



QUANTIFYING THE IMPACT OF 5G AND COVID-19 ON MOBILE DATA CONSUMPTION

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Authors

Francesco Rizzato, Principal Technical Analyst

Ian Fogg, VP Analysis

Opensignal is the independent global standard for analyzing consumer mobile experience. Our industry reports are the definitive guide to understanding the true experience consumers receive on wireless networks.

Key Findings

Mobile data is now the oxygen of the mobile experience. Smartphone users need mobile data to use any network application, including music, video and multiplayer games. The amount of mobile data included is now an extremely common way to set price plans for both post-pay and pre-pay users. For operators, it's a major operating cost that can cause network congestion and drive increased spending on network densification or more wireless spectrum.

5G users are on average consuming up to 2.7x more mobile data than 4G users

In all 20 leading 5G markets analyzed, we see much greater mobile data usage among 5G smartphone users than by 4G users. The greatest increases are in Japan (2.7x), Canada (2.2x), Germany (2.1x) and South Korea (2.1x). The three markets with the greatest 5G data consumption are Taiwan (47.3 GB/month), Saudi Arabia (42.0 GB/month) and South Korea (37.9 GB/month).

There's no sign of 5G mobile congestion nationally, even in high usage 5G markets

To date, 5G is severing the link between high mobile data traffic and network congestion. The markets for 5G data consumption also top Opensignal's 5G global experience benchmarks. In effect, 5G users are able to enjoy both much faster download speeds and consume much more data. Historically, where mobile users consumed large amounts of data it causes network congestion which depresses speeds, but for 5G users we see no indication of slowdowns in markets with high 5G data consumption.

Despite lockdowns, mobile data usage is still rising

Between the first quarter of 2020 and the same quarter in 2021 there was an average increase in monthly mobile data usage of 1.3 GB per smartphone user (17.2%) across the 65 markets Opensignal analyzed, although it's slightly lower than the 2.1 GB increase in the previous year.

The proportion of both heavy and light smartphone users is increasing

Average mobile data consumption figures hide key trends. In 89% of the markets, we saw an increase in the proportion of heavy smartphone users that used over 1 GB in a day between the first quarters of 2021 and 2020. But 54% of markets also saw an increase in the proportion of smartphone users consuming under 50 MB a day. Operators need to understand how their competitors' usage patterns are changing in order to adjust their strategy.

Mobile data is the oxygen of the mobile experience

Mobile data is critical to mobile users because the more capacity available, the more users are able to watch video for long periods and in higher quality, listen to streaming music for longer, play more multiplayer games, share larger media files to social networks and download more apps. Every single cellular network activity consumes mobile data – it is the oxygen powering the mobile experience. As a result, many users choose their tariff plan based on the amount of data offered and operator marketing teams agonize over how much data to offer for what price.

However, data traffic is an extremely significant cost for mobile network operators because as mobile usage increases, speeds and mobile experience can deteriorate as networks become more congested. Rising mobile data traffic increases the need for mobile operators to raise spending to add new cell sites and upgrade mobile antennas or site backhaul links, and it helps to explain the large sums operators spend in auctions for new wireless spectrum.

With the COVID-19 crisis, the trend in mobile data consumption is no longer clear. During the last year we have seen many users rely on their smartphones more heavily, and often operators have offered extra free mobile data to their users to help. For other users, mostly based at home, they have relied on their home broadband more heavily and perhaps used less mobile data than usual. Understanding the real underlying trends is essential so the mobile industry can build the capacity to support mobile users' needs in the future and avoid mobile congestion.

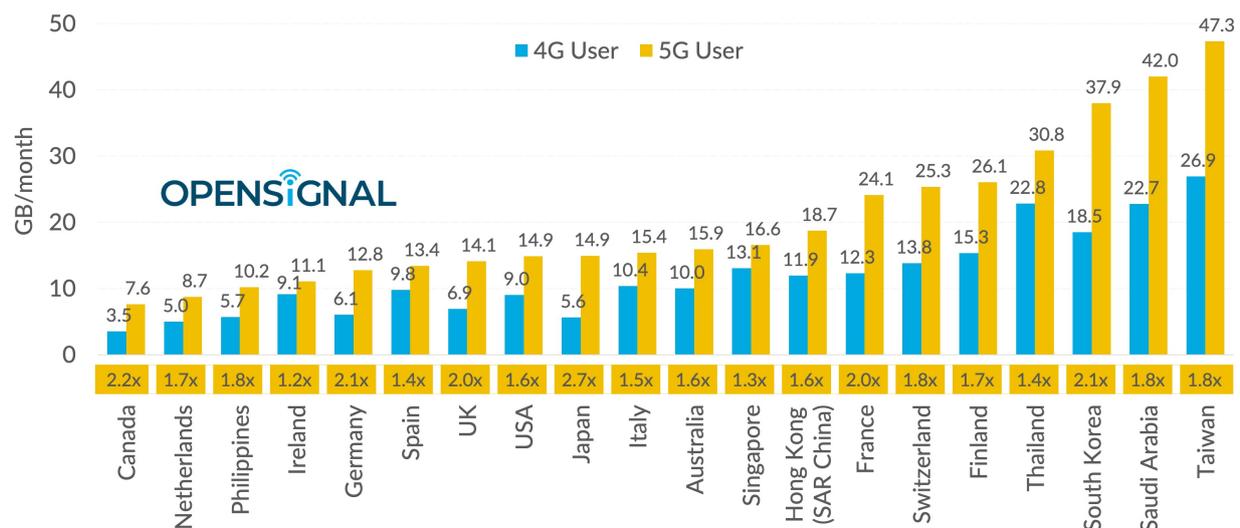
New 5G technology also opens up new opportunities for users as well as risks for mobile operators. While 5G allows operators to use new types of wireless spectrum – for example bands in the 3-6 GHz range or mmWave bands – that add extra capacity, the much faster 5G connections mean users could consume so much more data that congestion could still occur. Through Opensignal's ongoing analysis of the real-world experience of mobile users we will see how these two competing trends will play out.

The high quality 5G experience drives much greater mobile data usage

Across all 20 leading 5G markets, we see much greater mobile data usage among 5G users than by 4G users. The greatest increases are in Japan (2.7x), Canada (2.2x), Germany (2.1x) and South Korea (2.1x). In all but two markets, 5G users consume more than 10 GB a month.

However, the most striking trend is in the three markets with the greatest monthly 5G mobile data consumption – Taiwan (47.3 GB), Saudi Arabia (42.0 GB) and South Korea (37.9 GB) – because all three regularly top Opensignal's global comparisons of 5G experience. These three markets have used 5G to sever the previous link between high mobile data consumption and low speeds usually caused by mobile network congestion.

5G users in 20 leading 5G markets consume up to 2.7x more mobile data than 4G users

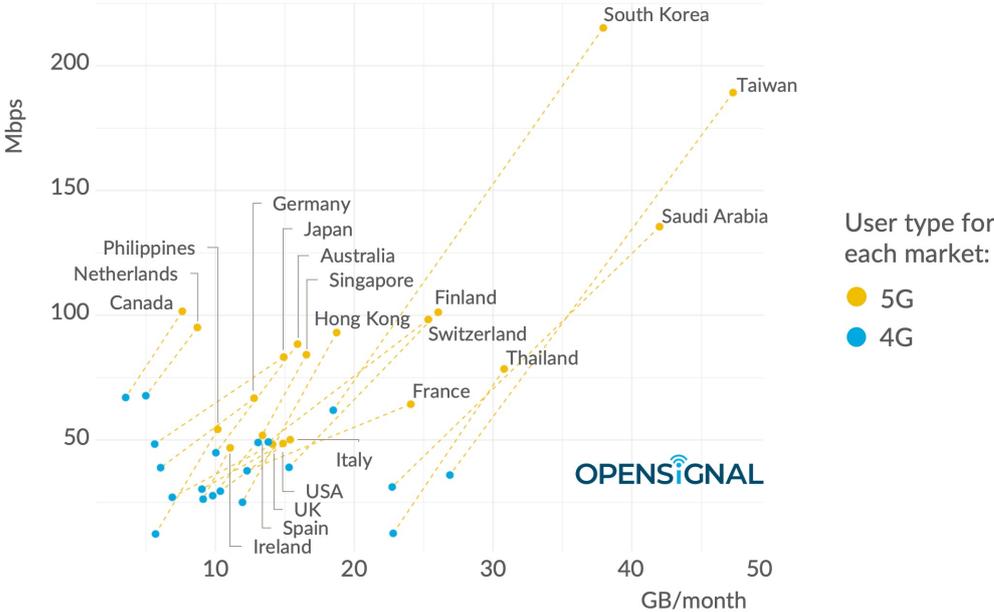


Data collection period: 1 January – 31 March 2021 | © Opensignal Limited

5G users consume more mobile data than do 4G users because of four main reasons:

- **Video streams use more data, even for the same viewing time.** Even if 5G users watch exactly the same number of minutes of mobile video as 4G users, video apps will typically automatically switch to higher quality levels because of the greater quality of the mobile connection. As a result, 5G users will spend more time watching HD mobile video streams which require more data per minute. Plus, as the mobile video will work with fewer interruptions, if any, 5G users will be more likely to watch more and longer video streams over mobile connections.
- **Music will stream in higher quality.** There is a new music format war starting in 2021 as more mobile music providers offer lossless audio, including Spotify and Apple, alongside long-standing lossless proponent Tidal, and also new surround sound formats such as Dolby Atmos, which Apple calls “spatial audio”. These formats require much more data throughput for the same song length. On a high quality connection, more users will switch to higher quality music, whether they stream or download the music for offline use on their smartphone.
- **5G users are early adopters.** In some markets it’s indisputable that 5G is still niche. But with every 2021 flagship smartphone arriving with 5G as standard, and most 2021 mid-range and 2020 flagship models also including 5G, this is no longer the case in major 5G markets such as South Korea, Saudi Arabia, the UK and the U.S.
- **A faster, better, 5G experience encourages more cellular usage.** In the past, mobile users relied on Wifi and only used cellular connections when Wifi was not available. With high quality 5G, mobile users will rely on their cellular connection more of the time which increases cellular mobile data usage. Opensignal has already seen a marked speed advantage for 5G over public Wifi. Already, Apple offers options for 5G users to set their iPhone to use more data on 5G automatically, rather than restricting cellular mobile data use to be different to Wifi because of 5G’s quality. Also, a faster 5G experience makes cellular more viable for users to tether devices to their smartphone and share the cellular connection.

5G users consume much more data and experience faster download speeds compared to 4G users



Dotted lines connect 5G and 4G users in the same market.
 Data collection period: January 1 – March 31, 2021 | © Opensignal Limited

When we consider the relationship between the speed 5G and 4G users experience and their average download speed we see that all markets that experienced an average increase in speed also show an increase in data consumption. In effect, the better 5G experience does appear to encourage more mobile data usage.

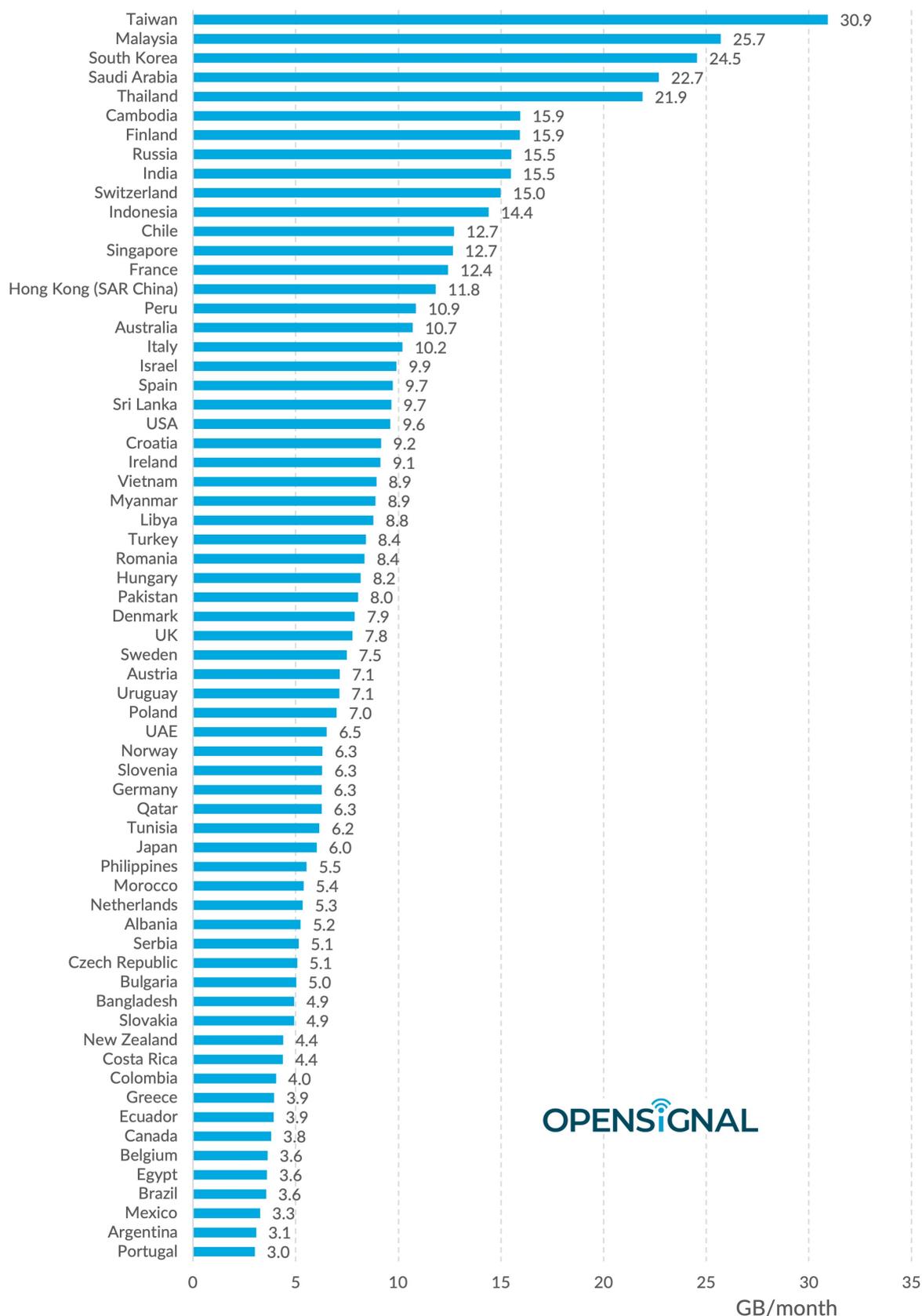
Opensignal’s data indicates that 5G users who enjoy a better, faster mobile experience than 4G users, either consumed more content on their smartphones or enjoyed video and audio streams at a higher quality to explain their greater data usage. For example, mobile video services are now likely sending high-resolution HD video where, on more congested 4G, they would only be able to stream lower-quality video resolutions.

Mobile data usage in the highest of 65 international markets is 10 times more than the lowest

Taiwan's smartphone users have the greatest overall monthly mobile data consumption of the 65 international markets analyzed by Opensignal, with an average of 30.9 GB data used. This is over 10 times greater than the mobile data usage in the lowest market, Portugal, where smartphone users consumed 3 GB per month in the first quarter of 2021.

In five markets, mobile users consumed more than 20 GB of data per month. There is a clear gap between these five – Taiwan, Malaysia, South Korea, Saudi Arabia and Thailand – and the 15.9 GB consumed in joint sixth place by Finland and Cambodia. While smartphone users in 18 markets consumed over 10 GB, in 14 markets users consumed under 5 GB.

Smartphone users' average monthly mobile data consumption Q1 2021



Data collection period 1 January – 31 March 2021 | © Opensignal Limited

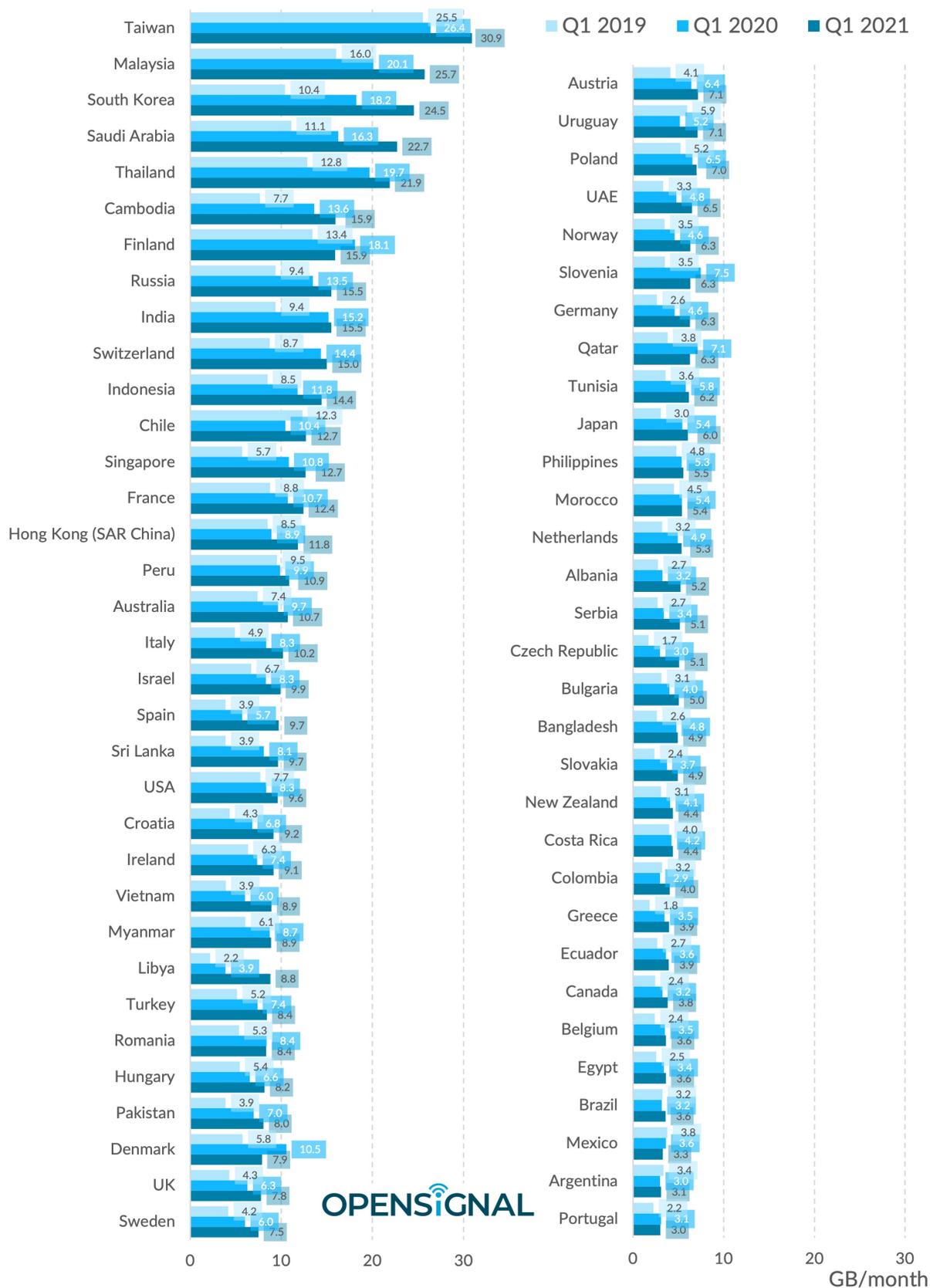


These wide market differences in smartphone mobile data consumption levels are due to a number of factors:

- **Degree of 5G adoption.** Leading 5G markets will likely see more overall mobile data consumption because as we have seen (above) 5G users have higher levels of mobile data usage. Among the five leading markets in overall mobile data consumption, 5G is available in all bar Malaysia.
- **Dependency on mobile networks for internet connectivity.** Some countries lack extended fixed broadband infrastructure and people need to use their smartphones in order to access the internet
- **Time that smartphone users spend connected to Wifi.** For example, in Portugal smartphone users spent on average 65.2% of their time connected to Wifi compared with 27.8% in Taiwan. When smartphones are connected to Wifi they normally stop using mobile data. However, they often consume more data as mobile apps and operating systems assume there is no longer a per MB charge for data
- **Mobile data tariff plans and the extent of pre-pay plans.** Globally, there are wide ranges in price levels and different approaches to pricing mobile data. Operators tend to package mobile data into smaller chunks for pre-pay compared to post-pay contract plans. Some operators also offer unlimited mobile data plans, which tend to limit the connection speed after hitting certain usage thresholds, or during congested times. The share of mobile users with pre-pay varies greatly by market, but it is common for the vast majority of users in emerging markets to be on a pre-pay plan.
- **Free, or cheap, temporary mobile data initiatives.** Due to last year's crisis, we have seen operators offer cheap data tariffs or even free data. This partly explains Malaysia's high ranking because Malaysian operators have offered 1 GB of mobile data per day for free during the crisis.

COVID-19 era changes

Trend in smartphone users' average monthly mobile data consumption



Data collection periods: 1 Jan – 31 Mar 2019 & 1 Jan – 30 Mar 2020 & 1 Jan – 31 Mar 2021 | © Opensignal Limited

Over the last three years on average mobile data consumption increased. Between the first quarter of 2020 and the same quarter in 2021 there was an average increase in mobile data usage of 1.3 GB a month per user (17.2%) across 65 markets. This is a slightly lower increase than the 2.1 GB per month per user (37.3%) increase between the first quarters of 2019 and 2020 but the last year has been unusual.

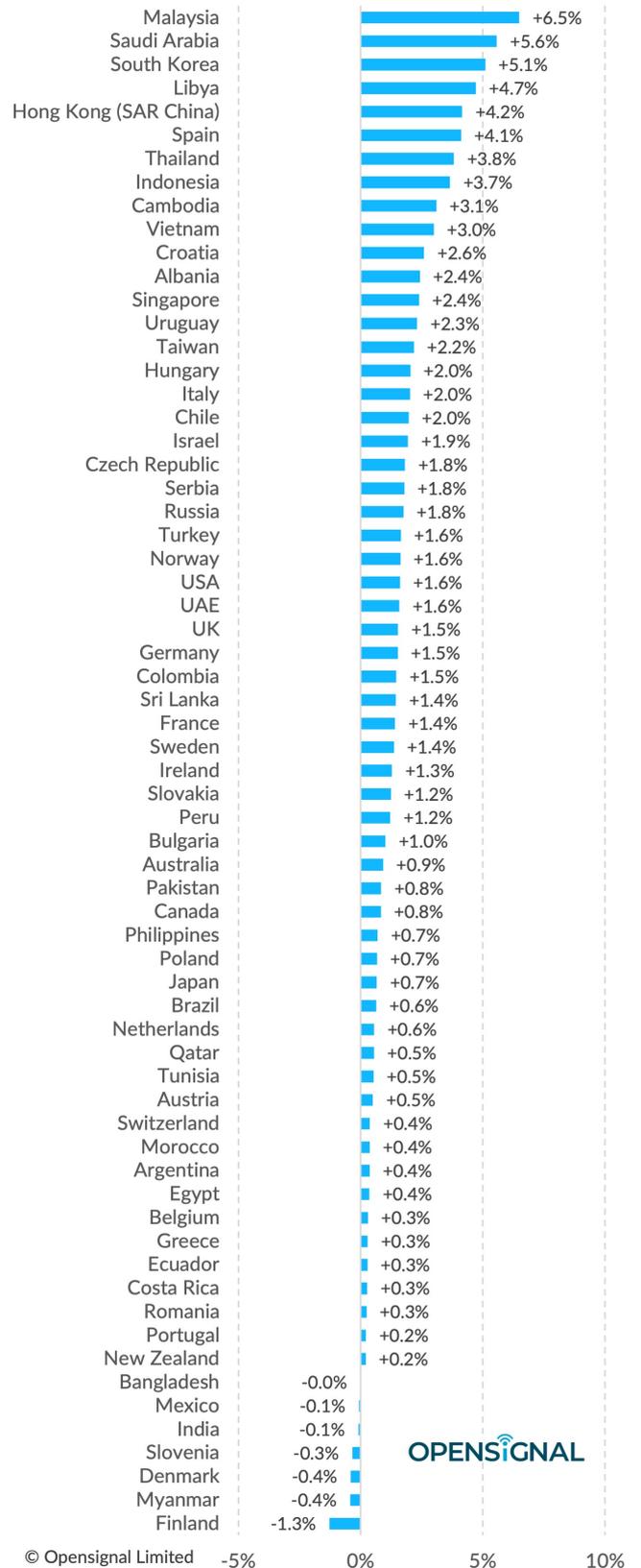
Overall, some markets saw drops in mobile data consumption in the last year, for example Finland (-11.9%) and Denmark (-25.3%). But in many markets average smartphone user monthly data usage increased, for example in Australia, Germany, Indonesia, Italy, Malaysia, Taiwan, Singapore, and South Korea.

However, overall market averages hide trends in different groups of users during the crisis. In most markets we see mobile data consumption polarizing: a large proportion of smartphone users have used less mobile data, while a smaller proportion of users have used considerably more mobile data. It is the net impact of these segments that drives the overall per user average. This has significant implications for mobile operator businesses, especially in strong pre-pay markets where smartphone users buy data when they need it.

To analyze the impact of the crisis on smartphone users' mobile data usage, we have segmented smartphone users based on the amount of mobile data they use, and looked at how these groups have changed over time. We've compared the most recent full quarter (Q1, 2021) and compared it with the first quarter of 2020, as a pre-COVID-19 baseline because in most markets COVID-19 did not alter most users' behavior that early, and instead had an impact in the second quarter or in late March 2020 at the earliest.

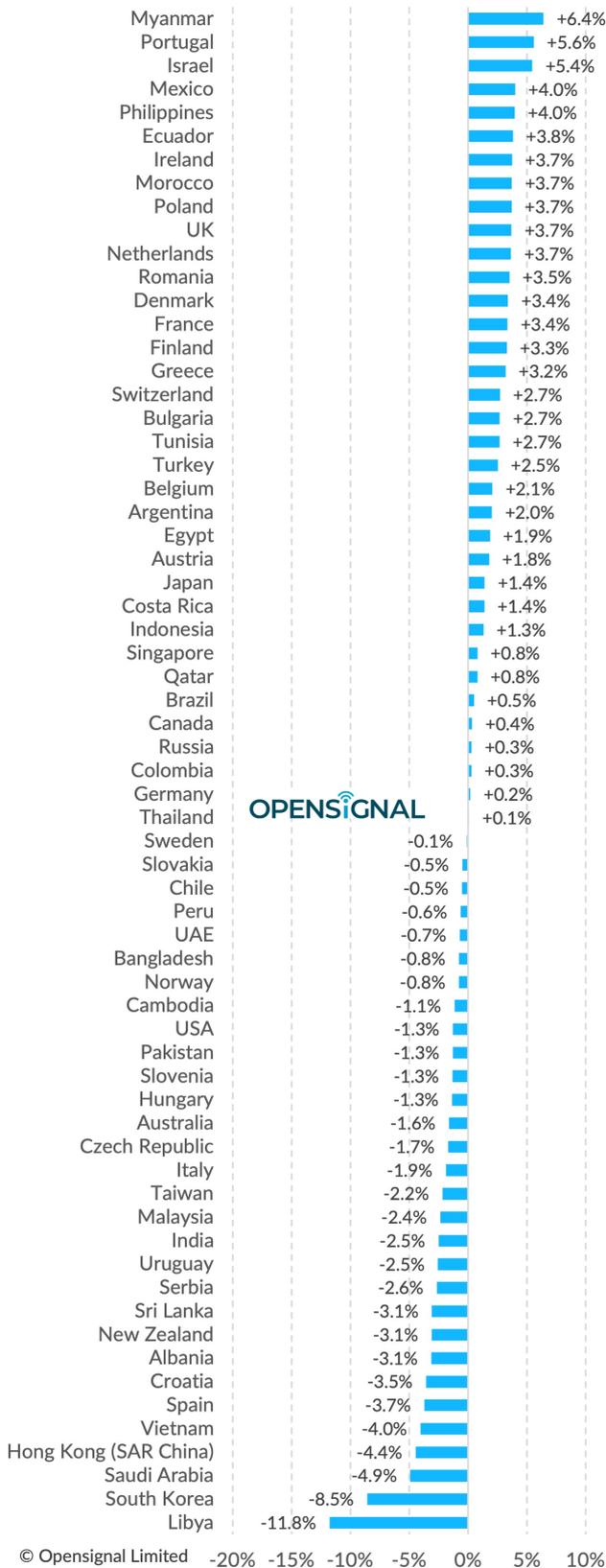
Change in proportion of heavy smartphone data users (1GB+ a day)

Q1 2021 compared with Q1 2020



Change in share of light smartphone data users (50MB or less a day)

Q1 2021 compared with Q1 2020



Almost all markets saw the share of heavy users increase: between the first quarter of 2020 and the same quarter one year later, 89% of markets (58) saw an increase in the proportion of heavy smartphone users that used over 1GB in a day, the seven exceptions were: Bangladesh, Denmark, Finland, India, Mexico, Myanmar and Slovenia.

However, it's clear there is a widening of the gap between heavy and light mobile users, because the majority of markets (35 or 54%) saw the share of smartphone users consuming under 50 MB a day also increase.

The future

Opensignal's analysis quantifies smartphone users' mobile data consumption and provides a benchmark to understand the impact of 5G on users' experience and mobile networks' data traffic. Although in a few selected markets we observed smartphone users' average mobile data consumption decrease in the past year due to changed dynamics following the pandemic, our data indicates that mobile data consumption will keep rising in the future.

In fact, our data shows that, as smartphone users access a better mobile experience such as faster mobile connections, they consume more and/or better quality videos and music, thus leading to the rise in data traffic that mobile operators need to support.

High data consumption highlights the need for new capacity to support 5G users

Our analysis also shows that additional market-specific factors, such as Wifi penetration, mobile data tariff plan structures and degree of 5G adoption help explain the large differences we observe among international markets, with smartphone users in some regions on average consuming as much as 10x more mobile data compared to users in other markets.

However, solely focusing on the average mobile data consumption levels can hide underlying key trends, as in the majority of the markets we analysed, we observed a polarisation between light and heavy mobile data users, with the latter group generally representing a minority of the users but accounting for the vast majority of the mobile data consumed on the operators' networks. Understanding the behaviour and mobile experience of this limited group of heavy mobile users could allow operators to optimise their network's resources and mitigate any congestion and bad experience for the totality of their users.

Our Methodology

Opensignal measures the real-world experience of consumers on mobile networks as they go about their daily lives.

We collect billions of individual measurements every day from many millions of smartphones worldwide. Our measurements are collected at all hours of the day, every day of the year, under conditions of normal usage, including inside buildings and outdoors, in cities and the countryside, and everywhere in between. By analyzing on-device measurements recorded in the places where subscribers actually live, work and travel, we report on mobile network service the way users truly experience it. We continually adapt our methodology to best represent the changing experience of consumers on mobile networks and, therefore, comparisons of the results to past reports should be considered indicative only.

Confidence Intervals

For every metric we calculate statistical confidence intervals indicated on our graphs. When confidence intervals overlap, our measured results are too close to declare a winner. In those cases, we show a statistical draw. For this reason, some metrics have multiple operator winners.

In our bar graphs we represent confidence intervals as boundaries on either sides of graph bars. In our supporting-metric charts we show confidence intervals as +/- numerical values.

Our Metrics

Video Experience

Measures the average video experience of Opensignal users on 3G and 4G networks for each operator. Our methodology involves measuring real-world video streams and uses an ITU-based approach for determining video quality. The metric calculation takes picture quality, video loading time and stall rate into account. We report video experience on a scale of 0-100.

Voice App Experience

Measures the quality of experience for over-the-top (OTT) voice services — mobile voice apps such as WhatsApp, Skype, Facebook Messenger etc. — using a model derived from the International Telecommunication Union (ITU)-based approach for quantifying overall voice call quality and a series of calibrated technical parameters. This model characterizes the exact relationship between the technical measurements and perceived call quality. Voice App Experience for each operator is calculated on a scale from 0 to 100.

Games Experience

Measures how mobile users experience real-time multiplayer mobile gaming on an operator's network. Measured on a scale of 0-100, it analyzes how the multiplayer mobile Games Experience is affected by mobile network conditions including latency, packet loss and jitter to determine the impact on gameplay and the overall multiplayer Games Experience.

Download Speed Experience

Measures the average download speed experienced by Opensignal users across an operator's 3G, 4G and 5G networks. It doesn't just factor in 3G, 4G and 5G speeds, but also the availability of each network technology. Operators with lower 5G or 4G Availability tend to have a lower Download Speed Experience because their customers spend more time connected to slower generation networks.

Upload Speed Experience

Measures the average upload speed experienced by Opensignal users across an operator's 3G and 4G networks. Upload Speed Experience doesn't just factor in 3G and 4G speeds, but also the availability of each network technology. Operators with lower 4G Availability tend to have a lower Upload Speed Experience because their customers spend more time connected to slower 3G networks.

4G Availability

Measures the average proportion of time Opensignal users spend with a 4G connection on each operator's network.

4G Coverage Experience

Measures how mobile subscribers experience 4G coverage on an operator's network. Measured on a scale of 0-10, it analyzes the locations where customers of a network operator received a 4G signal relative to the locations visited by users of all network operators.