread across ASEAN (Terragraph is currently being used to provide commercial services in one city in Malaysia), they offer the prospect of lower-cost, widely accessible and affordable broadband for all.

These initiatives create socio-economic benefits for consumers, businesses and governments throughout ASEAN countries. **Individuals** benefit through increased access to information and services, which leads to improved quality of life, health, education and income. **Businesses** benefit from increased organisational efficiency and ease of reaching and communicating with customers. Finally, **governments** can use better connectivity to boost efficiency and transparency, as well as increasing the reach and quality of e-government services.

Quantifying these impacts is fraught with difficulty, but economic and econometric studies (notably by GSMA and Deloitte in 2012) provide an indication of how increased Internet take-up and usage translate into productivity and consumption, with an impact on GDP.

We estimate that the **economic benefits to ASEAN countries stemming from Facebook's connectivity initiatives may reach USD70 billion** over the next five years (2020–24), in nominal current GDP terms.[1] The biggest impact by far is linked to Facebook's investment in international capacity and edge infrastructure, which allows operators to offer much more data to end users, and benefits all Internet users (over 450 million people in the ASEAN region by 2024). Facebook's initiatives with operator partners are also enabling millions of people to get online earlier or upgrade to higher-quality Internet services: the first phase of its OTNx project in Indonesia is expected to facilitate high-speed broadband coverage to 10–15 million people, and Express Wi-Fi has already attracted nearly 70 000 monthly active users in the region, a number which is growing rapidly. The estimated economic benefits derived from selected Facebook's initiatives are shown in Figure 1.1 below.

Beyond infrastructure and connectivity initiatives, Facebook is also working to reduce barriers to end-user demand for online services, through Free Basics, one of the most extensive localisation efforts undertaken online, as well as its 'Data for Good' initiatives.[2]

FIGURE 1.1: ESTIMATED CUMULATIVE IMPACT OF FACEBOOK CONNECTIVITY INITIATIVES, 2020–2024
[SOURCE: ANALYSYS MASON, 2020; ALL VALUES IN NOMINAL USD AT PROJECTED CURRENT EXCHANGE RATES]

Source of impact	Drivers of impact	Cumulative 2020-24 GDP impact, USD billion 2015
Edge networks and submarine cables	Internet traffic / data usage	63.5
OTNx	High-speed Internet take-up and Internet traffic / data usage	6.1
Total		**69.6**

[1] This represents the overall impact of initiatives with Facebook's involvement, however some of these initiatives rely on contributions from operator partners as well as Facebook.

[2] Demand-focused initiatives are not the subject of this report, but some case studies providing more detail on these initiatives and their impact are included in Annex B. Free Basics aims to help people discover the relevance and benefits of connectivity by providing free access to basic online services; Facebook supported over 111 languages in 2019; Data for Good initiatives include the Crisis Communication Response Program (CCRP) which aims to ensure efficient connectivity in crisis conditions.

THE IMPACT OF FACEBOOK'S CONNECTIVITY INITIATIVES IN THE ASEAN REGION

Around 300 million people across ASEAN countries are not Internet users due to various barriers to connectivity

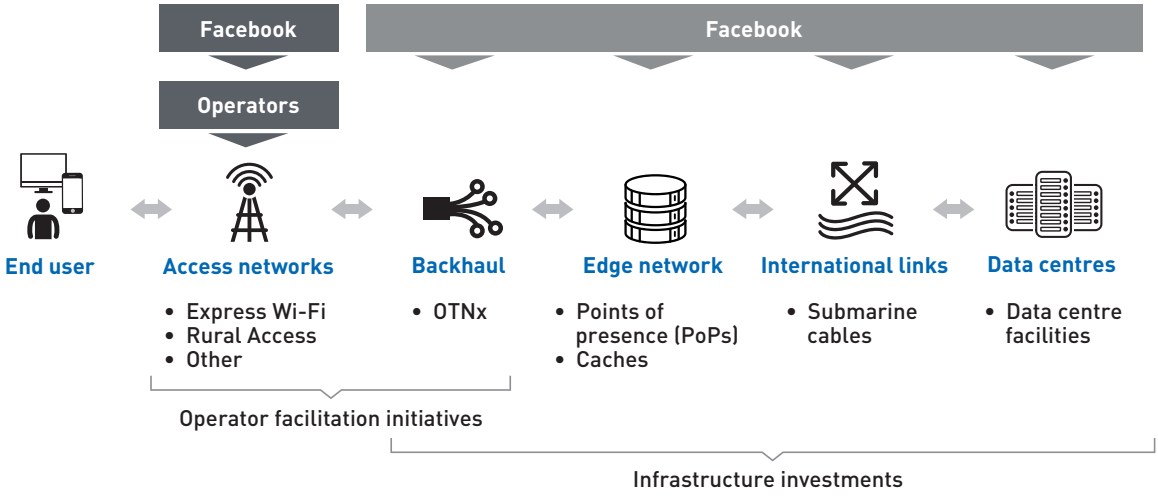
Availability
Broadband networks (e.g. 3G) are only available to 93% of the population

Relevance
Seven of the ten ASEAN countries score below the global average on local and relevant content

Affordability
1GB of monthly data is not affordable for many of those on low incomes

Readiness
Many people lack digital literacy skills and are not familiar with digital technologies

To address these barriers, Facebook is investing in initiatives across the entire connectivity value chain



These initiatives generate economic impact in ASEAN countries through improving connectivity outcomes in the region

Initiative	Fibre backhaul	Edge networks and submarine cables
Connectivity impact	Higher-speed Internet networks extended to 10-15 million people in Indonesia	Facebook's investments in edge network and international capacity will enable a 9% increase in total Internet traffic in ASEAN by 2024
Economic impact, 2020-2024[1]	USD6.1 billion	USD63.5 billion

Total 2020-2024 economic impact: USD69.6 billion

[1] Economic impact denotes cumulative nominal GDP impact of Facebook's initiatives over 2020-2024; we note that this includes only the effects that could be quantified

2 The connectivity value chain and barriers to connectivity

Connecting to the Internet requires many connections to be made, often spanning whole countries or continents and multiple networks. The end user's device must connect to the network of an internet service provider (ISP), whether through a physical medium (such as a cable made of copper wire or optical fibre) or a wireless signal (cellular or Wi-Fi). The ISP then manages the exchange of information between users and online service and content providers over infrastructure at local, national and international levels. The infrastructure and the value chain that enable this exchange of information, at high speed and on a massive scale, are complex and depend on sustained investment from many market participants. This 'connectivity value chain' is described in Section 2.1.

This report focuses on the countries of the Association of Southeast Asian Nations (ASEAN), comprising Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. The report builds on the Facebook- and Axiata-commissioned paper on the move towards the fourth industrial revolution in ASEAN, which proposes policy initiatives to facilitate development of the region's digital economy.[3]

ASEAN member countries are extremely diverse; while Singapore is one of the most advanced global markets for connectivity, much of the region remains relatively under-connected by international standards. They lag behind most developed markets in terms of connectivity infrastructure outside of the largest cities, reflecting the difficulty of making a return on investment in places where incomes are relatively low, and where the cost of deployment may be relatively high. This lack of availability of infrastructure creates its own barrier to people getting online and is compounded by issues related to the affordability of devices and services, awareness of the Internet and perceived relevance, and the ability and readiness of people to get online. The barriers to connectivity and their relationship to this value chain are explored in Section 2.2.

Section 2.3 introduces the initiatives that Facebook has launched in order to help tackle these barriers, by providing financial and technical inputs that can make infrastructure easier and cheaper to deploy.

2.1 Internet connectivity relies on a complex chain of networks and relationships

When end users access the Internet, they communicate with computers, devices and people that are also connected to the Internet, often on different networks, in different countries or even continents. In many cases, end users communicate with computers hosted in large data centres, which provide the services and host the content that users want to access or contribute. This content travels between end users and the servers of the online service or content provider across a 'connectivity value chain' (shown in Figure 2.1) consisting of various types of infrastructure.

2.2 Around 300 million people across ASEAN countries remain unconnected to the Internet due to a combination of challenges and barriers to connectivity

Through its sponsorship of the Inclusive Internet Index, Facebook consistently monitors the extent to which Internet services are available to, and being used by, people worldwide. The latest data, published in February 2020, shows that despite strong growth in Internet user numbers, nearly half of the world's population remains unconnected, a proportion that is mirrored in ASEAN: 43% of ASEAN's population did not use the internet at the start of 2020.[5]

This proportion varies across ASEAN: only 25% of people in Laos use the Internet, but the figure in Singapore is 98%. This take-up is highly correlated with the level of economic development and the degree of urbanisation (Figure 2.2), as Internet service availability and take-up is typically lower in less affluent and more rural populations.

Even among those people who do use the Internet, many do not have access to 'meaningful connectivity', as speeds and data allowances are insufficient to access multimedia and other applications that make up a full Internet experience.[7] This is sometimes due to poor network performance (e.g. only having access to slow 2G networks), and sometimes because meaningful connectivity comes at a price that is too high for many people.

[3] Analysys Mason for Facebook – Building towards ASEAN's fourth industrial revolution: digital policy building blocks for the 2020s, 27 February 2019.

[4] Data on share of people using the Internet: Euromonitor; Data on population coverage calculated based on GSMA Intelligence and Euromonitor.

[5] Facebook, The Economist Intelligence Unit - Inclusive Internet Index 2020, see https://theinclusiveinternet.eiu.com/

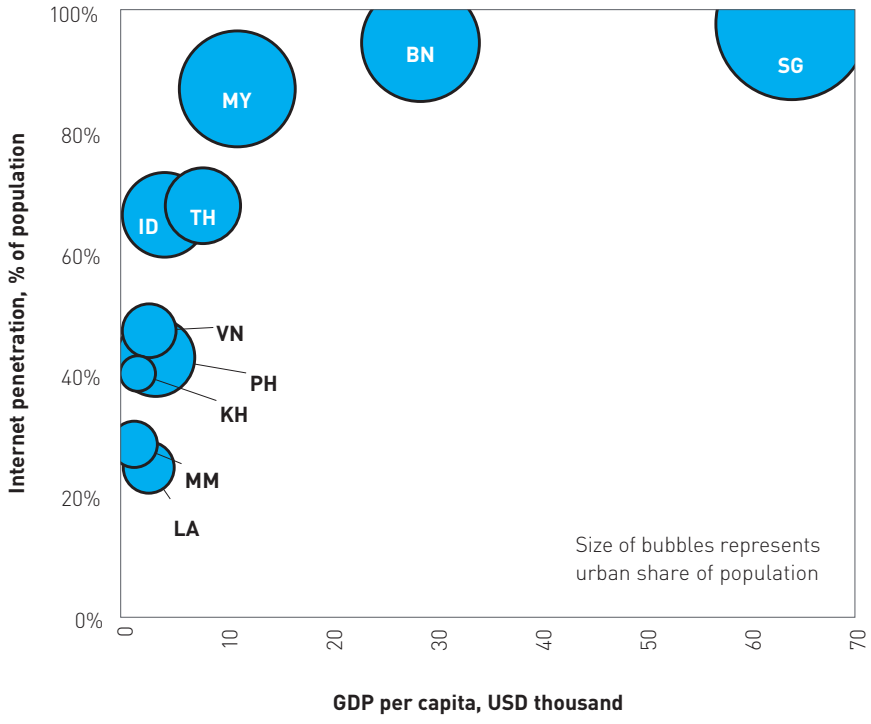
[6] Brunei data taken from ITU as it is not covered by the Inclusive Internet Index from EIU and Facebook

[7] A4Ai – "Meaningful Connectivity — a new standard to measure internet access", see https://a4ai.org/meaningful-connectivity-a-new-standard-to-measure-internet-access/

FIGURE 2.1: CONNECTIVITY VALUE CHAIN [SOURCE: ANALYSYS MASON, GSMA INTELLIGENCE, EUROMONITOR,[4] 2020]

Value chain element	End user	Access networks	Backhaul	Edge network	International links	Data centres
Description	**End users** access the Internet using browsers and applications on their devices, sending and receiving data across the connectivity value chain	**Access networks** provide the final connection to end users • mobile access networks may use different technology generations (2G, 3G, 4G, 5G) and send wireless signals to mobile devices or to fixed-wireless access (FWA) routers • fixed-line access networks may use copper or fibre-optic lines, with the latter offering higher connection speeds	**Backhaul** is the part of the network that provides connectivity from access networks to the core networks and the wider Internet. This may be high-capacity fibre cables, or use wireless technologies (e.g. microwave or satellite), depending on type of terrain, technical requirements, and cost considerations	**Edge network elements**, such as Internet exchange points (IXPs), points of presence (PoPs) and caches are used to create efficient peering links and to store content, minimising the distance that content needs to travel to reach the end user, thereby reducing the time required for the user's request to be processed (i.e. latency) and the cost of transporting data	**International links** such as submarine and terrestrial fibre cables connect remote geographies to deliver content between them	**Data centres** are facilities that store content and process data at large scale
Challenges in ASEAN countries	Only half of the region's population uses the Internet, with various barriers impacting adoption of connectivity services	Broadband networks (mainly 3G) are available to 93% of the population but further investment is required to extend coverage to the remaining population, particularly in rural areas	There is a lack of fibre infrastructure outside of major cities, and wireless backhaul can be unsuitable for high-speed broadband services	There is a limited number of content provider points of presence (PoPs); popularity of local content in several markets drives demand for local caching infrastructure	Demand for international capacity is growing rapidly. Investment is required to meet this demand and ensure route redundancy to mitigate the risk of cable cuts	Content providers' presence within the region is largely limited to Singapore; intra-ASEAN connectivity remains essential

FIGURE 2.2: INTERNET PENETRATION, SHARE OF URBAN POPULATION, AND GDP PER CAPITA LEVEL OF ASEAN COUNTRIES, 2018 [SOURCE: ANALYSYS MASON, FACEBOOK INCLUSIVE INTERNET INDEX[6], EUROMONITOR, 2020]



There are four broad categories of barrier to connectivity that prevent people from getting online:[8]

Availability

Many people do not have access to physical network coverage where they live. This primarily relates to access networks, although the commercial case for extending this coverage is impacted by other elements in the connectivity value chain, as discussed in Section 3.3.

Mobile broadband networks were available to 93% of the ASEAN population in 2019, primarily through 3G coverage. Investment by mobile network operators (MNOs) has seen coverage expand significantly, with Laos, Myanmar, and Vietnam all seeing 3G coverage grow by 40–50 percentage points over the last five years, to reach around 90%. There is still much to be done to extend coverage to the remaining population, particularly in more rural and hard-to-access topographies, and to achieve coverage levels closer to that of more developed regions (typically 97–100%).[9]

Affordability

While service affordability is improving over time, many people across the ASEAN region cannot afford Internet services or devices, or the amount of data and/or content that would make an Internet connection useful and meaningful for them. In most Asian countries, the GSMA has found that the price of 1GB of data for the 20% of people with the lowest income equates is well above the affordability target of 2% set by organisations such as the International Telecommunication Union (ITU), UNESCO Broadband Commission for Sustainable Development and the Alliance for Affordable Internet (A4AI).[10]

Relevance

While there is an abundance of online content and services, people may not see the available content as relevant, interesting or easy to understand.

ASEAN countries are linguistically and culturally diverse, and locally-relevant content is important to make the Internet relevant and accessible to most people. According to the Inclusive Internet Index, seven of the ten ASEAN countries score below the global average on localised content or relevant content metrics (e.g. e-finance, e-health, e-commerce content ratings),[11] indicating that improvements are needed to create or adapt content so that it is seen as relevant by local populations across the region.

Readiness

Many people lack the ability to enjoy meaningful connectivity, for a variety of reasons: some have insufficient reading or writing skills to use online services, others lack the skills or confidence to go online, whilst many people are still not aware of what content and services they can access on the Internet, and how they can benefit from them. Internet users may also be reluctant to go online because of concerns around privacy and security.

The Inclusive Internet Index assesses a region's readiness level based on a blended score of literacy, trust and safety, and related policy. Most ASEAN countries score above the global average for Internet readiness, however further improvements in this area can support efforts to tackle the affordability and availability barriers.[12]

[8] The four barriers were introduced in the State of Connectivity 2015 report, by Analysys Mason and internet.org by Facebook. These are consistent with classifications from other organisations, such as the GSMA, which define barriers in terms of network coverage, lack of awareness and locally relevant content, lack of digital skills, and affordability. See: Connected Society Consumer barriers to mobile internet adoption in Africa, GSMA 2019. The World Economic Forum's Internet for All initiative also identifies similar barriers to Internet inclusion: infrastructure, affordability, skills, awareness and cultural acceptance, and relevant content. See: https://www.weforum.org/projects/internet-for-all

[9] Source: GSMA Intelligence

[10] For the East Asia and Pacific region, the price of 1GB of data represents 9.1% of monthly income of the 20% of population with the lowest income; GSMA. See: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/07/GSMA-State-of-Mobile-Internet-Connectivity-Report-2019.pdf.
Alliance for Affordable Internet (A4AI) defines Internet service as affordable if the price of 1GB of data equates to no more than 2% of gross national income (GNI) per capita. See https://a4ai.org/affordable-internet-is-1-for-2

[11] Only Vietnam, Singapore, and Malaysia score above global average for these metrics. Facebook, The Economist Intelligence Unit – Inclusive Internet Index 2020, see https://theinclusiveinternet.eiu.com/

[12] Facebook, The Economist Intelligence Unit – Inclusive Internet Index 2020, see https://theinclusiveinternet.eiu.com/
Note: No data available for Brunei and Laos.

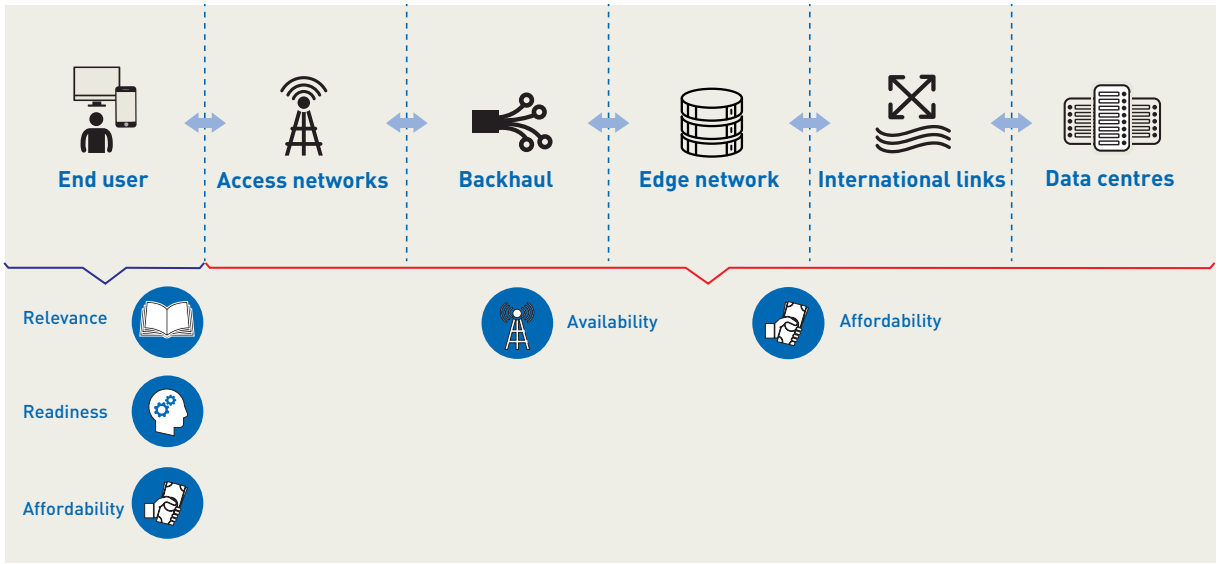
Investment in infrastructure is key to addressing the *availability* barrier, and the cost of this infrastructure must typically be recouped through service pricing, which in turn affects the *affordability* barrier. Operators and investors need to commit money to roll out projects, for which they require a return that is commensurate with the risk they take. This return is hard to achieve when the infrastructure is expensive, risks are high, and demand is uncertain. These challenges have restricted investment in parts of the ASEAN region, particularly in rural areas where costs are higher to reach dispersed populations in more challenging conditions, and where demand from end users is negatively impacted by the affordability, relevance and readiness barriers (see Figure 2.3).

In order to help overcome these barriers, Facebook partners with stakeholders such as ISPs, infrastructure operators and governments to deploy or enable solutions that can improve connectivity outcomes.

Addressing the *availability* and *affordability* barriers (which relate to infrastructure) requires investment in infrastructure across the connectivity value chain, and Facebook is investing directly in terrestrial fibre, edge network and international links to the ASEAN region. These investments support delivery of Facebook applications. They also benefit a wide range of stakeholders by reducing the cost of providing content to end users, improving network performance, and supporting the business case for connectivity services in general. Facebook is also driving initiatives to identify and support new approaches for deploying access networks, in order to bring down the cost of providing broadband access networks to currently unserved communities and help to extend meaningful connectivity to more people across the region.

These connectivity initiatives are helping to bring people online for the first time and enabling more meaningful connectivity for those who are already Internet users.

FIGURE 2.3: BARRIERS TO CONNECTIVITY ARISING ALONG THE CONNECTIVITY VALUE CHAIN [SOURCE: ANALYSYS MASON, 2020]



2.3 Facebook is actively engaged in connectivity initiatives and investments aimed at reducing these barriers across ASEAN and globally[13]

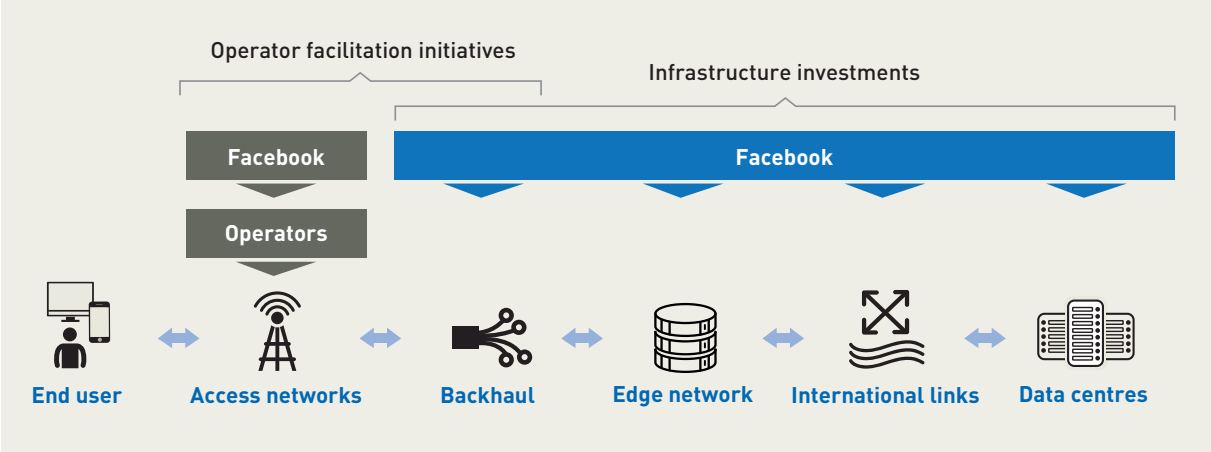
Facebook has launched a broad set of initiatives aimed at improving global connectivity, by helping to address barriers to affordability, relevance and readiness. The primary focus of this report is on Facebook's initiatives that aim to improve the supply of connectivity infrastructure, thereby addressing the *availability* and *affordability* barriers to connectivity. These connectivity infrastructure initiatives can be split into two categories, illustrated in Figure 2.4:

- **Investments in connectivity infrastructure** – Facebook invests in connectivity infrastructure, either directly or through long-term contracts. These investments are typically made alongside other investment partners and cover backhaul, edge network, submarine cables and data centres (discussed in Section 3).
- **Initiatives that support operator investments** – Facebook has developed programmes through which it works closely with local telecoms operators to improve connectivity, typically using innovative platforms and technologies that can improve the economics of network deployment and operation. These initiatives are primarily focused on access network infrastructure and aim to support operators in bringing more people online through extending network coverage and improving service affordability (discussed in Section 4).

We examine the economic and social impact of Facebook's connectivity initiatives in Section 5.

Facebook has also undertaken some initiatives focused on barriers to end-user demand for online services. These include Free Basics, which aims to help people discover the relevance and benefits of connectivity by providing free access to basic online services, as well as efforts on localisation and language support to make Facebook applications more widely accessible. Furthermore, Facebook's 'Data for Good' initiative focuses on generating and disseminating data concerning humanitarian efforts, including the Crisis Communication Response Program (CCRP) which aims to ensure efficient connectivity in crisis conditions. These demand-focused initiatives are not the focus of this report, but some case studies providing more detail on these initiatives and their impact are included in Annex B.

FIGURE 2.4: TARGETING OF FACEBOOK INFRASTRUCTURE INITIATIVES ACROSS THE CONNECTIVITY VALUE CHAIN
[SOURCE: ANALYSYS MASON, 2020]



[13] Facebook's initiatives in the Sub-Saharan Africa region are covered in detail in the related report, Analysys Mason for Facebook - The impact of Facebook's connectivity initiatives in the Sub-Saharan Africa region, 2020.

3 Facebook's infrastructure investments in connectivity

Direct infrastructure investments are projects in which Facebook contributes financially to infrastructure deployment through a variety of investment models. This section describes the types of infrastructure projects that Facebook invests in (summarised in Figure 3.1), outlining the objectives and business models of these investments, and highlighting examples in the ASEAN region.

To support the growth in the demand for content on Facebook's platforms (including Instagram and WhatsApp), Facebook is investing in building its own data centres. These are 'hyperscale' facilities[14] that enable efficiencies in power and cost compared to leasing space in smaller third-party data centres. As shown in Figure 3.2, most of Facebook's data centres are in the USA, with three in Europe (Ireland, Sweden, Denmark). Facebook is also currently building a data centre in Singapore, in addition to its data centres outside the region.

Even with a data centre in the region, content on Facebook's platform must be able to reach markets where end users are located. This has led Facebook to invest in submarine cables (Section 3.1). which reduces the need for ISPs to invest in international capacity themselves to access the content. In order to further improve network performance and economics for ISPs, Facebook is investing in edge network elements such as Internet exchange points (IXPs), points of presence (PoPs) and caches that help bring content closer to end users (Section 3.2). Finally, to support the extension of broadband access networks to provide coverage to more end users, Facebook is also investing in fibre backhaul infrastructure (Section 3.3).

FIGURE 3.1: SUMMARY OF FACEBOOK INFRASTRUCTURE INVESTMENTS [SOURCE: ANALYSYS MASON, 2020]

	Facebook investments
	Facebook invests in a small number of global hyperscale **data centres,** which are used to serve all world regions; within ASEAN, a data centre in Singapore is under construction
	Facebook invests in **international links** such as submarine and terrestrial fibre cables. It has invested in the APG cable and is now investing in three Transpacific and two intra-Asia links connecting to ASEAN countries
	Facebook invests in **edge network** elements, such as PoPs and caches. It has four PoPs in ASEAN and caches in all ten countries in the region
	Facebook is partnering with local operators to invest in **backhaul infrastructure** and is currently supporting a deployment in Indonesia
	Facebook does not invest directly in deploying **access network** infrastructure, but aims to stimulate investment through operator facilitation initiatives (Section 4)

[14] The term hyperscale typically refers to very large data centres with hundreds of megawatts of capacity, built by online service providers such as Facebook, Amazon, Microsoft, and Google.

FIGURE 3.2: FACEBOOK'S GLOBAL DATA CENTRES [SOURCE: BAXTEL, PRESS SEARCH, ANALYSYS MASON, 2020]

Even with a data centre in the region, content on Facebook's platform must be able to reach markets where end users are located. This has led Facebook to invest in submarine cables (Section 3.1). which reduces the need for ISPs to invest in international capacity themselves to access the content. In order to further improve network performance and economics for ISPs, Facebook is investing in edge network elements such as Internet exchange points (IXPs),[15] points of presence (PoPs) and caches that help bring content closer to end users (Section 3.2). Finally, to support the extension of broadband access networks to provide coverage to more end users, Facebook is also investing in fibre backhaul infrastructure (Section 3.3).

3.1 Submarine cable investments reduce the need for operators to invest in international connectivity

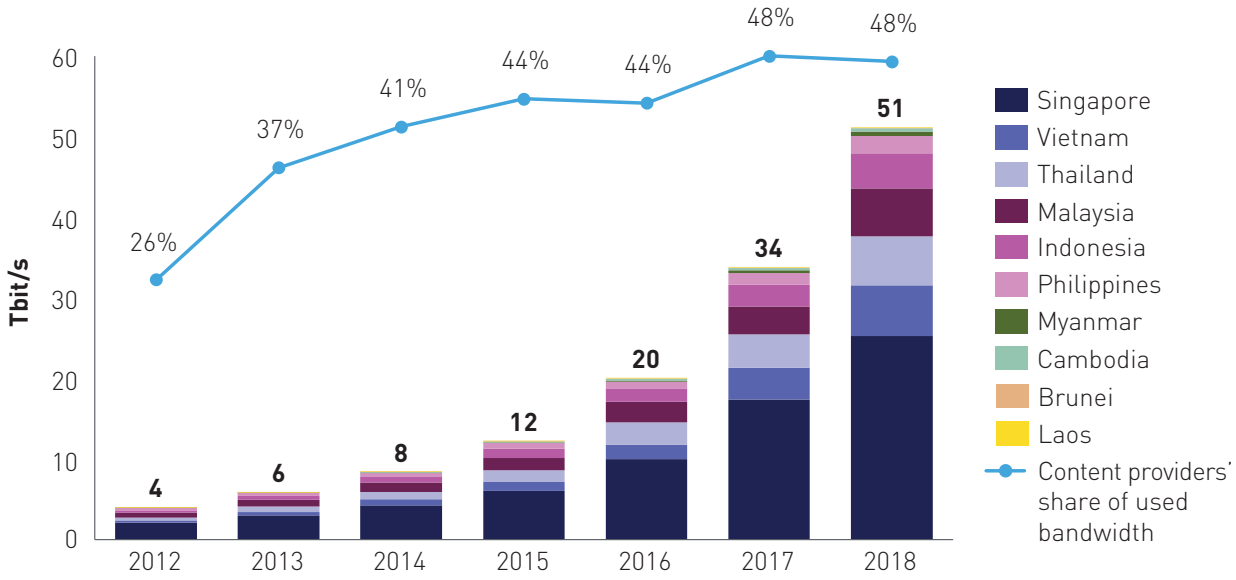
Submarine cables are designed to transport data over short and long distances, using international fibre links laid along the seabed between and around continents. Along with other content providers, Facebook is a major purchaser of capacity on cables serving ASEAN countries. Facebook uses this capacity to transport content to its regional PoPs.

There are currently 65 existing and planned submarine cable systems landing in ASEAN countries, out of which five have landings in the USA and seven in Europe, Africa, and/or the Middle East. The remaining cable links are intra-regional, carrying capacity among countries in the Asia-Pacific region or between points within the same country (particularly for Indonesia, Malaysia, and the Philippines). The intra-Asia submarine cables bring further international capacity to ASEAN countries via major Asian hubs, such as Japan and Hong Kong.

The ASEAN region has seen a rapid increase in demand for international bandwidth over recent years. This growth is largely driven by end-user demand for Internet content from providers, including Facebook. Content providers are responding to this demand by bringing traffic close to end users to improve the quality of user experience; by the end of 2018, content providers accounted for almost half of the international bandwidth demand in ASEAN (Figure 3.3). Whilst telecoms operators are also investing in increasing their international bandwidth, the fact that content providers are bringing traffic to the region is reducing the need for operators to fund this bandwidth.

[15] Note: Facebook does not invest in IXPs directly but rather supports their development by third parties.

FIGURE 3.3: UTILISED INTERNATIONAL BANDWIDTH IN ASEAN COUNTRIES AND CONTENT PROVIDERS' SHARE OF THIS BANDWIDTH [SOURCE: TELEGEOGRAPHY, ANALYSYS MASON, 2020]



Facebook's investments in submarine cables benefits the Internet ecosystem in the ASEAN region

By acting as a major customer for international capacity, Facebook is supporting other players' investments in new cables. However, with the growth of Facebook's global demand for international connectivity, it has started to supplement its purchase of capacity on third-party cables by investing directly in new submarine cables as part of consortia. Facebook's first investment in the ASEAN region was as part of the consortium for the APG cable (which was ready for service in 2016), and it is now investing in another large intra-Asia link (Southeast Asia Japan Cable 2, or SJC2) as well as all of the new trans-Pacific cables connecting to ASEAN planned to go live in 2020-21 (see Figure 3.4).

FIGURE 3.4: FACEBOOK'S INVESTMENT IN SUBMARINE CABLES IN THE ASEAN REGION
[SOURCE: ANALYSYS MASON, FACEBOOK, TELEGEOGRAPHY, 2020. NOTE: TARGET READY FOR SERVICE DATES MAY BE SUBJECT TO CHANGE]

Cable system	Target ready for service	Design capacity
APG	2016	58Tbit/s
PLCN	2020	126Tbit/s
SJC2	2020	126Tbit/s
Jupiter	2020	60Tbit/s
HKA	2020	77Tbit/s
BtoBE	2021	108Tbit/s

Where Facebook invests as part of consortia, the new submarine cables carry traffic not only for Facebook and its consortium partners, but also for other parties that purchase or lease capacity on the resulting infrastructure through long-term contracts. These investments increase the supply of submarine capacity available at multiple landing points, and in aggregate across the ASEAN region, which helps to reduce the price of submarine capacity for ISPs. This in turn results in a combination of better connectivity and lower prices for end users, increasing the quality and affordability of broadband services over time.

Facebook's investments in capacity to carry content to its regional PoPs means that ISPs are able to interconnect with Facebook within the region. This reduces the cost of international capacity for ISPs and allows them to free up bandwidth on links to other regions for other content.

Investment in new cables can also create new routes, which can be used to improve the number and diversity of paths used to carry traffic within a region, and to and from other regions. This enhances service reliability when a cable experiences faults and reduces the cost and the latency of links to newly connected locations compared to existing routes.[16]

Finally, Facebook's involvement in these projects can ensure that the deployment takes place, as evidenced by interviews with Facebook which revealed that in several Asian submarine cable projects, Facebook increased its investment share following a last-minute exit by a consortium partner.

Case study: Asia-Pacific Gateway (APG)

In 2012, Facebook joined the 2009-initiated consortium of operators building the 10 400km cable between Malaysia and Japan, with branches landing in most countries along the way: Singapore, Thailand, Vietnam, China, Taiwan and South Korea. The cable went live in 2016 and has peak capacity of 58Tbit/s. The project was designed to provide redundancy, and this need was amplified by repeated breaks in the Asia-America Gateway (AAG) cable, which particularly affected Vietnam and Malaysia.

Following the launch of APG (the capacity of which was over seven times greater than on AAG), Viettel was able to assure its customers that it would not be affected by the February 2017 AAG cable cut, due to capacity redirection to the APG cable.[17] Malaysia's Time Dotcom, reportedly stated that the APG cable also lowered the region's dependency on Singapore as the main gateway for Internet traffic and allowed high volumes of traffic to be exchanged with the USA at the lowest possible latency.[18]

Submarine cable investments are also important to provide diverse routes to improve the reliability of international connectivity and to drive down capacity prices

Although content providers make significant submarine cable investments to satisfy their own demand and that of their users, these investments also help to improve resilience for the entire connectivity ecosystem by providing alternative routes to existing cables, for example in the event that a cable on one route is damaged.

Intra-Asian submarine cable redundancy is essential to ensure uninterrupted service between countries in the region (e.g. between data centres in Singapore and customers in Indonesia and the Philippines). Most of the countries are coastal and some are archipelagos and must have multiple submarine connections in case of a failure. Some markets rely on other Asian countries for international connectivity; for instance, Cambodia and Myanmar do not have a direct link to the USA via existing or planned cables.

[16] Latency is a measure of the delay between a request being made by one user and it being received by another user. Lower latency results in a more responsive experience, which has been associated with greater user satisfaction and higher demand.

[17] See http://international.viettel.vn/news-detail/thanks-to-apg-the-impact-of-aag-cable-cut-has-been-reduced

[18] Malaysian Wireless – "APG Submarine Cable System now live, links Malaysia to fastest Internet network in Asia", 5 November 2016.

Luzon Bypass Infrastructure (LBI)

As part of the Pacific Light Cable Network (PLCN) deployment, Facebook is working with the Philippines' Department of Information and Communication Technology (DICT) and the BasesConversion and Deployment Authority (BCDA) to deploy the Luzon Bypass Infrastructure (LBI) – a 250km terrestrial cable connecting landing stations on the East and West coasts of Luzon.

The LBI provides redundancy for the PLCN cable by allowing it to avoid the seismically unstable and turbidity current-prone area of the Luzon Strait between the Philippines and Taiwan; in 2006, an earthquake resulted in cuts on 14 cables, leaving only one link connecting countries south of Taiwan to the USA, and connectivity in markets without a diversified route suffered over the three months it took to repair the cuts.

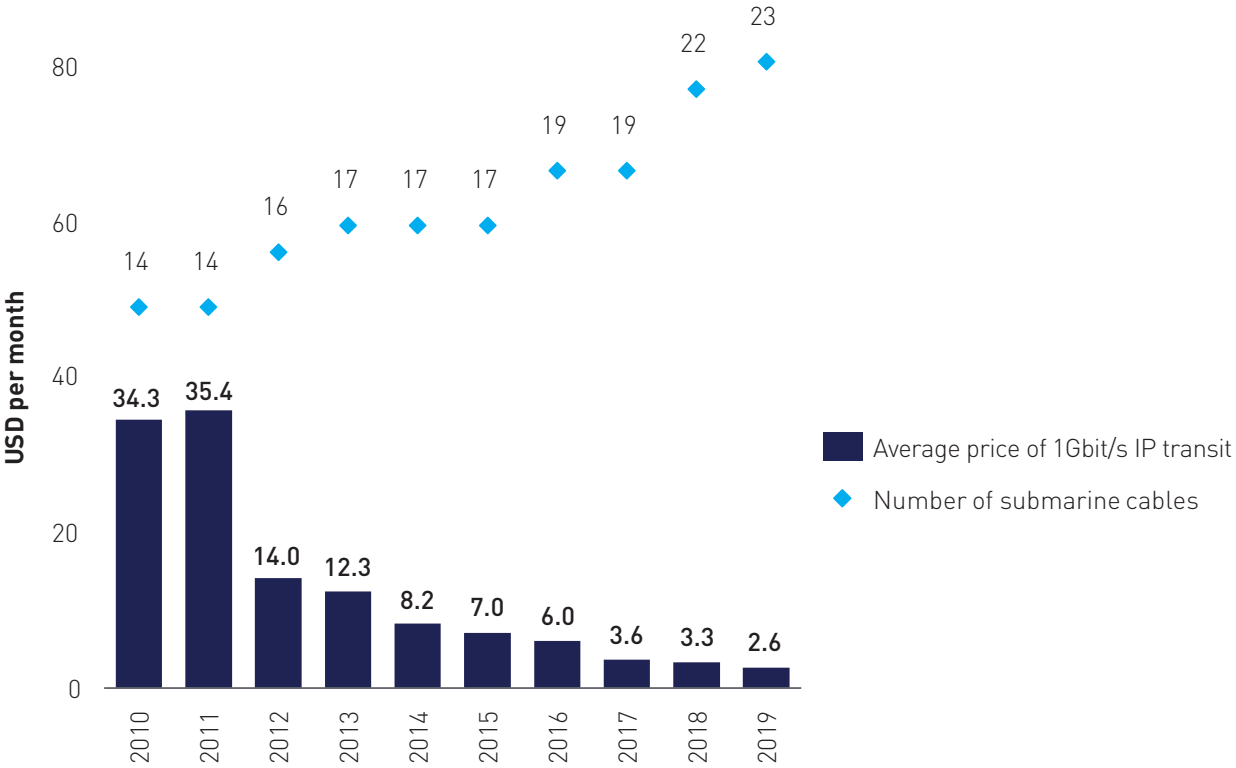
The LBI will be built by BCDA and operated by DICT, with Facebook constructing the submarine links connecting to the landing stations. In exchange for utilising the bypass infrastructure, Facebook will provide the Philippine government with the amount of bandwidth corresponding to the level of BCDA/DICT investment, which should significantly expand capacity available for the government's connectivity programmes.[19] DICT reportedly estimates that this could also cut the cost of Internet services in the country in half.[20]

[19] BCDA press release – "Philippine Government Teams Up with Facebook for High Speed Broadband Infrastructure".

[20] CNN Philippines – "Ultra-high speed infrastructure to cut internet cost by half – DICT", 9 Jun 2019.

The increased supply of capacity through the introduction of new systems also drives down the capacity cost and the price of Internet services to the end users as a result. Figure 3.6 shows that the growing number of submarine cables landing in Singapore has been correlated with a decline in the cost of IP transit.

FIGURE 3.6: IP TRANSIT PRICE AND NUMBER OF SUBMARINE CABLES IN SINGAPORE
[SOURCE: TELEGEOGRAPHY, ANALYSYS MASON, 2020]



3.2 Edge network investments allow ISPs and MNOs to access content on Facebook's platform at locations closer to their own networks, at much reduced costs

The term 'edge network' refers to infrastructure that enables the processing, transfer or storage of data at distributed locations around the periphery of a network, rather than in a small number of centralised data centres. Facebook has been investing in its internal network (or 'production network') with the aim of maximising efficiency and minimising costs associated with delivering content by enabling ISPs and MNOs to access and exchange content within the ASEAN region, rather than further afield. This reduces costs for the MNOs and ISPs as well as improving the performance of Facebook applications and the user experience. To achieve this, Facebook is investing in edge network elements, including PoPs and caches.

- **PoPs:** locations where ISPs can interconnect with the Facebook internal network (typically through peering arrangements, as explained in the box below) and access all of its content, with reduced cost and latency compared to accessing this content in other regions.
- **Caches:** servers deployed within a country that store local copies of popular content of a static nature (such as videos and pictures)[21] that can then be delivered to multiple end users with lower cost and superior performance.

These network elements allow content to be stored closer to the end user, which generally reduces transit costs to the ISPs. In order to receive content available on Facebook's platform, an ISP needs to establish a connection to Facebook's internal network. This can be achieved by the ISP peering with Facebook at an

[21] Static content is akin to pre-recorded content, as once created it does not change and can be accessed many times over in the same exact form. In contrast, dynamic content is created and consumed at the same time; it can include voice and video communications and online gaming data, for example.

out-of-region PoP (which would require the ISP to pay for international links) or at a local or regional PoP (which can be located at an IXP;[22] the ISP then only pays for connectivity to the PoP).

Additionally, an ISP can have a Facebook cache installed within its network.[23] Although this requires the ISP to pay for the traffic to fill the cache, it also yields significant savings for the ISP, because once the content is in the cache the ISP does not have to pay for the traffic when other users try to access the same content – it can be served from the cache, becoming even more efficient at particular times when international links are heavily utilised.

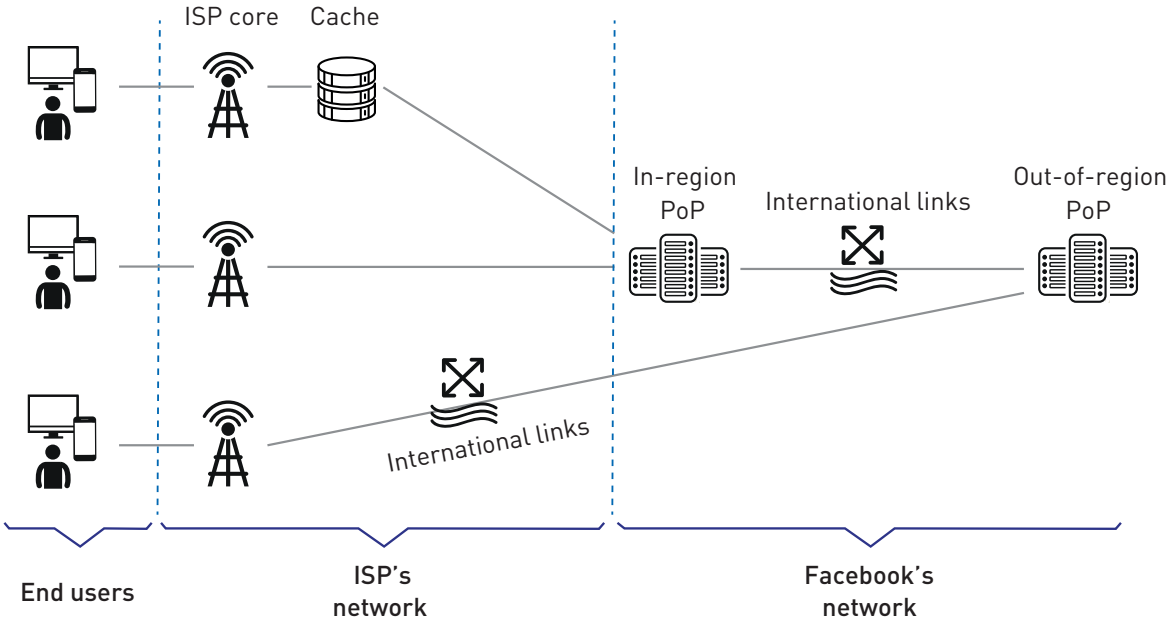
Interconnection: transit and peering

When end users request access to a piece of content or a service online, their request and the response often pass through multiple separate networks. These networks must be able to communicate with one another, either directly or indirectly through other networks. That is, the networks of ISPs, platforms providing content such as Facebook, research and educational organisations and enterprises are ***interconnected.***

The exchange of traffic between these interconnected networks relies on commercial agreements that fall broadly into two categories: ***transit*** provides access to all Internet destinations for a fee, while ***peering*** only provides reciprocal access between two networks. Generally, interconnection is established either through a bilateral agreement to exchange traffic at a dedicated PoP, or through a multilateral arrangement where multiple networks connect into an IXP. Facebook PoPs and caches may be collocated with IXPs, where multiple networks can interconnect and exchange traffic within their country, as well as accessing content on Facebook's platform.

Figure 3.7 provides a very simplified view of how traffic flows between end users and the Facebook internal network, through either international links, links to Facebook's PoPs in the region, or Facebook's caches in ISP networks.

FIGURE 3.7: SIMPLIFIED VIEW OF FACEBOOK INTERNAL NETWORK TOPOLOGY [SOURCE: ANALYSYS MASON, FACEBOOK, 2020]



[22] IXPs are locations where multiple networks can interconnect and exchange traffic within their country, including accessing content from Facebook caches.

[23] Note that a Facebook cache can also be installed at a peering facility such as the IXP, where ISPs can access it (particularly small ISPs, for which it may not be feasible to install a Facebook cache within their own networks). In this case, IXP members can split the cost of filling the cache.

PoPs

To date, Facebook has invested significant amounts to deploy four PoPs in the ASEAN region. ISPs and network operators can interconnect with the Facebook internal network at its PoPs, through an open peering policy, to access content and applications available on Facebook's platform.

Facebook's PoPs enable the exchange of all types of traffic, including dynamic content such as users' instant messages and video calls. Facebook's investments in international capacity support its ability to transport the content from its major data centres to its PoPs within ASEAN, where it exchanges traffic with the local networks. This allows parties that interconnect with Facebook at its PoPs to reduce their international connectivity and transit costs, because they no longer have to pay to bring the content into the region.

As well as making it more economical for ISPs to serve Facebook traffic, the PoPs give Facebook greater control over its internal network, thus improving the performance, reliability and resilience of its service delivery.

Caches

Cache servers are intelligent storage appliances (a type of computer server) which are deployed close to end users and replicate static content (e.g. photos, videos, thumbnails, text, ads) that would otherwise be stored in large data centres. They store content that is requested by end users for a period of time, so that it can be served efficiently to other users at a later stage.

This lowers the use of (or optimises) international capacity, cuts costs and improves user experience by reducing latency. In general, the network which hosts the cache pays for the connectivity needed to fill the cache,[24] although in effect this cost is recouped multiple times as a result of the cache being in place.

Caches are installed in ISPs' networks throughout all ten ASEAN countries. Caches may be hosted within the networks of large ISPs and may be in neutral locations, such as IXPs, where the cache can be reached by multiple network operators and ISPs thereby eliminating infrastructure duplication and reducing costs. Facebook caches are deployed at IXPs in several countries, and Facebook's caches are believed to increase the IXPs' attractiveness to other operators, which are then incentivised to interconnect at the exchange supporting the development of the Internet ecosystem in these countries.

3.3 Backhaul fibre investments through Open Transport Network are accelerating the expansion of mobile broadband networks to more people

The Open Transport Networks (OTNx) initiative relates to Facebook's investments in fibre infrastructure for the purpose of establishing backhaul in developing countries. These projects are carried out in partnership with local operators, who deploy and maintain fibre-optic cable and equipment providing high-capacity backhaul connections to core networks. These connections enable mobile access networks to be upgraded to higher-speed (3G and 4G) capabilities and improve performance of an existing technology or allow new network technologies such as Wi-Fi to be deployed.

The primary aim of OTNx projects is to enable operators to significantly improve the performance of mobile Internet services where currently deployed wireless microwave backhaul is a constraint on providing additional capacity.

Facebook's model for OTNx has been to co-fund deployments, with local operator partners having ownership of the infrastructure deployed. The resulting infrastructure operates on an open-access basis,[25] which means that the delivery of Facebook's traffic is not prioritised over delivery of other content. When selecting particular geographies for investment, Facebook prioritises large countries with a lack of fibre infrastructure, although it also needs to consider other factors such as the regulatory environment and interest from potential partners.

Within ASEAN, Facebook is currently supporting fibre deployment through OTNx in Indonesia.

[24] In the case where the operator is also connected to a Facebook PoP, it only pays to extend its network from the cache to the PoP, without paying for transit of Facebook's traffic from outside of the region

[25] Open access means that all operators may acquire wholesale access to the infrastructure on an equal basis.

Case study: Indonesia backhaul

In late 2019, Facebook entered into partnership with an Indonesian operator for the deployment of fibre infrastructure across select Tier 2-3 cities across the country (with population between 100 000 and 1 million) to support 4G coverage extension. The selected cities lack extensive fibre infrastructure and do not generate sufficient traffic to stimulate operators' standalone investment into fibre backhaul.

The first phase of the project will build 3000km of fibre across 20 cities in East Java, West Kalimantan, North Sulawesi and Bali, facilitating high-speed internet to approximately 10-15 million people over the course of 12-14 months; Facebook estimates that the project will allow 5 million people to move into a faster speed bracket of Internet service. Along with funding, Facebook also provides operator support through its fibre planning tool and sharing of design best practices. This combination results in an efficient and sustainable wholesale model which otherwise would be difficult to achieve given the long-term nature of these types of infrastructure investment. This model also helps MNOs to divert their capital to upgrading their cell sites and connecting more regions with high-speed 4G services.

4 Facebook's initiatives that support investments by operators

Operator facilitation initiatives are projects where Facebook provides advice, organisational support, software, or hardware to enable operator partners (MNOs and ISPs) to deploy and operate networks. Facebook does not own any part of the infrastructure deployed in relation to these initiatives; the goal is to support its partners in extending and upgrading their networks in a sustainable manner.

This section describes various operator facilitation initiatives being undertaken by Facebook, outlining the aim, functionality and business model of each initiative, and providing examples – highlighting projects in the ASEAN region. We first discuss Express Wi-Fi (Section 4.1), a solution developed by Facebook that combines low-cost Wi-Fi equipment with custom software and analytics capabilities to enable Internet connectivity at a much lower cost than traditional mobile cells. We then outline a number of other operator facilitation initiatives designed to reduce connectivity costs and support improvements in network coverage and performance (Section 4.2). In other regions, including sub-Saharan Africa[26] and Latin America, Facebook is targeting specific initiatives to improve rural access.

4.1 Express Wi-Fi brings cheaper data to new and existing Internet users

Express Wi-Fi is a software platform that Facebook offers free of charge to its partners – MNOs and ISPs – to enable them to deploy, operate and monetise Wi-Fi services. The software platform can be integrated into the partners' systems and includes a set of online tools for network monitoring and management. The platform also provides a choice of models for revenue generation through a browser app on users' devices: they can either purchase a data pack or adopt the 'freemium' model (the latter requiring users to watch an advertisement instead of making a payment). These features enable operator partners to provide the service in a more efficient and affordable way, allowing them to extend service coverage into areas where there may have previously been no commercial case for network deployment.

Express Wi-Fi can be used to address a range of connectivity gaps:

- **Coverage gap –** extending connectivity to areas previously underserved by (primarily mobile) broadband networks[27]

[26] Facebook's initiatives in the sub-Saharan Africa region are covered in detail in the related report, Analysys Mason for Facebook - The impact of Facebook's connectivity initiatives in the sub-Saharan Africa region, 2020.

[27] Note that current Express Wi-Fi technology requires SMS verification on the customer side, so the presence of at least 2G connectivity is required in deployment areas.

- **Usage gap –** boosting service usage by capturing new users within already covered areas and increasing their data consumption due to improved service quality and affordability

- **Capacity gap –** solving the problem of network overload in urban and semi-urban areas by allowing operators to offload their mobile traffic onto the Wi-Fi network.

There are currently 17 countries worldwide with Express Wi-Fi deployments with over 30 live partners, including three ASEAN countries (Indonesia, the Philippines, Thailand). Despite these Express Wi-Fi initiatives in ASEAN being in the early stages of development they have already attracted close to 70 000 monthly active users, and this number is expected to grow significantly as services reach maturity and are deployed in more countries across the region.

A notable feature of the Express Wi-Fi operating model is that the sale of data packs to end users in communities is done via local entrepreneurs who have Express Wi-Fi hotspots installed in their shops. This creates a revenue stream for the entrepreneurs who act as resellers, providing a cash influx for local communities while reducing operational spend for operators.

Case study: Express Wi-Fi in Indonesia

In many rural and remote areas, difficult geographical terrain and challenging economics can constrain infrastructure deployment, meaning residents and visitors suffer from poor broadband connectivity. In partnership with Facebook, Indonesian ISP D-Net has successfully deployed Express Wi-Fi in remote areas such as towns around Mount Bromo, in order to "connect the unconnected". Previously, in order to access the internet, residents had to leave the town and travel a few kilometres in search of hotspots or mobile network coverage.

With the Express Wi-Fi service, Internet access became available within the town for the first time, enabling activities such as information search, business promotion and entertainment. Residents are even able to gain additional income through becoming retailers of the Express Wi-Fi service, selling data packages to locals and out-of-town visitors to Mount Bromo.[28] One such local entrepreneur was so successful in selling Express Wi-Fi data cards that the proceeds enabled her to purchase the local petrol station.

In January 2020, Indonesian infrastructure provider BaliTower announced a partnership with Facebook to use the Express Wi-Fi platform to manage, operate and grow its existing Wi-Fi operations in Greater Jakarta and Bali in a sustainable and scalable way; BaliTower expects that the initiative will help increase the quality of the Wi-Fi service it offers as well as allowing the company to extend its service coverage.[29]

4.2 Facebook is spearheading other initiatives to reduce network and data costs

In addition to the Express Wi-Fi initiatives described above, Facebook is working to identify new opportunities and develop new tools to support the provision of connectivity worldwide. As outlined below, it has a number of further initiatives at varying stages of development.

The *Telecom Infra Project* (TIP) is a collaboration platform, conceived by Facebook alongside four other founding members, which aims to facilitate discussion and cooperation among telecoms operators, vendors, governments and other stakeholders in order to design, build and deploy new and more cost-effective technological solutions and hardware. Having brought together over 500 global organisations under TIP, Facebook is facilitating collaboration among members by establishing project groups, carrying out knowledge-sharing meetings and summits, and providing space and tools for joint work.

TIP helps to bring more players into the market at every step of the value chain, supporting start-ups and disrupting traditional vendor models. This plays a particularly important role in developing regions, including ASEAN's poorer communities, where competition and innovation are key to ensuring affordability. In addition, some operators believe that TIP has the potential to improve costs also in richer urban areas: in Malaysia, edotco (Axiata's tower subsidiary) reportedly stated that 1GB of data in Kuala Lumpur costs USD1.4 to provide but only generates USD0.8 in revenue, and that reducing the costs of

[28] https://expresswifi.id/2018/11/30/7-area-express-wi-fi-di-kawasan-bromo-tengger-semeru/

[29] https://www.balitower.co.id/uploads/BaliTower%20Siaran%20Pers%20-%20Facebook.pdf

infrastructure together with new commercial models facilitated by TIP could help reduce this gap.[30]

Technologies developed and improved within TIP also underpin Facebook's Rural Access programme, which encapsulates a variety of Facebook's initiatives designed to support the deployment of high-speed broadband infrastructure in rural areas by providing a combination of financial aid, network planning and technical advice, organisational and operational tools, and support in regulatory discussions.

The scope and shape of Facebook's Rural Access initiatives vary widely, reflecting the need to find innovative, tailored solutions to specific technological, geographical and socio-economic challenges. Facebook's largest Rural Access project is being deployed in Peru, where Facebook works alongside several MNOs and government bodies to extend 3G and 4G connectivity to rural areas of the country. Facebook helps its partners to identify and use efficient network planning tools and low-cost technological solutions enabling them to deploy mobile sites, to form an open-access wholesale network in the case of Peru.

Another example of Facebook's connectivity initiatives under development is Terragraph, a solution to provide high-capacity wireless backhaul and fixed-wireless access (FWA) using high-frequency spectrum. The Terragraph solution is at the trial stage but an initial commercial deployment in Malaysia has indicated a positive impact on Internet service take-up and speeds, at a lower cost to Facebook's MNO partner than alternative solutions.

Case study: Terragraph trial in Malaysia

In 2019, YTL Communications carried out a large-scale trial of Terragraph in Georgetown, Malaysia, serving 120 business users with FWA and deploying 50 public Wi-Fi hotspots. The deployment enabled gigabit-level speeds, and by using street furniture and power assets it was able to cover an area of 2.5km^2 within just 2.5 months. YTL Communications's Wi-Fi customers (over 30 000 unique users served over a six-month period) experienced average speeds of over 50Mbit/s and peak speeds of up to 190Mbit/s.[31]

To create the network, Terragraph uses millimetre-wave radios that are meshed with one another. The radios can be deployed on physical assets such as street furniture to provide a last-mile link between an ISP's fibre presence and the end user; this mitigates the costs associated with rights of way and deployment of buried last-mile fibre, while providing speeds equivalent to a fixed fibre-based Internet access service. Based on the results from the trial and projected commercial costs, it was estimated that Terragraph capex per home passed could be as low as 30% of that for an equivalent buried fibre build, and that the total cost for the operator over the long term could be 40% lower than for trenched fibre, depending on the market. YTL further reported having collected a substantial number of positive testimonies from the trial customers and has recently launched commercial FWA services in Georgetown.

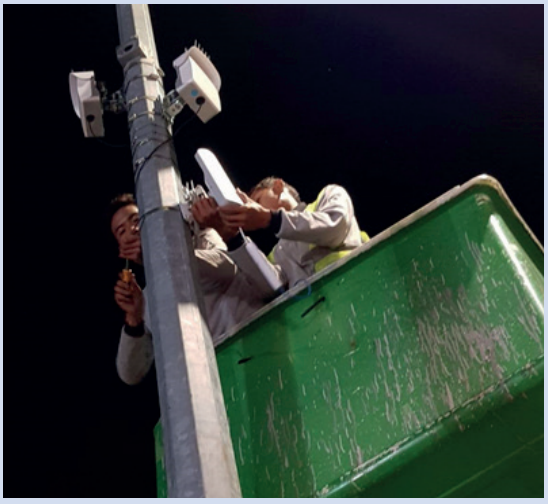


FIGURE 4.1: TERRAGRAPH NETWORK BEING DEPLOYED IN GEORGETOWN, PENANG
[SOURCE: FACEBOOK, YTL COMMUNICATIONS, 2020]

While we have discussed a selection of Facebook's most advanced connectivity initiatives, there are many more at various stages of development. Facebook's connectivity teams continually work to identify and develop new initiatives that can be used to extend broadband coverage and make services more affordable. By addressing the barriers to connectivity and helping more people to achieve meaningful Internet access, these initiatives can deliver substantial economic and social benefits to the ASEAN region, which we explore further in Section 5 below.

[30] LightReading – "Axiata Calls On TIP to Fix Telco Cost Problem", 14 November 2019, see https://www.lightreading.com/asia-pacific/axiata-calls-on-tip-to-fix-telco-cost-problem/d/d-id/755649

[31] Source: YTL Communications, Facebook.

5 Economic impact of Facebook connectivity initiatives

Although Facebook's connectivity initiatives are diverse, they all share the same goals: reducing the barriers to connectivity and making the Internet more widely available, accessible and affordable to more people. Facebook's investments support the delivery of content available on its platform and improve engagement with Facebook applications, but they also create wider benefits to the ASEAN countries, by improving connectivity and access to online content and services more broadly. The resulting increase in take-up and usage of Internet access has wide-reaching benefits for economies in the region.

In addition to its direct investments in infrastructure in the region, Facebook has dedicated efforts and resources globally to develop the connectivity initiatives that are now being deployed in the ASEAN region. We have quantified the impact of Facebook's connectivity initiatives by focusing on the improvement in connectivity outcomes that they enable, in terms of increased Internet traffic and take-up of online services. Quantitatively, we estimate the economic impact of Facebook's initiatives in ASEAN to be USD70 billion in additional GDP over a five-year period between 2020 and 2024.

This section explains how Facebook's initiatives translate into economic benefits, largely thanks to the increased connectivity and Internet use that they enable. Section 5.1 discusses the economic impact derived from bringing new Internet users online for the first time and from increasing Internet engagement and traffic (based on assessment of Facebook's investments in edge network infrastructure, submarine cable capacity and OTNx). Section 5.2 then describes how economic value is created as a result of Facebook's direct investments, including through indirect and induced effects. Finally, Section 5.3 illustrates the effects of connectivity improvements on stakeholders (individuals, enterprises, governments) that result in the overall social and economic gains.

5.1 Increased connectivity outcomes enabled by Facebook's initiatives, in the form of new users and additional traffic, create significant economic value

Facebook's initiatives enhance operators' ability to extend the coverage of broadband networks, thus enabling more people to go online (a higher take-up[32] of Internet access services). They also stimulate more meaningful use of the Internet by improving the quality of access networks (e.g. higher speeds) and the performance of service delivery (e.g. through lower latency), which results in higher Internet *traffic*.[33]

The initiatives also reduce the costs faced by operators and ISPs in providing connectivity and content to end users, enabling them to provide more affordable services. The resulting improvements in connectivity and Internet usage can then translate into economic and social benefits, as illustrated in Figure 5.1 and Figure 5.2 below.

FIGURE 5.1: FLOW FROM FACEBOOK CONNECTIVITY INITIATIVES TO ECONOMIC AND SOCIAL BENEFITS
[SOURCE: ANALYSYS MASON, 2020]

[32] *Take-up* reflects the number of people who use Internet services, often expressed as a share of national population ('penetration'); take-up increases when service coverage is extended and more people have the opportunity to get connected. Additionally, take-up within covered areas (i.e. the number of people who have access to the Internet and choose to use it) can be expected to increase when service quality and affordability improve, as the value of the service to the user goes up.

[33] *Traffic* refers to the amount of content and data consumed by the average Internet user. It is primarily a function of affordability and quality of connectivity and services, and improvements in these factors allow users to consume more content online.

FIGURE 5.2: IMPACT OF FACEBOOK INITIATIVES ON CONNECTIVITY OUTCOMES [SOURCE: ANALYSYS MASON, 2020]

Initiative	Coverage	Quality	Affordability
Infrastructure investments			
Submarine cables	—	✓	✓
Edge network	—	✓	✓
OTNx	✓	✓	✓
Operator facilitation initiatives			
Express Wi-Fi	✓	✓	✓
Other initiatives	✓	✓	✓
(TIP /Rural Access, Terragraph)	✓	✓	✓

These increases in take-up and traffic mean that people are more able to obtain and disseminate information, interact with other people, enterprises and government agencies, and perform transactions online. All these activities create benefits for individual stakeholders as well as wider economic and social benefits through improved health and welfare outcomes, skills and education, job creation and productivity. We have sought to quantify these benefits for selected initiatives in terms of the additional GDP that could stem from them over the next five years, which we estimate at USD70 billion. This is shown in Figure 5.3 and explained further below.

FIGURE 5.3: ESTIMATED CUMULATIVE IMPACT OF FACEBOOK CONNECTIVITY INITIATIVES, 2020–2024
[SOURCE: ANALYSYS MASON, 2020; ALL VALUES IN NOMINAL USD AT PROJECTED CURRENT EXCHANGE RATES]

Source of impact	Drivers of impact	Cumulative 2020–24 GDP impact, USD billion 2015
OTNx	High-speed Internet take-up and Internet traffic / data usage	6.1
Edge networks and submarine cables	Internet traffic / data usage	63.5
Total		**69.6**

OTNx initiatives generate economic impact by allowing more users to get online and increasing traffic by improving the quality and affordability of services

As of 2018 only half of people in the ASEAN countries had used the Internet, which is a constraint on the economic development of the region. A 2012 study by GSMA and Deloitte used econometric analysis of the data from 96 countries across the world to determine that a 10% increase in mobile broadband *take-up* (e.g. from 50% to 55%) yields a 0.15 percentage point increase in the rate of growth in GDP per capita in a given year, over and above the baseline growth projected for the country or region.[34]

[34] GSMA, Deloitte – "What is the impact of mobile telephony on economic growth?", November 2012; See: https://www.gsma.com/publicpolicy/wp-content/uploads/2012/11/gsma-deloitte-impact-mobile-telephony-economic-growth.pdf; Note: we have not carried out a detailed review of the GSMA and Deloitte methodology; a purposeful triangulation of the take-up to GDP per capita growth and traffic to GDP per capita growth parameters, with a view of specific markets and timeframes, may alter the modelling results presented within this report.

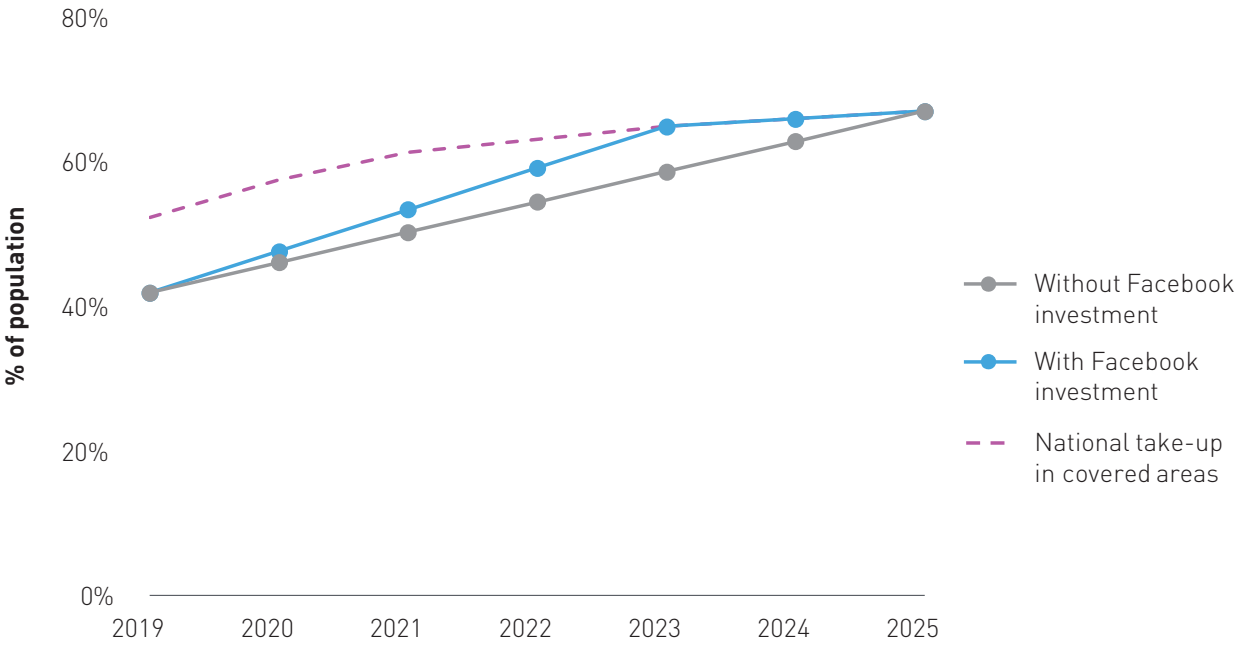
In addition to helping new users get online, Facebook connectivity initiatives improve the quality and affordability of connectivity, which can lead to increased *traffic* and greater use of online services. This increased engagement with the Internet can translate into economic growth, as evidenced by the GSMA and Deloitte study mentioned above. The study found that, on average, if a country doubled its *traffic* consumption per mobile broadband user over a five-year period, this would lead to a 0.5% increase in GDP-per-capita growth rate in each of these years.

A key example of Facebook initiatives bringing new users online is its investments in fibre backhaul through the OTNx programme. As discussed in Section 3.3, in Indonesia these investments will enable 4G networks with high-capacity backhaul to be extended to 10-15 million people. It can be expected that this coverage will enable the Internet take-up in the affected region to scale up and reach the national average earlier and faster than would have happened without Facebook's investment, leading to an uplift in the national take-up level.

In addition to the Internet take-up increase, the OTNx programme is expected to contribute to faster substitution of 3G connections with 4G. Historical data suggests that data consumption levels of 4G users tend to be significantly higher than those of 3G users;[35] therefore, Facebook investments are expected to result in the growth of Internet traffic in the areas covered by the initiative.

In estimating the impact, we assume that high-speed Internet take-up in areas where OTNx has been deployed will converge with the forecast national average three years after the infrastructure deployment (in Indonesia in 2023), whereas without Facebook's investment this would take until 2025. This results in 0.9 million people in Indonesia getting online up to two years earlier than they would have done without the OTNx investments, as shown in Figure 5.4.

FIGURE 5.4: HIGH-SPEED INTERNET TAKE-UP IN INDONESIA, WITH AND WITHOUT OTNX INVESTMENT
[SOURCE: ANALYSYS MASON, GSMA INTELLIGENCE, 2020]

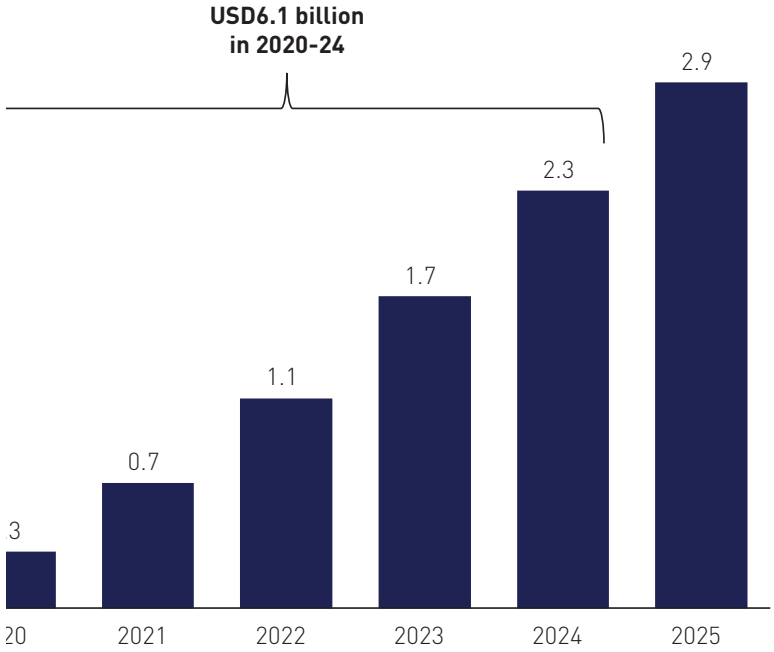


As mentioned above, the GSMA and Deloitte study establishes a relationship between increased Internet take-up and Internet traffic and GDP per capita growth. By applying the relationship parameters to the incremental increases in take-up and traffic estimated to be attributable to Facebook's initiative in each year, we can infer the implied increase in GDP per capita growth. This can in turn be used to calculate the economic impact attributable to Facebook's initiatives in each year. Figure 5.5 presents the resulting GDP impact values and shows that cumulatively, Facebook's OTNx investments in Indonesia could have a GDP impact of over USD6 billion between 2020 and 2024.[36]

[35] Source: Analysys Mason Research.

[36] The detailed methodology used to derive this estimate is described in Annex A.

FIGURE 5.5: PROJECTED YEARLY GDP IMPACT OF FACEBOOK'S OTNX INITIATIVES IN INDONESIA
[SOURCE: ANALYSYS MASON, EUROMONITOR, 2020]



The above results relate only to Facebook's deployment in Indonesia, and if the OTNx initiative were to be extended to the rest of the ASEAN countries (excluding Singapore as its 3G and 4G coverage is already at 100%), we estimate that it could accelerate provision of 4G coverage to a further 21 million people, which could generate an additional GDP impact of USD4.5 billion between 2020 and 2024.[37]

Edge network and submarine cable infrastructure support a large share of Internet traffic delivered to the ASEAN region, enabling people to make greater use of the Internet

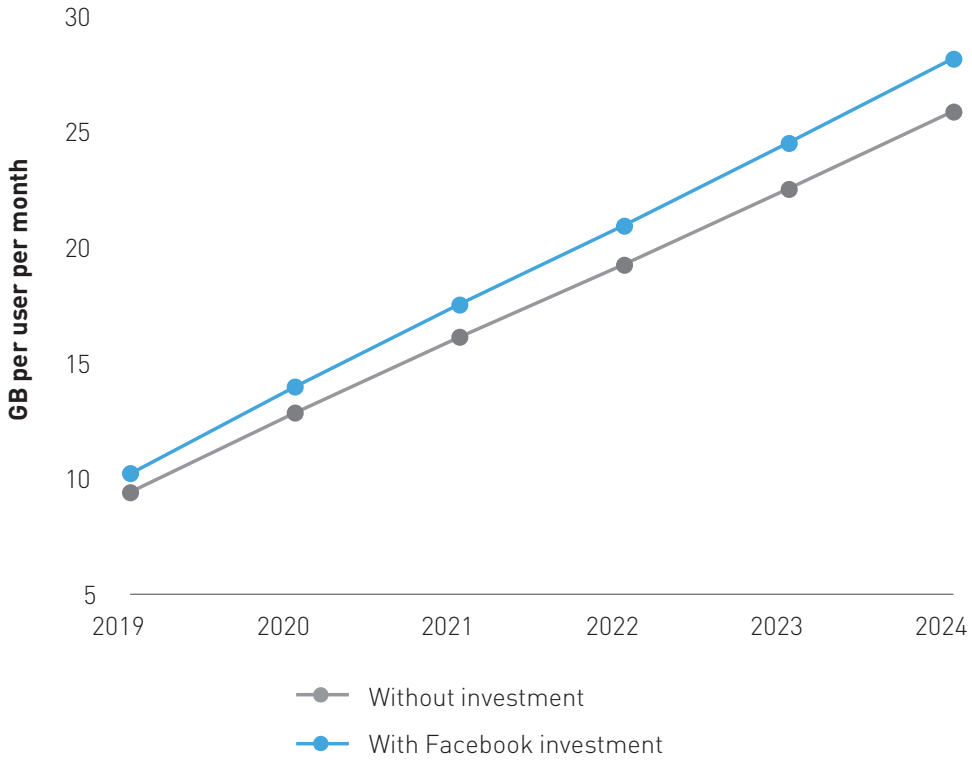
While all of Facebook's connectivity initiatives help to drive or facilitate increased Internet traffic to some degree, including to its own applications, we estimate that the most significant impact results from its investments in edge network infrastructure (caches, PoPs and support to IXPs) and submarine cables (both direct investments in new cables and capacity purchase on existing cables).

As discussed in Section 3.2, these investments improve the performance of Facebook's applications and reduce latency. Furthermore, the popularity of Facebook's platforms means that operators and ISPs would likely still carry as much Facebook / Instagram / WhatsApp traffic as they could in the absence of Facebook's edge network investments, and so these investments free up budget and capacity on operators' and ISPs' networks to carry more traffic from other online service and content providers. Overall, Facebook's investments make data cheaper and more affordable for end users, which drives growth in overall Internet usage.

[37] Assuming Facebook initiatives start in 2021; based on the assumption the initiative would cover 5.6% of each country's population, consistent with the planned coverage in Indonesia.

We estimate that across the ASEAN countries, Facebook's investments in edge network and international capacity will enable total Internet traffic to increase by 9% by 2024, relative to what could have been expected if this infrastructure was not in place (Figure 5.6).

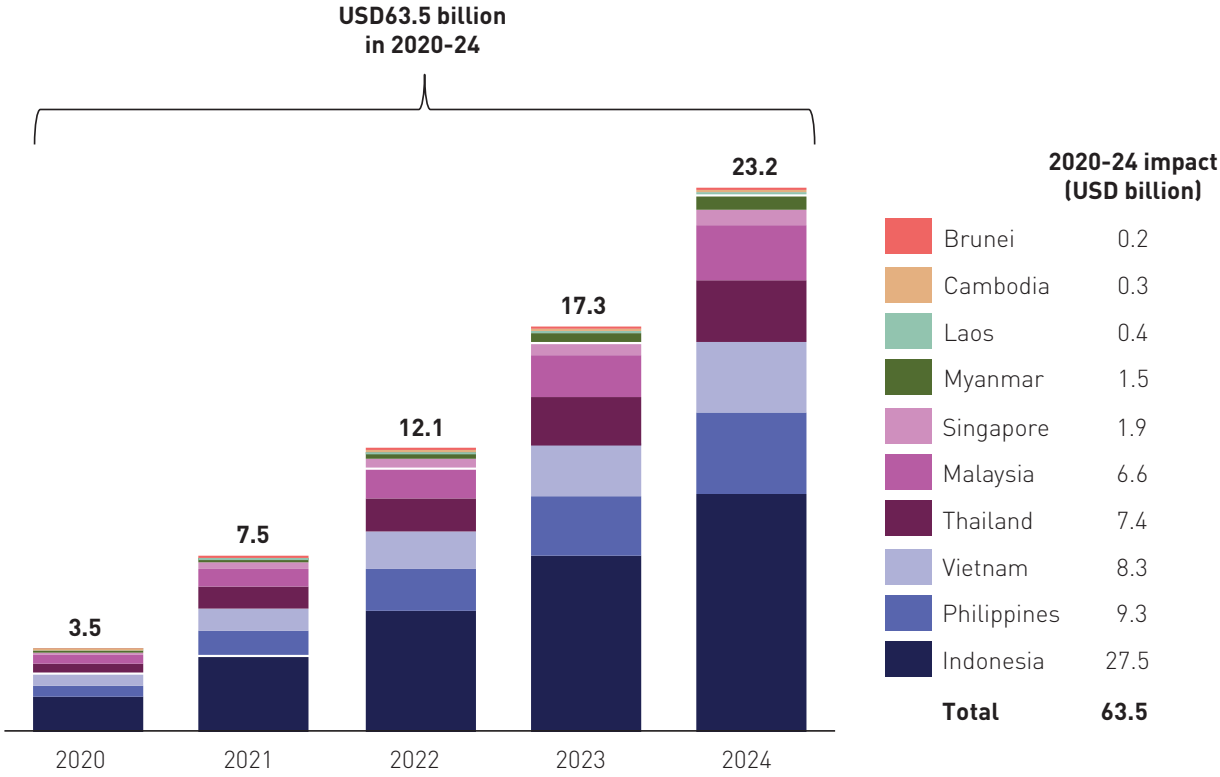
FIGURE 5.6: AVERAGE MONTHLY DATA USAGE PER USER IN ASEAN COUNTRIES, [SOURCE: ANALYSYS MASON, 2020]



Based on GSMA and Deloitte study, which defines the relationship between an increase in traffic and the resulting increase in GDP per capita growth, this higher traffic could increase the rate of growth in GDP per capita by 0.11 percentage points in each of the next five years (2020-2024). By using this increased growth rate to calculate the difference in GDP for each year, we have calculated the annual incremental GDP value attributable to Facebook's initiatives for each of the ASEAN countries, as shown in Figure 5.7 below. Looking at the cumulative impact over 2020-2024, these annual increases equate to an overall GDP contribution of approximately USD64 billion across the region over the five-year period.[38]

[38] The detailed methodology used to derive this estimate is described in Annex A.

FIGURE 5.7: PROJECTED YEARLY GDP IMPACT OF FACEBOOK'S EDGE NETWORK AND SUBMARINE CABLE INVESTMENTS IN ASEAN [SOURCE: ANALYSYS MASON, 2020]



5.2 Facebook's initiatives create economic value both as a direct result of investment, and through multiplier effects

In addition to the economic benefits that result from increased Internet penetration and traffic, Facebook's initiatives also benefit the ASEAN economies through the economic activity involved in building infrastructure within the region. This creates local jobs and provides a boost to local economies.

A study by Copenhagen Economics found that infrastructure investment by Google in Europe not only creates direct benefits in terms of jobs required for construction, maintenance and project management, but also produces further positive economic outcomes through indirect and induced effects (i.e. effects in the broader supply chain and the knock-on impact on the broader economy of the jobs created and income generated). According to the study, network connectivity investments can have a GDP multiplier of 1.35, meaning that for every USD1 of direct investment a further USD1.35 of GDP is generated through indirect and induced effects.[39]

Facebook has made substantial investments in the ASEAN region in recent years, including in its edge network, submarine cables and OTNx deployments. While much of the direct investment benefit is likely to accrue outside the region (due to construction being carried out by international infrastructure operators and Facebook using its global team to manage the initiatives), the indirect and induced effects should take place within the ASEAN countries, generating additional GDP.

Most importantly, however, these investments support future growth in connectivity, the potential impact of which greatly exceeds the direct investment effects.

[39] While investments in the ASEAN region are likely to exhibit a different multiplier effect to Europe, the general principles are the same for both regions.

5.3 The economic and social gains from Facebook's connectivity initiatives stem from impacts on various stakeholders

The macroeconomic impact on GDP presented above stems from the increased availability of information, services and digital tools on various stakeholders (individuals, enterprises and governments). In this section we present tables providing a breakdown of the constituent impacts of connectivity on the economy and society, looking at these three groups of stakeholders in turn.

For example, individuals' access to health information and e-health services results in longer life expectancy and improved health outcomes, which has a positive impact on labour market participation and GDP. Below we highlight a selection of these many benefits, which are illustrated through sample metrics and examples. Note that these benefits are not additional to the GDP impacts estimated in Section 5.2, but rather they serve to illustrate how those impacts are accrued.

FIGURE 5.8: INDIVIDUALS BENEFIT THROUGH INCREASED ACCESS TO INFORMATION AND SERVICES, WHICH LEADS TO IMPROVED QUALITY OF LIFE, HEALTH, EDUCATION AND INCOME[40]

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 much higher than the ethnic majority group. Typically located in lower-income, more remote mountainous communities, ethnic minority women are much less likely to attend antenatal or postnatal care or deliver 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, whose main mechanism was to reach out to pregnant women or recent mothers via mobile messages containing crucial information about pregnancy, pre-natal care, birth, and post-natal care. 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.

[40] 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 the World Health Organisation standards, there should be at least one doctor for every 439 people in a given community. In Thailand in 2019 one doctor had to serve 2065 people; the problem is primarily caused by low access to healthcare in remote regions, which are seen as too costly to serve 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; 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 more using them 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 platform, 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's platforms increased by a compound annual growth rate of 14.3% between the first half of 2014 and 2019.

Impact metric	How connectivity affects outcomes	Examples of Internet-enabled service
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 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 has surpassed one 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 and is a major contributor to financial inclusion in Indonesia.

FIGURE 5.9: FOR ENTERPRISES, CONNECTIVITY BENEFITS RESULT FROM INCREASED ORGANISATIONAL EFFICIENCY AND EASE OF REACHING AND COMMUNICATING WITH CUSTOMERS[41]

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, SMEs, investors, universities and other digital economy players, to accelerate recognition of Thailand as a technology innovation hub in Southeast Asia.

[41] Sources: 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; 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; 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.asiaoutlookmag.com/news/evaluating-the-role-of-technology-in-asean-6

Impact metric	How connectivity affects outcomes	Examples of Internet-enabled service
Development of e-commerce	Products purchased online are estimated to be 10% cheaper than their offline counterparts	• 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 changed with 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 since taken advantage of the mobile Internet to enhance agricultural productivity. Since the 'Green Way' app was launched in 2016, more than 100 000 farmers across in 329 townships have downloaded the app, and the founders hope to double their user base by the end of this year and serve two million farmers over the next three years.
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 changed with 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 since taken advantage of the mobile Internet to enhance agricultural productivity. Since the 'Green Way' app was launched in 2016, more than 100 000 farmers across in 329 townships have downloaded the app, and the founders hope to double their user base by the end of this year and serve two million farmers over the next 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 5.10: FOR GOVERNMENTS, CONNECTIVITY IMPROVEMENTS CAN ALSO BOOST EFFICIENCY AND TRANSPARENCY, AS WELL AS INCREASING THE REACH AND QUALITY OF E-GOVERNMENT SERVICES[51]

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 has 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. www.egov.go.th receives around 400 000 visits on desktop and mobile web applications each month.
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 using e-government systems, online platforms and mobile technologies for increasing transparency as one of the key developmental objectives. Anti-corruption agencies of Indonesia (KPK) and Malaysia (MACC) operate online portals and mobile applications for reporting corruption, which attract a large number of citizens.
e-government service take-up	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 1 hour vs. 1 day before digitalisation). These 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 has 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.

[42] 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.

Annex A Impact assessment methodology

This annex details the methodology used to estimate the impact of Facebook initiatives.

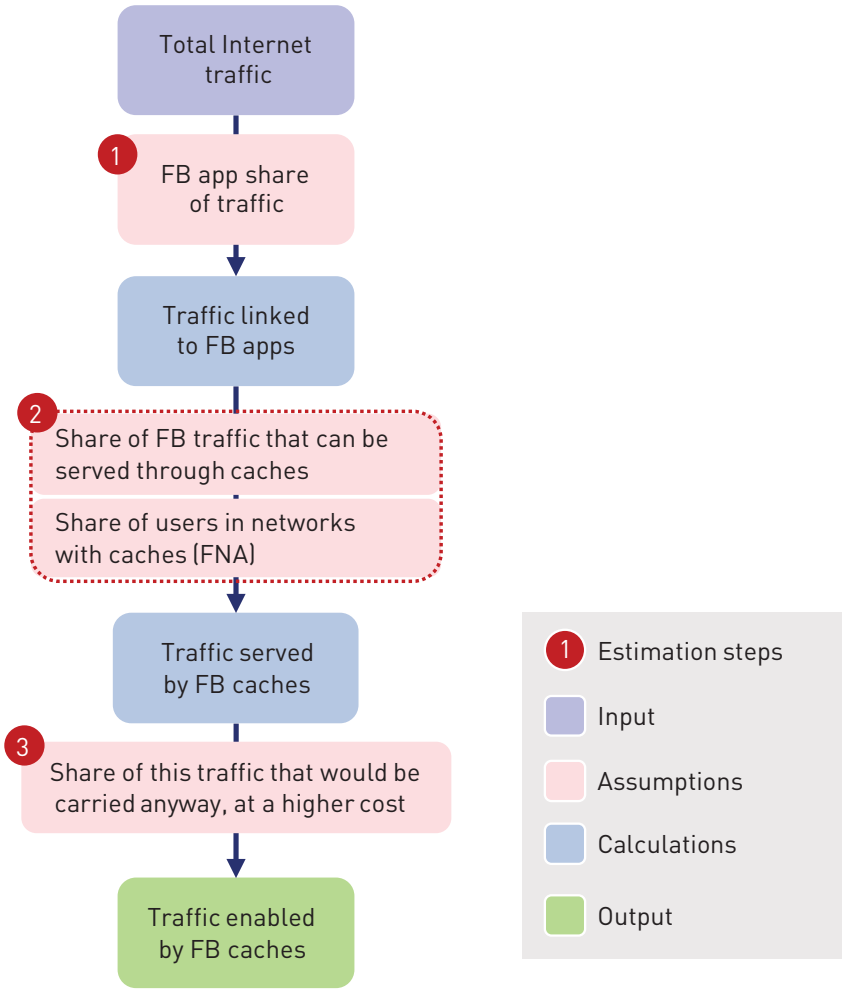
A.1 Edge networks and submarine cable investments

A.1.1 Estimating traffic enabled by Facebook caches

The following steps are taken to estimate the traffic enabled by Facebook (FB) caches (illustrated in Figure A.1 below).

- **Step 1:** Traffic linked to Facebook's applications (Facebook, Instagram, WhatsApp) is estimated as a share of total Internet traffic in the region.
- **Step 2:** Traffic served by Facebook caches is estimated by further adjusting Facebook's traffic by the following parameters:
  - share of Facebook traffic that can be served through caches; that is, the traffic that can be static (i.e. stored and requested on demand), unlike video calls and messaging content that needs to be dynamic
  - share of users in networks with caches; that is, the share of the region's Internet users who are served by ISPs that access Facebook caches.
- **Step 3:** Traffic enabled by Facebook caches is estimated by adjusting the traffic served by Facebook caches by a parameter reflecting the share of this traffic that would be carried anyway, by ISPs at a higher cost, if Facebook caches were not available.

FIGURE A.1: ESTIMATING THE TRAFFIC ENABLED BY FACEBOOK CACHES [SOURCE: ANALYSYS MASON, 2020]



A.1.2 Estimating traffic enabled by Facebook PoPs

The following steps are taken to estimate the traffic enabled by Facebook PoPs (illustrated in Figure A.2 below), starting from the traffic linked to Facebook applications (described above).

- **Step 1:** Traffic linked to Facebook's applications (Facebook, Instagram, WhatsApp) is estimated as a share of total Internet traffic in the region.

  Traffic served by Facebook PoPs is estimated by further adjusting Facebook's traffic by the following parameters:

  – Share of Facebook traffic that is not served by caches

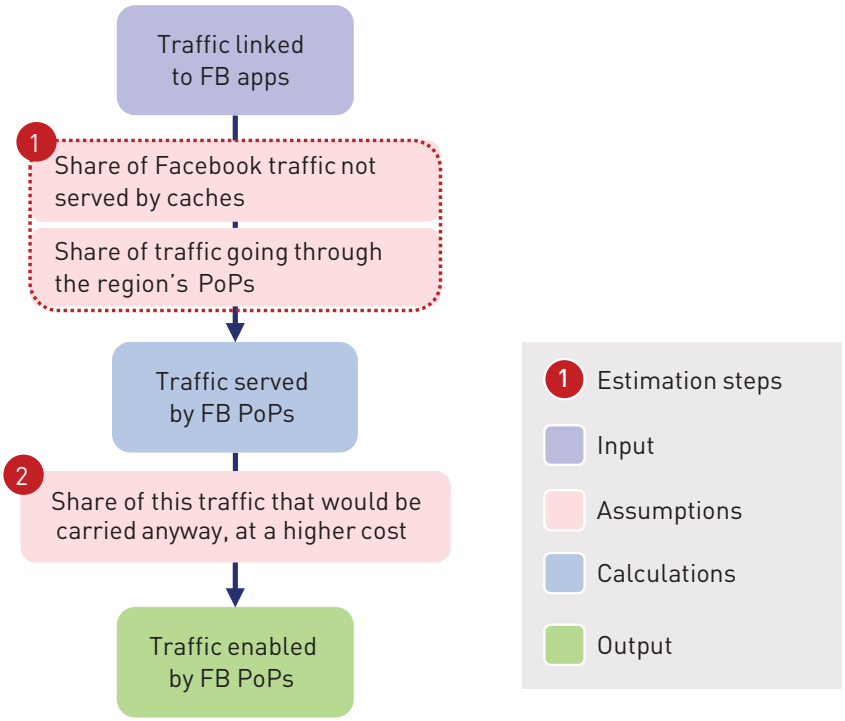
  – Share of Facebook traffic going through the region's PoPs. This share varies by country, depending on the extent of its connectivity to a PoP within and outside the region. An ISP can generally obtain Facebook traffic through one of four models:

    1. IP transit from home country (generally very expensive)
    2. Backhaul to regional hub + IP transit
    3. Backhaul to regional hub with Facebook PoP + peering
    4. Backhaul to rest-of-the-world (RoW) hub with Facebook PoP + peering

  For a given country, the share of Facebook's traffic that goes through regional PoPs therefore depends on whether the country can easily obtain backhaul to a PoP (i.e. at reasonable cost and without regulatory hurdles that would prevent this) relative to the alternative of purchasing connectivity to other regions such as Europe.

- **Step 2:** Traffic enabled by Facebook PoPs is estimated by adjusting the traffic served by Facebook PoPs by a parameter reflecting the share of this traffic that would be carried anyway, by ISPs at a higher cost, if Facebook PoPs were not available.

FIGURE A.2: ESTIMATING TRAFFIC ENABLED BY FACEBOOK POPS [SOURCE: ANALYSYS MASON, 2020]



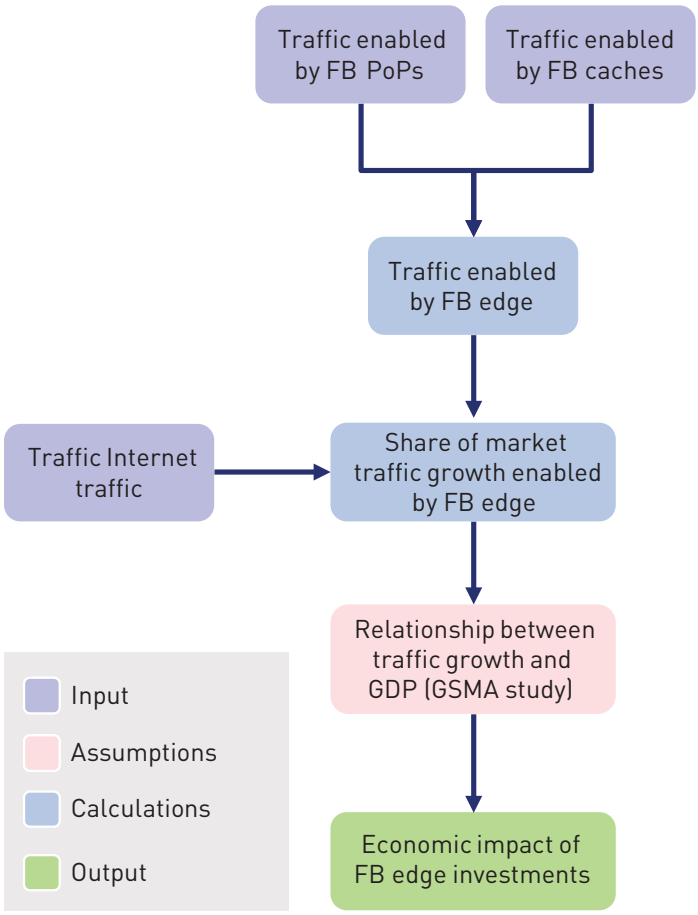
A.1.3 Estimating the GDP impact of Facebook caches and PoPs

The total traffic enabled by Facebook's edge investments is the sum of traffic enabled by its caches and traffic enabled by its PoPs. A comparison of this traffic to the total Internet traffic shows the growth in traffic volume that can be attributed to Facebook's edge investments, and by applying the link between traffic growth and GDP (put forward by GSMA and Deloitte – see below) it is possible to estimate the GDP enabled by these initiatives.

Relationship between traffic growth and GDP

The 2012 study by GSMA and Deloitte established that, on average, if a country doubled its traffic consumption per user over five years, it would experience a 0.5% increase in GDP per capita growth in each of these years.[43]

FIGURE A.3: CALCULATING THE ECONOMIC IMPACT OF FACEBOOK'S EDGE NETWORK INVESTMENTS
[SOURCE: ANALYSYS MASON, 2020]



[43] GSMA, Deloitte – "What is the impact of mobile telephony on economic growth?", November 2012. Note: we have not carried out a detailed review of the GSMA and Deloitte methodology; a purposeful triangulation of the take-up to GDP per capita growth and traffic to GDP per capita growth parameters, with a view of specific markets and timeframes, may alter the modelling results presented within this report.

In order to assess the value of existing investments, the above methodology is applied to a forecast period, comparing base-level traffic projections with scenarios in which Facebook's edge is "switched off", i.e. when traffic enabled by Facebook's caches and PoPs is excluded. To produce results for the overall region, this methodology is followed for individual ASEAN countries, noting that modelling assumptions vary depending on cache and PoPs in a given country, its distance to the regional hub, and the level of international connectivity available.

By applying the relationship between growth in traffic per user and growth in GDP per capita it is possible to calculate new rate of growth in GDP per capita and new total GDP, and a comparison of the resulting values to base-line GDP yields the share of GDP growth enabled by edge investments. The cumulative value of this additional GDP comprises the economic value of the initiatives.

A.2 OTNx

The OTNx initiative in ASEAN countries achieves two connectivity outcomes:

- increased Internet take-up – extending 4G coverage, enables Internet access for people who were previously unconnected

- increased data traffic – extending 4G coverage contributes to faster substitution of 3G connections with 4G, which is associated with increasing levels of data consumption.

The impact of the OTNx initiative can therefore be assessed by quantifying both of these connectivity outcomes and using the relationship between these outcomes and GDP (established by third-party studies) to measure the final economic value.

The following steps are involved in such an assessment (illustrated in Figure A.4 below):

- **Step 1:** At a national level for each country, the population coverage of 3G+ technologies and penetration of unique mobile Internet users are used to derive the national level of mobile broadband take-up within areas that have coverage. At the same time, the population coverage of 4G and penetration of unique 4G users are used to derive the national level of 4G take-up within covered areas.

- **Step 2:** For each country, the population covered by each OTNx initiative is known. As a result of OTNx, it is assumed that mobile broadband take-up in the area concerned will reach the national level (derived as per Step 1 above) within three years of the launch of the initiative. It is also assumed that the 4G take-up in the area will reach the national level within the same timeframe.

- **Step 3:** In the counterfactual scenario (with no Facebook initiative), it is assumed that the mobile broadband take-up in the area will reach the national level by 2025 (a delay of one or two years compared to the case with OTNx). Therefore, the impact of Facebook's initiative is to shift the mobile broadband penetration curve earlier in time, which results in incremental penetration increase from the year the initiative is launched until the year when the two scenarios converge. It is also assumed that the 4G take-up in the area will reach 90% of the national level by 2025; therefore, an additional impact of the initiative is to enable more mobile broadband users to receive higher-quality Internet services.

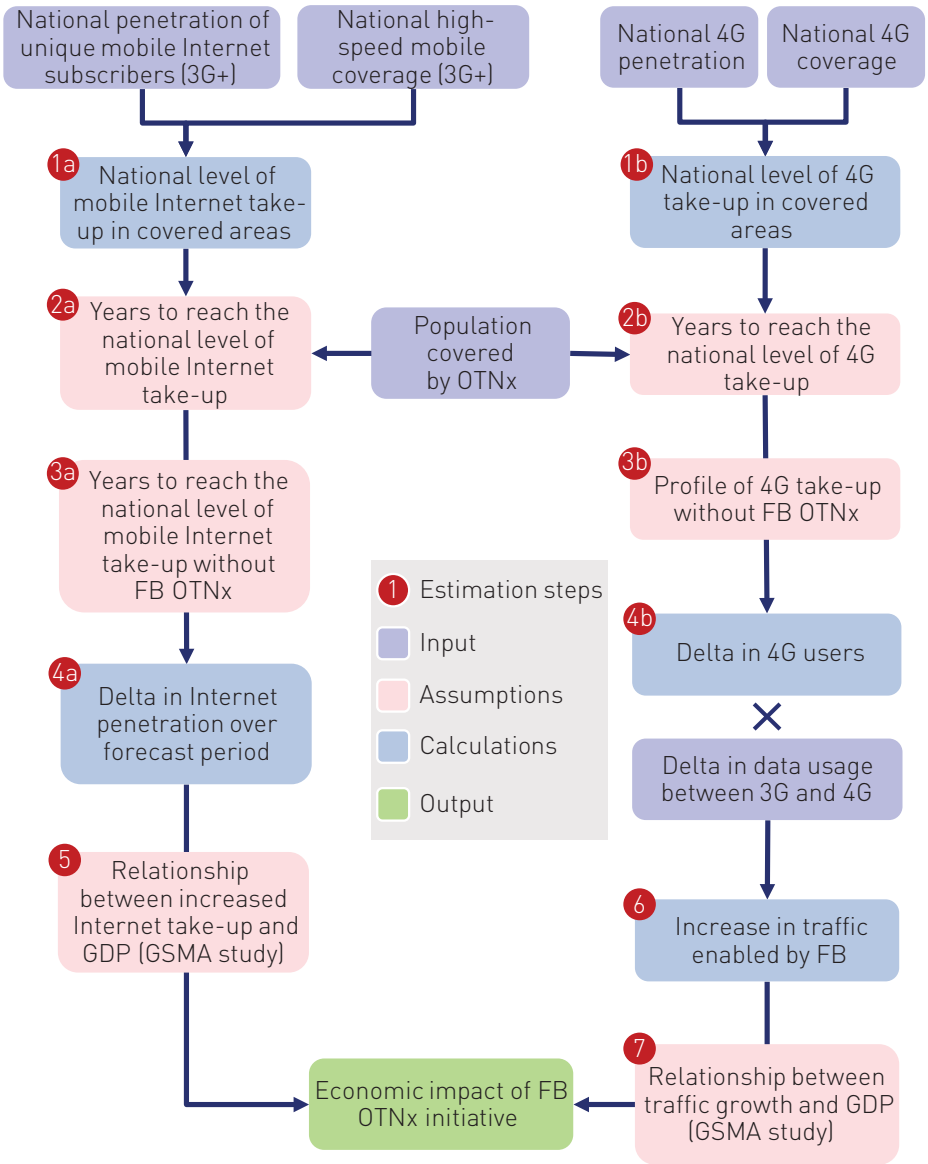
- **Step 4:** The deltas in mobile broadband take-up and 4G take-up (difference in take-up levels with and without OTNx) are derived for the area. The former is applied to the number of affected Internet users and a blended national average is calculated, obtaining the impact on mobile broadband penetration at the national level.

- **Step 5:** According to the GSMA and Deloitte 2012 study, a 10% increase in mobile broadband penetration in a given country results in a 0.15 percentage point increase in the GDP-per-capita growth rate for this country.[44] The relationship established in the study is therefore used to calculate the take-up impact on GDP of a given Facebook OTNx initiative.

- **Step 6:** Total Internet traffic is calculated for both scenarios, with the Facebook scenario showing a traffic uplift driven by higher numbers of 4G users.

- **Step 7:** According to the GSMA and Deloitte 2012 study, if a country doubled its traffic consumption per mobile broadband user over a five-year period, this would lead to a 0.5% increase in GDP-per-capita growth rate in each of these years. This link is therefore used to calculate the traffic impact on GDP of a given Facebook OTNx initiative.

FIGURE A.4: CALCULATING THE ECONOMIC IMPACT OF FACEBOOK'S OTNX INITIATIVES [SOURCE: ANALYSYS MASON, 2020]



[44] Note: we have not carried out a detailed review of the GSMA and Deloitte methodology; a purposeful triangulation of the take-up to GDP per capita growth and traffic to GDP per capita growth parameters, with a view of specific markets and timeframes, may alter the modelling results presented within this report.

Annex B Demand-side initiatives

This annex provides two additional case studies on Facebook initiatives aimed at stimulating demand for connectivity.

Free Basics

Free Basics is an online platform that Facebook has deployed in partnership with MNOs to provide access to low-bandwidth services without data charges. Services that are available through the platform are provided by website developers, non-profit organisations and governments, and include content such as news, employment, health, education and local information.[45]

The Free Basics platform is open to any developer who submits a site as long as the site meets the programme's technical criteria (e.g. no video or large photos).[46] Free Basics is also non-exclusive so that any mobile operator can choose to participate. Mobile operators are not paid to offer Free Basics, and developers are not charged to have their sites included in the programmes.

By enabling people to access the benefits and relevance of connectivity without data charges, Free Basics is designed to help bring people online and transition them to regular use of the broader internet. Free Basics also provides a baseline of connectivity intended to help people stay connected consistently and incentivised to continue purchasing data to stay on the internet when they are able to do so.

Within ASEAN, Free Basics is deployed in Cambodia, Indonesia, Laos, the Philippines and Thailand.

Connectivity Crisis Response (CCR)

CCR is functionality built into the Facebook app and website that allows people to communicate, receive information and request or offer resources and financial aid in the event of a crisis such as a natural catastrophe or a terrorist attack.

CCR includes the following functions:

- **Mark yourself safe,** allowing people to signal their safety to friends and family
- **Give or find help,** connecting affected people with providers of necessary items or services
- **Raise money,** enabling fundraising
- **Get information,** compiling updates on the development of crises and information from humanitarian organisations, local non-profits and governments.

CCR enables urgent communication without the use of mobile networks, which may become overloaded during a crisis.[47]

[45] Source: Facebook connectivity, Free Basics, see https://connectivity.fb.com/free-basics/

[46] See https://developers.facebook.com/docs/internet-org/platform-technical-guidelines/

[47] Source: Crisis Response Program, see https://www.facebook.com/about/crisisresponse/

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