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ECONOMIC IMPACT OF GOOGLE'S APAC NETWORK INFRASTRUCTURE

FOCUS ON JAPAN

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Economic impact of Google's network infrastructure in Japan

DATA TRAFFIC IN JAPAN IS GROWING STRONGLY, DRIVEN IN PART BY THE POPULARITY OF GOOGLE'S SERVICES

Japan data traffic growth 2010–2019 (EB)

12% Google services' share of APAC internet traffic

GOOGLE INVESTED OVER USD2 BILLION IN NETWORK INFRASTRUCTURE ACROSS APAC, WHICH SUPPORTS THE INTERNET IN JAPAN

>$2bn

Google's APAC network infrastructure investment

Japan investments

- **3** submarine cables (Unity, SJC, Faster)
- **5** private facilities and **11** IXPs with Google PoPs
- **~50%** of bandwidth purchased from telcos
- **26** cities where GGC nodes are deployed

GOOGLE'S INFRASTRUCTURE INVESTMENT HELPS JAPAN REALISE STRONG ECONOMIC BENEFITS FROM INCREASED INTERNET USAGE

Last 10 years (2010-2019)	Next 5 years (2020-2024)
419 000 Jobs	**464 000** Jobs
$269bn in GDP	**$202bn** in GDP

1 All currency in USD, in real 2019 terms

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THESE INVESTMENTS IMPROVE THE CONNECTIVITY ECOSYSTEM WHICH BENEFITS CONSUMERS AND BUSINESSES

2024

89 Exabytes internet traffic

151Tbit/s in additional capacity

17ms reduction in end-user latency

4.4x faster download speeds vs. rest of APAC

66% lower IP transit prices vs. rest of APAC

3 new use cases supported

- Video Conference
- Commerce and Transactions
- Cloud Services

JAPAN CLOUD SPEND IS EXPECTED TO GROW STRONGLY DRIVING ADDITIONAL ECONOMIC BENEFITS

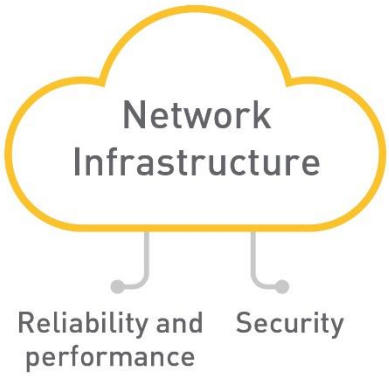
Japan cloud spend (USD bn) 2018–2023

Benefits of cloud adoption

- Supports digital transformation agenda
- Additional economic impact from 2019-2023

146 000 Jobs **$129bn** in GDP

NETWORK INFRASTRUCTURE IS IMPORTANT FOR CLOUD – IT IMPROVES:



Case Study: DeNA

DeNA is a provider of mobile portal and ecommerce websites. It deploys several cloud-based products to ensure smooth-running of its complex Machine Learning models in improving gamer experience.

"[GCP] enables error-free auto-scaling and low latency... Significantly increases system speed and stability."

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REGULATORY AND INVESTMENT REGIMES NEED TO SUPPORT FURTHER INVESTMENT IN NETWORK INFRA DEPLOYMENT TO GENERATE ADDITIONAL ECONOMIC BENEFITS
Deployment and landing of submarine cables
> Transparent and clearly laid out procedure to obtain licences / permits
> Single agency provides a central point of contact to facilitate the process for licence and permit applications
> Open cable landing station provides non-discriminatory and cost-oriented access to landing parties
> Open investment policy allowing majority submarine cable ownership by foreign investors
> Fast-tracked permit application process for inspection and repair works
> Exemption of submarine cable works from cabotage laws
> Implementation and effective enforcement of cable protection laws
Protection and maintenance of submarine cables
Supported by
Strong respect for the law and effective regulatory enforcement
> Government regulations are effectively enforced without improper influence
> Administrative proceedings are conducted without unreasonable delay
> Due process is respected in administrative proceedings
5 out of 7 best practices observed in Japan

Japan has one of the world's most developed telecoms landscapes, with around 80% of the population using the internet.[2] Internet traffic generated across both fixed and mobile networks has been growing strongly at around 29% annually from 2010 to 2019, reaching 112EB in total in 2019.

There are three main telecoms service providers in Japan:

- **NTT**, the incumbent and largest telecoms operator
- **KDDI**
- **SoftBank**.

Both fixed and mobile networks provide extensive coverage: around 98% of households[3] have access to fibre broadband and nearly 99% of the population is within range of 4G mobile coverage.[4]

Japan is also one of the main submarine cable hubs in APAC: it is connected to 21 international submarine cable systems that, as of 2019, offered a total of 724Tbit/s in potential capacity.[5]

1 Google's network infrastructure investments contributed to higher internet usage in Japan, equivalent to 35% of internet traffic in 2019

Google's investments in network infrastructure not only improve service performance and reliability of its content and services, they also improve the overall performance and cost-effectiveness of internet infrastructure in Japan. Investments in submarine cables bring new supply, improve the diversity of links and also support the expansion of Google's edge infrastructure in Japan. The connectivity improvements include lower latency, faster end-user speeds, lower cost of international connectivity and stimulation of new use cases. These effects translate into more internet traffic generated by both consumers and businesses in Japan.

Google is an investor in three submarine cable systems that land in Japan, namely:

- **Unity**, Google's first submarine cable investment in APAC, which launched in 2010 and connects Japan to the USA
- **SJC**, a Pan-Asia cable launched in 2013, which connects Singapore, Japan, China, Hong Kong, the Philippines, Brunei and Thailand
- **Faster**, launched in 2016, which connects Japan, Taiwan and the USA.

These cables bring a total of 151Tbit/s in potential capacity to Japan. Google also purchases additional capacity on other international links provided by telecoms carriers, and this purchased bandwidth accounts for close to half of Google's network capacity in Japan.

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2 Ministry of Internal Affairs and Communications, Japan – "Information and Communications in Japan 2019"; see: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2019/chapter-3.pdf#page=25

3 FTTx coverage and capex worldwide: forecasts and analysis 2019–2025, Analysys Mason Research

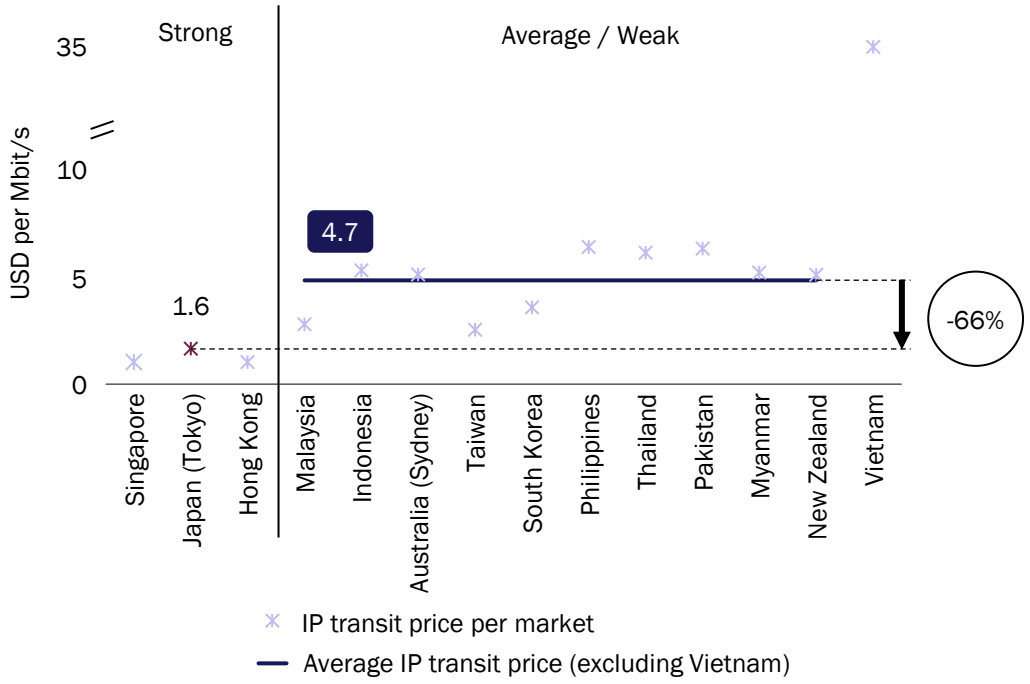
4 Analysys Mason Research

5 Refers to the estimated theoretical maximum capacity that a cable could handle with current technology

Besides bringing additional bandwidth into Japan, Google's investments in submarine cables improve route diversity. Our modelling also found a correlation between Google's network investments and lower end-user latency; in Japan, this effect may be linked to end-user latency reductions of 17ms by 2019.

Google's investments have also contributed to the decline in the cost of international bandwidth: IP transit prices in Japan are amongst the lowest in the region, as shown in Figure 1 below.

Figure 1: IP transit prices[6] across APAC [Source: TeleGeography, Analysys Mason, 2019]



Apart from investments in international capacity, Google has also invested in edge infrastructure and deployed PoPs in five private peering facilities and cross-connected to IXPs at 11 locations as provided in Figure 2 below. GGC nodes are also deployed in operator networks in 26 cities across Japan.

Name of facility / fabric	Type	Location
BBIX Osaka	Public	Osaka
BBIX Tokyo	Public	Tokyo
DIX-IE	Public	Tokyo
Equinix Osaka	Public	Osaka

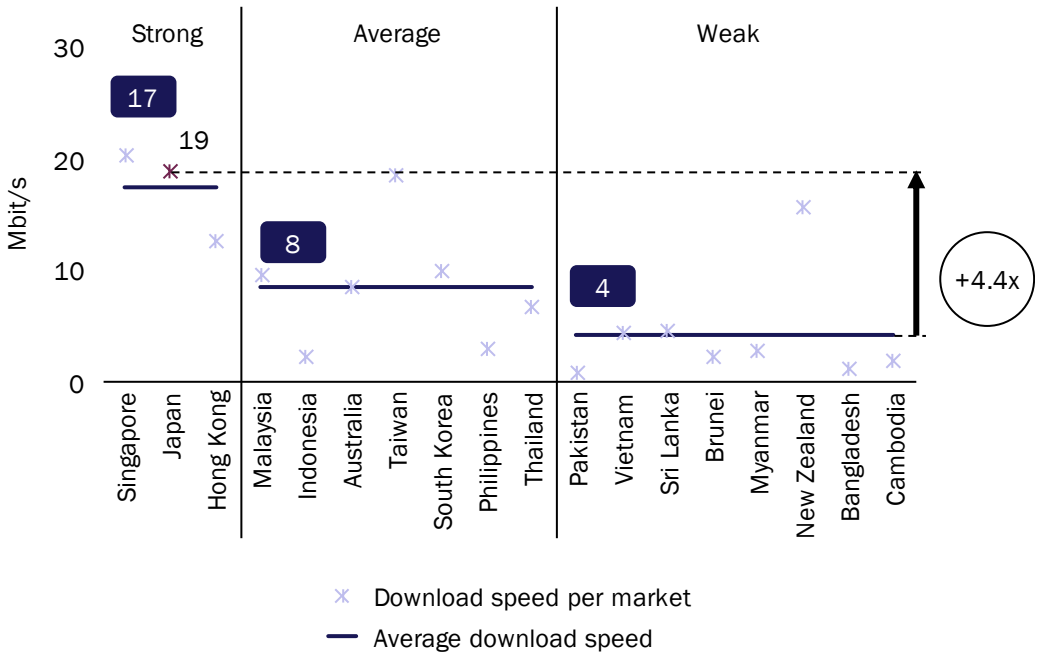
Figure 2: List of Google peering facilities in Japan [Source: Google, PeeringDB, 2020]

6 Refers to USD per Mbit/s of IP transit prices in 2019 based on the committed data rate of 10Gbit/s from TeleGeography; calculation is based on averaging the weighted median prices by cities and quarters (up to Q3 2019) to derive 2019 prices; IP transit price data for 10Gbit/s is referenced, as it provides the highest number of available data points (14 APAC economies with submarine cables)

Equinix Tokyo	Public	Tokyo
JPIX Osaka	Public	Osaka
JPIX Tokyo	Public	Tokyo
JPNAP Osaka	Public	Osaka
JPNAP TokyoPeering	Public	Tokyo
KINX (switch at AT Tokyo)	Public	Tokyo
KRIX (Sejong, switch at AT Tokyo)	Public	Tokyo
AT Tokyo	Private	Tokyo
ComSpace	Private	Tokyo
Equinix Osaka (OS1)	Private	Osaka
KDDI Otemachi	Private	Tokyo
NTT Telepark	Private	Osaka

These investments in edge infrastructure and PoPs bring popular Google content closer to end users in Japan, which has led to faster download speeds[7]; in 2019, the average download speeds in the country were up to 4.4× that of less well-connected economies, as shown below in Figure 3.

Figure 3: Download speed comparison [Source: M-lab, 2019]

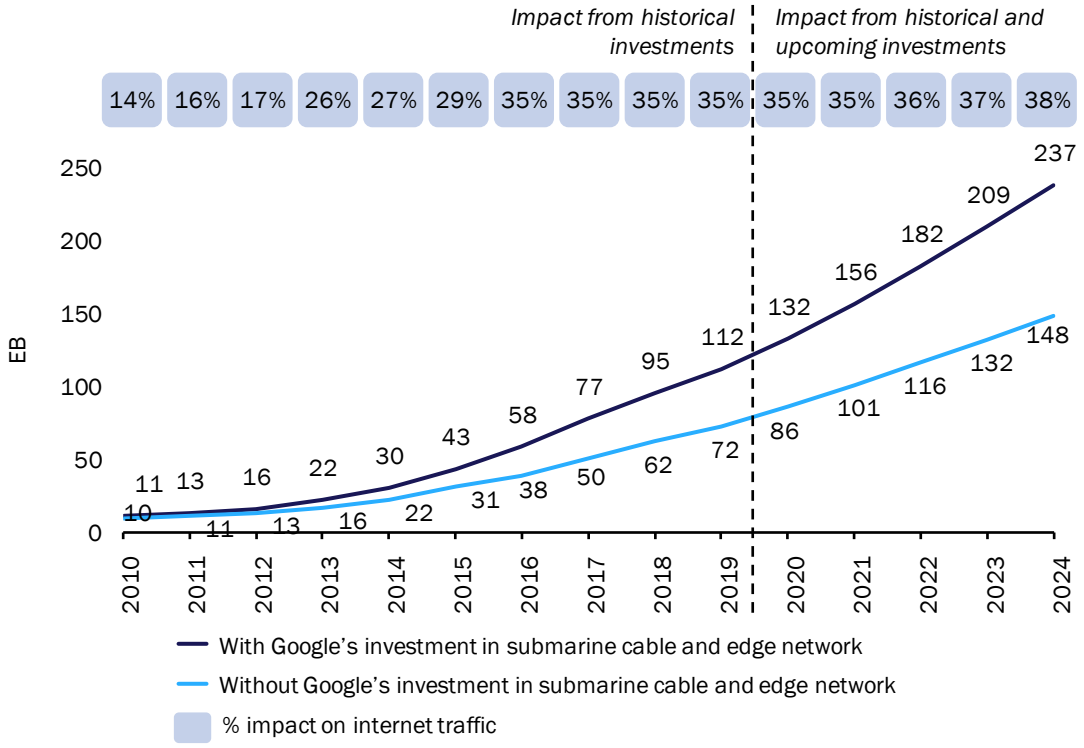


7 Google traffic is a significant contributor to network traffic in APAC – approximately 12% of total uplink and downlink network traffic, according to Sandvine

Improvements in latency and internet speed increase ISPs' ability to deliver innovative services such as cloud services, video conferencing and gaming. Low latency is also critical for transactional services, including e-commerce.

The end result of these improvements is greater demand for the internet in Japan: based on Analysys Mason's modelling, we estimate that internet traffic in Japan would have been 35% lower in 2019 in a scenario where Google had not invested in network infrastructure, and 38% lower by 2024, as seen below in Figure 4.[8]

Figure 4: Impact of Google's investments in edge network infrastructure on internet traffic served by Google's services in Japan [Source: Analysys Mason, 2020]



2 The positive impact of Google's network infrastructure investment benefits the internet ecosystem in Japan, supporting 419 000 jobs and led to USD40 billion in additional GDP in 2019

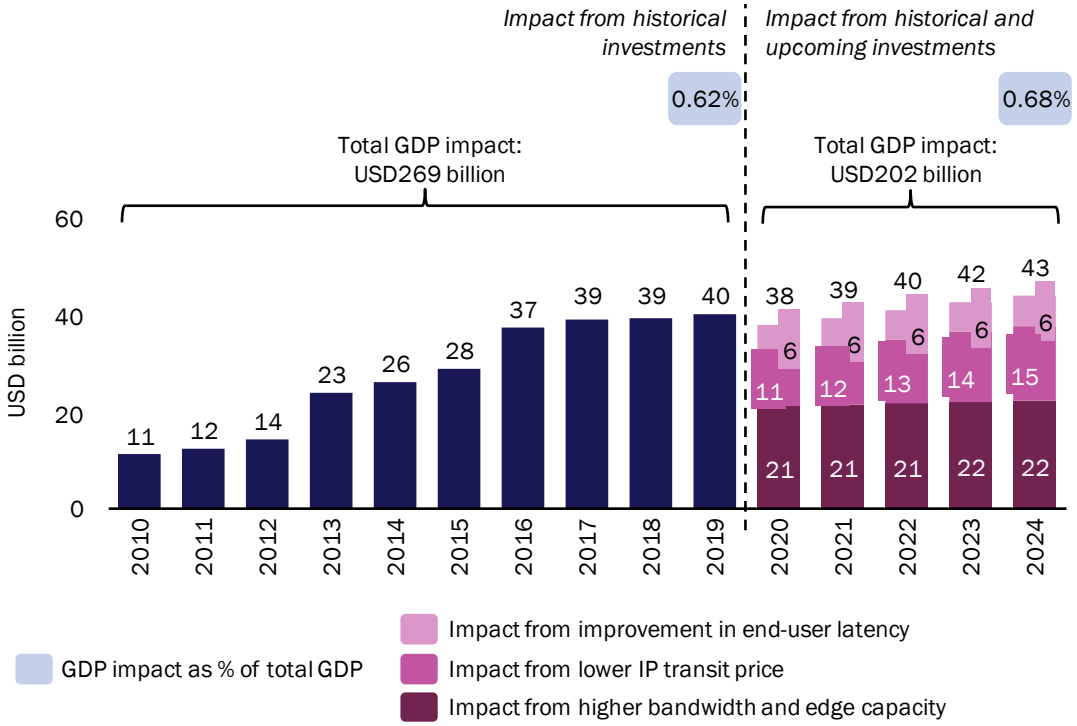
The increase in internet use has a positive impact on economic activity across various sectors, leading to benefits for consumers and businesses. The increase in internet use has a positive impact on economic activity across various sectors, leading to benefits for consumers and businesses. We estimate that the increase in internet usage contributed USD269 billion in GDP impact (in real

8 This takes into account the effect of the entire submarine cable system(s) that Google participates in. As explained in Annex A of the full report, the fact that Google was an investor in these systems appears to have a statistically significant effect on their impact on the geographies they serve, including Japan.

terms[9]) in Japan from 2010 to 2019; in 2019, we estimate that GDP would have been 0.62% lower in the scenario where Google had not made investments in network infrastructure.

Google's continued network investments from 2020 onwards are expected to spur higher internet traffic. The historical and continued investments are expected to contribute an additional USD202 billion in GDP impact from 2020 to 2024, of which USD43 billion would be in 2024 alone (see Figure 5 below). This GDP impact represents the mid-range of Analysys Mason's modelling estimates and could range between USD35 billion and USD464 billion from 2020 to 2024 (see *Figure 6* below).

Figure 5: Increase in real GDP attributable to Google's network infrastructure investments in Japan [Source: Analysys Mason, 2020]



9 GDP figures are in constant USD using 2019 as the base year and using a fixed exchange rate to USD in 2019; GDP statistics in USD are sourced from the World Bank and Euromonitor

Figure 6: Increase in real GDP from 2020 to 2024 attributable to Google's network infrastructure investments in Japan by modelling scenarios and connectivity components [Source: Analysys Mason, 2020]

Drivers of data traffic impacting GDP	Conservative[10]	Base case[11]	Aggressive[12]
Bandwidth and edge impact + IP transit price + Latency impact	96	202	464
Bandwidth and edge impact + IP transit price impact	88	172	388
Bandwidth and edge impact only	35	107	290

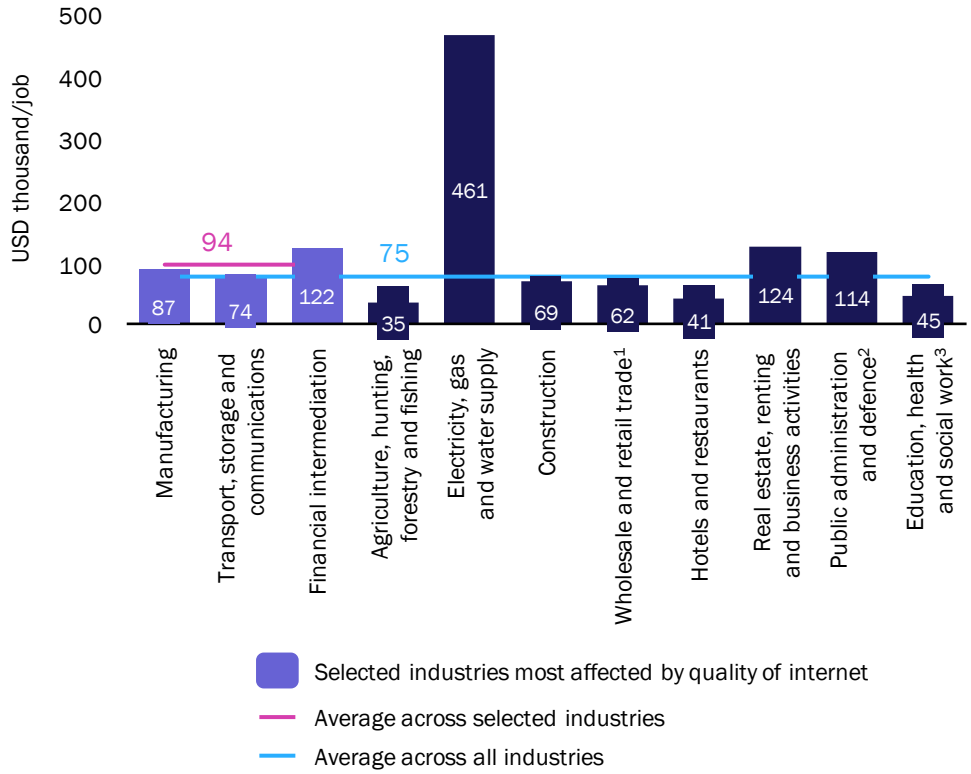
The economic benefits arising from Google's network infrastructure investments translate into jobs: direct jobs in the construction and telecoms sector and indirect jobs driven by the improvement of broadband connectivity across the broader economy, particularly in industries such as IT, financial services and manufacturing. Based on an assessment of gross value added (GVA) across industries in Japan, we estimate that, in 2019, the average GVA per job was USD94 000 in industries most affected by the quality of the internet (see Figure 7 below).

10 The conservative modelling scenario refers to the use of coefficients (within the 95% confidence interval) in the supply and demand side equations to provide the lowest GDP impact. Specifically, the highest coefficient values are used in the supply side equation for latency and both latency and IP transit price variables in the demand side equation for mobile data usage; the lowest coefficient values are used in the supply side equation for internet bandwidth and internet bandwidth variable in the demand side equation for mobile data usage

11 The base case modelling scenario refers to the use of mid-point coefficients (within the 95% confidence interval) in the supply side equations (coefficients for submarine cable count and Google submarine cable percentage variables) and demand side equation (coefficients for internet bandwidth); Latency and IP transit price variables in the demand side equation are kept at the highest coefficient values which provides the lowest GDP impact

12 The aggressive modelling scenario refers to the use of coefficients (within the 95% confidence interval) in the supply and demand side equations to provide the highest GDP impact while keeping latency and IP transit variables unadjusted (see above base case modelling scenario). Specifically, the lowest coefficient values are used in the supply side equation for latency; the highest coefficients are used for the supply side equation for internet bandwidth and the internet bandwidth variable in the demand side equation for mobile data usage

Figure 7: 2019 GVA per job by industry in Japan [Source: Analysys Mason, national statistics authority via Euromonitor, 2020]



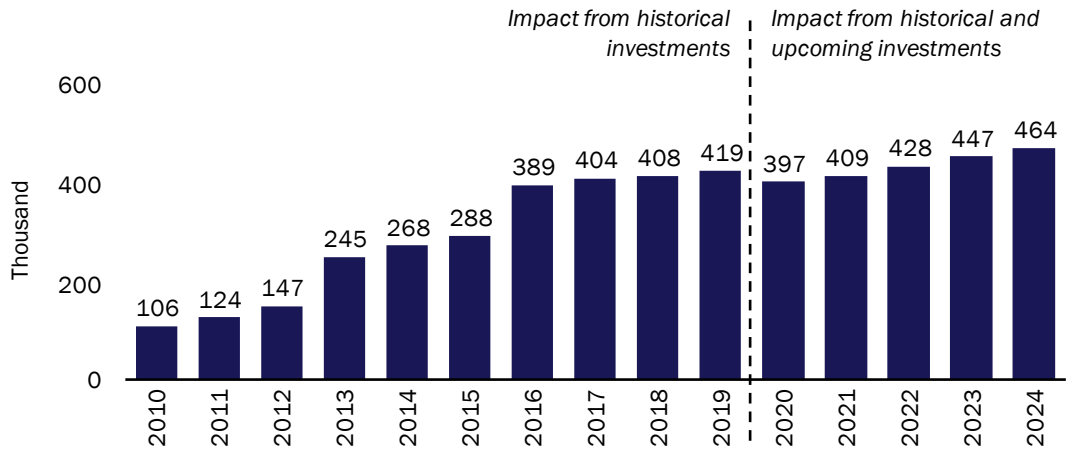
[1] Includes repair of motor vehicles, motorcycles, personal and household goods

[2] Includes compulsory social security

[3] Includes other community, social and personal service activities

Based on this assessment, we estimate that Google's network investments and their impact on GDP led to around 419 000 jobs by 2019, which will grow to 464 000 jobs by 2024 (see Figure 8 below).

Figure 8: Impact of Google's network investments on job creation in Japan [Source: Analysys Mason, 2020]



3 Investments in network infrastructure contribute to the reliability and security of the cloud, driving further positive economic impacts as cloud spending expands 18% annually

According to BCG's "Ascent to the Cloud" report, Japan has one of the largest public cloud markets in APAC. The country's public cloud spend is growing at 18% annually, from USD8 billion in 2018 to an expected USD18 billion in 2023. The increase in cloud spend is expected to have a cumulative GDP impact of USD129 billion between 2019 and 2023 and support 146 000 jobs in 2023.[13]

Google is an important player among global public cloud service providers. At the end of 2019, GCP had been deployed in seven cloud regions in APAC, two of which are in Japan. The GCP region in Tokyo was launched in 2016 and a second region in Osaka launched in 2018. The expansion supports the rapidly growing customer base in Japan, brings lower latency to customers and improves system availability.[14]

Google's network infrastructure investments provide route diversity, connecting cloud regions in Japan to other regions through different paths and enable low service latency, high levels of availability and increased resilience to cable cuts. The improved reliability, resilience and security of the Cloud service is important to Google Cloud customers in Japan as shown in the case study below.

13 The studies underlying the cloud market forecasts were conducted before the onset of the COVID-19 pandemic and thus did not include the effects on the economy arising from COVID-19. We have left these forecasts unchanged, although the forecasts used for the main economic impact assessment in this report reflect updated forecasts as of June 2020. The size of the cloud services market may actually increase faster than anticipated as a result of COVID-19

14 Google Cloud Blog; see: https://cloud.google.com/blog/products/infrastructure/google-cloud-launches-new-osaka-region-to-support-growing-customer-base-in-japan

Case study: DeNA deploys GCP to improve gaming experience for customers

DeNA is a provider of mobile portal and ecommerce websites in Japan. Its popular game Gyakuten Othellonia is highly complex for beginners, leading to a high churn rate.

Working with GCP, DeNA deployed several cloud-based products to ensure smooth-running of its complex Machine Learning models in improving gamer experience, which helped to lower churn rates. They were able to leverage GCP's open and serverless technologies to host their AI models without worrying about scalability of infrastructure or the portability of code.

> "[GCP] enables error-free auto-scaling and low latency… Significantly increases system speed and stability."
>
> **DeNA**

Besides improving the performance of cloud services, Google's network investments also serve as the underlying infrastructure layer delivering cloud traffic. Carrying cloud traffic on Google's own network reduces the security footprint, making it less likely that GCP customers' traffic will be attacked, intercepted, or manipulated by malicious actors.

4 Japan's regulatory regime is conducive to the deployment and landing of submarine cables

Interviews with submarine cable owners have confirmed that Japan has a mature and well-established application process for landing submarine cables. Landing station owners generally provide access to submarine cable owners however its terms and conditions could be improved. There are also no equity limits on foreign investments in network infrastructure so far. These factors have enabled Japan to become a leading submarine cable hub in the region.

Japan is also a jurisdiction with strong regulatory enforcement principles. It scores well on the Rule of Law index, with a regulatory enforcement factor score of 0.79.[15] This boosts investors' confidence, particularly in the context of capital-intensive investments such as the deployment of submarine cables.

There are potential improvement points that Japan could consider implementing to support the submarine cable industry. We understand that negotiations between the fishery and submarine cable industries have historically been difficult. In order to address this issue, Japan could consider regulatory involvement in facilitating discussions between the fishery industry and submarine cable owners in order to arrive at a fair compensation amount for the fishery industry.

15 World Justice Project – "Rule of Law Index 2020"; see https://worldjusticeproject.org/our-work/research-and-data/wjp-rule-law-index-2020