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Ericsson Mobility Report

June 2022

Letter from the publisher

At the crossroads of change

Resilient networks are the foundation for continued digitalization of societies and industries. Continuous network modernization and coverage build-out has led to several hundred million people becoming new mobile broadband subscribers every year. 5G is scaling faster than any previous mobile generation and we expect 5G subscriptions to reach 1 billion by the end of 2022. In several regions, deployment of 5G standalone networks is also picking up pace, as communications service providers prepare for innovation to address the business opportunities beyond enhanced mobile broadband. A solid digital network infrastructure underpins enterprises' digital transformation plans, and their new capabilities can be turned into new customer services. As exemplified in this edition, service providers are looking to expand out of pure connectivity into service enablement platforms.

Global mobile network data traffic has doubled in the last two years, driven by continuing growth in smartphone usage, mobile broadband and now the digitalization of societies and industries. But traffic is not the only thing that grows. The ongoing war in Europe, as well as increased geopolitical tension in the world, leads to a range of global threats – economic as well as social – that must be navigated. And in our field of networking, the threat landscape calls for constant diligence in keeping ahead with security. You can read more about security in this edition.

Managing the continued strong traffic growth while reducing energy consumption is also a top priority. Older technologies are being replaced by continuous build-out of 4G and 5G networks, substantially improving network performance and energy efficiency with each generation.

5G technologies play a key role in modernization, providing multiples of capacity while becoming more energy efficient. Innovative network technologies enable service providers to introduce new services that in turn support societies and enterprises to reduce their carbon emission footprint. In this edition, we share some examples of how 4G and 5G technologies make it possible to unleash the power of IoT connectivity to enhance both enterprises' business performance and sustainability.

We hope you find the report engaging and useful!

Fredrik Jejdling
Executive Vice President and
Head of Business Area Networks

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Forecasts

Taking a wide view, subscription and traffic trends are following the expected patterns in our forecasts – 5G and the associated new technologies are trending upwards, as older generations begin to slow or decline. If we go down a layer, differences between the regions and countries become clear due to their unique circumstances. For example, while 5G dominates the stories in our forecasts, it's also notable that earlier-generation technologies still play an important role in closing the digital divide in many regions, by connecting the unconnected.

Over 100 million FWA connections are forecast by the end of 2022.

100m

5G mobile subscriptions will surpass 1 billion in 2022.

1bn

Over 20 service providers had launched public 5G standalone networks by the end of 2021, and this number is expected to double in 2022.

2x

The monthly average usage per smartphone is expected to pass 15GB in 2022.

15GB

5G mobile subscriptions to surpass 1 billion in 2022

By the end of 2027, 5G subscriptions are expected to reach 4.4 billion.

Service providers continue to switch on 5G and more than 210 have launched commercial 5G services globally.[1] Deployment of 5G standalone (SA) networks is also increasing, with more than 20 commercial launches at the end of 2021. The most common 5G services that service providers have launched for consumers are enhanced mobile broadband (eMBB), fixed wireless access (FWA), gaming and AR/VR-based services. When it comes to 5G offerings for enterprises, the most common segments targeted are manufacturing (smart factories), transport, smart cities and ports.

A weaker global economy and the uncertainties caused by Russia's invasion of Ukraine have impacted our global estimate for 2022 by around 100 million, and the forecast has been adjusted accordingly.

Strong 5G subscription growth

5G subscriptions[2] grew by 70 million during the first quarter to around 620 million, and that number is expected to surpass 1 billion by the end of this year. Currently, North America and North East Asia have the highest 5G subscription penetration, followed by the Gulf Cooperation Council countries and Western Europe. In 2027, it is projected that North America will have the highest 5G penetration at 90 percent.

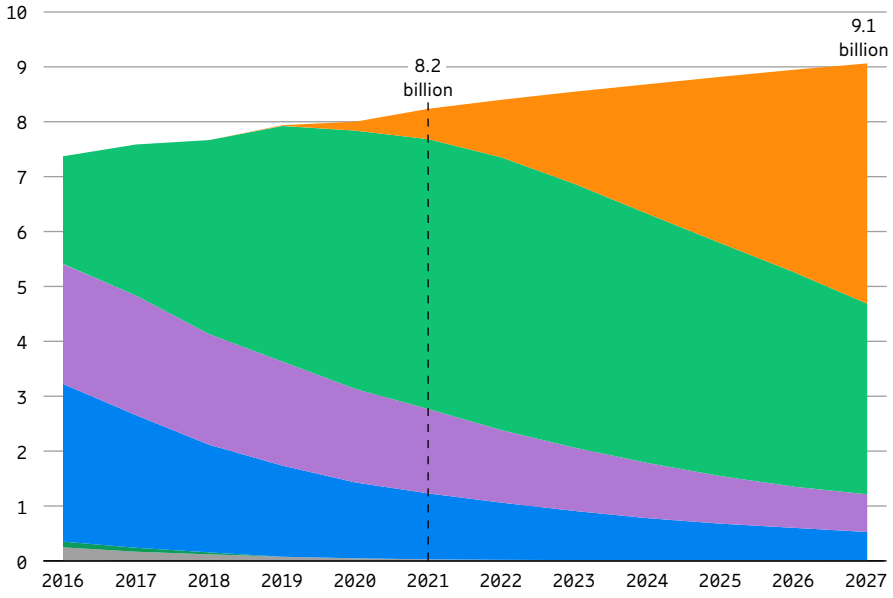
By the end of 2027, we forecast 4.4 billion 5G subscriptions globally, accounting for 48 percent of all mobile subscriptions. 5G subscription uptake is faster than that of 4G following its launch in 2009, reaching 1 billion subscriptions 2 years sooner than 4G did. Key factors include the timely availability of devices from several vendors, with prices falling faster than for 4G, as well as China's large, early 5G deployments. 5G will become the dominant mobile access technology by subscriptions in 2027.

Subscriptions for 4G continue to increase, growing by 70 million during the quarter to around to 4.9 billion. The technology is now projected to peak at 5 billion this year, then decline to around 3.5 billion by the end of 2027 as subscribers migrate to 5G.

3G subscriptions declined by 49 million, while GSM/EDGE-only subscriptions dropped by 59 million during the quarter and other technologies[3] decreased by about 5 million.

During the quarter, China had the most net additions (+16 million), followed by the US (+4 million) and Bangladesh (+3 million).

Figure 1: Mobile subscriptions by technology (billion)



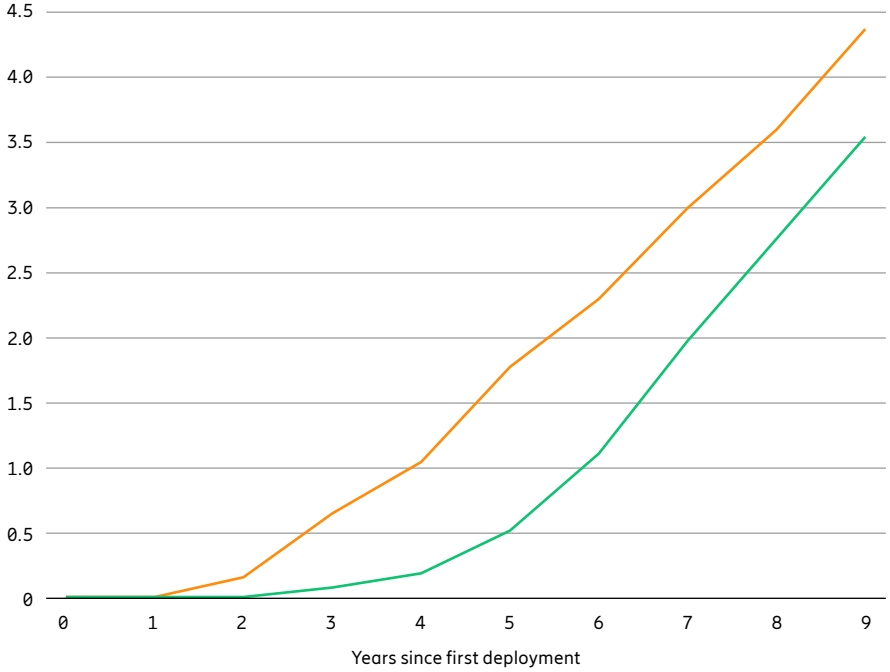
5G subscriptions are forecast to reach 4.4 billion in 2027.

4.4 bn

- 5G
- LTE (4G)
- WCDMA/HSPA (3G)
- GSM/EDGE-only (2G)
- TD-SCDMA (3G)
- CDMA-only (2G/3G)

[1] GSA (May 2022).
[2] A 5G subscription is counted as such when associated with a device that supports New Radio (NR), as specified in 3GPP Release 15, and is connected to a 5G-enabled network.
[3] Mainly CDMA2000 EVDO, TD-SCDMA and Mobile WiMAX.

Figure 2: Comparison of 5G and 4G subscription uptake in the first years of deployment (billion)



5G subscription uptake is faster than for 4G.

5G (2018–2027)
4G (2009–2018)

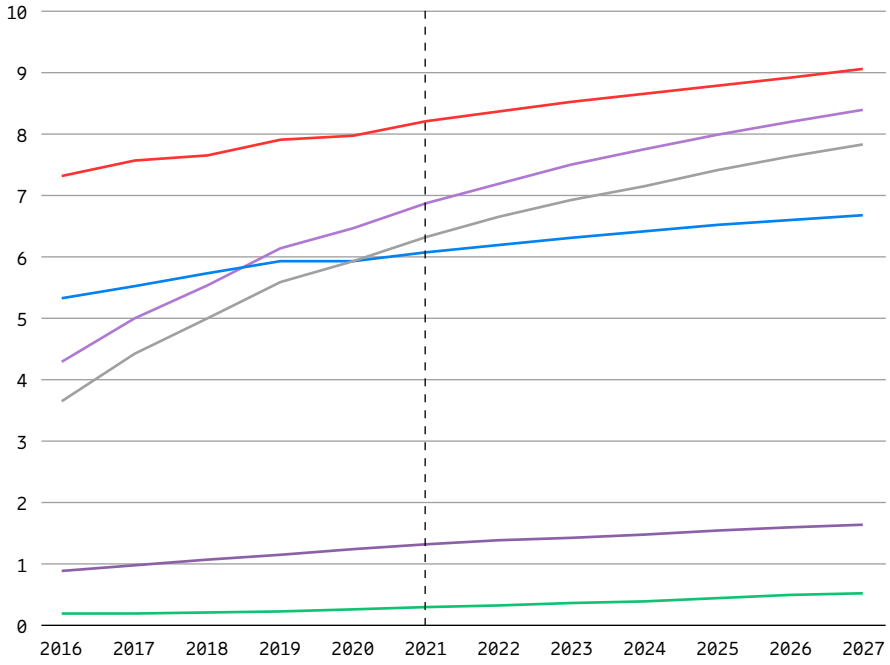
Mobile broadband dominates mobile subscriptions

At the end of 2021, there were around 8.2 billion mobile subscriptions, and we project this figure will increase to around 9.1 billion by the end of 2027. During the same time, the share of mobile broadband subscriptions will increase from 84 to 93 percent. The number of unique mobile subscribers is projected to grow from 6.1 billion at the end of 2021 to 6.7 billion by the end of the forecast period.

Subscriptions associated with smartphones continue to rise. At the end of 2021 there were 6.3 billion, accounting for about 77 percent of all mobile phone subscriptions. This is forecast to reach 7.8 billion in 2027, accounting for around 87 percent of all mobile subscriptions at that time.

Subscriptions for fixed broadband are expected to grow around 4 percent annually through 2027.[4] FWA connections are anticipated to show strong growth of 17 percent annually through 2027. Subscriptions for mobile PCs and tablets are expected to show moderate growth, reaching around 540 million in 2027.

Figure 3: Subscriptions and subscribers (billion)



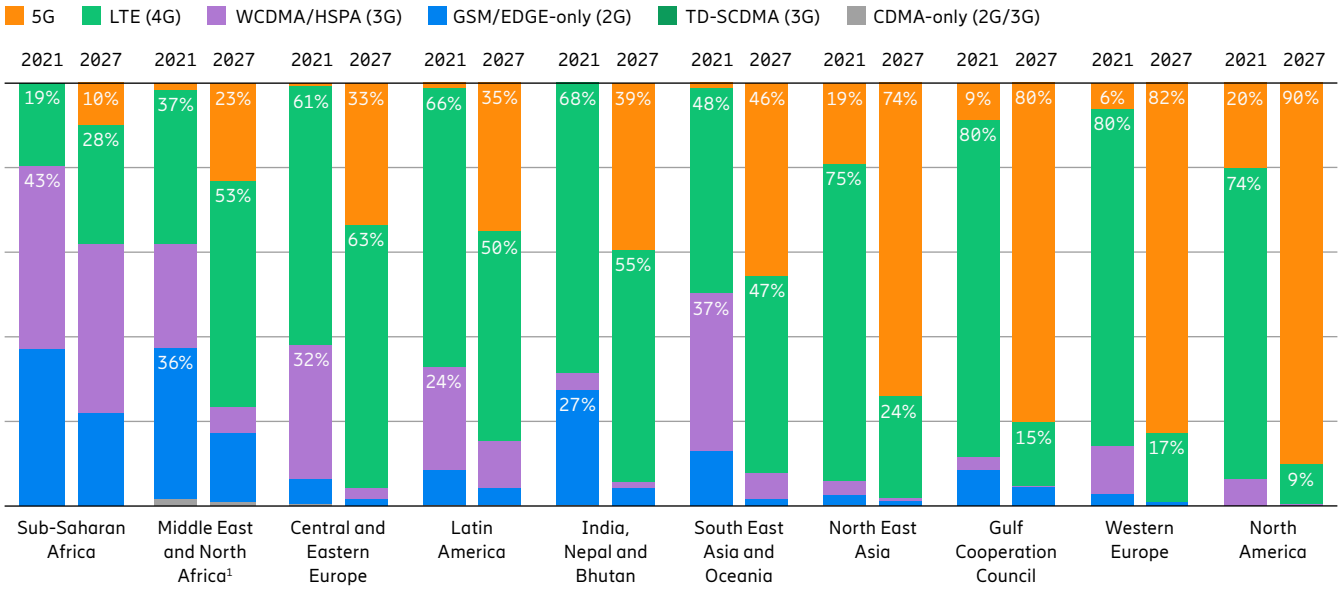
Mobile subscriptions
Mobile broadband subscriptions
Smartphone subscriptions
Mobile subscribers
Fixed broadband subscriptions
Mobile PC and tablet subscriptions

[4] The number of fixed broadband users is at least three times the number of fixed broadband connections due to shared subscriptions in households, enterprises and public access spots. It is the opposite for mobile phones, where subscription numbers exceed user numbers.

Region-specific factors impact subscription adoption patterns

North America and North East Asia regions reached similar 5G subscription penetration in 2021.

Figure 4: Mobile subscriptions by region and technology (percent)



Sub-Saharan Africa
Demand for mobile voice and data services continues to grow in the region. Investment in telecom infrastructure accelerated during 2020–2021 in the wake of COVID-19, including mobile coverage and fixed wireless access (FWA) build-out, enabling service providers to address additional subscriber segments with mobile broadband. In 2021, the number of 4G subscriptions grew by 26 percent, and strong growth is expected to continue during 2022. Migration towards 4G devices continues to be an important driver for 4G subscription uptake, which in turn drives the growth of mobile data traffic. 3G mobile data traffic is still increasing, but the majority of traffic growth is expected to be in 4G. Over the forecast period, total mobile broadband[2] subscriptions are predicted to increase, reaching 78 percent of mobile subscriptions.

Regulatory initiatives are being taken to make more spectrum available in key markets across Africa. This will enable access to mobile services for a larger part of the population, especially in rural areas that have traditionally been underserved.

Middle East and North Africa
Mobile subscription growth in the region is predominantly driven by the uptake of 4G services in less mature markets. In 2021, 4G subscriptions increased by about 54 million, while 2G and 3G declined. Digitalization is a high priority in some countries as a means for transforming economies and societies. Service providers are motivated to undertake extensive network modernization and expansion to improve network performance, which stimulates further subscription growth. 5G subscriptions grew to around 10 million in 2021, and the region is forecast to reach nearly 200 million 5G subscriptions in 2027.

Gulf Cooperation Council (GCC)
In the GCC countries that are major travel destinations, tourism has begun to return to pre-pandemic levels, giving rise to seasonal, mostly pre-paid mobile subscriptions. 5G saw strong growth in 2021, adding 5 million subscriptions, while 4G grew by less than 1 million subscriptions. From 2022 onwards, 5G will be the only growing subscription type. It is expected to reach over 65 million, representing 80 percent of total subscriptions in 2027. Monetization through growing both traditional and IoT mobile connections remains a key short-term priority for service providers.

[1] All Middle East and North Africa figures include GCC countries.
[2] Mobile broadband includes radio access technologies HSPA (3G), LTE (4G), 5G, CDMA2000 EV-DO, TD-SCDMA and Mobile WiMAX.

Another focus is extracting value from network investments through partnerships with regulators, solution providers, and vendors. Service providers are also exploring new types of service offerings, for example at mega-events such as the 2022 international football tournament in Qatar.

GCC service providers are targeting a range of services beyond mobile broadband to monetize 5G, including IoT, financial services, video services and cloud gaming. All these have the potential to increase mobile subscriptions, data consumption and service revenues. As demand for high-speed connectivity increases, FWA will also drive growth in broadband subscriptions. Demand for dedicated networks is also expected to grow as 5G use cases emerge.

Central and Eastern Europe

Technology adoption and subscription uptake are typically slower in this region than in Western Europe. This is due in part to slower spectrum allocation processes, as well as consumers being reluctant to upgrade to more expensive subscriptions. 4G is the dominant technology, accounting for 61 percent of all subscriptions at the end of 2021. Mobile subscription growth has flattened, and is expected to be virtually zero in the coming years. However, migration from 2G/3G to 4G continues to look strong up to 2024, from which time 5G is expected to add the most subscriptions. During the forecast period, there will continue to be a significant decline in 3G subscriptions, from 32 percent of mobile subscriptions to 3 percent.

Latin America

4G is currently the dominant radio access technology in the region, accounting for two-thirds of all subscriptions at the end of 2021. 4G subscription growth is strong, with more than 70 million added in 2021, and growth is expected to continue during 2022. However, 3G subscriptions are steeply declining as users migrate to 4G and 5G. Many service providers will sunset 3G networks in the next two years to enable the reuse of valuable radio spectrum for 4G deployments.

Commercial 5G has been launched in seven countries, and trials are ongoing in six other countries. Service providers are accelerating 5G deployments in mid-band (3.5GHz) and low-band to stimulate 5G subscription uptake. There were around 5 million 5G subscriptions at the end of 2021, and more substantial uptake is expected from 2023 onwards. By the end of 2027, 5G will account for 35 percent of mobile subscriptions.

India, Nepal and Bhutan

In India, mobile broadband is the foundation on which the government's "Digital India" initiative will be realized. Currently, 4G is the dominant subscription type driving connectivity growth. Commercial launches of 5G networks are planned for the second half of 2022 in India, with enhanced mobile broadband expected to be the initial main use case.

With increasing availability and affordability of 5G smartphones, along with rapid adoption of smartphones in urban and rural areas, 5G subscriptions are expected to rapidly increase to reach around 50 million in the region by the end of 2023. 5G will represent around 39 percent of mobile subscriptions in the region at the end of 2027, with about 500 million subscriptions. As subscribers migrate to 5G, 4G subscriptions are forecast to decline annually to an estimated 700 million subscriptions in 2027.

South East Asia and Oceania

4G is currently the dominant radio access technology in the region, making up 48 percent of all subscriptions at the end of 2021. In 2021, almost 100 million 4G subscriptions were added, and this strong growth is projected to continue in 2022. 5G subscriptions were around 15 million at the end of 2021 and are expected to more than double during 2022. As more network deployments take place over the next few years, 5G mobile subscriptions are expected to grow at an CAGR of 83 percent over the forecast period, reaching 570 million in 2027. This figure will almost equal the total regional number of 4G subscriptions at that time.

There are about 15 commercial 5G mobile networks in the region, including in Australia, Singapore, New Zealand, Thailand, Indonesia, Malaysia and the Philippines. Trials have also commenced in several countries including Cambodia, Sri Lanka and Vietnam, highlighting the strong 5G momentum in the region. In addition to mobile services, service providers in Australia, Indonesia and the Philippines have also launched 5G FWA services. In Australia, all service providers have deployed 5G in a combination of low-, mid- and high-bands.

North East Asia

Service providers continue to invest strongly in 5G deployments to further fuel 5G subscription growth. The current focus for service providers is to improve nationwide coverage by adding more sites or introducing services on low-band. In 2021, 5G grew strongly, adding around 275 million subscriptions, as migration from 4G to 5G subscriptions picked up pace. 5G is the only growing subscription type and is expected to reach 1 billion at the end of 2023. The rapid growth of 5G subscriptions, supported by the availability of more 5G device models, has positively impacted service providers' financial performance. Major service providers in leading 5G markets, such as China, Taiwan and South Korea, have reported a positive impact of 5G subscribers on service revenues and ARPU in 2021.

Western Europe

4G is widely deployed and has the highest penetration of all regions.[3] Due to continued migration from 2G and 3G, 4G subscriptions grew by 7 percent to account for 80 percent of all mobile subscriptions at the end of 2021. 5G subscription growth was also strong, rising from 5 million in 2020 to 31 million in 2021.

4G is expected to decline in favor of substantially increased 5G subscription uptake from 2023 onwards. 5G subscriptions are expected to reach almost 150 million at the end of 2023, and penetration will reach 82 percent by the end of 2027. Many service providers will be sunsetting 3G networks in the next few years to enable the reuse of radio spectrum for 4G and 5G.

North America

5G has entered the second wave of build-outs and user adoption. New mid-band spectrums (C-band and 3.45–3.55GHz) in multi-band 5G networks enhance the mobile user experience, stimulating subscription growth. In 2021, 5G grew strongly, adding around 64 million subscriptions, as migration from 4G to 5G subscriptions picked up pace significantly. 5G is the only growing subscription type and is expected to reach 250 million at the end of 2023. An increasing variety of broadband bundles offered by service providers across North America makes it easy for customers to find suitable 5G service offerings. FWA has gained traction as a fixed broadband option for consumers, as well as small and medium enterprises. By 2027, 400 million 5G subscriptions are anticipated, accounting for 90 percent of mobile subscriptions.

[3] On par with the GCC countries.

India's 5G future: A closer look

Indian consumers and enterprises anticipate adopting 5G. This is positive news for the economy and society, as well as the service providers.

The Indian market today

India is among the world's fastest growing economies. It has a developed software industry with e-commerce, digital payments and educational technology standing out. Industrial enterprises are making unprecedented investments in digital transformation to modernize their processes – increasing demand for reliable network connectivity.

India's strong growth supports a dynamic mobile services market. Over the past five years, it has seen rapid adoption of smartphones and migration up to 4G. In the region as a whole (including India, Nepal, and Bhutan), the share of 4G has grown from 9 percent of mobile subscriptions in 2016 to 68 percent in 2021.[1] This has had a significant positive impact on India's consumers, economy and society. With a low penetration of fixed broadband, consumers have mostly relied on mobile broadband for remote working, education, healthcare services, shopping and other services during the COVID-19 pandemic.

Challenges in the Indian market

While India presents significant opportunities for growth, it also holds challenges for service providers. Indian service providers have recently been raising the price of data (the average price of 1GB of mobile data reached USD 0.68 in 2021) and mobile services revenue has continued to grow. Despite this, service provider ARPU remains low. Moreover, India has some of the highest prices for spectrum in the world, constraining service providers' ability to invest in infrastructure.

In the India region as a whole, mobile data traffic has grown by more than 15 times in the past 5 years (from 0.8EB per month to 13EB per month in 2021) and is expected to more than double in the next 3 years. With the projected traffic increase, service providers would benefit significantly from the efficiency gains provided by 5G.

The state of 5G

The Indian Department of Telecommunications (DoT) plans to auction 5G spectrum in June–July 2022. Even as the government continues to work on the process of auctioning 5G spectrum, India's leading service providers are testing 5G at multiple locations, focusing on use cases for both urban and rural consumers. These include FWA for rural broadband, mobile cloud gaming, cloud-connected robotics, and remote healthcare.

5G outlook

5G is projected to account for almost 40 percent of mobile subscriptions – 500 million – by the end of 2027. By then, smartphone users in the region are forecast to consume 50GB of data per month on average. Even though 5G has not been launched commercially, there is already a good foundation for 5G uptake in India. There is significant consumer interest in adopting 5G – as an Ericsson ConsumerLab study indicated, 40 million smartphone users could take up 5G in its first year of availability.

Additionally, 21 percent of respondents that are smartphone users indicated that they already have a 5G-ready device. Indian consumers also claim to be willing to pay 50 percent more for 5G bundled plans. This presents a unique opportunity to grow revenue within a market that has historically had very low ARPU.[2]

Looking into the future

According to an Ericsson-Arthur D Little study, 5G will enable Indian mobile service providers to generate USD 17 billion in incremental revenue from enterprises by 2030. Much of this is projected to be driven by the adoption of 5G in the manufacturing, energy and utilities, ICT and retail industries. Indian enterprises consider 5G to be the most important technology for their digital strategies.[3]

5G will also enable service providers to launch new services for consumers, including home broadband (5G FWA), enhanced video, multiplayer mobile gaming, and AR/VR services. Consumers anticipate that service providers will offer pricing plans with service bundling and data sharing.

5G can play an important role in achieving India's digital inclusion goals, especially in bringing broadband to rural and remote homes. Trials have proven the potential offered by 5G to bridge the digital divide by enabling access to high-speed broadband through FWA.

[1] Ericsson Mobility Visualizer, Mobile subscriptions.
[2] Ericsson ConsumerLab, 5 ways for a better 5G (May 2021).
[3] Ericsson and OMDIA, Survey of Indian Enterprises (March 2022).

Traffic has grown by more than 15 times in the past 5 years, and is expected to more than double in the next 3 years.

15x

Bhutan

The Himalayan country of Bhutan was one of the first in South Asia to launch 5G. While currently only available in three cities, Bhutanese service providers plan to expand 5G coverage throughout the country.

5G deployment is expected to aid the Bhutanese Government's efforts to bridge the digital divide. Service providers look forward to exploring new services and use cases, including AR, VR, automation and IoT. 5G FWA is seen as key to bringing broadband to people in remote and rural regions where fiber is less practical.

Nepal

Mobile services dominate the telecoms landscape in Nepal. 4G coverage has expanded in the past 5 years, now accounting for around 35 percent of the 41 million mobile subscriptions. Including 3G, mobile broadband connections account for over two-thirds of subscriptions in Nepal.[4] The government is encouraging service providers to expand 4G coverage and focus on improving network quality and customer experience.

Nepalese service providers are expected to begin 5G trials in 2022.[5]

Figure 5: India region mobile subscriptions by technology (million)

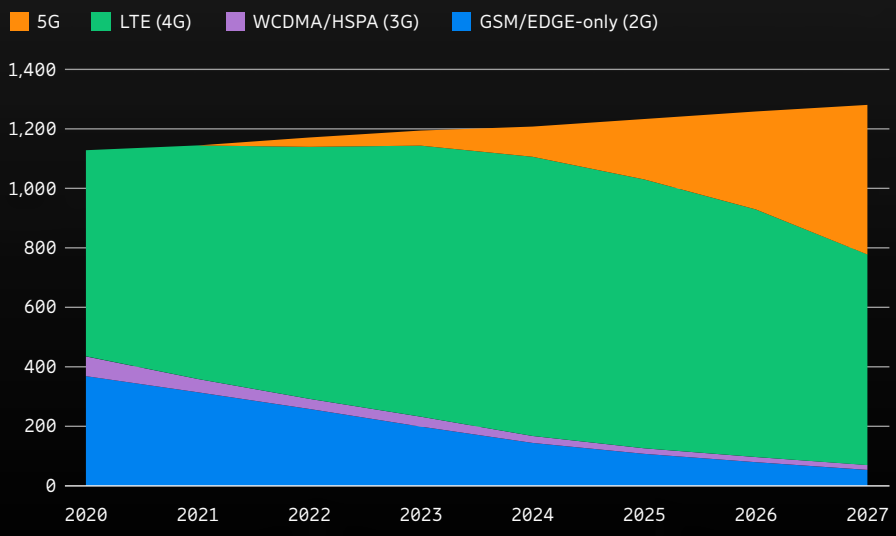
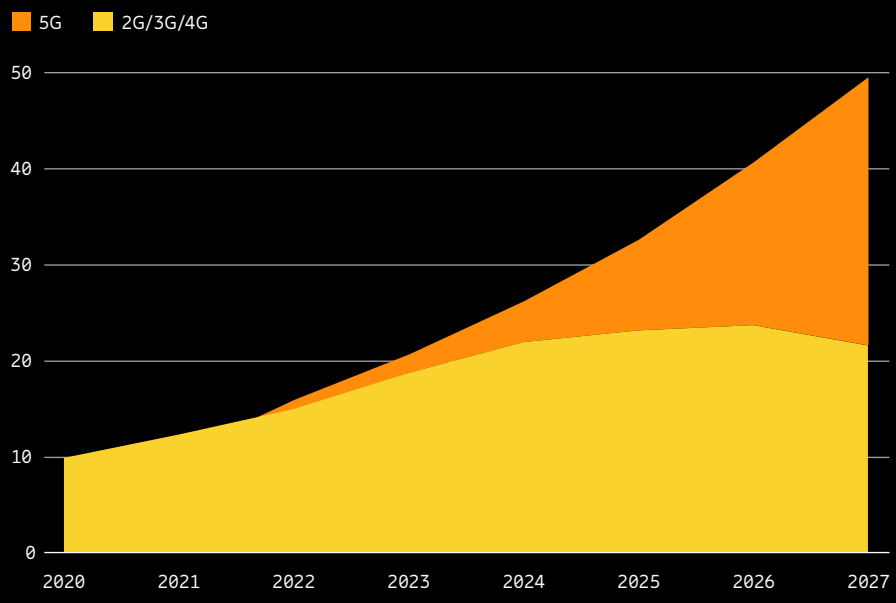


Figure 6: India region mobile data traffic (EB per month)



[4] Nepal Telecommunications Authority, MIS Report (2022).
[5] The Kathmandu Post, "Nepal Telecom to begin first 5G trials from June" (January 27, 2022).

Over 100 million FWA connections in 2022

More than 75 percent of service providers surveyed in over 100 countries are offering fixed wireless access (FWA) services. Around 20 percent of these service providers apply differential pricing with speed-based tariff plans.

Service providers with FWA offerings doubled in three years

An updated Ericsson study[1] of retail packages offered by service providers worldwide shows that, out of 311 service providers studied, 238 had an FWA offering, representing an average of 77 percent globally. Service providers' adoption of FWA offerings has more than doubled in the last three years.

More service providers now offering 5G FWA

During the last 6 months, the number of service providers offering 5G FWA services has increased from 57 to 75, representing growth of around 30 percent. There is growth across all regions, with the strongest increase in North America, where 60 percent of all service providers surveyed now offer 5G FWA.

During the last 6 months, the number of service providers offering 5G FWA services has grown by about 30 percent.

~30%

Figure 7: Global number of service providers offering FWA

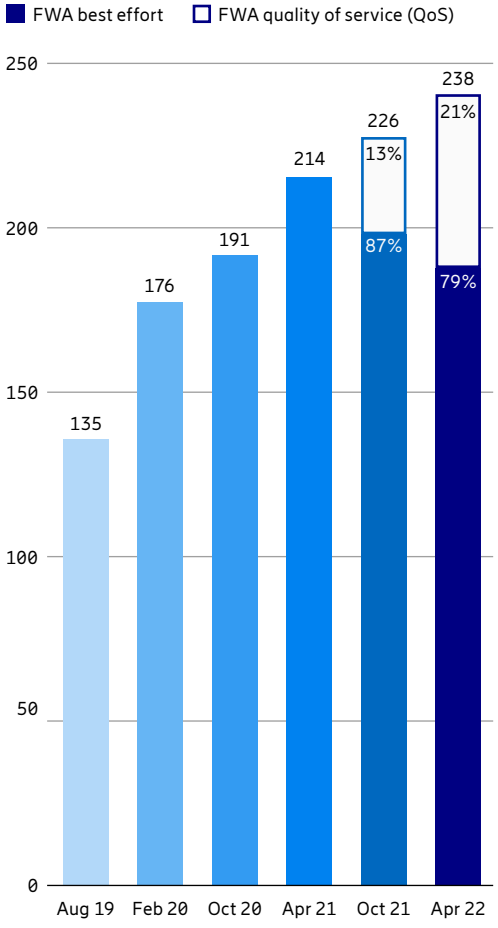
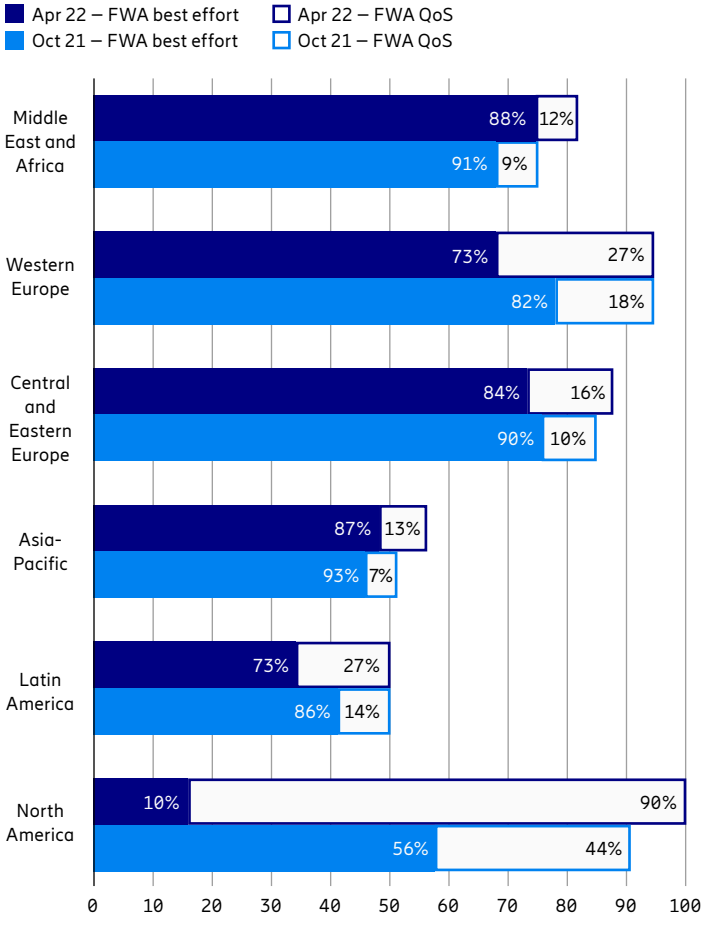
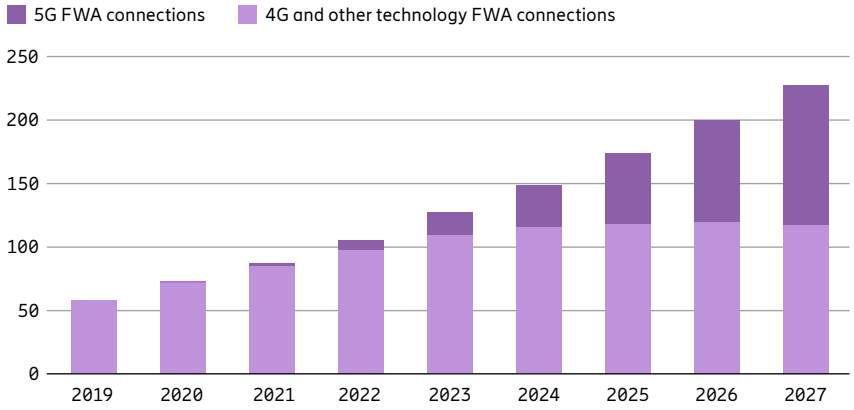


Figure 8: Regional percentage of service providers offering FWA



[1] Adjusted for revised service provider base, April 2022.

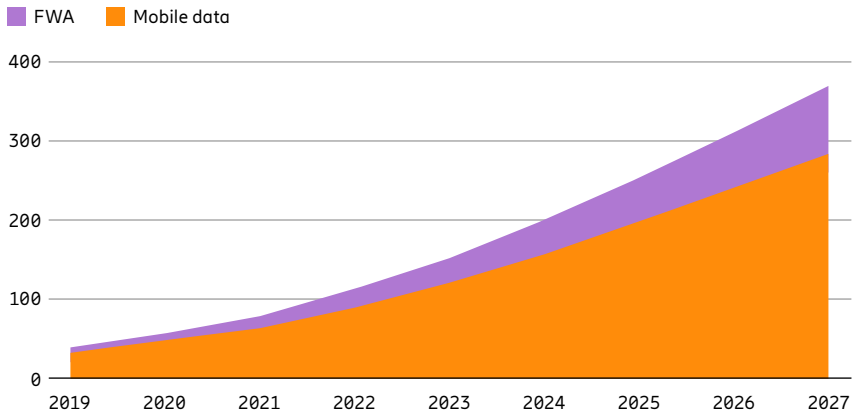
Figure 9: FWA connections (millions)



Definition of FWA

FWA is a connection that provides primary broadband access through mobile network-enabled customer premises equipment (CPE). This includes various form factors of CPE, such as indoor (desktop and window) and outdoor (rooftop and wall-mounted). It does not include portable battery-based Wi-Fi routers or dongles.

Figure 10: Global mobile network data traffic (EB per month)



Speed-based tariff plans on the rise

The majority (79 percent) of FWA offerings are still best effort, with volume-based tariff plans (that is, buckets of GB per month). About 20 percent of service providers offer speed-based tariff plans (also referred to as QoS), a significant increase from 13 percent in October 2021.

Speed-based tariff plans are commonly offered for fixed broadband services such as those delivered over fiber or cable. These types of plans are well understood by consumers, enabling the service providers to fully monetize FWA as a broadband alternative. Around 20 percent of these speed-based offerings are basic, with average/typical speeds being advertised. Almost 80 percent are more advanced offerings, involving speed tiers, such as 100Mbps, 300Mbps and 500Mbps. Service providers with 5G FWA are more likely to have QoS FWA with speed-based offerings, with 26 out of 75 utilizing this approach (35 percent). Speed-based offerings are growing across all regions, with the North America region showing the highest adoption, with 90 percent of all offerings being speed based.

High numbers of service providers in all regions offering FWA

More than 80 percent of service providers in North America, Europe and the Middle East and Africa regions are offering FWA. In Latin America and Asia-Pacific, more than 50 percent of service providers are offering FWA. All service providers in North America offer FWA services.

FWA connections set to more than double by 2027

Some service providers and regulatory bodies are starting to report FWA connections, but globally there is still limited reporting. Based on Ericsson's own research, we estimate that there were close to 90 million FWA connections by the end of 2021, and during 2022 that figure will exceed 100 million. This number is forecast to more than double by 2027, reaching almost 230 million. This figure represents 15 percent of fixed broadband connections. Of these 230 million, the number of 5G FWA connections are expected to grow to around 110 million by 2027, representing almost half of the total FWA connections.

FWA data traffic projected to grow by almost five times

FWA data traffic represented almost 20 percent of global mobile network data traffic by the end of 2021, and is projected to grow almost 5 times to reach 86EB in 2027.

About 20 percent of service providers monetize FWA with speed-based tariff plans.

~20%

Mid-tier smartphones take 5G into the mainstream

An increasingly established mid-tier device segment reflects a maturing 5G ecosystem.

5G adoption continues

- Over 650 5G smartphone models have been launched, accounting for 50 percent of all 5G devices by form factor.
- 5G device shipments more than doubled in 2021 over 2020 and surpassed 615 million units shipped.
- There is a greater focus on standalone (SA) enablement for smartphones including 3CC New Radio (NR) carrier aggregation.
- Global smartphone shipments rose 6 percent in 2021 compared with 2020.[1] However, additional limitations are evident in 2022 due to geopolitics, continued supply chain constraints and the COVID-19 situation in China.
- There is an optimistic outlook for extended reality (XR) use cases over the intermediate term based on XR glasses, headsets or heads-up displays as peripherals connected to smartphones or other 5G smart devices.

Devices in 2022

In line with expectations, devices introduced so far in 2022 show improved capabilities, including carrier aggregation extended from two to three NR carriers for SA, NR dual connectivity for SA and improved uplink capabilities. The trend is clear, with more focus on SA. Apart from improved device capabilities, a wider range of 5G smartphone models are now available in the mid-tier price segment.[2] This means that 5G smartphones are becoming increasingly affordable for more market segments.

This comes at a time when we see a price trend break at the lowest end of 5G devices. Impacted by supply, inflation and globalization challenges, there have been indications for some time of an emerging price floor of USD 120.

5G use cases for the future

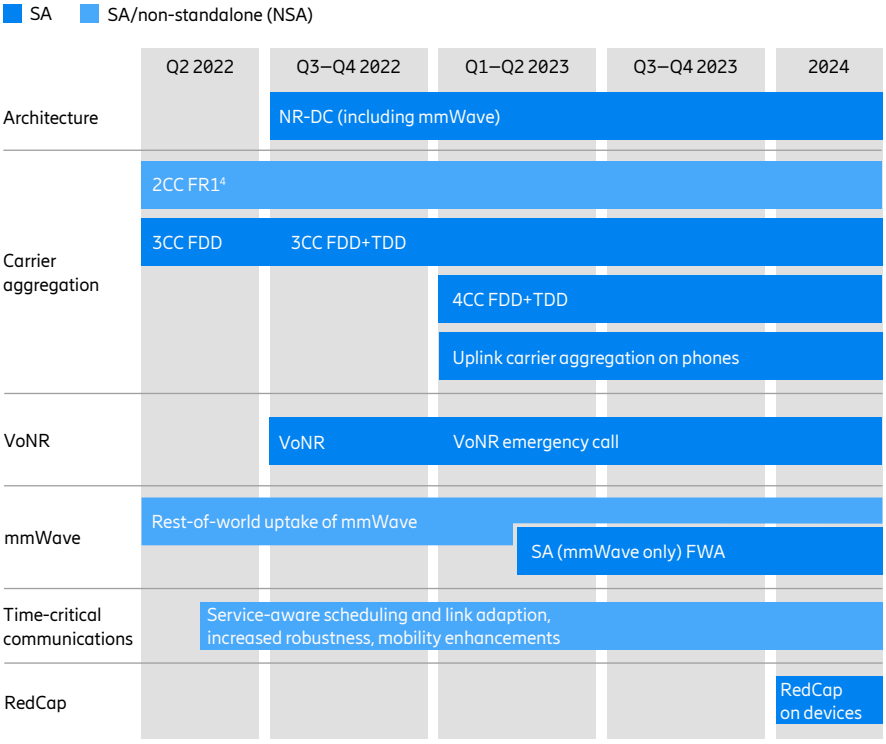
The latest Mobile World Congress was awash with XR demos. Bounded – or committed maximum – latency, combined with network slicing, enables new device-powered use cases and will result in new innovations. As XR glasses will be connected through companion devices for the next few years, the smartphone will likely be part of that innovation for a longer time than generally anticipated. The first devices have started to enter the market, and more are expected throughout this year.

In 2024, the first reduced capability (RedCap) devices should be available, introducing relaxed requirements on the receiver in the device, allowing lower costs compared to standard NR. RedCap devices can facilitate the expansion of the NR device ecosystem to cater to the use cases that are not currently best served by NR specifications. This includes wearables, industrial wireless sensors and video surveillance.

5G SA networks increasingly deployed

More than 20 service providers had launched public 5G SA networks on mid- and low-band by the end of 2021. Please see page 20 for more information about 5G SA.

Figure 11: 5G technology market readiness[3]



[1] IDC Worldwide Quarterly Mobile Phone Tracker.
[2] Mid-tier devices are defined here as being 5G-compatible smartphones retailing at USD 300–700.
[3] Readiness means more than one infrastructure vendor and device vendor ready.
[4] Frequency range 1 (FR1) for 5G NR designates frequency bands below 7.125GHz.

Massive IoT shows strong growth in 2021

The number of IoT devices connected by NB-IoT and Cat-M technologies is expected to overtake 2G/3G connected IoT devices in 2023.

The Massive IoT technologies NB-IoT and Cat-M – primarily consisting of wide-area use cases involving large numbers of low-complexity, low-cost devices with long battery life and low throughput – continue to be rolled out around the world. The number of IoT devices connected via 2G and 3G has been in slow decline since 2019, and NB-IoT and Cat-M technologies are the natural successors. The number of devices connected by these Massive IoT technologies increased by almost 80 percent and reached close to 330 million in 2021.

The number of IoT devices connected by NB-IoT and Cat-M technologies is expected to overtake 2G/3G connected IoT devices in 2023, and to overtake broadband IoT in 2027, making up 51 percent of all cellular IoT connections at that time. The growth of Massive IoT technologies is enhanced by a recently added network capability that enables Massive IoT co-existence with 4G and 5G in FDD bands, via spectrum sharing.

About 124 service providers have commercially launched NB-IoT networks and 55 have launched Cat-M.[1] These technologies complement each other, and around 40 service providers have launched both technologies.

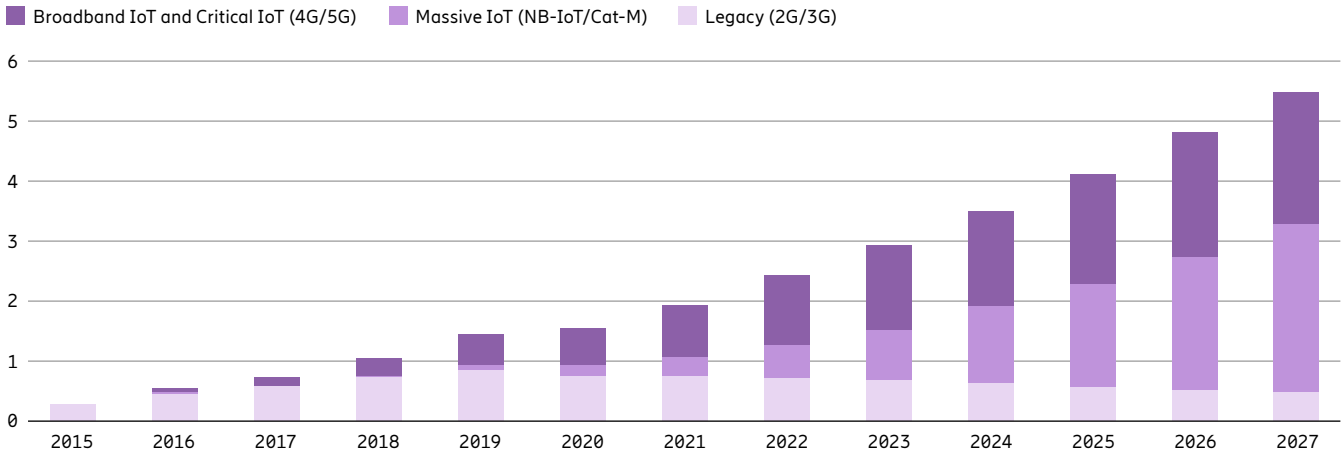
In 2021, broadband IoT (4G/5G) overtook 2G and 3G as the technology that connects the largest share of all cellular IoT connected devices, accounting for 44 percent of all connections. Broadband IoT mainly includes wide-area use cases that require high throughput, low latency and large data volumes. By the end of 2027, 40 percent of cellular IoT connections will be broadband IoT, with 4G connecting the majority. As 5G New Radio (NR) is being introduced in old and new spectrum, throughput data rates will increase substantially for this segment.

North East Asia is the leading region in terms of the number of cellular IoT connections, and is forecast to reach 1.5 billion in 2022. The region is set to account for 60 percent of all cellular IoT connections in 2027.

Figure 12: IoT connections (billion)

IoT	2022	2027	CAGR
Wide-area IoT	2.1	5.9	19%
Cellular IoT[2]	1.9	5.5	19%
Short-range IoT	12.5	24.3	12%
Total	**14.6**	**30.2**	**13%**

Figure 13: Cellular IoT connections by segment and technology (billion)



[1] GSA (May 2022).
[2] These figures are also included in the figures for wide-area IoT.

Enhanced communication services from VoLTE to VoNR

High-quality 4G and 5G voice and other communication services continue on a growth trajectory.

VoLTE continues to grow
Service providers continue to use the IP Multimedia Subsystem (IMS) to support mobile voice services for 4G and 5G smartphones and other smart devices. Voice over LTE (VoLTE) has been activated in over 280 networks to date. Now, launches of Voice over New Radio (VoNR) – the voice application for 5G standalone (SA) networks – have commenced.

It is estimated that the number of subscriptions with voice service built on IMS will exceed 4.6 billion by the end of 2022 and is projected to reach nearly 7 billion by the end of 2027. This will account for around 90 percent of all combined 4G and 5G subscriptions at that time. This is partly driven by the growing obsolescence of Circuit-Switched Fallback (CSFB) which requires 2G or 3G.

First commercial VoNR services to be introduced
IMS is the standardized voice platform for 5G SA networks, which do not support CSFB. 5G voice services can be deployed using a variety of applications in 5G networks: LTE New Radio (NR) dual connectivity, Evolved Packet System (EPS) fallback and VoNR. These are used in different phases of the 5G coverage build-out. Once nationwide 5G SA is in place, only VoNR will be used. The first EPS fallback voice-enabled networks have gone live in North America, Asia-Pacific and Europe. VoNR and 5G video calling has completed interoperability testing with network infrastructure and devices, and the first VoNR services are ready to be rolled out.

Device availability and use case uptake
There are more than 650 voice-enabled 5G smartphone models available. The majority of these smartphones support 5G non-standalone (NSA) networks and the remaining, and quickly growing, part supports 5G SA. Note that all 5G SA smartphones support IMS for voice. Other devices include indoor and outdoor customer premises equipment with fixed wireless access (FWA) capabilities.

New voice use cases leveraging IMS include multi-device network capabilities which tie several devices – such as phones, smartwatches, smart speakers and cars – to the same phone number. More than 100 networks support cellular smartwatches with a VoLTE one-number service.

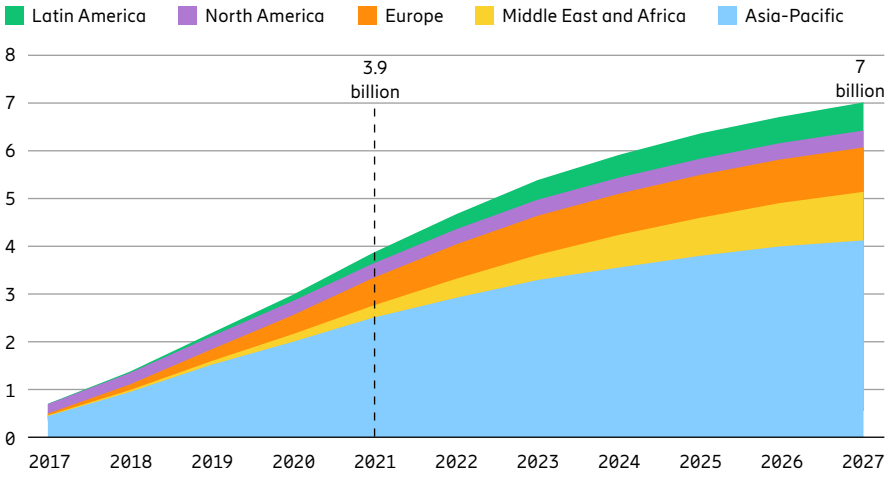
Europe following North America's trends
An application built on IMS enables mission-critical push-to-talk services for public safety organizations, utilities and local private 4G networks. This has started to be deployed widely in North America, and now the European market is following suit.

Once mission-critical communications for 5G have been finalized in the 3GPP standards, additional use cases with low latency and high-capacity broadband can be enabled.

VoLTE subscriptions are predicted to exceed 4.6 billion by the end of 2022.

4.6bn

Figure 14: VoLTE subscriptions by region (billion)



Source for network and device statistics: GSA and GSMA (March 2022).

Mobile network traffic doubled in last two years

Mobile network data traffic grew 40 percent between Q1 2021 and Q1 2022.

The quarter-on-quarter mobile network data traffic growth between Q4 2021 and Q1 2022 was around 10 percent. Total monthly global mobile network data traffic reached around 93EB. In absolute numbers, this means that it has doubled in just two years (since Q1 2020).

Over the long term, traffic[1] growth is driven by both the rising number of smartphone subscriptions and an increasing average data volume per subscription, fueled primarily by increased viewing of video content. Figure 15 shows the net addition and total global monthly network data traffic from Q1 2015 to Q1 2022, along with the year-on-year percentage growth for mobile network data traffic.

Figure 15: Global mobile network data traffic and year-on-year growth (EB per month)

Source: Ericsson traffic measurements (Q1 2022).
Note: Mobile network data traffic also includes traffic generated by fixed wireless access (FWA) services.

[1] Traffic does not include DVB-H, Wi-Fi or Mobile WiMAX. VoIP is included.

5G share of mobile data traffic growing

Continued strong smartphone adoption and video consumption are driving up mobile data traffic, with 5G accounting for around 10 percent of the total in 2021.

Total global mobile data traffic – excluding traffic generated by fixed wireless access (FWA) – reached around 67EB per month by the end of 2021 and is projected to grow by a factor of around 4.2 to reach 282EB per month in 2027. Including FWA, this takes the total mobile network traffic to around 84EB per month by the end of 2021, and to 368EB per month by the end of 2027. The traffic growth up to 2027 includes an assumption that an initial uptake of XR-type services, including AR, VR and mixed reality (MR), will happen in the latter part of the forecast period. If adoption is stronger than expected, data traffic could increase even more than currently anticipated towards the end of the forecast period (particularly in the uplink). Currently, video traffic is estimated to account for 69 percent of all mobile data traffic, a share that is forecast to increase to 79 percent in 2027.

Populous markets that launch 5G early are likely to lead traffic growth over the forecast period. 5G's share of mobile data traffic was around 10 percent in 2021, and this share is forecast to grow to 60 percent in 2027.

Traffic growth varying across regions

Traffic growth can be highly volatile between years and can vary significantly between countries, depending on local market dynamics. Globally, the growth in mobile data traffic per smartphone can be attributed to three main drivers: improved device capabilities, an increase in data-intensive content and growth in data consumption due to continued improvements in the performance of deployed networks.

Globally, the average monthly usage per smartphone is expected to surpass 15GB in 2022.

15GB

These differences are reflected, for example, in the difference between the Sub-Saharan Africa region, where the average monthly mobile data usage per smartphone was 3GB, and the Gulf Cooperation Council countries where it was 22GB per smartphone in 2021. The global monthly average usage per smartphone was 12GB by the end of 2021 and is forecast to reach 40GB by the end of 2027.

New services expected to drive data growth in North America

In North America, the average monthly mobile data usage per smartphone is expected to reach 52GB in 2027. Unlimited data plans and improved 5G network coverage and capacity are increasingly attracting new 5G subscribers. The data traffic generated per minute of use will increase significantly in line with the expected uptake of new XR and video-based apps. This is due to higher video resolutions, increased uplink traffic, and more data from devices off-loaded to cloud compute resources. In 2027, 5G subscription penetration in North America is predicted to be the highest of all regions at 90 percent.

Figure 16: Global mobile network data traffic (EB per month)

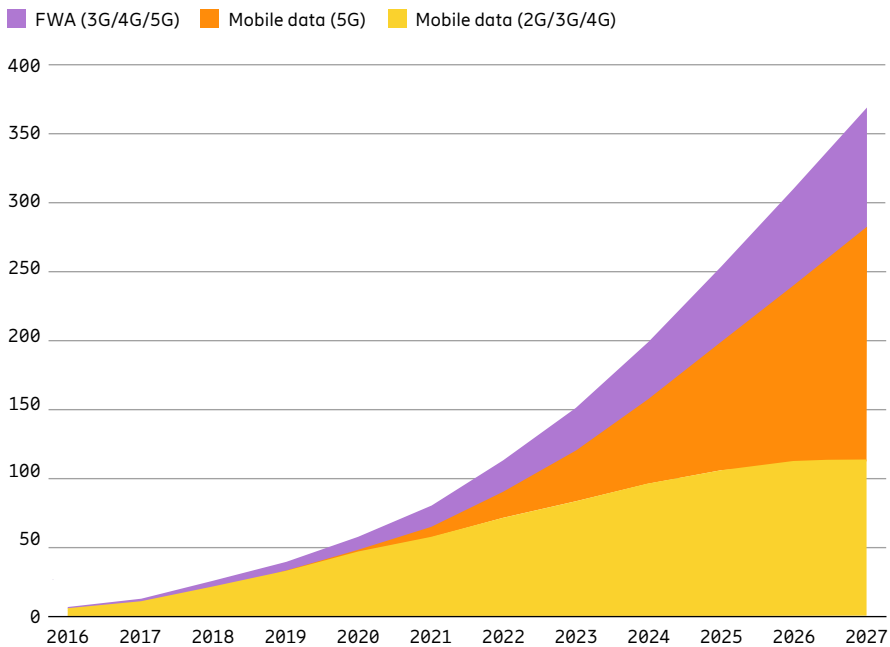
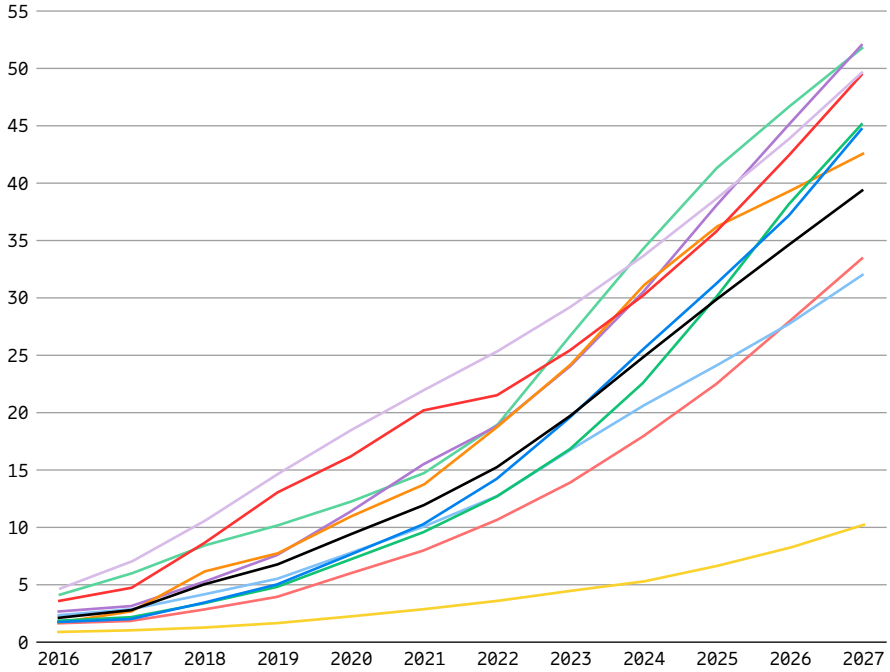


Figure 17: Mobile data traffic per smartphone (GB per month)



Regions	2021	2027	CAGR 2021–2027
North America	15	52	24%
Western Europe	15	52	23%
GCC	22	50	15%
India, Nepal, Bhutan	20	50	16%
South East Asia and Oceania	9.4	45	30%
Middle East and North Africa[1]	10	45	28%
North East Asia	14	43	21%
Global average	12	40	22%
Latin America	7.9	34	28%
Central and Eastern Europe	10	32	22%
Sub-Saharan Africa	2.9	11	25%

In **Western Europe**, service usage and traffic growth is expected to follow a similar pattern to that anticipated for North America. The more fragmented market situation has led to later mass-market adoption of 5G. But, by 2027, traffic usage per smartphone is projected to reach 52GB per month – similar to the usage in North America at that time.

The **North East Asia** share of total global mobile data traffic is expected to be around 30 percent in 2027. In the region, 5G subscribers currently use, on average, 2–3 times the amount of data than 4G subscribers. As more 4G subscribers migrate to 5G, average mobile data traffic per smartphone will increase. Video is the dominant traffic type. For example, in South Korea, video traffic share has increased 6 percentage points since the introduction of 5G services in 2019. Service providers expect additional traffic growth with the introduction of new video services, for example high-definition video and XR services.

In the **Middle East and North Africa** region, data traffic is expected to continue rising as the transition to 4G networks continues, coupled with the availability of more affordable 4G devices and data packages. The average data traffic per smartphone is expected to be around 45GB per month in 2027.

In the **Gulf Cooperation Council (GCC)** countries, smartphone data traffic will increasingly be lifted by 5G traffic due to the availability and relative affordability of 5G devices, especially in the higher ARPU markets. Operator monetization plans for 5G will also bring to bear a myriad of services relying on eMBB (enhanced Mobile Broadband), further stimulating data traffic growth. By the end of the forecast period, it is expected to reach an average of around 50GB per month.

Data traffic in **Sub-Saharan Africa** will maintain an upward trajectory, as mobile broadband-capable devices become more accessible. This is due to increasingly affordable price plans and service provider subsidies in some parts of the region. In markets such as South Africa and Kenya, recent spectrum allocations will enable service providers to extend their coverage and capacity of 3G/4G networks, leading to rising data traffic. 3G mobile data traffic is still increasing, but most of the traffic growth is expected to be in the 4G networks. The average data traffic per smartphone is expected to reach 11GB per month over the forecast period.

In **India, Nepal and Bhutan**, people have been dependent on mobile networks to stay connected during the successive lockdown waves, in both their personal and work lives. Mobile networks continue to play a pivotal role in driving social and economic inclusion, as service providers in India prepare to launch 5G this year.

Total mobile data traffic in the India region is estimated to grow by a factor of 4 between 2021 and 2027. This is driven by high growth in the number of smartphone users and an increase in average usage per smartphone. The average data traffic per smartphone in the India region is the second highest globally. It is projected to grow from 20GB per month in 2021 to around 50GB per month in 2027 – a CAGR of 16 percent.

In **South East Asia and Oceania**, mobile data traffic per smartphone continues to grow strongly and is expected to reach around 45GB per month in 2027 – a CAGR of 30 percent. Total mobile data traffic is expected to grow by a factor of around 6 between 2021 and 2027, driven by continued strong growth in 4G subscriptions and increasing 5G subscription uptake in several markets. Wider 5G adoption and new XR services are expected to drive traffic growth in the latter part of the forecast period up to 2027.

Latin America is expected to follow a similar trend as South East Asia and Oceania over the forecast period, while individual countries show very different growth rates for data traffic per smartphone. Traffic growth is driven by coverage build-out and continued strong adoption of 4G (and eventually 5G), linked to a rise in smartphone subscriptions and an increase in average data usage per smartphone. The average data traffic per smartphone is expected to reach 34GB per month in 2027.

In **Central and Eastern Europe**, growth is fueled by the migration of 2G and 3G subscribers to 4G, up to 2024, which is when 5G is expected to overtake previous generations as the technology contributing the most subscriptions. Over the forecast period, the monthly average data traffic per smartphone is expected to increase from 10GB to around 32GB per month.

It is important to bear in mind that there are significant variations in monthly data consumption within all regions, with individual countries and service providers having considerably higher monthly consumption than any regional averages.

[1] All Middle East and North Africa figures include GCC countries.

5G offerings picking up speed

The "data bucket model" remains the most common subscription type, but service providers are increasingly offering packages that include gaming, streaming and speed tier options to incentivize service uptake.

Key insights

- In order to motivate consumers to move up through the tiers, 17.5 percent of 5G service providers now use data speed together with volume-based and unlimited subscriptions.
- Service-based connectivity packs are becoming an integrated part of purchasing a subscription.
- Rich media, and now cloud gaming, is used by 45 percent of service providers to draw consumers towards 5G subscriptions and devices.

An updated Ericsson study[1] of retail packages offered by 311 mobile service providers worldwide shows that, although the type of service packaging remains similar to previous studies, an increasing number of service providers are expanding the list of options available to consumers. However, the most common variants are the same and the innovation is mostly found in variations of existing themes.

Data buckets remain the default offerings for nearly all service providers (99 percent). A common approach is to complement with "service-based connectivity packs" or an unlimited option at the premium end.

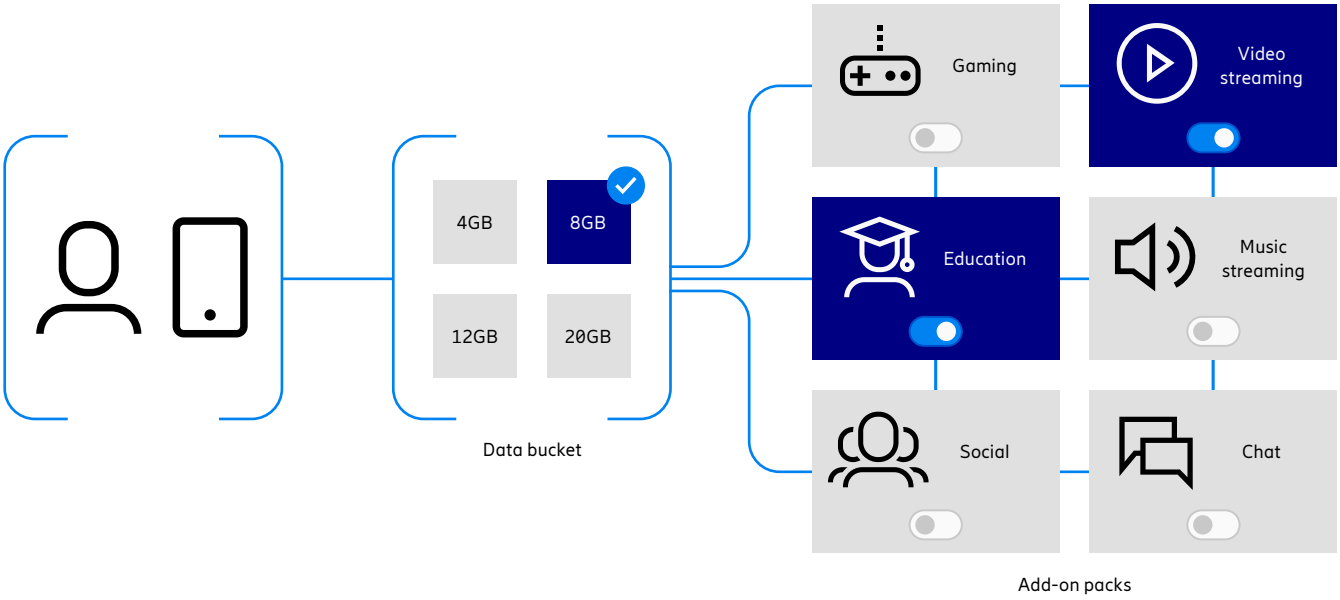
Nearly 40 percent of all service providers surveyed offer unlimited data under their premium packages. However, boundary conditions, such as not allowing tethering or limiting the use of IoT devices, are becoming more common with these offerings.

More than 90 percent of service providers applying these conditions have launched 5G. It may sound counterintuitive to put limitations on packages that are being sold as "unlimited". However, it highlights some of the challenges that these types of packages bring, especially with 5G offering throughput which could mean that certain usage may equal hundreds, if not thousands, of GB per month.

Service-based options on the rise

The service-based connectivity model seems to be going through a change. The total number of service providers offering any type of service-based connectivity continues to increase. At the same time, the number of those targeting data-intensive services, such as gaming or video and music streaming, have decreased somewhat. However, many of these seem to have been refining their packaging.

Figure 18: Example of how consumers can build custom service packages



[1] April 2022.

Previously, add-on packs were often found under a separate website "tab" and were at risk of going unnoticed by many consumers. Now, numerous service providers have made them an integral part of the subscription selection process. After choosing the bucket size, and perhaps a speed tier, it is a matter of choosing click-to-add extras such as a "video pack" or an "education pack" (see Figure 18). This selection then provides additional GB to use for that particular service class, or even unlimited use without depleting the basic bucket. Service-based connectivity packs offer GB or hours (unlimited also available) to be used only for a specific service, without consuming data from the base subscription. Commonly, these offerings target data-intensive services like video streaming/conferencing or cloud gaming. The offering only provides the connectivity; service subscriptions must be purchased separately.

During the early days of the pandemic, specific service-based connectivity packages, often labeled "work and education packs" were offered in some markets. These packages typically offered discounted GB to use for a combination of video conferencing services, streaming, office software suites and web browsing.

These types of packages have now become quite common, especially in markets with lower income levels, mostly in South East Asia and Eastern Europe.

Extracting a premium for 5G

The number of networks that offer 5G continues to increase and nearly 50 percent of the service providers surveyed have now launched 5G for smartphones. Of these, 35 percent charge a premium for 5G services. The average price premium over 4G is around 11 percent.

Using speed tiers to incentivize consumers

A significant percentage of service providers offering fixed wireless access (FWA) have been using speed tiers (also known as quality of service, or QoS) to segment the market and motivate consumers to move up to higher-priced tiers. Similarly, 5G service providers are now starting to use speed tiers for smartphones to extract additional value. Some of them also offer speed tiers for 4G services, but it is the wider range of speed enabled by 5G that makes such offerings attractive. Nearly 18 percent of 5G service providers are utilizing speed as a segmentation tool.

In Western Europe, however, this proportion is nearly 30 percent. A majority (60 percent) of the service providers using speed tiers are doing so in combination with both bucket and unlimited packages. In many cases, speed is used in combinations where the consumer can choose between similarly priced packages with a high speed but limited data allowance, or a lower speed coupled with unlimited traffic. Others simply provide the highest speeds with the most expensive plans. One interesting, and somewhat unique, example is a service provider which offers consumers a choice between two premium packages (a 15GB bucket or unlimited data) followed by a choice between three speed tiers: 15Mbps, 150Mbps or 1Gbps – at different price points.

Gaming draws consumers to 5G

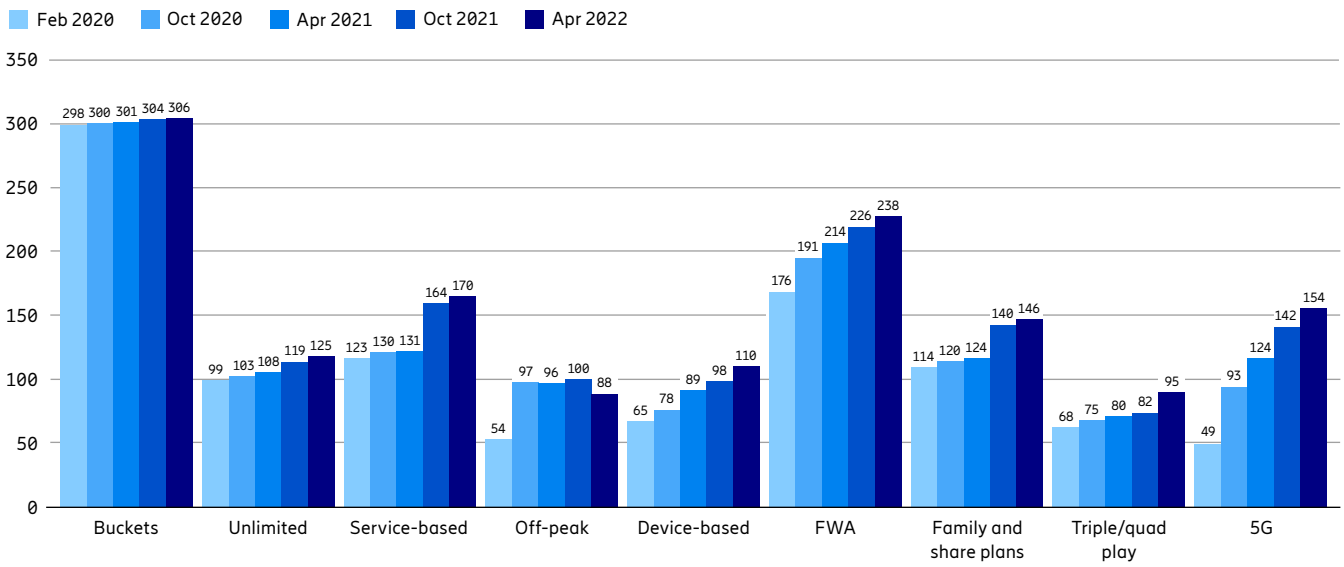
So far, cloud gaming services have exclusively been launched alongside 5G packages, with 35 service providers offering this at the time of the study. Generally, these services are developed by a partner company that provides the cloud gaming hardware acceleration platform, which is then packaged and offered by the service provider. This is often done with a revenue share model and the service provider implementing some form of "carrier billing".

About one in five service providers have taken this approach a step further, and have created specific connectivity packages targeting gaming users. These are designed as service-based connectivity packs which offer unlimited or time-based gaming sold as add-on packages. This allows consumers to play cloud-based games without consuming data from their regular buckets.

So far, only one service provider surveyed has created a package targeting the frustration at the heart of all gamers – lag. They use marketing terms like "priority" and "more network resources to beat lag when gaming" as a way to attract gamers and make 5G stand out in terms of the low-latency capability it offers.

Beside the use of speed tiers and adding new advanced services, like gaming, it is common to bundle with popular streaming services. Around 45 percent of 5G service providers are doing this in various forms with their more expensive offers. To summarize, there is an increased effort to differentiate 5G subscription offerings to provide additional value compared to 4G.

Figure 19: Number of service providers per type of offering



5G SA deployment: Moving beyond eMBB

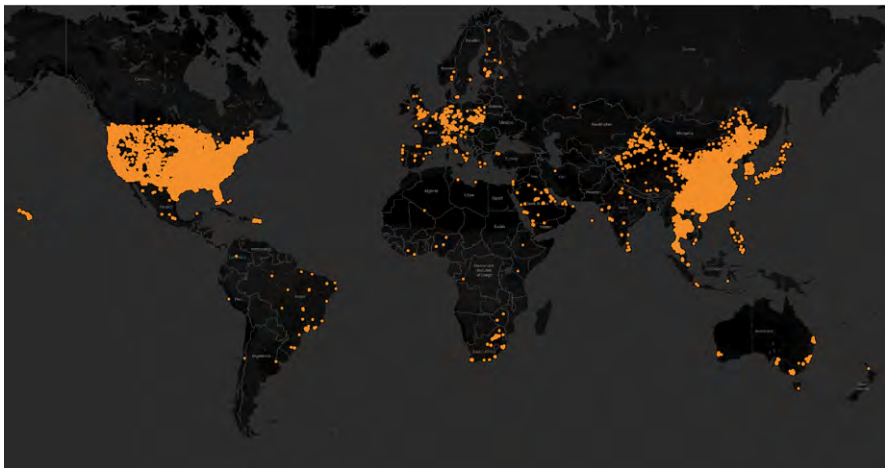
5G standalone (SA) deployments – the road to new services and business models.

Key insights

- Early deployment of 5G SA architecture provides a first-mover advantage for service providers with market-leading ambitions (frontrunners).
- The common key drivers for service providers to deploy 5G SA architecture are:
  - sense of urgency to transform the network into a new service delivery machine as the foundation for creating new business opportunities for top-line revenue growth
  - need to overcome learning-curve barriers related to new operating models, business strategies and service innovation

An increasing number of progressive service providers in several markets are deploying 5G SA networks. More than 20 had launched public 5G SA networks on mid- and low-band by the end of 2021.[1] This figure is expected to double during 2022 as more service providers deploy 5G New Radio (NR) SA and 5G Core networks. China and North America were the first markets in which 5G SA was launched, followed by commercial launches in several other markets, including Australia, Japan, South Korea, Singapore, Thailand, Germany and Finland. 5G SA networks provide a substantial competitive advantage for service providers that leverage its full benefits and potential. 5G SA mid-band (TDD) deployments with continuous coverage are important to deliver a consistent user experience for the new differentiated service offerings enabled by SA architecture.

Figure 20: 5G SA is increasingly commercially deployed and trialed across markets



Source: Based on analysis by Ericsson of Ookla® Speedtest Intelligence® data for October 2021 to April 2022.
Note: Samples include iOS and Android smartphones connecting to a 5G SA network. Sample density varies across markets, reflecting differences between markets with more extensive commercially launched 5G SA or markets with mainly trials/tests.

[1] GSA, January 2022.

Realizing 5G's full potential

The overwhelming majority of commercially launched 5G networks are based on NR non-standalone (NSA) technology, using existing 4G radio access for signaling, and an Evolved Packet Core (EPC) network. However, many use cases for Critical IoT, enterprises and industrial automation will only be feasible with the 5G NR SA and 5G Core architecture. In 5G SA architecture, automated end-to-end network slicing is simplified, with assured quality of service (QoS), security and flexibility, to multiple customer segments. The 5G SA core is a flexible and programmable platform, allowing services to be flexibly designed based on customers' specific requirements.

5G Core is built using cloud-native technologies which allow upgrades and new functionalities to be more cost-efficiently deployed, without impacting live services. The possibility to add new network functionalities, quickly scale capacity and run in-service software upgrades will make it possible for service providers to create and deploy new services for automated and customized connectivity in hours, rather than days or weeks. With 5G Core, service providers will be able to provide better network slicing and offer end-to-end service-level agreements (SLAs) to customers. Service exposure and traffic steering functionalities introduced in 5G Core will provide additional tools for service differentiation. Edge computing support enables distribution of user plane functionality to break out traffic dynamically at the edge. The reduction in latency and increased service reliability leads to enhanced end-user service experience.

5G SA device availability increasing

5G SA-compatible devices are increasingly becoming available, accounting for over half of all announced 5G devices. China is moving fast towards 5G SA-only networks.

In China, it has been mandatory for 5G devices to be SA-capable since early 2020, and since February 2021, both new and existing 5G devices are on "SA by default". 5G network traffic has increased due to continued 5G subscriber uptake, plus part of the traffic previously generated on the 4G network moving to 5G NR.

The device ecosystem is also developing support for multiple network slices on commercial smartphones. End users can be provided with differentiated services, for example, setting separate personal and work profiles, with one slice for generic mobile broadband traffic, another for services like gaming, and one or several slices for enterprise applications like video conferencing and collaboration. This functionality will only be supported in 5G SA architecture.

The need for network and business transformation

Consolidated feedback from service providers who have already commercially launched 5G SA networks highlights a set of business, network technology and operational drivers for their deployments. A common driver is the sense of urgency to transform the network into a new service delivery machine as the foundation for creating new business opportunities for top-line revenue growth. Another driver mentioned is the importance of overcoming learning-curve barriers related to new operating models, business strategies and service innovation. Early deployment of 5G SA architecture provides a first-mover advantage for service providers with market-leading ambitions (frontrunners). Service providers that do not evolve as fast as their competitors risk falling behind during this significant transformation.

Key drivers for service providers to deploy 5G SA

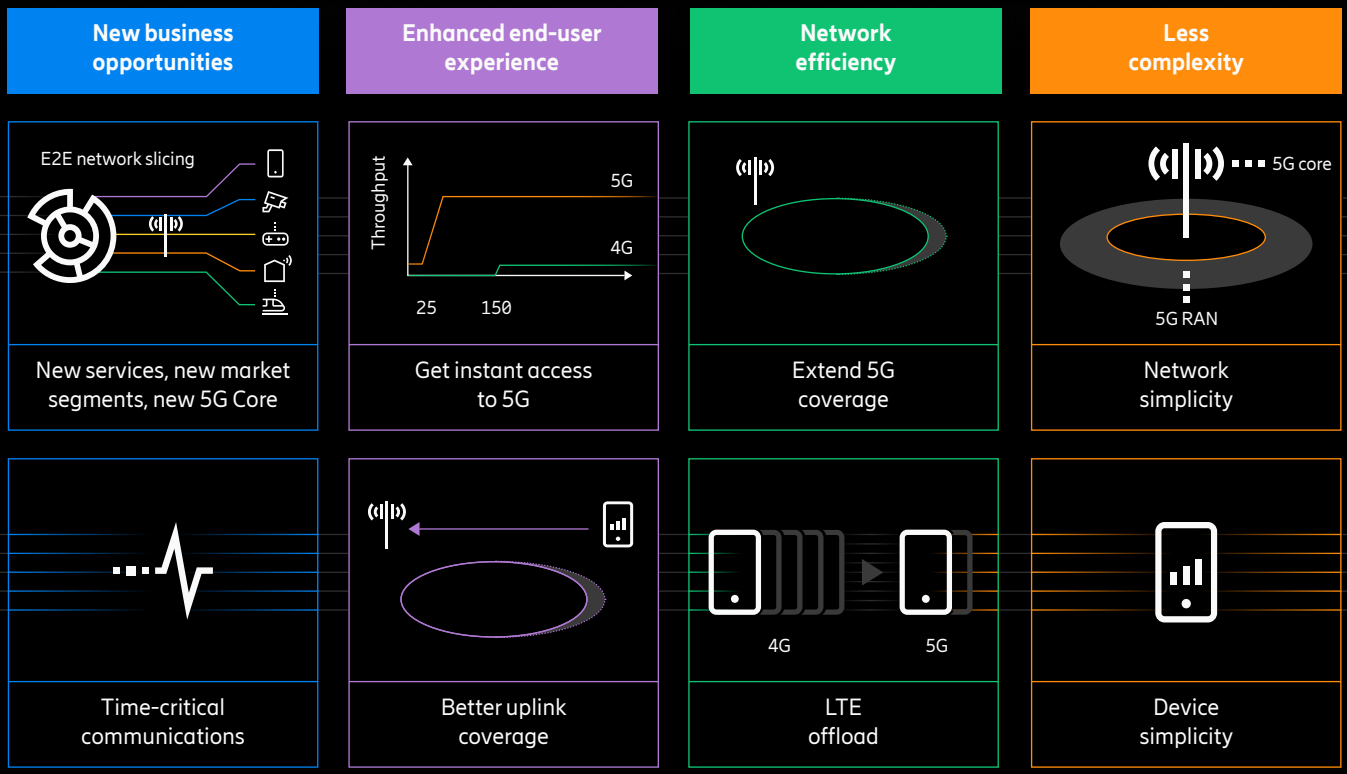
Business drivers:

- ambition to be seen as a market leader
- opportunity to become a service creator, moving beyond being a connectivity provider
- address a wider range of potential business opportunities (enterprise, consumers, government and society)
- increase market share and address new customer segments and use cases for top-line growth
- speed up development of innovative services with 5G technology
- quickly validate new business opportunities in real-life scenarios
- enhance customer mobile broadband experience, such as faster network responsiveness due to less handover interruption time, lower latency and higher bitrates

Network technology and operational drivers:

- introduce automated end-to-end network slicing, supporting high reliability and time-sensitive applications or those requiring guaranteed minimum bandwidth
- build a more powerful and programmable network for new use cases only possible with 5G SA
- support and accelerate enterprise transformation and industry digitalization to offer higher reliability for critical applications
- enable a mobile edge to support new industry and enterprise services
- enable rapid, easy integration between network and customer applications through network exposure
- greater speed and agility to bring new services to market
- reduce network complexity and operational inefficiencies from running different core network architectures for 4G and 5G
- more efficient network management

Figure 21: Selection of 5G SA key benefits[2]



[2] Examples of other benefits include: enhanced security (advanced encryption and identity protection), simplified operations and service agility.

One-quarter of the world's population now covered by 5G

5G is the fastest-deployed mobile communication technology in history, and is forecast to cover about 75 percent of the world's population in 2027.

Global 4G population coverage was around 85 percent at the end of 2021 and is forecast to reach around 95 percent in 2027. There are currently 809 commercial 4G networks deployed across the world. Of these, 336 have been upgraded to LTE-Advanced, and 54 Gigabit LTE networks have been commercially launched.[1]

The build-out of 5G continues, with more than 210 networks commercially launched across the world. 5G population coverage reached around 25 percent at the end of 2021. This is about 18 months faster than the time it took for 4G network build-out to reach 25 percent population coverage after its first commercial launch year.

Managing network sunsets in Europe

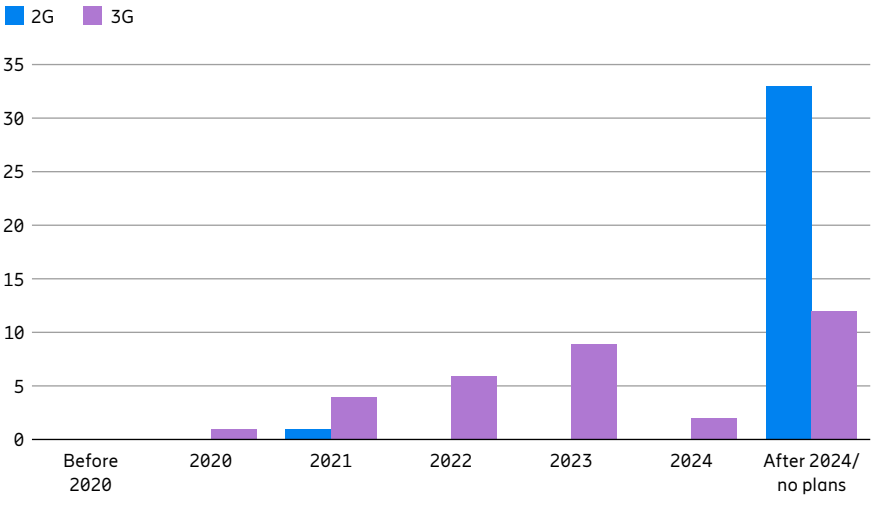
Service providers manage network sunsets differently across the world. Even within Europe, there are some differences in strategies service providers are using.

A major service provider in Switzerland was one of the first in the world to sunset 2G (2021) and has official plans to shut down 3G before 2025. In Germany, the order in which technologies are due to close follows a typical pattern (see Figure 22). 3G networks were closed last year and at least one service provider has communicated the sunsetting of 2G in 2025.

Similarly, the Czech Republic and Norway had several sunsets of 3G last year and service providers in both countries plan to close 2G in 2025. In the UK there are also plans to close down 3G before closing 2G. In France, service providers have plans that go beyond 2025 before sunsetting either 2G or 3G.

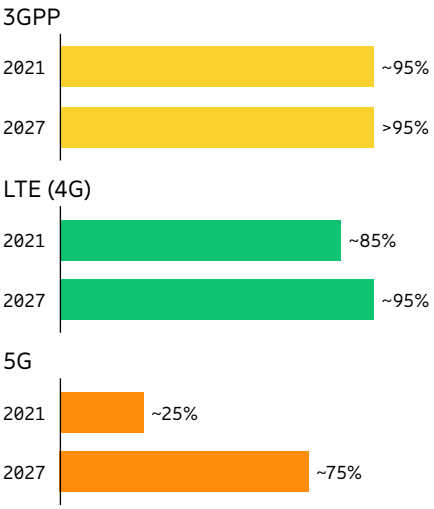
There are several reasons behind the different sunsetting timetables for 2G and 3G. IoT dependency on GSM is one reason, where a large amount of devices in use today have built-in 2G support and substantially longer lifespans than normal cellular devices. IoT in 3G is mainly supporting electronic devices with life in parity with a mobile device. There could be a substantial value for a service provider to close down 3G, as a significant amount of spectrum could then be released for 4G and 5G usage – something that 2G closures will not contribute to. Keeping the 2G service, from a spectrum perspective, can be achieved at a very low cost. Eventually, a reduction in the number of active network technologies will be needed to lower the total cost of ownership.

Figure 22: Service providers' sunsetting plans for 2G and 3G in Europe



Source: Ericsson customer survey
Base: 34 service providers across Europe

Figure 23: World population coverage by technology[2]



[1] Ericsson and GSA (May 2022).
[2] The figures refer to coverage of each technology. The ability to utilize the technology is subject to factors such as access to devices and subscriptions.

Articles

While 5G roll-outs are by no means complete, they are well under way. For many in the industry, efforts to utilize 5G to go beyond simply providing "fast connectivity" are already in focus. Our articles explore how the industry is already looking forward to what comes next, asking how to: make gains in sustainability; utilize technologies like IoT and edge to maximize efficiencies and push exciting use cases; use 5G as a springboard for innovation; truly capture the opportunities for all consumers and enterprises in all regions; and, with all this growing potential, how to keep 5G safe and secure.

MTN considers 5G to be an innovation platform that could completely transform society and businesses. Here's how new ways of working will allow service providers to fully capture the 5G opportunity in Sub-Saharan Africa.

The transition to cellular LPWA and 4G/5G technologies makes it possible to unleash the power of IoT connectivity. With Telia, we explore the positive impact of these technologies in areas such as business efficiency and sustainability.

As 5G grows in prominence due to advancing digitalization, networks become a more enticing target for threat actors. We explore the motivators, opportunities and capabilities of threat actors, and how to protect 5G networks.

Deploying edge computing is key to enabling latency-critical and bandwidth-hungry 5G use cases, and can cost less than on-premise IT resource for an enterprise. This capability represents huge untapped growth potential for service providers.

Unleashing the power of IoT connectivity

Telia Company's purpose is to reinvent better, connected living, and it strives to improve business efficiency. The transition to cellular LPWA and 4G/5G technologies makes it possible to unleash the power of IoT connectivity to enhance enterprises' business performance and sustainability.

Key insights

- Telia experienced more than double the growth in the number of cellular-connected IoT devices on its networks across the Nordic and Baltic countries in 2021.
- Globally, the number of IoT devices connected by cellular LPWA technologies is expected to overtake 2G/3G connected IoT devices in 2023.
- Emerging use cases, supported by cellular LPWA IoT technologies, improve business performance and efficiency for enterprises across various industries.

At the crossroads of change

In recent years, Telia has seen a continuous rise in the number of cellular-connected IoT devices on its networks across the Nordic and Baltic countries. 2021 saw an increase of 44 percent, more than double the growth compared to 2020. The growth is primarily fueled by large-scale smart meter deployments, based on the low-power wide-area (LPWA) IoT technologies, NB-IoT and Cat-M. In addition, the adoption of embedded universal integrated circuit cards (eUICC)[1] has simplified the global deployment of connected devices by allowing remote SIM provisioning of multiple network profiles.

NB-IoT and Cat-M technologies are ideal for connecting massive volumes of low-cost, low-complexity IoT devices with long battery life and limited data throughput demand. These technologies, which form part of the 5G standard, are the successors to 2G and 3G networks that are being replaced as the industry moves to adopt broadband and critical IoT, powered by 4G and 5G.

IoT devices migrating to modernized networks

2G and 3G networks are being phased out globally to enable the reuse of valuable radio spectrum for 4G and 5G deployments. By modernizing the networks with the latest technology and replacing old equipment, it is possible to realize new business opportunities and create significant energy savings at the same time.

About 30 percent of all cellular IoT devices are still connecting through 2G/3G networks. However, enterprises are migrating their IoT devices and services to Cat-M and NB-IoT networks, which are more energy efficient, reliable and have higher capacities. Across Europe, the sunsetting of 3G networks is happening before 2G (see Figure 22, page 22), but the order and the schedule varies from country to country and between service providers. Telia will decommission its 3G networks before 2G, with the 3G sunset already in motion across Telia's markets in the Nordics and Baltics.

Globally, the number of IoT devices connected via 2G and 3G has been in slow decline since 2019. The combined segment of cellular LPWA, broadband and critical IoT (4G/5G) overtook 2G/3G in terms of IoT connection numbers for the first time in 2020. LPWA IoT technologies are expected to make up about 50 percent of all cellular IoT connections in 2027 (see Figure 13, page 13).

Extending IoT connectivity reach with cellular LPWA

LPWA IoT technology supports solutions requiring low total cost, long battery life and the ability to operate in remote locations. Its energy efficiency comes from sending smaller amounts of data at defined time intervals and then quickly powering down the transmitter in between. The two different cellular LPWA IoT network technologies, NB-IoT and Cat-M – both under the 5G standard – are inherently more secure and have longer reach than previous generations. For example, Cat-M can have a reach of up to 100km and NB-IoT up to 120km from a radio base station. The extended reach and high-penetration capabilities make it possible to cost-efficiently connect sensors in cities, remote rural, coastal, and maritime areas, and even deep inside buildings or underground. In several tests throughout its development, Telia has shown that NB-IoT can connect devices placed as deep as 80m underground.[2]

The transformational power of enterprise digitalization

Organizations that embrace this new era of digitalization enjoy increased efficiency and cost reductions, thanks to better predictability and greater control. Digitalization also means companies are becoming software businesses, generating proprietary data. They are no longer an isolated part in a vertical market, but a data-driven, interconnected element of a wider, digital ecosystem of services.

[1] eUICC is the software that lets an embedded SIM (eSIM) accommodate multiple SIM profiles and enables it to be provisioned remotely.
[2] In tests conducted by Telia, together with a customer, an NB-IoT connection reached 80m into a concrete underground shelter. This was 60m deeper than a mobile phone call reached during the same test.

For example, when an agriculture machinery manufacturer equips a tractor with more than 300 IoT sensors and the ability to process more than 150,000 measurements per second, the business and its value creation changes. The tractor is now a data-generating unit, part of an ecosystem of related services such as weather forecasting, commodity pricing and crop yield predictions.

There are many more examples: A car manufacturer that harnesses IoT connectivity is no longer just selling cars, they are also enabling carpooling services and shared ownership alternatives, while gathering and handling information about the driver, roads, traveling habits and even the weather. Providers of consumer IoT services improve the health and lifestyle of consumers thanks to health monitoring, lifestyle optimization and entertainment apps.

Enterprises can be transformed and their new capabilities turned into new customer values and chargeable services. Internal processes and cost control become more effective too, as every decision can be based on real-time data. Monitoring enables less repeating and reactive maintenance, and there is no longer a need for so many trips or manual efforts, leading to clear sustainability gains such as reduced CO2 and pollution from fossil-fueled vehicles. Smarter energy systems, smarter grids and better monitoring allow for a more efficient use of resources.

A truly data-driven, or rather data-native, company makes data the basis for all decision making, regardless of whether it relates to technology, business decisions or sustainability.

IoT connectivity goes underground for pest control

As cities expand and urbanization grows, there is typically an increase in common underground pests, such as rats. Poison traps have traditionally been used for pest control. However, this method allows poison to enter the food chain whereby birds, foxes and domestic pets eat the poisoned rats above ground.

A pest control company in Denmark developed a new digital trap that enables an ethical, non-toxic approach. At first, the solution utilized 2G (GSM/GPRS) for connectivity, but due to the heavy steel covers below the surface of the drains, 25 percent of the traps could never connect to the network. By migrating from legacy connectivity to NB-IoT technology, the connection success rate rose from 75 percent to 100 percent. NB-IoT technology fulfilled the performance requirements to connect the traps deep underground, enabling performance monitoring and information gathering about the number of triggered traps, maintenance needs and sewer flooding in hard-to-reach places. This gave the company a competitive advantage.

Navigating treacherous waters with IoT

Hundreds of thousands of islands making up the archipelagos of Finland and Sweden are battered by brutal storms every winter. Navigation marks are extensively deployed to support marine traffic safety, but these often break free from their anchors and float across long distances. In the past, local maritime authorities had to go out on resource-demanding and fuel-consuming runs each spring to find the marks and return them to their correct locations.

This article was written in cooperation with Telia Company, a market-leading service provider in Sweden, providing innovative services for more digitalized and sustainable societies across the Nordics and the Baltics.

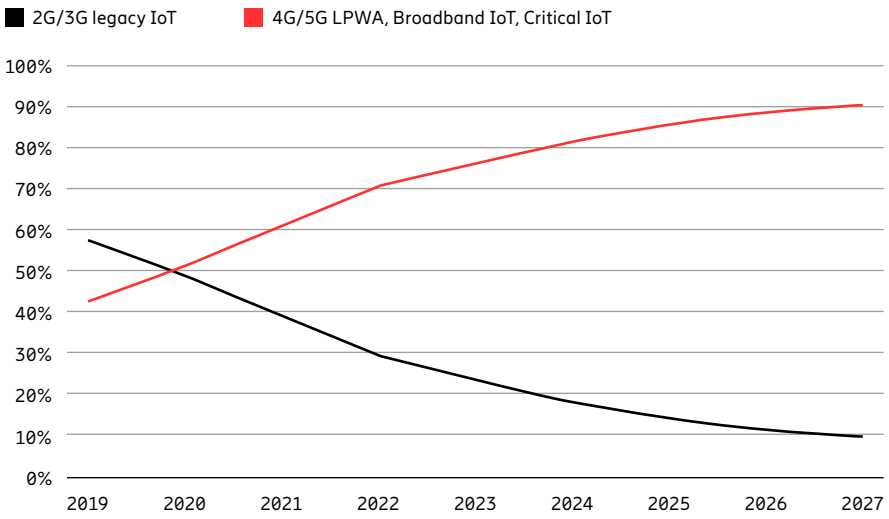
A Finland-based global provider of advanced tracking and sensor solutions took on the challenge, developing a tracker using NB-IoT and aiming to deploy them in over 20,000 navigation marks in the Finnish archipelago. NB-IoT is the ideal connectivity solution for the hard-to-reach offshore navigation marks thanks to its extensive reach and the ability to operate for up to ten years on a single battery charge. Sea routes will be digitalized by remotely tracking navigation marks, which create savings in cost and resources, reduce CO2 emissions and make the waters safer.

Remove roaming limits

Global multinational enterprises (MNEs) need to connect IoT devices across different countries and regions. For an MNE to procure local solutions from a local service provider in each market would be very challenging to implement and to operate, both technically and commercially.

Using cellular network capabilities, they can change the connectivity profile of devices through eUICC. The SIM profile is changeable over-the-air (OTA) and can be set to become a local network device to fulfill the legal requirements that exist in each market, or to have a roaming profile when allowed.

Figure 24: Percentage share of 2G/3G vs 4G/5G connections for cellular IoT



Source: Ericsson Mobility Visualizer.
Note: NB-IoT and Cat-M access technologies are also referred to as LPWA technologies.

A Finland-based manufacturer of industrial and marine gearboxes, as well as drives for process industries, needed to set up easy-to-use and cost-effective mobile connections for some of its 200,000 gearboxes across 40 countries. In many critical segments of the process industry, optimized gearboxes that allow for uninterrupted operations and cost-effective maintenance are vital. Unplanned maintenance leads to production loss.

Installed sensors measure data such as oil quality, relative humidity, temperature, gearbox vibrations, pressure, and cleanliness of the equipment. Pre-installed IoT devices transmitted the relevant information to different stakeholders, such as the process control system, the operations and maintenance personnel and the equipment manufacturer. Through eUICC SIM cards, health monitoring the equipment and anticipating subscription costs became transparent and easier to manage.

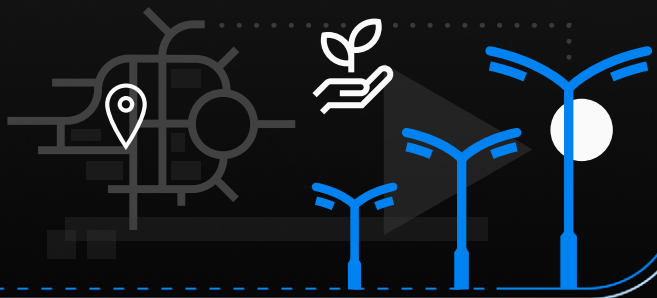
Transforming tomorrow with IoT

4G and 5G networks will continue to evolve, further enhancing IoT connectivity capabilities with higher data speeds, lower latency, improved security, and extreme reliability. Supported by 4G networks, businesses can achieve better efficiencies and performance with cellular IoT technologies, and Telia's 5G network presently supports use cases such as remotely controlled high-lift wheel loaders, autonomous field robots for mechanical weed control and automated port operations.

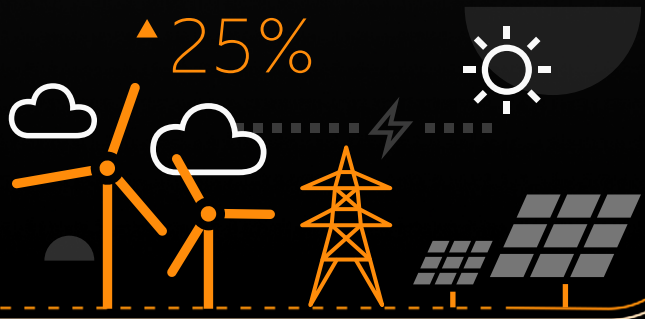
Service providers are uniquely positioned to support the digital transformation of a wide range of industries with evolving cellular IoT technologies, as they enable industries to become truly data driven, efficient and sustainable to further contribute to a better society. As 5G and IoT transform connectivity and unlock new intelligence, the possibilities are only limited to what enterprises and service providers can imagine.

Telia's enterprise IoT use cases making a positive sustainability impact

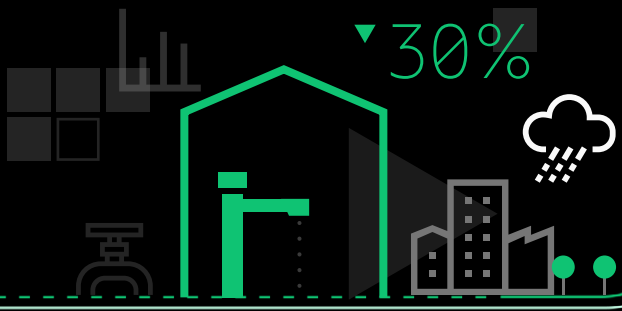
Industry: Smart utilities
Solution: Connected lighting
Description: Migration of 2G-based IoT to cellular LPWA IoT. This enables low-cost measuring and control units to be built into equipment, addressing the growing demand for advanced lighting solutions.
Value created: Economically viable connectivity can be built into low-cost equipment. More sophisticated coordination of lighting across wide areas, countering energy shortages and improving energy efficiency. Cost-efficient managed solution provided by Telia.



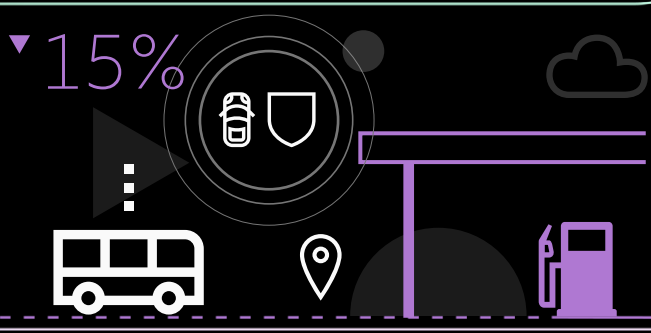
Industry segment: Smart utilities
Solution: Connected powerlines
Description: IoT connectivity provides grid owners with real-time visibility of the capacity of different parts of the grid. This enables extra energy from wind and solar to be prioritized ahead of traditional power sources such as fossil fuels.
Value created: Grid line capacity increased by up to 25 percent.



Industry: Smart utilities
Solution: Connected water taps
Description: Digitalization of water taps in public environments, such as hospitals and swimming pools, to collect data and optimize water and energy consumption. This makes the maintenance and construction planning of buildings more efficient.
Value created: Water consumption in public buildings reduced by 30 percent.



Industry: Smart public transport
Solution: Connected buses
Description: IoT technology provides a clear overview of vehicle location, direction and status.
Value created: Fuel consumption reduced by up to 15 percent with improved driver and passenger safety.



The evolution of MTN's connectivity platform

Continued investment in 4G – and the expansion of 5G – technologies are expected to play a crucial role in realizing MTN's ambitions, and will enable it to meet evolving market demands and monetize new use cases across markets in the Sub-Saharan Africa region.

Key insights

- MTN views 5G as an innovation platform that could transform various aspects of business and livelihood beyond pure connectivity.
- Traditional business models and "ways of doing things" will not be sufficient for service providers to fully monetize emerging 5G opportunities. Network slicing is needed to enable revolutionary business models and service pricing.
- MTN's 5G build-out strategy is based on meeting evolving market demands with the timely deployment of relevant technology enablers, in order to optimize the potential for monetizing new use cases.

MTN Group, South Africa, has defined its strategic "Ambition 2025" plan. It is built on MTN's current market position, where connectivity is the foundation, while platforms are gradually expanded to capture new growth opportunities and deliver value. In this context, 5G network deployment and evolution across markets plays an important role in enabling new services for consumers, enterprises, industries and society. For MTN, 5G is an innovation platform with the ability to transform various aspects of business and livelihoods beyond pure connectivity.

Data connectivity and usage – drivers for revenue growth

In the Sub-Saharan Africa region, connectivity is still dominated by 3G and 2G technologies, with 4G only making up around 20 percent of mobile subscriptions by the end of 2021.[1] However, demand for data connectivity and digital services is increasing across markets. Operating in 18 markets across the Middle East and Africa, MTN is pursuing these new growth opportunities.

Continuous network modernization and coverage build-out, supported by MTN's Rapid Rural Rollout (R3) program, has enabled it to capture strong new subscriber growth and stimulate increased data usage. This has resulted in increased data service revenues, despite price pressure in the markets. In South Africa, MTN networks experienced strong data growth as the number of customers actively using the internet grew by 12.5 percent, leading to a mobile data traffic growth of almost 60 percent in 2021. The average mobile data traffic per pre-paid subscriber was 2.3GB and 10.3GB for post-paid subscribers.

MTN considers data as a main driver of revenue growth over the medium term. Initiatives to stimulate further data adoption include data service bundling, segmented value propositions and the development and launch of freemium data propositions, supported by strategic over-the-top partnerships.

MTN's strategic priorities up to 2025

MTN continues to invest in 4G technologies and has expansive plans for 5G to realize the opportunities it has identified to evolve and expand its service offerings for the consumer, enterprise and industry segments. MTN's strategic priorities are articulated in its Ambition 2025 strategic framework, which is underpinned by 10 key technology strategic pillars intended to enable growth in connectivity and platforms businesses. Some of the most important pillars are ensuring best-in-class, ubiquitous access across mobile and fixed networks, maintaining network leadership and efficiencies, and the monetization of infrastructure. Other priorities include investment in sustainable technologies and zero-touch, service-aware networks. 5G networks will play an essential role in delivering on the technology pillars to realize the Ambition 2025 plan.

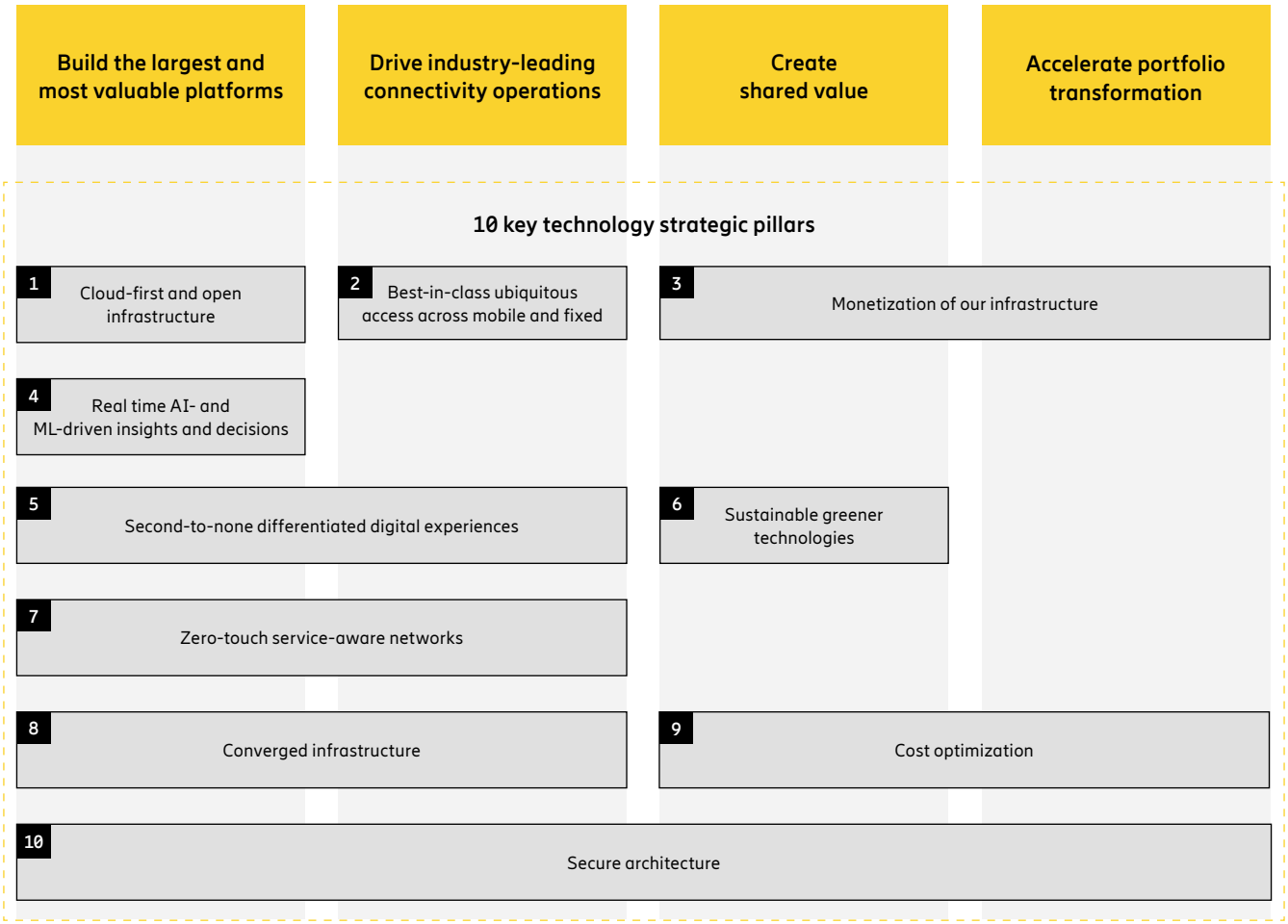
Monetization of network infrastructure includes a network-as-a-service (NaaS) strategy, where network sharing (national roaming, MOCN and MORAN) is the starting point, followed by 5G network slicing which enables exposure of network functionality via APIs to build new enterprise services. An additional step will be the monetization of data exposed via online third parties.

MTN

This article was written in cooperation with MTN, Africa's largest mobile network operator. MTN offers a range of communications services to customers in 18 markets across Africa and the Middle East – one of the world's fastest-growing regions for mobile telecommunications.

[1] Ericsson Mobility Visualizer.

Figure 25: MTN Ambition 2025 – strategic priorities



Building 5G for timely monetization

MTN's 5G network build-out strategy is based on meeting evolving market demands with the timely deployment of the relevant technology enablers, in order to optimize the potential for monetizing new use cases. So far, 5G subscriber uptake has been driven by a combination of increased 5G device penetration and fixed wireless access (FWA) subscriber uptake. The average 5G subscriber mobile data consumption is approximately twice that of 4G subscribers.

Mobile broadband and FWA are currently the main 5G services marketed by MTN. It stresses better user experience as the main value, in a manner that relates to consumer needs, rather than bandwidth and latency which are not relative to the consumer. Interest in high-speed, good-quality broadband increased as working from home practices spread during the pandemic. 5G FWA will compete with fiber-to-the-home as an alternative, cost-efficient home broadband solution.

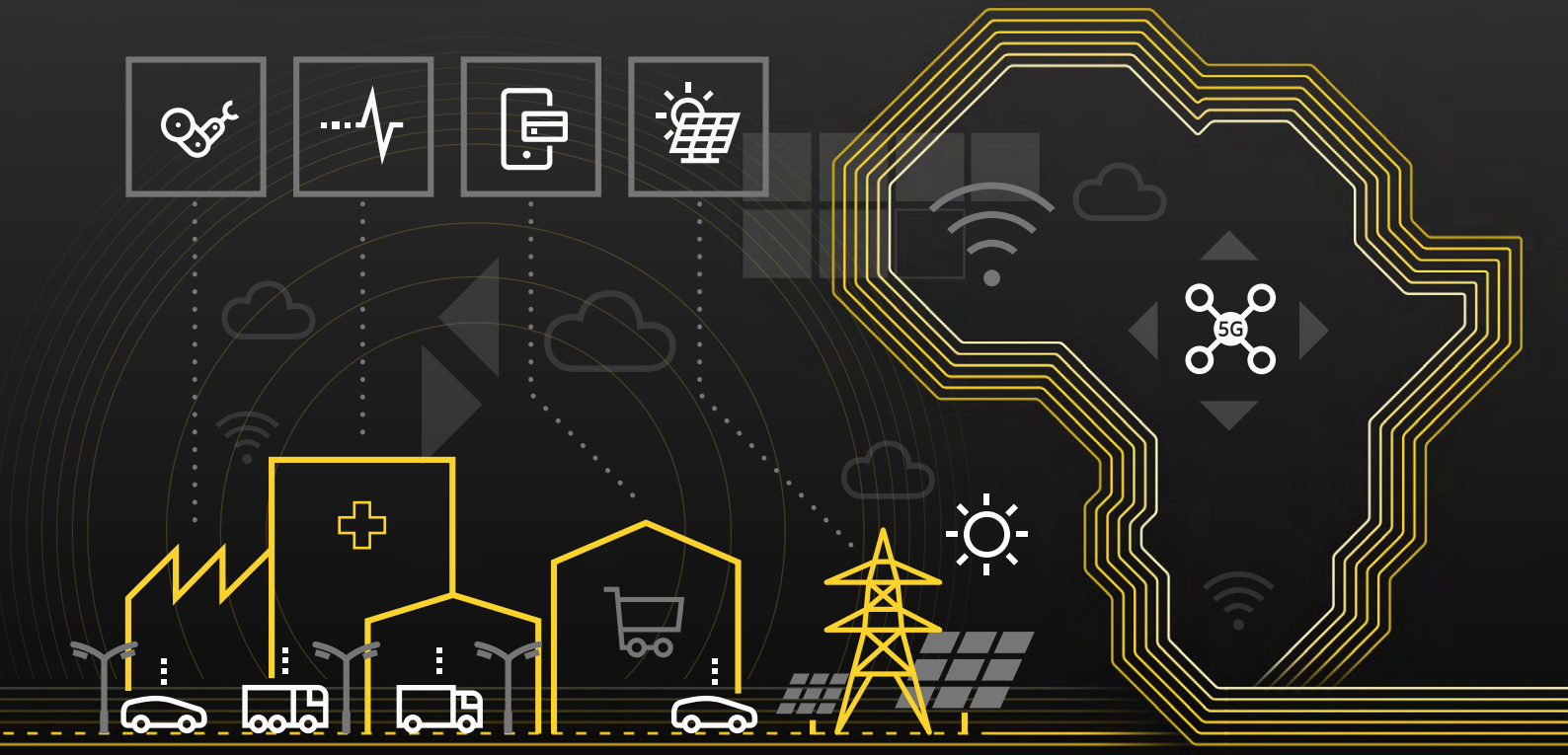
The deployment of 5G SA architecture, enabling network slicing, will be driven by consumer and enterprise use case evolution over time. In the 2023–2024 timeframe, the initial target will be consumers (enhanced mobile broadband/FWA). This will be followed by deployments for enterprises, as ultra-reliable low-latency communications (URLLC) for critical services – which are crucial for high-end industrial applications – and 5G-era massive machine-type communications (IoT) use cases start to emerge. Over-the-top services will also be an important offering to create stickiness.

The challenge of migrating to SA architecture is not related to the technology as such, but rather how to monetize these new types of services, while also adhering to local market regulations related to net neutrality.

The enterprise opportunities

5G will enable a range of new services across different sectors, such as mining, manufacturing, utilities and agriculture. MTN is sharing information with enterprise customers and industry verticals about the value of 5G connectivity and low latency for optimizing its operations, as well as the introduction of new services. Dedicated private networks are already being deployed in proof-of-concept trials to validate the value of new services. An AI-based face recognition system at mining sites is one example of a service being evaluated – this is currently 4G based, but will evolve to 5G.

According to MTN, the main new opportunities in the African market that can be addressed with 5G technologies are related to areas such as virtual education, industrial automation, telemedicine, remote health care and smart cities.



MTN's 5G deployment strategy

5G is still in its infancy in South Africa. Within the country, MTN is a leading service provider, with around 35 million mobile subscribers. Of these, about 50 percent are active mobile data users. At around USD 6.30, it has the highest blended average revenue per user (ARPU)[2] of all service providers in South Africa. MTN launched its 5G commercial services in June 2020 and reached 200,000 5G subscribers by the end of 2021. Continued 5G subscriber uptake will be strongly impacted by the availability of a wider range of low-cost 5G smartphones. In the recent spectrum auction, MTN acquired 100MHz of spectrum across three frequency bands: 40MHz in the 3.5GHz band, 40MHz in the 2.6GHz band and 2x10MHz in the 800MHz band. MTN's initial 5G network deployment strategy focuses on high-value urban areas and hot spots, where they will deploy high-quality 5G New Radio (NR) equipment on the mid-band 3.5GHz frequency (40MHz bandwidth) as a capacity layer. Initially, hot spots being targeted include key markets, university locations, institutions and residential areas serving consumers with high data usage potential.

Long term, a coverage layer on the 700MHz band will ensure that regulatory requirements for 5G coverage are fulfilled. Deployments in high-band spectrum (mmWave) will be carried out on a more limited basis in areas with high-capacity traffic demand and in areas for deployment of FWA services. 5G is also available in some areas through dynamic spectrum sharing (DSS), a technology which allows both 4G and 5G to be deployed in the same band and on the same radio. MTN has deployed about 1,000 5G mobile sites and aims to reach 25 percent 5G population coverage by the end of 2022, and 60 percent by 2025.

MTN will begin decommissioning its 3G network in 2025/2026, with 4G and 5G becoming the principal technologies used to deliver telecoms services to its customers. In Sub-Saharan Africa, 5G subscriptions will represent around 10 percent of all mobile subscriptions by 2027,[3] with South Africa expected to lead the adoption rate in the region. Local market research forecasts that the number of 5G subscribers in South Africa is expected to reach 11 million by 2025.[4]

Strategy execution – addressing the new opportunities

MTN knows that the traditional business models and "ways of doing things" will not be sufficient to enable it to make the most of the emerging 5G opportunities. To really benefit from 5G's capabilities, MTN will need to tie its 5G vision and roadmap closely to its digital transformation strategies. It will need to introduce network slicing if it expects to see revolutionary business models and service pricing. Network slices will be created on demand and will be independently controlled and managed with a degree of customization that could previously only be achieved with dedicated physical networks. Network slices allow partners to integrate into network platforms in a similar way to a dedicated private network, but with far less effort. They will also enable MTN to expand its role from connectivity to other areas of the value chain – such as cloud and edge services, orchestration and applications.

[2] Blended ARPU: 98 R, Q3 2021.
[3] Ericsson Mobility Visualizer.
[4] 2021 South Africa 5G Market Outlook Report from Africa Analysis, February 2021.

Enabling demanding use cases with CSP edge computing

Edge computing is key to enabling latency-critical and bandwidth-hungry 5G use cases, representing significant growth potential for communications service providers (CSPs).

Key insights

- Emerging low-latency, high-bandwidth 5G use cases require new capabilities that can be addressed by CSP edge computing.
- The cost of building out and operating CSP edge compute resources is marginally more than at large-scale data centers, but significantly less than enterprise on-premise compute solutions.
- Deploying the compute resources at the edge of a CSP mobile network brings additional advantages, including reduced latency, higher performance, and improved data security and privacy.

Demand for immersive use cases has been held back by factors in the development of a new ecosystem, including networks, devices and applications. As this ecosystem matures, we expect the value brought about by edge computing will overcome the cost advantages held by large-scale data centers. Our analysis indicates that it is clearly possible for a CSP to build-out edge computing with an annual cost base not materially higher than a data center.

Historically, enterprises could either run their application workloads on-premise, based on the company's own IT infrastructure, or hosted in centralized data centers. There are several fundamental differences between these deployment options, including cost, control, security and regulatory compliance.

With the rollout of 5G, CSP mobile networks present an attractive proposition for running demanding enterprise applications close to target customers. A cost analysis of deployment shows that the cost to CSPs to deliver edge compute resources to enterprise customers is nearly half of what it would cost for an enterprise to build its own on-premise infrastructure with similar performance, reliability and data security.

Enter edge

Edge refers to the distribution of compute resource and applications to geographically distributed sites on the premises of an enterprise or in a CSP network. It provides compute resource and storage closer to where the data is generated and consumed. It offers significant advantages by enabling advanced data processing capabilities located close to where they are needed, reducing the latency inherent in centralized data centers. Deploying software at the edge comes with an increased cost compared with centralized deployment, but also enables a range of enhanced capabilities, including increased performance, reliability, data security and privacy, as well as reduced cost/bandwidth for the transport network.

Since data does not need to travel to remote locations for processing, analysis and rendering, enterprises can save precious milliseconds on round-trip times (RTT) while benefiting from more reliable data throughput. Enterprise on-premise edge computing can help insulate their networks from cyberattacks and distributed denial-of-service (DDOS) attacks on more centralized locations. There is also reduced risk of data being intercepted in transit, further adding to the security and privacy features of edge computing.

Edge computing can help organizations to fully comply with jurisdictional data regulations and sovereignty laws by allowing data to be processed close to its source.

CSPs can leverage the proximity of their existing sites to end users to set up edge compute, providing low-latency and high-performance IT capabilities for enterprise workloads as a service. For example, one way enterprises can reduce on-premise IT infrastructure is by deploying "infrastructure-less" branch offices; all IT on-premise applications, from communication, image processing and analytics to specialized enterprise services, can be hosted on the network edge.

A number of considerations must be addressed while rolling out compute capabilities alongside connectivity. There can be limitations to adding resources to some sites due to constraints on space, power and/or network capacity. Another challenge could arise from low fault tolerance of the commercial off-the-shelf (COTS) hardware used at the edge sites. CSPs may also require new sites to provide both continuous coverage and compute capabilities at critical locations to enable particularly demanding use cases.

The cost of the edge

To compare the cost of deploying compute resources at different scales, we convert capital expenditure into depreciation by dividing each asset category by the number of years it will be written down, and then add the resulting depreciation to the annual opex, providing a snapshot of the yearly cost structure. For example, power and cooling systems are written down over 14 years, whereas COTS servers are typically written down over 3 years.

Capex includes:

- Server capex is mainly the cost of COTS servers and virtualization software.
- Other capex consists of the cost of components such as power distribution and cooling systems.

Opex includes:

- The electrical power required to run and cool the servers.
- Other opex, mainly the cost of operations and maintenance (O&M).

As an example, we estimate the cost of compute resources for a CSP in Sweden. Initially, edge compute rollout is expected to be on aggregation sites having power capacity installed up to 10kW, hosting an average of 8 server units, each with 4 cores. With approximately 8,000 access sites and 1 aggregation site per 10 access sites, there is a virtual processor (vCPUs) capacity of 25,600 (800 sites x 8 servers per site x 4 cores per server) for enterprise applications at CSP-owned edge sites. Capex depends on the required capacity plus redundancy in the edge hardware components to meet the reliability requirements for edge services or applications. The geographic distribution can also be leveraged to improve the system availability by avoiding a single point of failure. We categorize the capex into server capex and other capex due to the faster cycle of server performance improvement compared to others. Servers are typically depreciated over 3 years while investments in power and cooling systems are depreciated over 14 years. Upgrading aggregation sites with edge compute capability, with an average of 8 units of servers, can draw up to 1.6MW (800 sites x 8 servers per site x 250W per server) for running the servers. With an assumed power efficiency factor of 2, 3.2MW power is needed on average to power all the aggregation sites. The cost of compute resource at each aggregation site is estimated be around USD 20,000. Hence the USD per critical watt for an edge site is USD 20,000/(8 servers x 250W/server) = USD 10/W. This cost is very similar to USD per critical watt for building a large-scale data center.

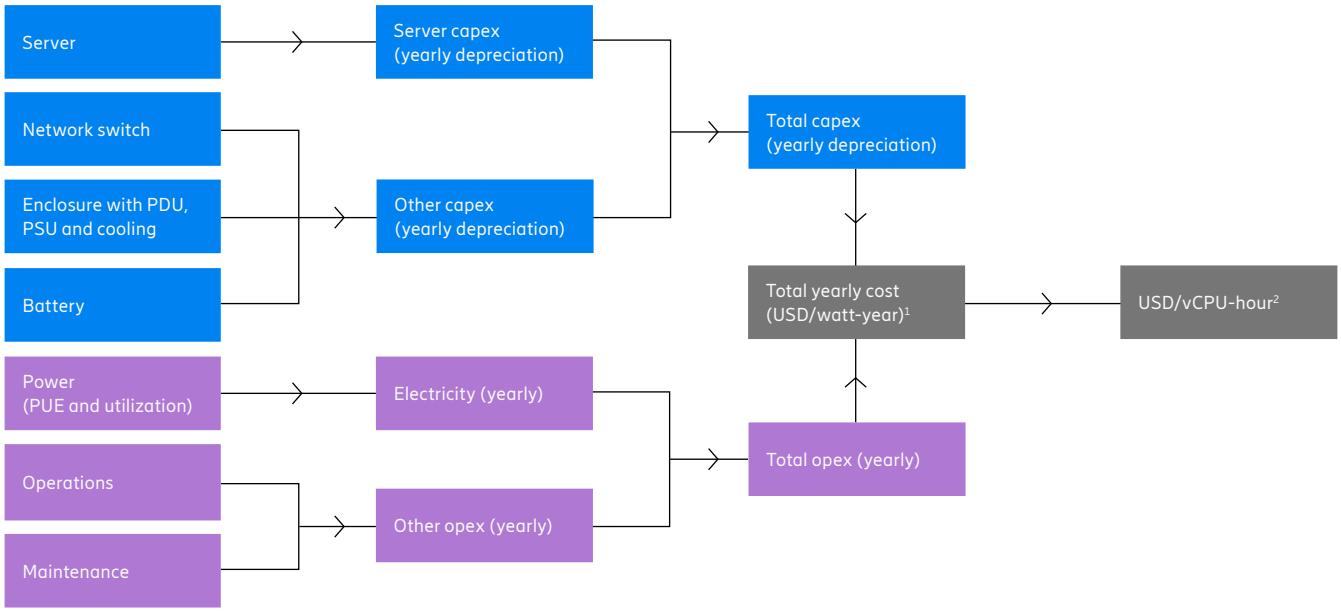
Opex is the sum of electricity cost and O&M. For the current study, we assume it to vary in the range of USD 0.10–0.15/kWh. For O&M, the cost of full-time employees required to manage and maintain the distributed edge servers is projected.

We constructed four different scenarios to estimate and compare the compute resource cost, based on USD per vCPU-hour.

- Scenario 1 is a base case with costs assumed for a small- or medium-sized enterprise handling its compute needs with its own IT infrastructure.
- Scenario 2 is an estimation of cost for a large-scale data center to provision the same capacity as the first case.
- Scenario 3 is built around provisioning the capacity used in the first two cases by deploying edge computing on the CSP network.
- Scenario 4 is an extension of the third case, with the addition of the cost to implement a set of measures to reduce power consumption. These include using renewable energy, dynamic usage of battery/power storage at peak times and advanced cooling technologies, including a heat exchanger for the server cabinets.

Server capex is the most significant parameter for all the scenarios except the base case where O&M (other opex) dominates due to the lack of scale. Electricity cost is the second largest factor in USD/CPU-hour for scenario 3. This leads to the significance of additional power efficiency elements in scenario 4. With an estimate of expenditure in use cases suitable for edge deployment, the cost of edge compute resources can be just 10 percent more than that of a large-scale centralized one. Capacity utilization is the most important parameter for increasing the cost efficiency of the edge resources.

Figure 26: Annual cost estimation framework for compute resources



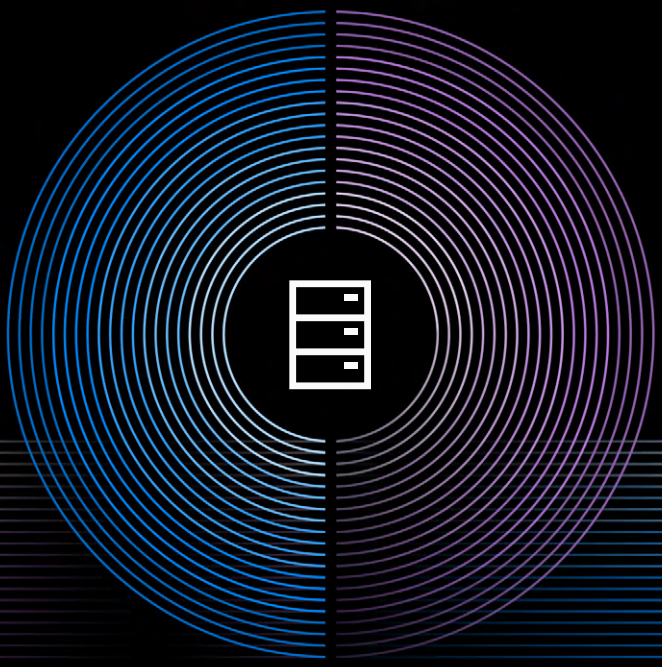
[1] USD/critical watt-year is equal to the total annual cost (depreciation) divided by the power (watts) required by the servers dimensioned for a defined compute capacity.
[2] USD/vCPU-hour: A unit of cost for compute resource that is equal to the total number of virtual processors divided into total annual cost of compute resource. This is an accepted metric for comparing the cost for alternative implementations.

Figure 27: Cost breakdown of compute resources for different scenarios (USD/vCPU-hour)

CSP edge infrastructure resources are marginally more expensive than those at a large-scale data center but much less than those at an enterprise on-premise compute solution. CSP edge infrastructure also provides better latency and proximity to enterprise applications.

When comparing the costs of a large-scale traditional data center and a CSP network edge, we need to consider that those alternatives enable different use cases. Positive features for a CSP-operated edge include high location sensitivity, reduced latency (in the millisecond range), and guaranteed connectivity. However, edge compute infrastructure will have limited scalability compared to large data centers.

The short- to mid-term edge opportunity for CSPs should be seen in the wider context of the enterprise opportunity, where edge computing will be an enabler for a broad range of use cases, for example offerings such as private 5G networks, IoT platforms, cloud gaming and immersive experiences with XR. In the long term, when compute is deeply integrated in mobile networks, the most demanding use cases, including closed-loop industrial control systems, industrial robotics, extended reality with real-time synchronous haptic feedback (the Internet of Senses) and negotiated automatic cooperative driving for autonomous vehicles, will open up an expanding set of opportunities.



Building out edge computing on the CSP network unlocks significant business opportunities.

Securing 5G networks in an evolving threat landscape

5G is, by design, more secure than previous generations, but it is being deployed and operated in an evolving and complex threat landscape. New, demanding use cases served by telecom networks can increase attack motivations and attack vectors are multiplying. These factors are exponentially increasing the need to protect networks.

Key insights

- More advanced digitalization enabled by 5G networks is becoming an integral part of national infrastructure. As a result, threat actors are highly motivated to seek out weaknesses.
- Convergence with common IT platforms and the transformation to cloud native expands the attack surface, creating new opportunities for threat actors.
- Threat actors have shown the capability to build targeted and context-specific malware, alongside the use of various defense evasion techniques to hide their activities.
- Building a secure 5G network requires a holistic approach through standardization, development, deployment and operations.

The evolving 5G threat landscape

With the introduction of 5G and billions of new devices, the threat landscape in which telecom networks operate is evolving significantly. Networks provide vital infrastructure for business-, mission- and society-critical applications, and as a result, threat actors are motivated to constantly evolve to seek out weaknesses.

Safeguarding 5G networks

As the value and volume of personal, business sensitive and public service information increases with continued digitization, security and privacy laws and regulations have been expanding. This is a reaction to decreasing risk tolerance and the deteriorating cyber security environment.

Regulators know the importance of 5G and see safeguarding these networks as vital. The threat landscape for 5G is more complex than with previous generations due to the convergence with traditional IT, enabling IT threat actors to attack telecom networks in a similar way. In addition, networks often have new functionalities, such as network slicing for service separation and isolation, along with an increased use of AI/ML for automation. While AI is widely explored for its potential in addressing security concerns in networks, it is also important to consider the security and transparency of AI. Edge computing places cloud resources closer to the access, bringing new challenges whilst enabling mission-critical, low-latency applications.

Attacks on telecom networks are rising

Threat actors are increasingly skilled and pervasive, and attacks are becoming more frequent. Research from CrowdStrike, a US cyber security company, shows which industry verticals are most frequently impacted by targeted intrusions.[1] The data showed that, between July 2020 and June 2021, the telecom industry was the most targeted, attracting 40 percent of attacks compared to 10 percent for the next-highest industry vertical. It should be noted that the data does not distinguish between the telecom enterprise and the telecom network intrusions for the industry.

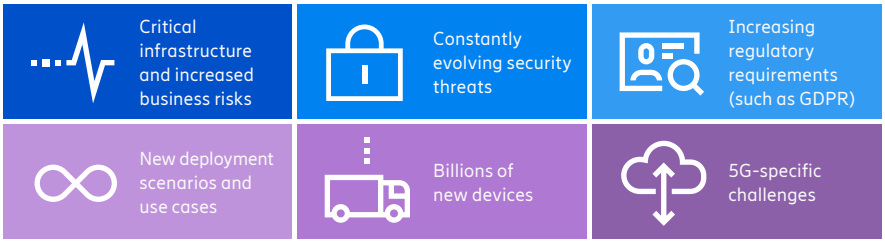
> "[5G] will empower a vast array of new and enhanced critical services, from autonomous vehicles and telemedicine to automated manufacturing and advances to traditional critical infrastructure such as smart grid electricity distribution. Given 5G's scope, the stakes for safeguarding these vital networks could not be higher."
>
> **Cybersecurity and Infrastructure Security Agency, US**

Threat actors: The motives, opportunities and capabilities

The well-known motivation, opportunity and capability model is a useful way of examining threat actor behavior. A threat actor must have all these factors to pose a risk.

Let's look at a real example: Last year, a threat activity cluster named LightBasin was publicly identified, having undertaken targeted intrusions towards service providers since at least 2016. The group has gained attention due to its presence being detected by multiple service providers, although their origin is still unconfirmed.

Figure 28: Evolving security landscape



[1] CrowdStrike, "Threat Hunting Report", (2021).

What motivates threat actors?
The main motivations to target telecom networks are surveillance/espionage, financial gain and disruption/sabotage.

In recent years, the most common type of attack in the cybersecurity landscape has been the deployment of financial gain ransomware. To achieve bigger payoffs, ransomware operators have shifted their targeting to high-profile organizations in industries such as manufacturing. Threat actors know this industry sector has a low tolerance towards downtime and is more inclined to pay out as a result. With increased use of 5G within different industry verticals' networks, the motivation to attack 5G networks should be looked at from the perspective of the related industry sector.

Personal data is also always of high interest. One objective of espionage is to obtain call metadata, especially call detail records (CDRs). This means customer billing and customer care systems are primary targets. LightBasin was observed targeting business support systems to obtain CDRs.

Disruption is the least typical of these motivations for targeting telecom networks. These attacks often have their roots in ideology, driven by personal, group or nation-state agendas. During the first quarter of 2022, a number of these attacks occurred on European networks, including targeted attacks to prevent local gamers from participating in a tournament and network-wide disruptive cyberattacks, putting critical services at risk.

Due to a shift in the tactics used by cybercrime and nation-state threat actors, and the increasing use of common IT platforms in telecoms, the likelihood of attacks has increased.

The opportunities for threat actors
New features within 5G networks bring many advantages, enabling new use cases. However, the technical complexities can create new opportunities for threat actors.

The ongoing transformation to cloud native introduces new concepts, new deployment methods and more complex partnership structures. With this trend, deployments are becoming more complex. This requires new types of competence and skill sets, from both vendors and service providers. Consequently, the risk for misconfigurations, which expose weaknesses, is increased. Vulnerabilities in virtualization, cloud services, or network slicing can have a considerable impact, as they may enable access to unauthorized resources.

Figure 29: Threat actor motivations

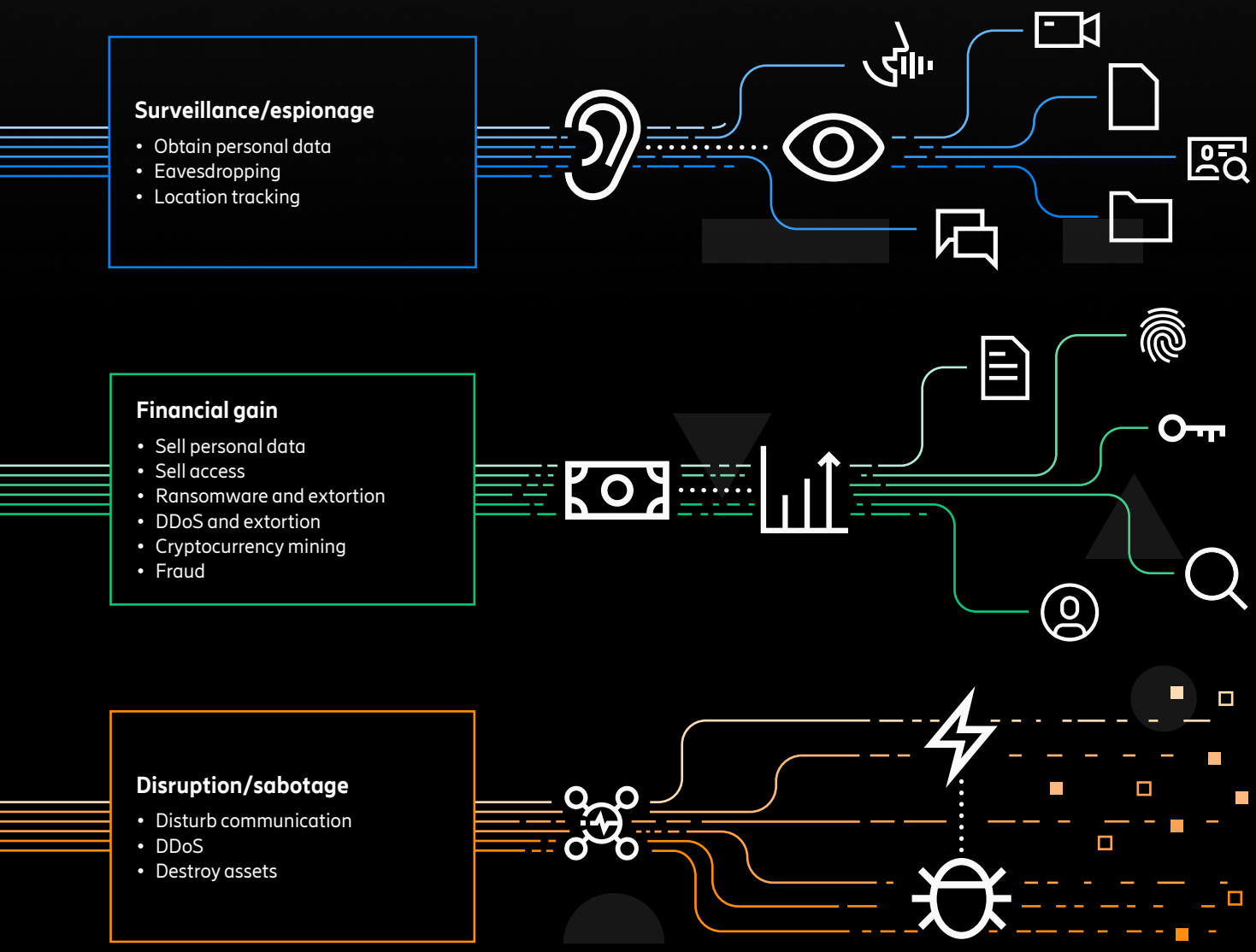
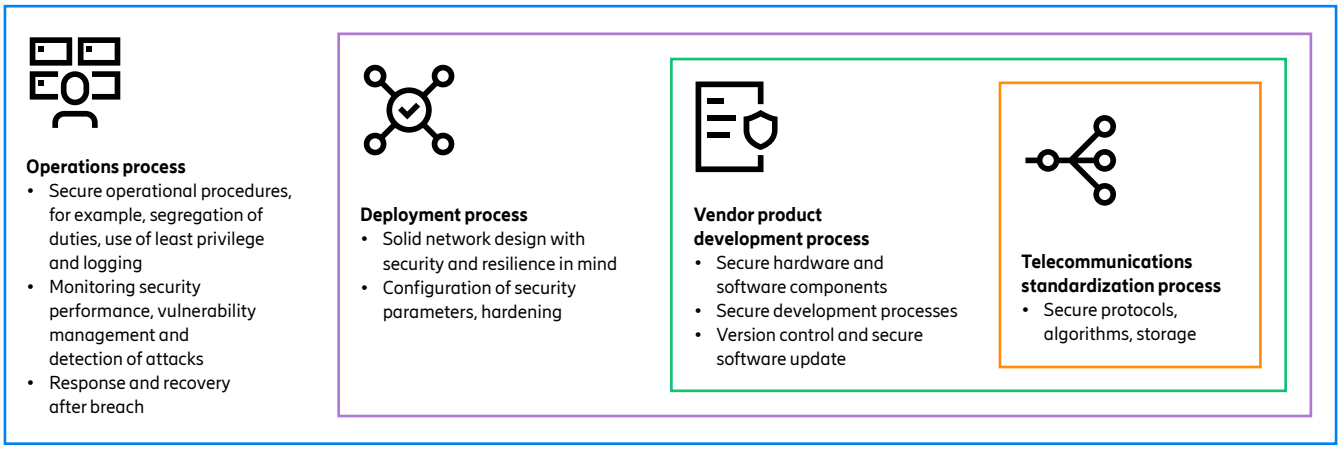


Figure 30: Protecting 5G end-users requires a holistic approach including the four key layers



5G will connect billions of devices, and not all these devices have sufficient security protection. Devices used for Industrial IoT are often optimized for a specific task, with design driven by cost efficiency. Vulnerabilities in these devices can be used to target the 5G network, or the industry vertical. This requires protection of devices to be provided from the network side. In general, any exposed interface provides an initial entry point for a threat actor. LightBasin accessed target networks via incorrectly exposed interfaces on the GPRS roaming exchange (GRX), a closed inter-service provider network.

Threat actors are increasingly using valid credentials for accessing targets. In addition to the traditional social engineering techniques for obtaining human identities, threat actors are looking for weaknesses presented by the surge of machine identities that are needed in cloud-native deployments. Strong multi-factor authentication, with management and monitoring of privileged accounts, is essential to prevent and detect account misuse. It will also limit the impact of credential theft and the exploitation of vulnerabilities.

What are the capabilities of threat actors?

Threat actors have shown the capability to build targeted and context-specific malware. Nation state threat actors routinely exhibit good operational security and use various defense evasion techniques to hide their activities, making it possible for them to move laterally in the target organization before being noticed. For instance, LightBasin carefully deleted traces in log files after their activities.

Threat actors try to blend their communication into normal traffic and use legitimate protocols, such as ICMP and HTTP. In addition to these, LightBasin used telecom-specific protocols to bypass firewalls and stay under the radar.

As the industry moves away from proprietary protocols and dedicated infrastructure, intrusion of telecom networks does not necessarily depend on extensive knowledge of these networks and their protocols. Threat actors targeting telecommunications networks will increasingly resort to routine vulnerability exploitation, supported by public availability of exploit code.

Even though 5G interconnects are more secure, older network generations will be used for several years, and attacks via interconnected interfaces will continue and will be more complex and difficult to detect as threat actors increasingly focus on defense evasion.

Trust in mobile networks is paramount

Trust in mobile networks, especially 5G, is the foundation for digitalization. To enhance trust, the GSMA Network Equipment Security Assurance Scheme (NESAS), jointly defined by 3GPP and GSMA, provides an industry-wide security assurance framework to facilitate improvements in security levels. NESAS defines security requirements and an assessment framework for secure product development and product lifecycle processes, and uses 3GPP-defined security test cases for the security evaluation of network equipment. NESAS is intended to be used alongside other mechanisms to ensure a network is secure and, in particular, to ensure an appropriate set of security policies covering the entire lifecycle of a network is in place.

3GPP standardization made major improvements in terms of security and privacy compared to 4G. 5G has been designed with new functionality that is intended to make it more resilient towards various existing frauds, subscriber privacy and eavesdropping issues, than earlier generations.

For instance, the industry is putting considerable effort into protecting the interconnect networks between the service providers, encrypting, and otherwise hiding subscriber identifiers, and preventing the modification of the user data sent between user equipment and radio base stations. 5G also provides a standardized and well-defined way to deploy zero-trust functions like authentication and authorization of API usage, and protected communication between and to the 5G network functions.

It's time for the active defense of telecom networks

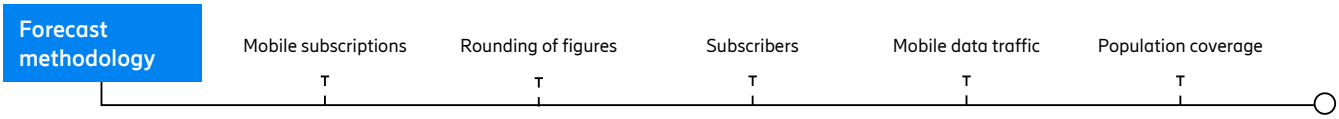
With networks being used in new contexts, connecting a greater variety of mission-critical processes, it is no longer enough to rely solely on standardized and regulatory-based security controls. Now the active defense of telecom networks is also required.

The entire industry is currently accelerating the journey from passive defense to active defense strategies. The embedded security inside network products is critical but still not enough. The telecom networks of today are built to evolve, and security must do the same.

Securing 5G networks

Telecom networks' availability and performance are more valuable than ever, which makes them attractive targets for malicious actors. Powerful security monitoring and automation, identity management, effective incident response handling and solid business continuity planning are critical to securing networks. Building a secure 5G network requires a holistic approach, rather than a focus on individual technical parts in isolation, to protect end users. Network operations is one of four key layers enabling the holistic approach, alongside standards, product development processes and network deployments.

Methodology



Forecast methodology
Ericsson makes forecasts on a regular basis to support internal decisions and planning, as well as market communications. The forecast time in the Mobility Report is six years and this moves forward one year in the November report each year. The subscription and traffic forecast baseline is established using historical data from various sources, validated with Ericsson internal data, including measurements in customer networks. Future developments are estimated based on macroeconomic trends, user trends, market maturity and technological advances. Other sources include industry analyst reports, together with internal assumptions and analyses.

Historical data may be revised if the underlying data changes – for example, if service providers report updated subscription figures.

Mobile subscriptions
Mobile subscriptions include all mobile technologies. Subscriptions are defined by the most advanced technology that the mobile phone and network are capable of. Our mobile subscriptions by technology findings divide subscriptions according to the highest-enabled technology they can be used for. LTE (4G) subscriptions, in most cases, also include the possibility for the subscription to access 3G (WCDMA/HSPA) and 2G (GSM or CDMA in some markets) networks. A 5G subscription is counted as such when associated with a device that supports New Radio as specified in 3GPP Release 15, and connected to a 5G-enabled network. Mobile broadband includes radio access technologies HSPA (3G), LTE (4G), 5G, CDMA2000 EV-DO, TD-SCDMA and Mobile WiMAX. WCDMA without HSPA and GPRS/EDGE are not included.
FWA is defined as a connection that provides broadband access through mobile network enabled customer premises equipment (CPE). This includes both indoor (desktop and window-mounted) and outdoor (rooftop and wall-mounted) CPE. It does not include portable battery-based Wi-Fi routers or dongles.

Rounding of figures
As figures are rounded, summing up data may result in slight differences from the actual totals. In tables with key figures, subscriptions have been rounded to the nearest 10th of a million. However, when used in highlights in the articles, subscriptions are usually expressed in full billions or to one decimal place. Compound annual growth rate (CAGR) is calculated on the underlying, unrounded numbers and is then rounded to the nearest full percentage figure. Traffic volumes are expressed to two significant figures.

Subscribers
There is a large difference between the numbers of subscriptions and subscribers. This is because many subscribers have several subscriptions. Reasons for this could include users lowering traffic costs by using optimized subscriptions for different types of calls, maximizing coverage and having different subscriptions for mobile PCs/tablets and mobile phones. In addition, it takes time before inactive subscriptions are removed from service provider databases. Consequently, subscription penetration can be above 100 percent, which is the case in many countries today. However, in some developing regions, it is common for several people to share one subscription, for example via a family- or community-shared phone.

Mobile network traffic
Ericsson regularly performs traffic measurements in over 100 live networks covering all major regions of the world. These measurements form a representative base for calculating worldwide total mobile network traffic. Mobile network data traffic also includes traffic generated by FWA services. More detailed measurements are made in a select number of commercial networks with the purpose of understanding how mobile data traffic evolves. No subscriber data is included in these measurements. Please note that the Ericsson Mobility Report data traffic forecast, both global and regional, represents the estimated traffic volume in all networks over the duration of a month. Traffic (in terms of throughput) in high-traffic areas will be much higher than the average traffic.

Population coverage
Population coverage is estimated using a database of regional population and territory distribution, based on population density. This is then combined with proprietary data on the installed base of radio base stations (RBS), together with estimated coverage per RBS for each of six population density categories (from metro to wilderness). Based on this, the portion of each area that is covered by a certain technology can be estimated, as well as the percentage of the population it represents. By aggregating these areas, world population coverage per technology can be calculated.

Disclaimer
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Ericsson Mobility Visualizer
Explore actual and forecast data from the Mobility Report in our interactive web application. It contains a range of data types, including mobile subscriptions, mobile broadband subscriptions, mobile data traffic, traffic per application type, VoLTE statistics, monthly data usage per device and an IoT connected device forecast. Data can be exported and charts generated for publication subject to the inclusion of an Ericsson source attribution.

Find out more
Scan the QR code, or visit
ericsson.com/mobility-visualizer

Glossary

2G: 2nd generation mobile networks (GSM, CDMA 1x)

3CC: Three component carrier

3G: 3rd generation mobile networks (WCDMA/HSPA, TD-SCDMA, CDMA EV-DO, Mobile WiMAX)

3GPP: 3rd Generation Partnership Project

4G: 4th generation mobile networks (LTE, LTE-A)

4K: In video, a horizontal display resolution of approximately 4,000 pixels. A resolution of 3840 × 2160 (4K UHD) is used in television and consumer media. In the movie projection industry, 4096 × 2160 (DCI 4K) is dominant

5G: 5th generation mobile networks (IMT-2020)

AI: Artificial intelligence

AR: Augmented reality. An interactive experience of a real-world environment whereby the objects that reside in the real world are "augmented" by computer-generated information

ARPU: Average revenue per user

CAGR: Compound annual growth rate

Cat-M1: A 3GPP standardized low-power wide-area (LPWA) cellular technology for IoT connectivity

CDMA: Code-division multiple access

dB: In radio transmission, a decibel is a logarithmic unit that can be used to sum up total signal gains or losses from a transmitter to a receiver

EB: Exabyte, 10^{18} bytes

EN-DC: EUTRA-NR Dual connectivity

FDD: Frequency division duplex

FWA: Fixed wireless access

GB: Gigabyte, 10^{9} bytes

Gbps: Gigabits per second

GHz: Gigahertz, 10^{9} hertz (unit of frequency)

GSA: Global mobile Suppliers Association

GSM: Global System for Mobile Communications

GSMA: GSM Association

HSPA: High speed packet access

Kbps: Kilobits per second

LTE: Long-Term Evolution

MB: Megabyte, 10^{6} bytes

Mbps: Megabits per second

MHz: Megahertz, 10^{6} hertz (unit of frequency)

MIMO: Multiple Input Multiple Output is the use of multiple transmitters and receivers (multiple antennas) on wireless devices for improved performance

mmWave: Millimeter waves are radio frequency waves in the extremely high frequency range (30–300GHz) with wavelengths between 10mm and 1mm. In a 5G context, millimeter waves refer to frequencies between 24 and 71GHz (the two frequency ranges 26GHz and 28GHz are included in millimeter range by convention)

Mobile broadband: Mobile data service using radio access technologies including 5G, LTE, HSPA, CDMA2000 EV-DO, Mobile WiMAX and TD-SCDMA

Mobile PC: Defined as laptop or desktop PC devices with built-in cellular modem or external USB dongle

Mobile router: A device with a cellular network connection to the internet and Wi-Fi or Ethernet connection to one or several clients (such as PCs or tablets)

MOCN: Multi-operator core network

MORAN: Multi-operator Radio Access Network

MR: Mixed reality. Immersive technology in which elements from both the real world and a virtual environment are fully interactive with each other

NB-IoT: A 3GPP standardized low-power wide-area (LPWA) cellular technology for IoT connectivity

NR: New Radio as defined by 3GPP Release 15

NR-DC: NR-NR Dual connectivity

PB: Petabyte, 10^{15} bytes

SA: Standalone

Short-range IoT: Segment that largely consists of devices connected by unlicensed radio technologies, with a typical range of up to 100 meters, such as Wi-Fi, Bluetooth and Zigbee

Sunsetting: The process of closing down older mobile technologies

TD-SCDMA: Time division-synchronous code-division multiple access

TDD: Time division duplex

VoIP: Voice over IP (Internet Protocol)

VoLTE: Voice over LTE as defined by GSMA IR.92 specification

VR: Virtual reality

WCDMA: Wideband code-division multiple access

Wide-area IoT: Segment made up of devices using cellular connections or unlicensed low-power technologies like Sigfox and LoRa

XR: Extended reality. An umbrella category for virtual or combined real/virtual environments, which includes AR, VR and MR

Key figures

Global key figures

Mobile subscriptions	2020	2021	Forecast 2027	CAGR* 2021–2027	Unit
Worldwide mobile subscriptions	7,990	8,230	9,050	2%	million
• Smartphone subscriptions	5,950	6,340	7,840	4%	million
• Mobile PC, tablet and mobile router subscriptions	260	290	540	11%	million
• Mobile broadband subscriptions	6,490	6,900	8,400	3%	million
• Mobile subscriptions, GSM/EDGE-only	1,380	1,200	510	-13%	million
• Mobile subscriptions, WCDMA/HSPA	1,700	1,530	690	-13%	million
• Mobile subscriptions, LTE	4,700	4,910	3,470	-6%	million
• Mobile subscriptions, 5G	161	550	4,370	41%	million
• Fixed wireless access connections	72	88	230	17%	million
Fixed broadband connections	**1,250**	**1,320**	**1,650**	**4%**	**million**
Mobile data traffic					
• Data traffic per smartphone	9.3	12	40	22%	GB/month
• Data traffic per mobile PC	16	17	26	7%	GB/month
• Data traffic per tablet	8.1	9.4	22	15%	GB/month
Total data traffic**					
Mobile data traffic	49	67	282	27%	EB/month
• Smartphones	48	65	276	27%	EB/month
• Mobile PCs and routers	0.5	0.6	2.4	24%	EB/month
• Tablets	1.1	1.3	4.1	21%	EB/month
Fixed wireless access	9.2	16	86	32%	EB/month
Total mobile network traffic	58	84	368	29%	EB/month
Total fixed data traffic	170	220	550	17%	EB/month

Regional key figures

Mobile subscriptions	2020	2021	Forecast 2027	CAGR* 2021–2027	Unit
North America	380	390	440	2%	million
Latin America	670	710	790	2%	million
Western Europe	510	520	530	0%	million
Central and Eastern Europe	560	570	580	0%	million
North East Asia	2,060	2,140	2,300	1%	million
China[1]	1,610	1,660	1,750	1%	million
South East Asia and Oceania	1,140	1,170	1,250	1%	million
India, Nepal and Bhutan	1,130	1,140	1,270	2%	million
Middle East and North Africa	710	740	830	2%	million
Gulf Cooperation Council (GCC)[2]	75	76	82	1%	million
Sub-Saharan Africa	830	840	1,060	4%	million

Smartphone subscriptions	2020	2021	Forecast 2027	CAGR* 2021–2027	Unit
North America	310	320	350	1%	million
Latin America	520	560	660	3%	million
Western Europe	410	410	440	1%	million
Central and Eastern Europe	390	410	440	1%	million
North East Asia	1,860	1,960	2,230	2%	million
China[1]	1,470	1,530	1,670	1%	million
South East Asia and Oceania	850	930	1,140	3%	million
India, Nepal and Bhutan	740	800	1,190	7%	million
Middle East and North Africa	420	460	620	5%	million
GCC[2]	61	63	72	2%	million
Sub-Saharan Africa	450	490	790	8%	million

Regional key figures

LTE subscriptions	2020	2021	Forecast 2027	CAGR* 2021–2027	Unit
North America	340	290	40	-28%	million
Latin America	400	470	390	-3%	million
Western Europe	390	420	90	-22%	million
Central and Eastern Europe	300	350	360	0%	million
North East Asia	1,770	1,600	560	-16%	million
China[1]	1,370	1,210	310	-20%	million
South East Asia and Oceania	470	570	580	0%	million
India, Nepal and Bhutan	690	780	700	-2%	million
Middle East and North Africa	220	270	440	9%	million
GCC[2]	60	61	12	-23%	million
Sub-Saharan Africa	128	160	300	11%	million

5G subscriptions	2020	2021	Forecast 2027	CAGR* 2021–2027	Unit
North America	14	79	400	31%	million
Latin America	1	5	270	N/A	million
Western Europe	5	31	440	56%	million
Central and Eastern Europe	0	2	190	N/A	million
North East Asia	135	410	1,710	27%	million
China[1]	117	357	1,410	26%	million
South East Asia and Oceania	3	15	570	N/A	million
India, Nepal and Bhutan	0	0	500	N/A	million
Middle East and North Africa	1	10	190	N/A	million
GCC[2]	1	6	65	47%	million
Sub-Saharan Africa	0	3	100	N/A	million

Data traffic per smartphone	2020	2021	Forecast 2027	CAGR* 2021–2027	Unit
North America	12	15	52	24%	GB/month
Latin America	5.8	7.9	34	28%	GB/month
Western Europe	11	15	52	23%	GB/month
Central and Eastern Europe	7.6	10	32	22%	GB/month
North East Asia	11	14	43	22%	GB/month
China[1]	11	14	44	22%	GB/month
South East Asia and Oceania	7.0	9.4	45	30%	GB/month
India, Nepal and Bhutan	16	20	50	16%	GB/month
Middle East and North Africa	7.5	10	45	28%	GB/month
GCC[2]	18	22	50	15%	GB/month
Sub-Saharan Africa	2.2	2.9	11	25%	GB/month

Mobile data traffic	2020	2021	Forecast 2027	CAGR* 2021–2027	Unit
North America	3.9	4.8	19	26%	EB/month
Latin America	2.5	3.7	19	31%	EB/month
Western Europe	4.2	5.8	20	24%	EB/month
Central and Eastern Europe	2.3	3.2	11	23%	EB/month
North East Asia	18	24	87	24%	EB/month
China[1]	15	20	68	23%	EB/month
South East Asia and Oceania	5.3	7.8	46	35%	EB/month
India, Nepal and Bhutan	9.5	13	49	27%	EB/month
Middle East and North Africa	2.7	4	23	34%	EB/month
GCC[2]	0.9	1.1	2.8	17%	EB/month
Sub-Saharan Africa	0.9	1.2	7.5	35%	EB/month

[1] These figures are also included in the figures for North East Asia.
[2] These figures are also included in the figures for Middle East and North Africa.

* CAGR is calculated on unrounded figures.
** Figures are rounded (see methodology) and therefore summing up of rounded data may result in slight differences from the actual total.

About Ericsson

Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans the business areas Networks, Cloud Software and Services, Enterprise Wireless Solutions, and Technologies and New Businesses. It is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's innovation investments have delivered the benefits of mobility and mobile broadband to billions of people globally. Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.

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