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Ericsson Mobility Report

November 2022

Letter from the publisher

Reducing environmental impact

The scientific evidence is clear: Climate change is proceeding at an alarming rate. Global warming needs to be limited to 1.5 C above pre-industrial levels. To achieve this, there is a need to halve global greenhouse gas (GHG) emissions by 2030 and reach Net Zero GHG emissions by 2050 at the latest. To contribute to this goal, a rapidly growing number of communications service providers and equipment vendors are committing to achieving Net Zero carbon emissions across their value chain by 2050 or earlier. The telecommunications sector has a key role to play in addressing global sustainability goals, by reducing its own emissions and enabling the digitalization of a range of services and industries. According to Ericsson research, the usage of ICT solutions in other sectors has the potential to reduce emissions by 15 percent by 2030.

One approach that reduces environmental impact, facilitating enterprises' journeys to Net Zero, is dematerialization. ICT solutions have the potential to lessen the need for material usage by substituting physical products with digital products and services, within both the ICT and other sectors. In this edition, we share some enterprise decision-makers' views on how ICT solutions and connectivity are enablers that facilitate their journey toward Net Zero. Augmented reality presents yet another significant opportunity for dematerialization, as use cases for both consumers and enterprises include substituting physical with virtual processes.

5G services have now been launched by 228 service providers, and over 700 5G smartphone models have been announced or launched commercially. We expect to approach 1 billion 5G users worldwide by the end of this year. Moreover, global mobile network data traffic is practically doubling every two years.

To reduce the environmental impact, the growing data traffic needs to be managed with smart network modernization, combined with a balanced approach to network performance and use of energy-saving functionality to break the trend of increasing energy usage in mobile networks. As described in this edition, service providers are taking actions to deploy the latest generation of energy-efficient radio hardware and software, increase the use of renewable energy sources and operate site infrastructure intelligently, for example by implementing predictive-maintenance methods on site.

We hope you find the report engaging and useful.

Fredrik Jejdling
Executive Vice President and
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Forecasts

By the end of 2022, 5G subscriptions are expected to reach 1 billion, and more smart 5G devices with additional capabilities are expected in the market during 2023. Our outlook for 2028 is that 5G subscriptions will pass 5 billion and Fixed Wireless Access (FWA) connections will reach 300 million, where 5G will account for almost 80 percent of FWA connections. Taking a global view, 5G is live in all regions, but how service providers are choosing to roll out varies, depending on many local factors. 5G mid-band population coverage for example, which is essential for an optimal 5G service offering and user experience, is deployed at different paces in different markets. It has reached 25 percent population coverage globally, but front-runner markets like the US have already reached 80 percent.

FWA is growing strong, with 300 million connections projected in 2028.

300m

Average data consumption per smartphone is expected to exceed 19 GB per month in 2023.

19GB

5G mobile subscriptions are forecast to reach 5 billion in 2028.

5bn

Video is expected to account for 80 percent of global mobile network traffic in 2028.

80%

5G mobile subscriptions to reach 5 billion in 2028

By the end of 2022, 5G subscriptions are expected to reach 1 billion.

Despite a weaker economy and geopolitical uncertainties, service providers continue to deploy 5G, with 228 having already launched commercial 5G services globally. Deployment of 5G standalone (SA) networks also continues, with around 35 service providers having deployed or launched 5G SA in public networks.[1] The most common 5G services launched by service providers for consumers are enhanced mobile broadband (eMBB), Fixed Wireless Access (FWA), gaming and some AR/VR-based services.

Strong 5G subscription growth

5G subscriptions[2] grew by 110 million during the third quarter to around 870 million, and that number is expected to reach 1 billion by the end of 2022. North America and North East Asia are expected to have the highest 5G subscription penetration by the end of 2022 at around 35 percent, followed by the Gulf Cooperation Council countries at 20 percent and Western Europe at 11 percent. In 2028, it is projected that North America will have the highest 5G penetration at 91 percent, followed by Western Europe at 88 percent.

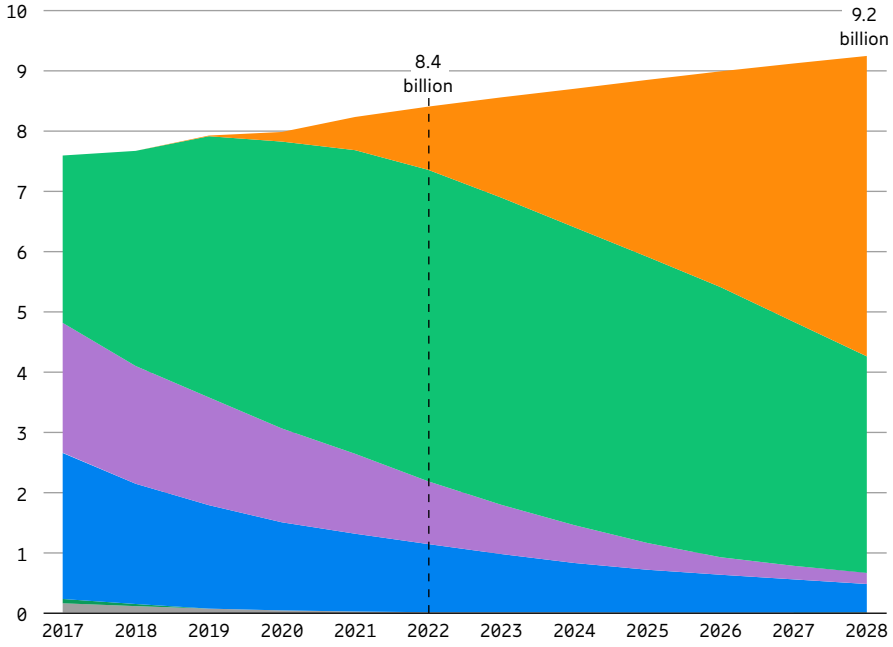
By the end of 2028, 5 billion 5G subscriptions are forecast globally, accounting for 55 percent of all mobile subscriptions. 5G subscription uptake is faster than that of 4G following its launch in 2009, with 5G expected to reach 1 billion subscriptions 2 years sooner than 4G. Key factors include the timely availability of devices from several vendors, with prices falling faster than for 4G, and 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 41 million during Q3 2022 to around 5 billion. 4G subscriptions are projected to peak at 5.2 billion by the end of 2022, then decline to around 3.6 billion by the end of 2028 as subscribers migrate to 5G.

During the quarter, 3G subscriptions declined by 41 million, while GSM/EDGE-only subscriptions dropped by 44 million and other technologies[3] decreased by about 6 million.

During the quarter, China had the most net additions (+15 million), followed by Nigeria (+5 million) and Indonesia (+4 million).

Figure 1: Mobile subscriptions by technology (billion)

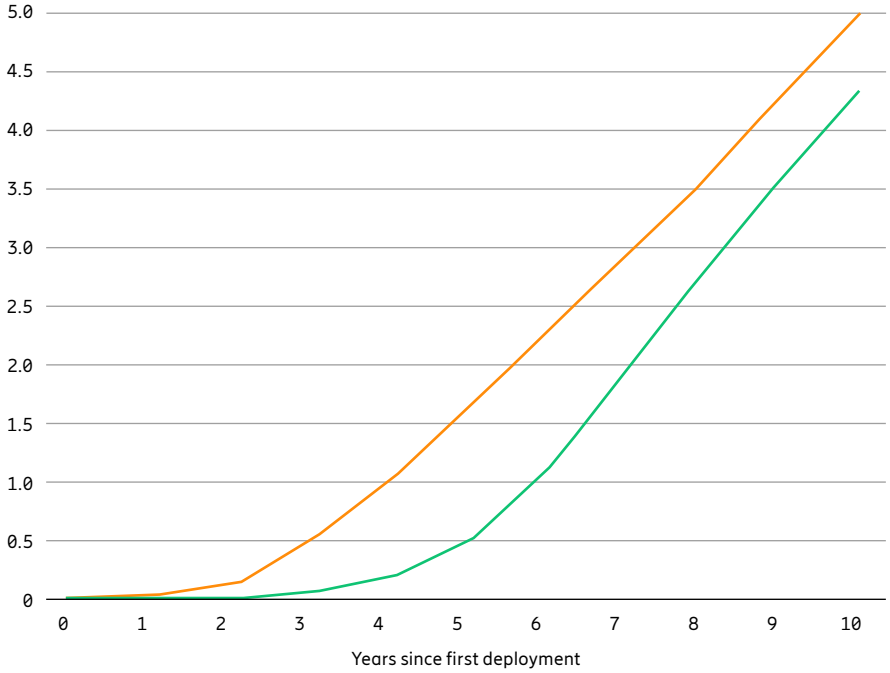


5G subscriptions are forecast to reach 5 billion in 2028.

5bn

[1] GSA (November 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 (2018–2028)
4G (2009–2019)

Mobile broadband dominates mobile subscriptions

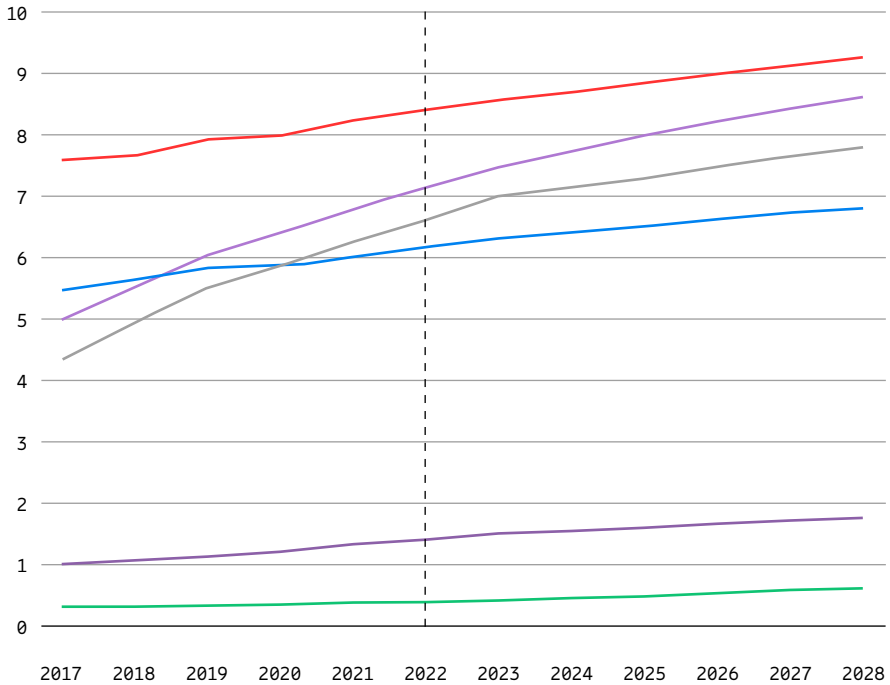
Around 8.4 billion mobile subscriptions are estimated by the end of 2022, and this figure is projected to increase to around 9.2 billion by the end of 2028. During this time, the share of mobile broadband subscriptions will increase from 85 to 93 percent, while the number of unique mobile subscribers is projected to grow from 6.1 to 6.8 billion.

Subscriptions associated with smartphones continue to rise. At the end of 2022, 6.6 billion smartphone subscriptions are estimated, accounting for about 79 percent of all mobile phone subscriptions. This is forecast to reach 7.8 billion in 2028, accounting for around 84 percent of all mobile subscriptions.

The FWA connection forecast has been increased in anticipation of strong growth of 19 percent annually through 2028, reflecting accelerated FWA plans in India.

Subscriptions for mobile PCs, tablets and routers are expected to show moderate growth, reaching around 680 million in 2028. Subscriptions for fixed broadband are expected to grow by around 4 percent annually through to 2028.[4]

Figure 3: Subscriptions and subscribers (billion)



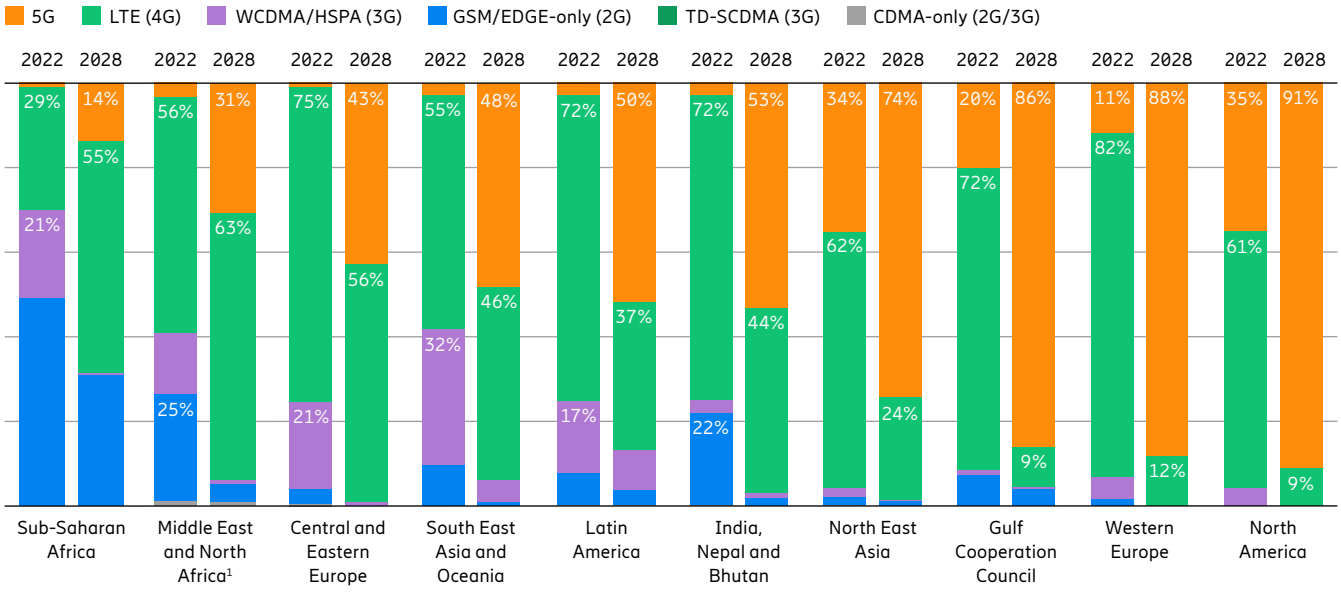
Mobile subscriptions
Mobile broadband subscriptions
Smartphone subscriptions
Mobile subscribers
Fixed broadband subscriptions
Mobile PC and tablet subscriptions

[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

Uptake is strong in North America and North East Asia, with both of these regions set to reach 5G subscription penetration of around 35 percent by the end of 2022.

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



Sub-Saharan Africa

Despite economic challenges, the Sub-Saharan Africa region's economy is projected to be one of the fastest growing regions globally, sustaining growth in the telecom industry.[2] With the COVID-19 pandemic becoming a lesser concern, network investments are shifting focus from reliable connectivity for social and economic sustenance, to increasing coverage and capacity, especially for mobile broadband connections.

2G connections are still accounting for about half of the total subscriptions but these are projected to decline as service providers migrate subscribers from legacy to 4G and 5G networks. 4G will be the main contributor to new connections up to 2028, accounting for more than half of all mobile subscriptions at that time.

Despite its early stage, the 5G journey has begun in Sub-Saharan Africa in the more mature markets such as South Africa, Nigeria and Kenya. 5G subscriptions are projected to constitute around 14 percent of all mobile subscriptions by the end of 2028.

Middle East and North Africa

Service providers' investment in 4G is expected to result in over 60 percent of subscriptions in the region being 4G in 2028. Similarly to Sub-Saharan Africa, service providers are migrating their subscribers from legacy networks, and the growth in 4G and 5G will continue at pace.

5G is forecast to be the strongest-growing segment as service providers explore various service offerings requiring high bandwidth and low latency.

Additionally, availability of a wide range of 5G devices at attractive price points will drive uptake of 5G subscriptions. By the end of 2028, there will be around 270 million 5G subscriptions forecast in the region, accounting for 31 percent of total mobile subscriptions.

Mobile financial services continue to gain momentum as mobile connectivity rises, with service providers extending their propositions from basic transfers and merchant payments to remittances, insurance and other more sophisticated services. An additional driver for growth has been a decisive shift to digital payments in many markets as a result of the COVID-19 pandemic.

[1] All Middle East and North Africa figures include GCC countries.
[2] International Monetary Fund, World Economic Outlook Report, "Countering the cost of living crisis" (October 2022).

Gulf Cooperation Council (GCC)
With overall subscription growth expected to be flat over the next six years, GCC markets are among the global leaders in 5G network deployments and service offerings. The increased vigorous competition combined with the right regulatory environment have contributed to the fast acceleration of the 5G market.

4G currently accounts for the majority of subscriptions, at 72 percent, with 5G at 20 percent of the total. 5G subscriptions are projected to grow steadily at an average annual rate of 30 percent, from 15 to 71 million up to the end of 2028, accounting for 86 percent of total connections at that time.

In addition to current 5G offerings focusing on the consumer market, service providers are increasingly building on B2B opportunities, as major digital transformation projects take place across various sectors. This is emerging as the next frontier of growth for service providers. Several service providers in the region are embracing investments in energy-efficient networks.

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, expected to account for 75 percent of all subscriptions at the end of 2022. Mobile subscription growth has flattened and is expected to be virtually zero in the coming years. However, the migration from 2G/3G to 4G continues to look strong up to 2024. From 2025, 5G is expected to be the only growing subscription type.

During the forecast period, there will continue to be a significant decline in 3G subscriptions, from 21 percent of mobile subscriptions to just 1 percent.

South East Asia and Oceania
By the end of 2028, it is expected that most major service providers across the region will have launched commercial 5G services. Many service providers are shutting down — or have plans to shut down — 2G and 3G services, in order to re-farm spectrum for 4G and 5G networks. 5G subscriptions are anticipated to reach around 620 million by the end of the forecast period, meaning 5G will become the leading technology in terms of subscriptions, with a penetration of 48 percent.

Innovations in 5G technology and go-to-market models continue to be seen in the region. In Singapore, where 5G standalone (SA) services are already being provided in the 3.5 GHz spectrum, a variety of mobile offerings designed to drive subscribers' appetite for 5G have been put in place, including bundles with video streaming and cloud gaming services. Singapore is the first country in the world to reach 95 percent 5G SA coverage. Australia has also seen several service providers launch 5G SA networks.

Malaysia continues to develop its unique approach for 5G rollout. The government-established Digital Nasional Berhad (DNB) is a Single Wholesale Network provider leasing 5G access to service providers. DNB aims to build-out 80 percent of 5G population coverage by the end of 2024.

Latin America
4G is currently the dominant radio access technology in the region, accounting for 72 percent of all subscriptions at the end of 2022. 4G subscription growth is strong, with more than 56 million added during 2022. However, 3G subscriptions are 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 radio spectrum for 4G deployments.

Commercial 5G has been launched in more than 10 countries. Service providers are accelerating 5G deployments in mid-band (3.5 GHz) and low-band to stimulate 5G subscription uptake. Around 19 million 5G subscriptions are expected at the end of 2022, and more substantial uptake is expected from 2023 onwards. By the end of 2028, 5G will account for 50 percent of all mobile subscriptions.

India, Nepal and Bhutan
In early October, service providers in India announced the launch of commercial 5G services. Initially, enhanced mobile broadband (eMBB) will be the main use case in India. Meanwhile 4G continues to be the dominant subscription type driving connectivity growth. 4G subscriptions are expected to peak in India in 2024 at around 930 million, and from there will decline to an estimated 570 million by the year 2028.

Aggressive 5G deployments by service providers, coupled with growing affordability and availability of 5G smartphones, should see 5G subscriptions in the India region reach around 31 million by the end of 2022 and 690 million by the end of 2028. 5G will represent around 53 percent of mobile subscriptions in the region at the end of 2028. Total mobile subscriptions in India are estimated to grow to 1.3 billion in 2028.

North East Asia
Service providers continue to invest strongly in 5G to improve coverage and capacity, with a focus on indoor coverage. In 2022, strong 5G subscription growth has continued, adding around 320 million subscriptions. 5G is the only growing subscription type and is expected to reach 1 billion in the region 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 mainland China, Taiwan and South Korea, have reported a positive impact of 5G subscribers on service revenues and ARPU.

Western Europe
4G is widely deployed and is expected to have the highest penetration of all regions at 82 percent by the end of 2022. 5G subscription growth has been strong during the year, rising from 32 million in 2021 to 63 million by the end of 2022.

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 88 percent by the end of 2028. 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 is in the second wave of build-outs and user adoption. The addition of mid-band spectrums now enables superior multi-band 5G experiences for many users. In 2022, 5G adoption continued to grow strongly, with more than 140 million subscriptions expected by the year-end. High-speed internet access to homes and small businesses with Fixed Wireless Access has become the primary technology fueling fixed broadband growth in North America. 5G is also growing in the enterprise segment with wireless WAN to branch office locations and to serve ultra-mobile professions. By 2028, around 420 million 5G subscriptions are expected, accounting for over 90 percent of mobile subscriptions.

5G in South East Asia and Oceania: A closer look

Although each country in the region is at a different stage of their 5G journey, 5G is growing strongly, with the regional number of 5G subscriptions expected to reach close to 30 million in 2022.

The South East Asia region

The South East Asia region – synonymous with the 10-country regional economic bloc, Association of Southeast Asian Nations (ASEAN) – is one of the most vibrant economic regions. It has witnessed an accelerated pace of digitalization since the outbreak of the COVID-19 pandemic. Indonesia, the Philippines, Vietnam, Thailand, Malaysia and Singapore have been the main drivers of digital adoption in the region. Growing 4G mobile broadband uptake has been a key factor in digital acceleration. Including Oceania, service providers are expected to add almost 90 million 4G subscriptions in 2022, with this strong growth to continue in 2023.

Rising consumer adoption of digital technologies and services is also driving technology-led industry transformation, and not just for large enterprises; small and medium enterprises have also been adopting digital technologies to align themselves with the shift in consumer behavior. A key factor in this accelerated digital adoption has been the digitalization action plans and frameworks launched by governments in the region. ASEAN has also taken multiple initiatives[1] to facilitate digitalization in its member countries. It has identified accelerating inclusive digital transformation as one of five broad strategies to boost the economy and improve society in the post-COVID-19 world. Recently, ASEAN articulated its strategy on how it intends to transform the region's economy and society through the fourth industrial revolution, or Industry 4.0. The strategy emphasizes the role of 5G as the key enabler of the digital infrastructure needed for Industry 4.0.[2]

The Oceania region

In Australia, COVID-19 accelerated the consumer shift toward digital technologies. Australians have embraced digital health, payments and ecommerce in a significant way over the past two years. The same is true of neighboring New Zealand, which has also witnessed accelerated consumer adoption of digital services in the past two years.

Enterprises in Australian sectors like health, education, mining and finance have been making significant investments in digital transformation. For instance, mining and metals companies have been investing in operational automation to improve productivity and safety. Australian mining companies that have also been pioneers in deploying private LTE networks in mines, are now keen to deploy private 5G networks. Similarly, post-COVID-19, Australian financial service companies have scaled up investments in online platforms and apps.

The Australian Government considers 5G to be a key enabler for digitalizing the economy and a driver of productivity growth. A focus on early and timely availability of spectrum has been key to the fast rollout of 5G networks, positioning Australia as a global leader in the deployment of 5G.

5G in South East Asia and Oceania

The region represents diversity when it comes to 5G evolution. Seven countries in the region – Australia, Indonesia, Malaysia, New Zealand, the Philippines, Singapore and Thailand – have commercially launched 5G. Service providers in Vietnam, the only prominent ASEAN nation yet to commercially launch 5G, have been conducting 5G commercial trials since 2019. While service providers in countries like Australia, Thailand and Singapore have achieved significant population coverage and network performance, those in the Philippines and Indonesia are at an early stage of 5G evolution.

5G is changing the connectivity landscape in Australia

With the launch of 5G enhanced mobile broadband (eMBB) and FWA, the connectivity landscape in Australia has changed in the past three years, with consumers seeking to upgrade to higher speeds to support their needs in areas such as entertainment and remote work. 5G now covers 80 percent of the Australian population.[3] Australian service providers have been at the forefront of launching 5G FWA to serve both residential households and enterprises. Australia has also witnessed the launch of 5G-enabled enhanced wireless solutions for enterprises, providing business-grade fixed wireless connectivity with added service-level agreements and managed services to connect to dedicated enhanced infrastructure. Even though a large share of the population is yet to switch to 5G, as the first country to launch 5G in the southern hemisphere, Australia is still ahead of many other markets in 5G adoption, with an estimated 5G mobile subscriber penetration of 30 percent by the end of 2022.

Australian service providers have deployed some of the world's most advanced 5G networks and achieved several world-first innovations. These innovations are focused on new product and solution development to maximize the use of available spectrum resources, helping service providers expand their 5G coverage and increase capacity and speed cost effectively.

[1] ASEAN, The Bandar Seri Begawan Roadmap.
[2] ASEAN, Consolidated Strategy on the Fourth Industrial Revolution for ASEAN (2021).
[3] www.telstra.com.au/5g

Examples of innovation include:

- use of carrier aggregation to stack 8 contiguous carriers of 100 MHz to deliver record peak download rates
- world record 5G standalone (SA) extended cell range (longest distance 5G data call) at 113 km
- the world's first deployment of multiple radio access technologies (4G, 5G, Cat-M, and NB-IoT) on one radio using spectrum sharing
- the first NB-IoT and spectrum sharing between 5G and 4G on the 700 MHz spectrum layer

Indonesia: An early stage of development
5G has been available in key Indonesian cities since 2021. The leading Indonesian service providers launched commercial 5G services using their existing spectrum holdings such as 1,800 MHz, 2,100 MHz and 2,300 MHz. However, the 5G network rollout has been slow due to a lack of adequate mid-band spectrum. New 5G spectrum bands (700 MHz, 2.6 GHz, 3.5 GHz and 26 GHz) will likely be made available to service providers from 2023.

Malaysia: Accelerating nationwide 5G
Malaysia is rolling out 5G via a single wholesale network with the aim to fast-track 5G deployment and accelerate the benefits of 5G for the country. Digital Nasional Berhad (DNB) is the special-purpose vehicle tasked with rolling out the nationwide 5G network, and aims to cover 40 percent of Malaysia's population with 5G by the end of 2022 and 80 percent by 2024. Five Malaysian service providers have commenced offering 5G services.

New Zealand: Focus on eMBB and FWA
New Zealand was one of the first countries in the region to commercially launch 5G in December 2019. Since then, all three service providers in New Zealand have launched 5G. These service providers have also launched 5G FWA targeting both residential and business users. New Zealand service providers are targeting 90 percent population coverage by 2023.

The Philippines: Making inroads with FWA
The Philippines was the first country in the region to launch 5G FWA in 2019. Mobile 5G was commercially launched in 2020. The country's 2 leading service providers have launched 5G in the 3.5 GHz band. A third service provider has launched a 5G FWA home broadband service.

Singapore: Nationwide 5G SA network
Singapore recently covered 95 percent[5] of the country with 5G SA. All three service providers in Singapore have launched 5G SA networks. Singapore service providers are focusing on developing innovative services for enterprises with proactive support from the government and the regulator.

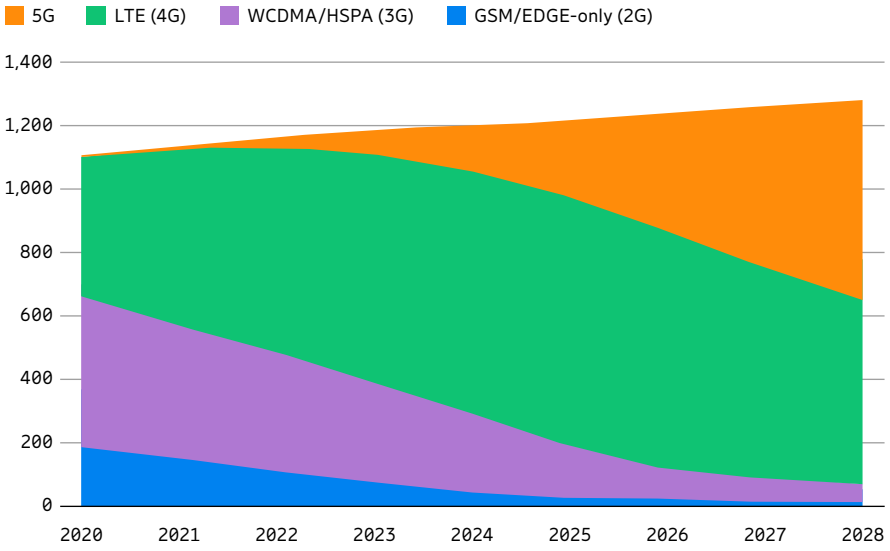
Thailand: Rapid network roll-out
Thailand was one of the first countries in South East Asia to launch 5G. Thai service providers have been quick to roll out 5G coverage across the country and 5G now covers more than 80 percent of the Thai population.[6] Around 7.3 million subscribers of the 2 leading service providers were using 5G at the end of Q2, 2022. Both service providers have attributed recent revenue growth and subscriber net additions to 5G.

Vietnam: Commercial trials ongoing
5G services have not yet been officially launched in Vietnam, although most service providers have carried out commercial trials across several bands. Three service providers have tested 5G services in main provinces and cities across the country. New 5G spectrum bands are expected to be available to service providers in 2023 and 2024.

Singapore has reached 95 percent 5G SA population coverage.

95%

Figure 5: South East Asia and Oceania region mobile subscriptions by technology (million)



The number of 5G subscriptions in the region is projected to reach almost 30 million in 2022.

30m

[4] www.digital-nasional.com.my/about-us
[5] www.singtel.com/about-us/media-centre/news-releases/singtel-5g-network-surpasses-95--nationwide-coverage
[6] AIS, Advanced Info Service PLC. 2Q22 Financial Results (8 August 2022).

Australia is leading in the region from a 5G perspective, with 30 percent 5G subscriber penetration in 2022.

30%

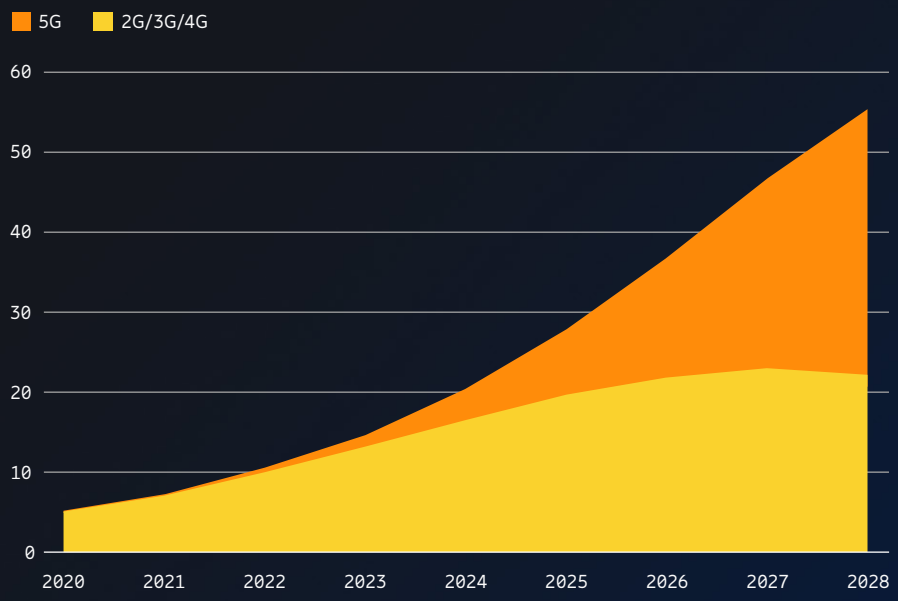
5G outlook

5G subscriptions in South East Asia and Oceania are expected to reach almost 30 million by the end of 2022. As service providers speed up 5G network coverage deployment over the next few years, 5G mobile subscriptions are expected to grow at a CAGR of 67 percent over the forecast period. The region is forecast to have around 620 million 5G subscriptions by the end of 2028, overtaking 4G. The expansion of 5G coverage and the launch of new offerings and use cases are expected to drive incremental revenue growth for service providers in the region.

Mobile service providers in South East Asia and Oceania have the potential to generate around USD 40 billion in additional revenue from offering 5G services to enterprises by 2030.[7] Much of this growth is expected to come from the adoption of 5G in industries like manufacturing, energy and utilities, financial services, healthcare, and media and entertainment. On the consumer front, 5G is already driving changes in usage behavior. 5G users in countries like Australia, Thailand and Singapore engage with immersive digital services such as cloud gaming, 360-degree videos, AR apps, and virtual events and concerts more frequently than 4G users.

5G adoption and growing consumer usage of new immersive services are key factors for growing mobile data usage in the region; mobile traffic per smartphone is expected to reach around 54 GB per month in 2028, a CAGR of almost 30 percent. Total mobile data traffic is expected to grow by a factor of 5 between 2022 and 2028.

Figure 6: South East Asia and Oceania region mobile data traffic (EB per month)



Total mobile data traffic in the region is forecast to grow by a factor of 5 by 2028.

5x

[7] Ericsson, 5G for business: a 2030 market compass (October 2019).

Broadband IoT (4G/5G) connections to dominate by end of 2028

LTE Cat-1 devices are increasingly being used for a variety of use cases.

The Massive IoT technologies NB-IoT and Cat-M – supporting wide-area use cases involving large numbers of low-complexity, low-cost devices with long battery life and low-to-medium throughput – continue to be rolled out around the world. Globally, 124 service providers have deployed or commercially launched NB-IoT networks and 57 have launched Cat-M, while 56 have deployed both technologies.[1] The number of devices connected by these technologies grew strongly in 2021 and is expected to reach almost 500 million by the end of 2022. The growth of Massive IoT technologies is enhanced by added capabilities in the networks, enabling Massive IoT co-existence with 4G and 5G in FDD bands, via spectrum sharing.

IoT devices connected via 2G and 3G have been in slow decline since 2019, and have a negative annual growth rate of around 15 percent up to 2028, as the rate of switch-off for both technologies, especially 3G, continues to increase in the coming years.

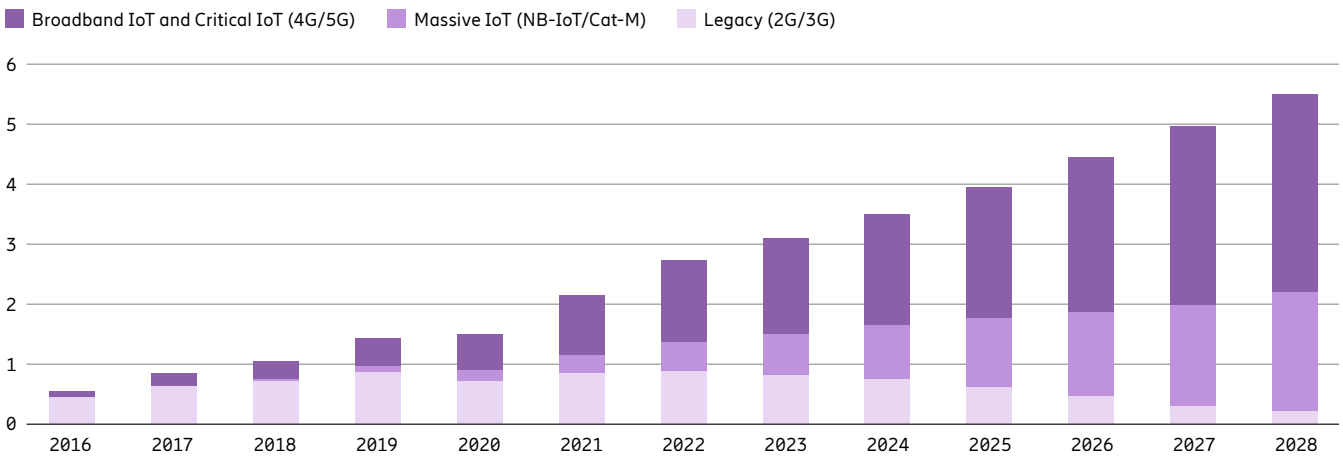
In 2021, broadband IoT (4G/5G) reached 1 billion connections, overtaking 2G and 3G as the technology that connects the largest share of all cellular IoT devices. This segment mainly includes wide-area use cases that require higher throughput, lower latency and larger data volumes than can be supported by Massive IoT devices. LTE Cat-1 devices, which support 10 Mbps downlink and 5 Mbps uplink speeds are increasingly being used for a variety of use cases. Hence, our forecast for the broadband IoT segment has been adjusted upwards. By the end of 2028, almost 60 percent of cellular IoT connections are forecast to 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, expected to pass 2 billion connections in 2023.

Figure 7: IoT connections (billion)

IoT	2022	2028	CAGR
Wide-area IoT	2.9	6.0	13%
Cellular IoT[2]	2.7	5.5	12%
Short-range IoT	10.3	28.7	19%
Total	**13.2**	**34.7**	**18%**

Figure 8: Cellular IoT connections by segment and technology (billion)



[1] Source: GSA September 2022.
[2] These figures are also included in the figures for wide-area IoT.

Over 300 million FWA connections by 2028

More than three-quarters of service providers surveyed in over 100 countries are now offering Fixed Wireless Access (FWA) services. Nearly one-third of service providers are now offering it over 5G, compared to one-fifth a year ago.

Almost one-third of service providers now offering 5G FWA

An updated Ericsson study[1] of retail packages offered by service providers shows that, out of 310 service providers studied worldwide, 238 (or 77 percent) had an FWA offering. During the last 12 months, the number of service providers offering 5G FWA services has increased from 57 (19 percent) to 88 (29 percent).

5G FWA arrives in emerging markets in 2022

Almost 40 percent of the new 5G FWA launches in the past 12 months have been in emerging markets. 5G FWA has arrived in populous countries such as Mexico, South Africa, Nigeria and the Philippines.

In addition, following the 5G spectrum auction in India in July, a major service provider has expressed a goal to serve 100 million homes and millions of businesses with 5G FWA services.

Figure 9: Global number of service providers offering FWA

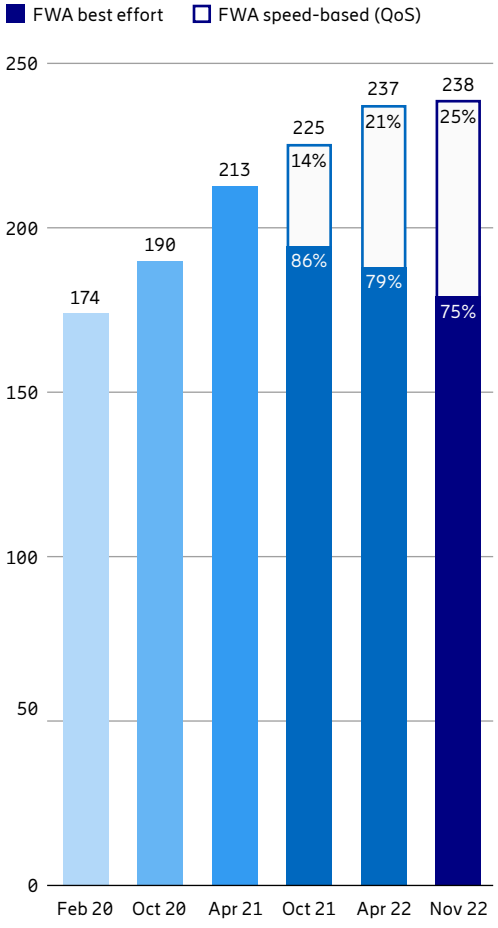
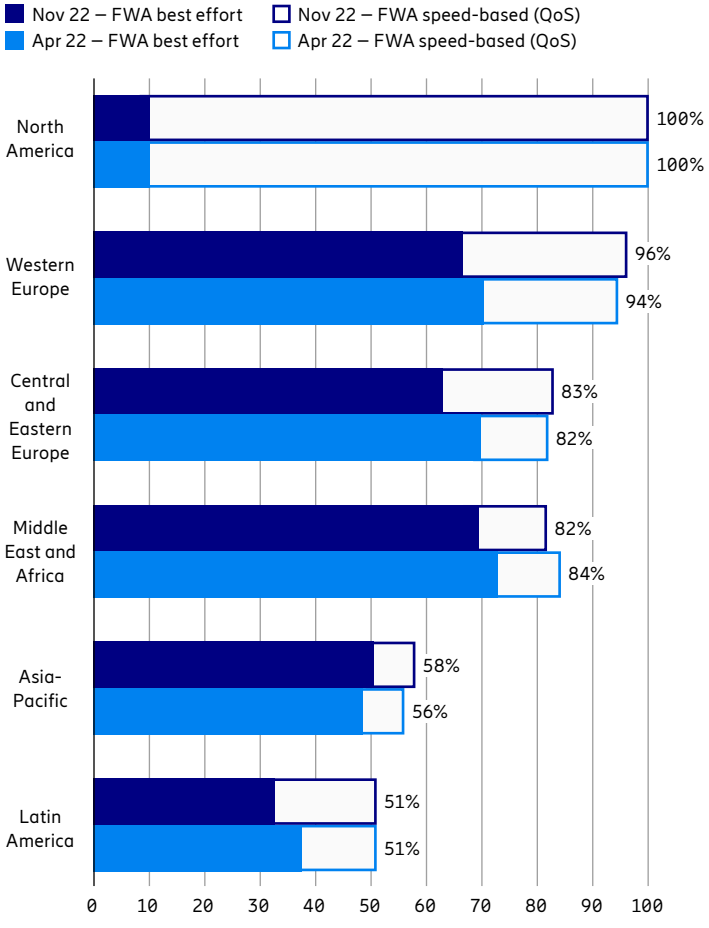
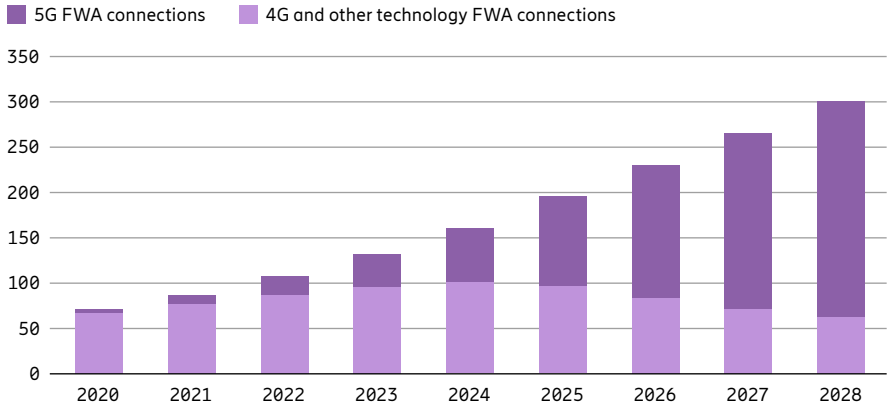


Figure 10: Regional percentage of service providers offering FWA



[1] Adjusted for revised service provider base.

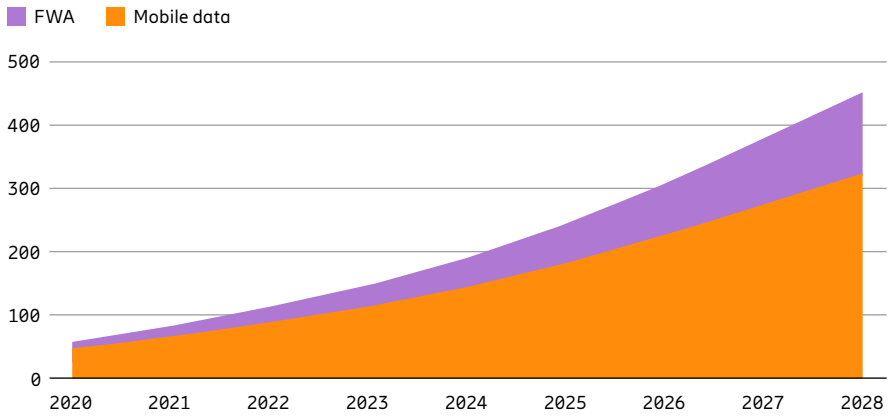
Figure 11: FWA connections (millions)



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 12: Global mobile network data traffic (EB per month)



Speed-based tariff plans doubled in the past 12 months

Most FWA offerings (75 percent) are still best effort, with volume-based tariff plans (that is, buckets of GB per month). About 25 percent of service providers offer speed-based tariff plans (also referred to as quality of service, or QoS), which is twice as many compared to a year ago.

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 35 percent of these speed-based offerings are basic, with average/typical speeds being advertised. Almost 65 percent are more advanced offerings, involving speed tiers, such as 100 Mbps, 300 Mbps and 500 Mbps. Service providers with 5G FWA are more likely to have QoS FWA with speed-based offerings, with 42 out of 88 utilizing this approach (48 percent). Speed-based offerings are growing across all regions, but there are large variations. In North America, 90 percent of offerings are speed based, while the Asia-Pacific and Middle East and Africa regions have below 15 percent.

FWA set to reach 300 million connections by 2028

There will be more than 100 million FWA connections estimated by the end of 2022. This number is projected to triple by 2028, reaching over 300 million. This figure represents 17 percent of fixed broadband connections. Of these over 300 million connections, the number of 5G FWA connections is expected to grow to around 235 million by 2028, representing almost 80 percent of the total FWA connections.

The forecast has been adjusted to include the high ambitions of 5G FWA in emerging markets, increasing the number of connections as well as the share of 5G FWA connections. Higher volumes of 5G FWA in large high-growth countries such as India have the potential to drive economies of scale for the overall 5G FWA ecosystem, resulting in affordable CPE that will have a positive impact across low-income markets.

FWA data traffic projected to grow by almost five times

FWA data traffic represented 21 percent of global mobile network data traffic by the end of 2022, and is projected to grow more than 5 times to reach almost 130 EB in 2028.

By 2028, 5G will account for almost 80 percent of FWA connections.

80%

Today, 25 percent of service providers apply differential pricing with speed-based tariff plans.

25%

Mobile service packaging trends

On a global scale, the types of service packages remain similar. However, a closer look reveals subtle differences in how offerings are packaged.

Key insights

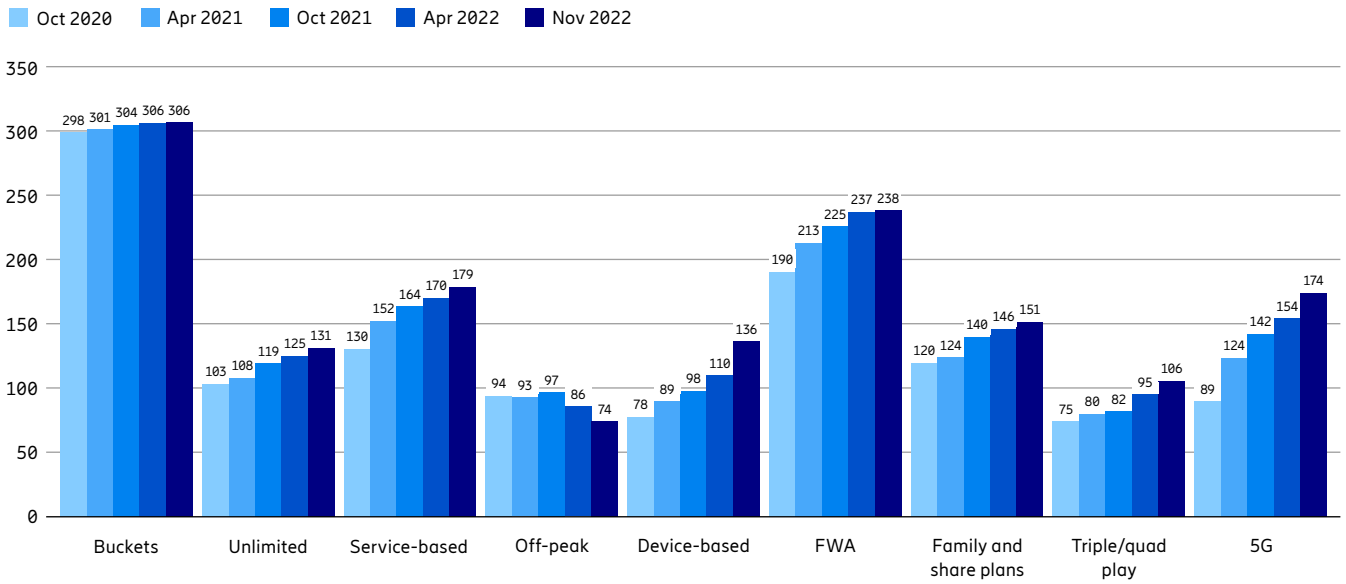
- In order to motivate consumers to move up through the tiers, 24 percent of 5G service providers now use data speed together with volume-based and unlimited subscriptions.
- Service-based connectivity packs are offered by 58 percent of all surveyed service providers.
- Of the surveyed service providers, 25 percent charge a price premium, compared to 4G offerings, with an average price premium of around 40 percent.

A November 2022 update of an Ericsson study of retail packages offered by 310 mobile service providers worldwide shows that, although the type of service packaging remains quite similar globally, there are subtle changes in the way offerings are packaged. In the past months, many service providers have made notable design changes on their websites. Most are cosmetic, for example changing fonts, color schemes and restructuring the layout, but there is also a lot of promotion activity, especially time-limited discounted offers. A more significant change, which is likely designed to create some stability for the service provider during these uncertain times, is a move toward long-term contracts on SIM-only plans. This is common practice when plans include a device, but it is now being pushed by a large number of service providers in several regions on their SIM-only plans.

In most cases the websites show these plans with a preselected 12, 24 or even 36-month contract, usually with a small discount vs. the monthly contract. In some cases, service providers have added annual price adjustments of 4–5 percent to the contract terms.

Data buckets remain the default offerings for nearly all service providers. A common approach is to complement with "service-based connectivity packs" or an unlimited option at the premium end. About 43 percent of all service providers surveyed offer unlimited data under their premium packages. There is also a little shifting back and forth in this area, where nine service providers have removed their unlimited offerings completely since the previous survey, four of which have 5G services. At the same time there are 17 who have started to offer unlimited – most of these (11) are still on 4G. The net result is an increase of eight service providers with unlimited offerings.

Figure 13: Number of service providers per type of offering



Boundary conditions, such as not allowing tethering or limiting the use of IoT devices, is still common with unlimited offerings, but a lower percentage of service providers now apply these: 77 percent vs. 90 percent previously. One reason for this change may be the introduction of speed tiers which have become more common. In a lot of cases, speed for the unlimited offerings is set at a (for 5G) very low level, from a few Mbps up to 10 or 20 Mbps in some cases. This moves a part of the boundary condition to the actual offering and keeps the potential traffic levels somewhat in check.

The total number of service providers offering any type of service-based connectivity is 179. The number of service providers targeting data-intense services like video streaming, gaming or music streaming, has decreased to 120. These packs are still mainly sold as add-ons often found under a separate "tab" on the web site. Integrating them into the "customer journey" as a part of the process of selecting a subscription is still a rare practice.

The specific type of service-based connectivity pack that arrived during the pandemic, often called "work and education packs", remains as an offering. These packs typically offer 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 somewhat lower income levels, mostly in South East Asia and Eastern Europe.

Extracting premium rates for 5G

The number of networks that offer 5G continues to increase and around 55 percent of the service providers surveyed have now launched 5G for smartphones. Of these, there are 25 percent who charge a premium for 5G, over their 4G service, with an average price premium of around 40 percent.

Using speed tiers to segment offerings

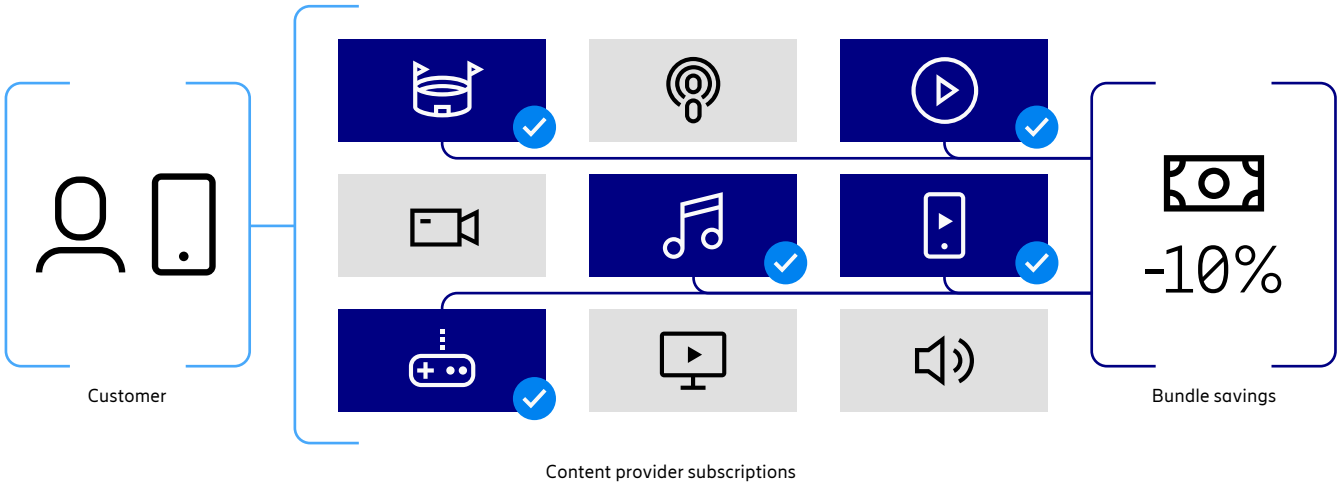
In our April 2022 updated study, it was found that 18 percent of 5G service providers used speed tiers for smartphones as a parameter for price differentiation. This pricing strategy is gaining momentum, and now 24 percent of those with a 5G offering use it to segment the market and motivate consumers to move up to higher-priced tiers. Around 74 percent of these service providers use speed tiers in combination with data buckets and 45 percent have a hybrid version (speed in combination with both buckets and unlimited data tiers). Four service providers with only 4G offerings use this practice as well.

As more and more service providers add speed tiers, the variation on the theme increases. The simplest form, where higher speed renders a higher price, is probably the most common. In many other cases the consumer can choose similarly priced packages with a higher speed and limited data allowance, lower speed coupled with a higher amount of data, or completely unlimited traffic. The speeds are not always clearly advertised, especially in the markets where rather low speeds are being offered with certain packages. In those markets, the higher-speed packages are simply announced as "full 5G speed". In Western Europe, where most examples of speed tiers exist, they are often clearly articulated and come in large steps, with hundred(s) of Mbps.

Content aggregation and gaming attract consumers to 5G

It is common to offer bundles with various popular entertainment services included, such as television and music streaming or cloud gaming platforms. Around 45 percent of 5G service providers are doing this in various forms. The most common practice is to increase the bundle value as the price of the tiers increases. A new form of bundling is starting to emerge, where some service providers act as aggregators. In these cases, the service provider offers a menu from which the consumer can choose from a variety of streaming services, and sometimes events. Often this menu is available regardless of which tier you are on, and the consumer has almost complete flexibility in terms of the number of services to add. The most proactive service providers are adding these offers as part of the customer journey and may also allow adding and removing them on a monthly basis. The main benefits to consumers are that there is usually a small discount, compared to signing up directly with the cloud gaming provider for example, and the fact that all services are charged on one single bill.

Figure 14: Service providers' new role as content aggregator



Mid-band essential for an optimal 5G service offering

Global 5G mid-band population coverage (outside China) has reached just over 10 percent, while mid-band coverage in Europe has reached 15 percent, but front-runner markets like the US have already reached 80 percent.

Three 5G spectrum bands
5G networks can be deployed in three radio spectrum bands, each with its own set of characteristics and benefits, as shown in Figure 15.

- Low-band for coverage and in-building penetration: 5G low-band (frequency division duplex, or FDD, below 7 GHz) is the most deployed band. It provides a wide coverage area due to its lower frequency. However, it is limited in capacity.
- Mid-band for coverage and capacity: 5G mid-band (time division duplex, or TDD, below 7 GHz) offers higher bandwidth and capacity than low-band.
- High-band (or mmWave) for targeted high-capacity areas and services: 5G high-band or mmWave (above 24 GHz) delivers unprecedented peak rates and low latency but less coverage.

5G deployment strategy linked to spectrum availability
There is a clear link between how service providers in different countries are deploying 5G with the spectrum availability. Three deployment approaches can be seen:

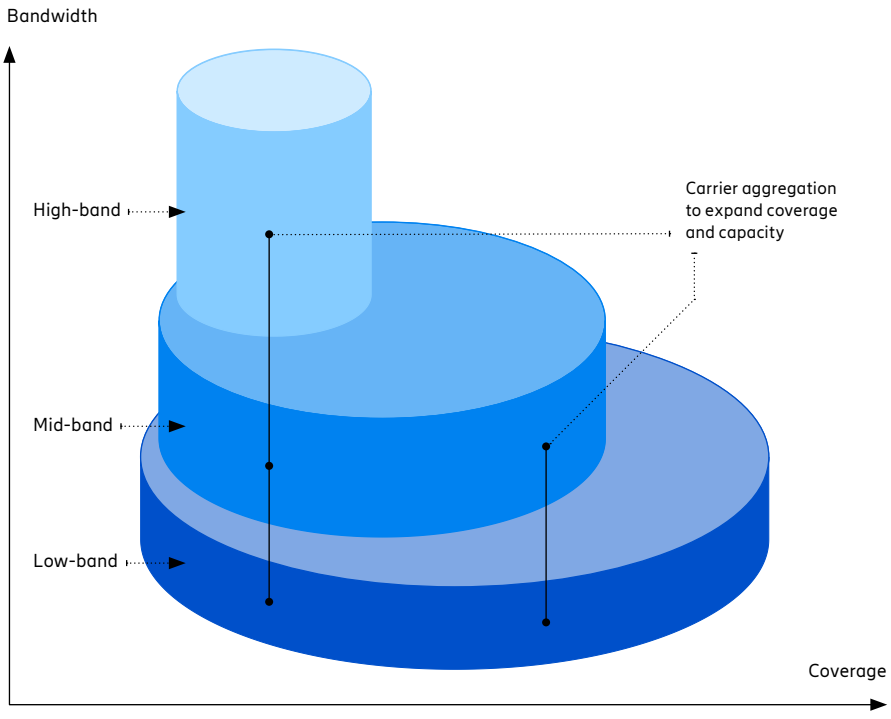
- **All three bands:** Low-, mid- and high-band. Examples include the US, Japan and Australia.
- **Low- and mid-band:** Examples include include Switzerland, the UK and China.
- **Mid-band only:** Examples include South Korea, Saudi Arabia and Oman.

The journey to 5G standalone multi-layer network
As spectrum becomes increasingly available, more service providers will evolve toward using all three bands, enabling 5G services with the flexibility to serve multiple use cases with different requirements by ensuring that devices are connected using the most appropriate band.

5G mid-band coverage outside China is set to reach over 10 percent by the end of 2022.

>10%

Figure 15: The three 5G spectrum bands



Mid-band's importance is rising

Mid-band is a sweet spot for delivering the 5G experience, as it combines high capacity (with Massive multiple input, multiple output, or MIMO) with good coverage and is available in most markets. Combined with a low-band FDD 5G carrier it can provide full coverage and mobility. While it is estimated that 5G mid-band population coverage will reach 25 percent worldwide by the end of 2022, outside China it is estimated to reach just over 10 percent.

Mid-band coverage in Europe to reach 15 percent by the end of 2022

Three years after the first 5G networks were launched in Europe, 5G population coverage in EU+[1] is estimated to be around 65 percent with some service providers announcing that they have reached 80 percent population coverage. This is possible using spectrum sharing with 5G non-standalone (NSA) and 4G on the same FDD band. Coverage with 3.5 GHz TDD mid-band has only reached around 15 percent. Countries such as Switzerland and France – with coverage obligations – are leading deployment. Service providers in Germany are relying more on spectrum sharing, while the Netherlands is still awaiting TDD mid-band licensing.

5G NSA offers use cases such as mobile broadband and Fixed Wireless Access, as well as a significant capacity increase. Evolving to 5G standalone (SA) brings additional service differentiation possibilities.

Mid-band coverage in the US to reach around 80 percent by the end of 2022

The US is one of a few countries that has significant 5G deployments across low-, mid- and high-band frequencies. Launched in April 2019, 5G services were first available in high- and low-bands. Ten service providers have deployed 5G on low-band, covering over 95 percent of the US population. High-band 5G services are available in 90 cities. The Federal Communication Commission subsequently allocated mid-bands over the course of several auctions during 2020–2022. Currently the three national service providers are rapidly deploying 5G mid-band networks nationwide. Around 80 percent mid-band population coverage is projected by the end of 2022.

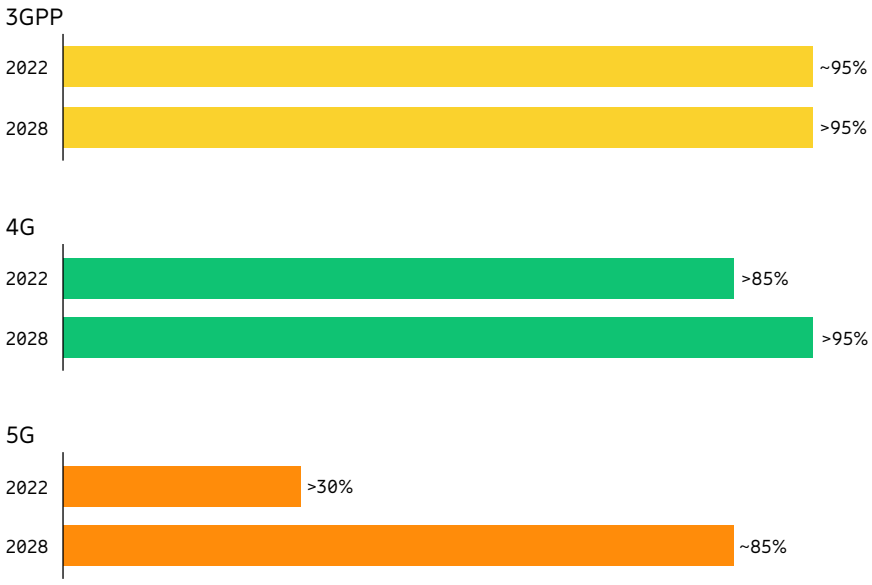
4G population coverage surpassed 85 percent globally at the end of 2021 and is projected to reach over 95 percent in 2028. There are currently 815 4G networks deployed across the world – 336 upgraded to LTE-Advanced, and 54 Gigabit enabled.[2]

The build-out of 5G continues, with 228 networks launched across the world. 5G population coverage is estimated to reach over 30 percent by the end of 2022, with coverage projected to increase to around 85 percent by 2028.

Globally, 5G population coverage is set to reach over 30 percent by the end of 2022.

>30%

Figure 16: World population coverage by technology[3]



5G population coverage is projected to reach 85 percent by 2028.

85%

[1] EU+ includes the EU countries plus Iceland, Norway, Switzerland and the UK.
[2] Ericsson and GSA (Nov 2022).
[3] 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.

2023 will bring more 5G smart devices with more capabilities

Even in these turbulent times, continued growth in the number of 5G device models and chipsets with an ever-expanding set of supported features is expected in 2023.

5G adoption continues in a weak smartphone market

- Following a strong 2021, global smartphone shipments were down by around 10 percent year-on-year in the first three quarters of 2022.[1]
- Despite overall negative trends in the smartphone market, 5G device shipments show resilience.
- Over 700 5G smartphone models have launched (with more than 200 in 2022).
- Focus on standalone (SA) enablement in smartphones continues, as more networks deploy 5G SA services and introduce NR-DC (dual connectivity) to enable FR2 (high-band spectrum).
- The outlook on new use cases for extended reality (XR) remains positive, focusing on smartphones or other 5G modem devices, with glasses following in the intermediate term.

SA with the treat of network slicing

The network slicing market has been developing for some time, starting with enterprise and then consumer use cases. Support for service differentiation on smartphones is established in the Android ecosystem, and other operating systems are expected to follow. Slicing in Fixed Wireless Access (FWA) is emerging based on network capabilities. Beyond network slicing, more networks with SA are being deployed along with compatible devices that have SA enabled for FDD and TDD. Chipsets have been ready for a while, and with enhanced carrier aggregation capability there is a good performance baseline for SA networks.

The awakening of XR

The number of XR-related press releases increases weekly. XR devices using a companion device for cellular connectivity have used a cable so far, but are expected to lose their cables before long. AR use cases would benefit from the ubiquitous coverage and mobility that only a cellular connection can offer.

RedCap – evolving standards to products

Another SA contender, this time focusing on IoT, is reduced capability (RedCap) chipsets and devices. The first RedCap-optimized silicon is expected in the market in 2023, with consumer products focused on wearables and IoT following in 2024. RedCap is initially expected to compete in the LTE Cat 4 space, with potential for more cost optimization, power efficiency and complexity reduction, at the expense of performance.

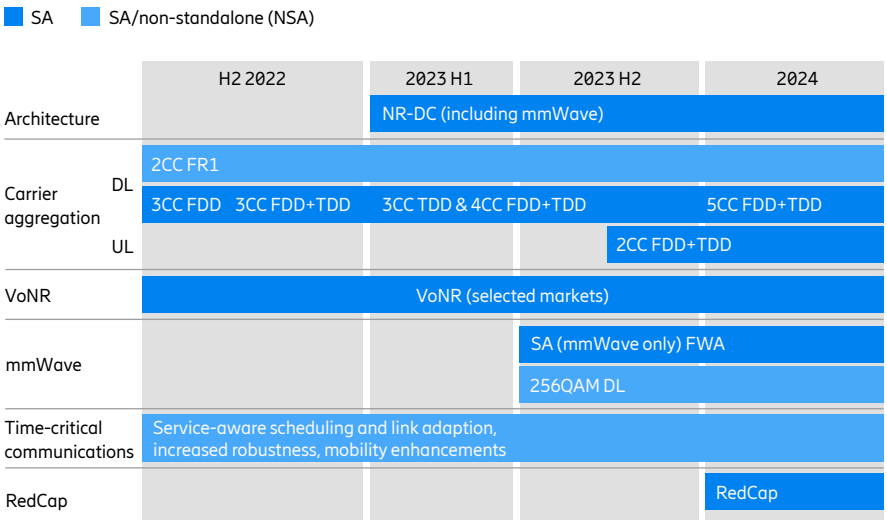
FWA – the rising star of 5G

The commercial success of FWA over 5G has been developing steadily. Connecting FWA with SA, potentially with a network slice, brings attractive new ingredients to the market. Increased competition in the chipset and device space is expected to contribute to continued growth.

Devices in 2023

The only safe prediction is that there will be more 5G device models. Growth will depend on several factors, including macroeconomic development and component availability. In 2023, 5G devices are expected to evolve with more spectrum aggregation capabilities (4CC DL, 2CC UL and NR-DC) plus improved power efficiency and low-latency capabilities.

Figure 17: 5G technology market readiness



Note: The graph illustrates availability of network functionality, as well as support in devices.

[1] Canalys, Global smartphone market fell 9% as consumers trim spending (18 October 2022).

Augmented reality over 5G

There is undoubtedly a lot of anticipation in the mobile community around the uptake of AR services over cellular networks. At this early stage in the emergence of a market that is projected to become important for service providers, we explore how the ecosystem is developing.

Key insights

- AR represents a major branch of the XR taxonomy that will place significant demands on 5G mobile network dimensioning.
- As the AR ecosystem develops, traffic arising from AR usage could significantly exceed the current mobile traffic forecast.
- When AR reaches mass-market adoption, service providers will need to take a stepwise approach to handle the traffic growth, including investments in Radio Access Networks (RAN), time-critical features and service-enabling platforms.

XR encompasses a taxonomy of technologies, including VR and AR

The VR branch is comprised of a range of immersive techniques which share several attributes. These include closed headsets and cameras directed inward to capture and model their subjects. Due to its closed nature, VR needs a confined area for its subjects to experience immersive services comfortably while using a closed head-mounted display. Other related technologies include 3D conferencing and volumetric video.

AR is applicable both indoors and outdoors for a large range of services for consumer, enterprise and industrial use. AR requires an open display with a view of reality which can be augmented with relevant data, making outdoor applications particularly relevant, yet also reliant on sufficient mobile coverage, capacity and performance.

The AR ecosystem

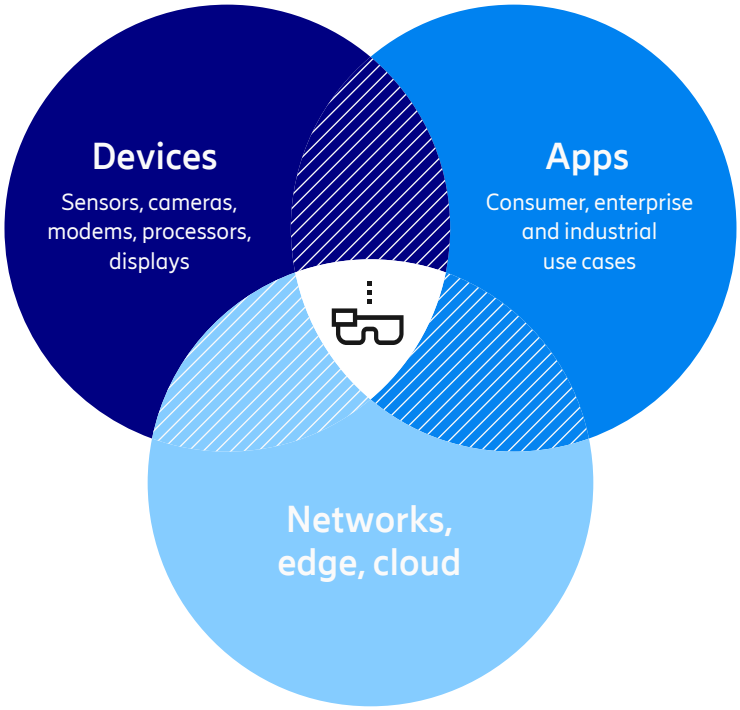
To meet market expectations, all parts of the AR ecosystem – including devices, apps, networks and edge compute – need to evolve with new capabilities, increased performance and greater efficiencies. While the devices receive most of the attention, the availability of enough suitable spectrum and investments needed to build out the networks are also significant.

AR devices

The development of head-mounted displays, in the form of glasses, is highly visible on the road to emerging AR applications and services. Behind the form factor lie questions as to how critical functions will be split and interoperability ensured between the headset, eventual tethering platform (smartphone), network edge and the cloud. This includes object detection and tracking, simultaneous localization and mapping (SLAM), and rendering of video streams combining reality and data augmentation.

The technology required to create smart glasses for mass-market adoption has progressed considerably in the last few years. Several prototypes, as well as commercial solutions, have emerged. As of 2022, however, AR headsets have not yet gained mass-market success. The technology components of the devices must mature enough to allow for a practical and attractive consumer product. Useful applications must also be developed and integrated over the ecosystem consisting of wearable devices/glasses, connectivity devices, and ultimately cloud-based compute resources. Additionally, high power consumption and low battery capacity are current challenges.

Figure 18: AR over 5G



The technology is not yet mature enough to enable comfortable standalone devices. Key factors for mass-market adoption include device form factor and connectivity. Mobility requirements drive cellular connectivity, but this is limited by form factor and power, which necessitates a paired connectivity device, such as a smartphone. Smartphones will continue to be connectivity hubs for personal devices in the near term.

The next wave of AR glasses will likely be more attractive, but will continue to rely on a connectivity device. Higher chip density and lower power consumption will be essential for size and weight considerations in glasses, as well as heat dissipation. Improved coverage and latency in 5G networks will allow more compute offload, and AR devices will have further reduced power consumption and better battery capacity, thereby enabling improved form factors. In the meantime, offloading processing to tethered smartphones will continue.

Application handling

Consumer categories with high potential for wide uptake in the intermediate term include gaming, entertainment, and retail. AR technology will also be used to improve enterprise and industrial operations in many areas, such as private networks, virtualized work, industrial automation, design, maintenance and public safety.

There is considerable work behind the scenes on the network architecture necessary for handling the requirements for delivering the emerging applications. Each application will place quality-of-service (QoS) demands on end-to-end service delivery over the networks connecting devices. These demands include uplink and downlink throughput, round-trip latency and reliability. Networks will handle the demands by setting up QoS flows that segregate traffic into categories ranging from best-efforts to performance guarantees.

Traffic from services requiring time-critical treatment will be segregated from eMBB traffic and assigned a different QoS flow. Ultimately, application developers will use tags provided by either device ecosystem players through their operating systems or service providers. The traffic categories will then be mapped to 3GPP QoS flows to enable interoperability across networks.

Service providers will be able to differentiate their subscription plans to map premium users' traffic to packet treatment with low latency features while mapping standard users' traffic to the default packet treatment.

5G network traffic

Our forecast for traffic growth includes an assumption that an uptake of XR-type services will happen in the latter part of the forecast period. The current forecast (see page 22) includes estimates of moderate uptake in the forecast period. This includes a limited effect on total traffic so far, with the most significant impact on uplink traffic ratio. To understand the forecast, it is important to be aware of the following factors:

- The forecast relies on a foundation of measurements in live networks worldwide. These measurements include indications of traffic types, including – but not limited to – voice, messaging, streaming media, browsing, social media and e-commerce.
- The global traffic forecast depicts the total mobile traffic in EB as well as the average mobile data traffic per device in GB across all regions and users over the course of a month. Actual traffic in a country, city or area and across urban, suburban and rural landscapes shows very large variations from the global averages.

As the AR ecosystem develops, traffic arising from AR usage could significantly impact the current forecast. The amount of traffic that will be generated over mobile networks, in addition to mobile broadband and fixed wireless traffic, will depend not only on the uptake and utilization rates of the applications, but also where the critical functions mentioned in the "AR devices" section take place. In the next wave, it is expected that compute functions including rendering of the composite video will take place either on a tethered smartphone or the AR headset.

As the augmentation objects become larger and rendering becomes more demanding, the work will increasingly need to be offloaded to network edge and cloud compute resources.

This is expected to put growing demands on networks especially uplink throughput and latency. The ability to meet those resource demands depends on spectrum employed, as well as network dimensioning.

As more demanding use cases start to gain significant uptake and increasing amounts of compute function is offloaded to the network edge and cloud, service providers will need to respond by deploying features and solutions to handle time-critical communications.

5G spectrum concerns

To address the growth of mobile traffic expected between now and 2030, including XR use cases (indoors and outdoors including mobility), additional spectrum in the mid-band range (2–7 GHz) will be critical. This may be within the 3.5 GHz, 4.5 GHz and/or 6 GHz ranges, depending on the country. Spectrum within 3.5 GHz and 4.5 GHz has already been licensed in many parts of the world and there is a device ecosystem with support for those bands. Spectrum within 6 GHz is currently under discussion for IMT identification at WRC-23. 6 GHz is a key opportunity for large scale harmonization of wide-area licensed use and in many cases, the last available mid-band resource.

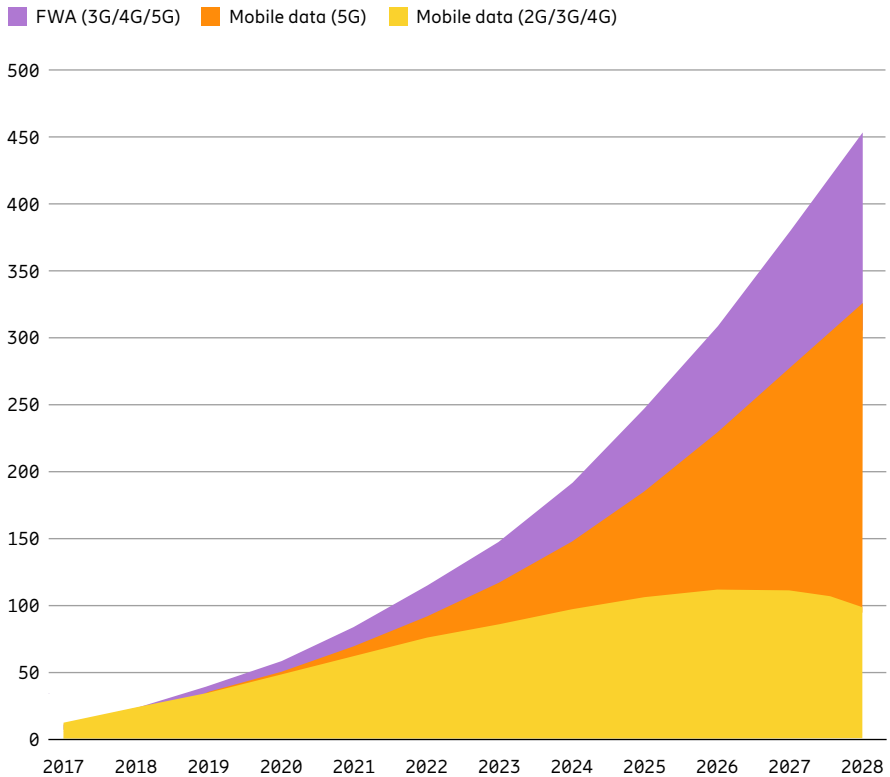
5G to drive all mobile data growth

In 2028, all growth in mobile data traffic will come from 5G, as 4G traffic is set to decline.

Total global mobile data traffic – excluding traffic generated by Fixed Wireless Access (FWA) – is expected to reach around 90 EB per month by the end of 2022 and is projected to grow by a factor of nearly 4 to reach 325 EB per month in 2028. Including FWA, this takes total mobile network traffic to around 115 EB per month by the end of 2022, and to 453 EB per month by the end of 2028. The predicted traffic growth up to 2028 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. However, if adoption is stronger than expected, data traffic could increase significantly more than currently anticipated toward the end of the forecast period, particularly in the uplink – see page 19 for more information. Currently, video traffic is estimated to account for around 70 percent of all mobile data traffic, a share that is forecast to increase to 80 percent in 2028.

Populous markets that launch 5G early are likely to lead in terms of traffic growth over the forecast period. 5G's share of mobile data traffic is expected to be around 17 percent by the end of 2022, an increase from 10 percent at the end of 2021. This share is forecast to grow to 69 percent in 2028. By then all growth in mobile data traffic will come from 5G.

Figure 19: Global mobile network data traffic (EB per month)



Traffic growth varying across regions

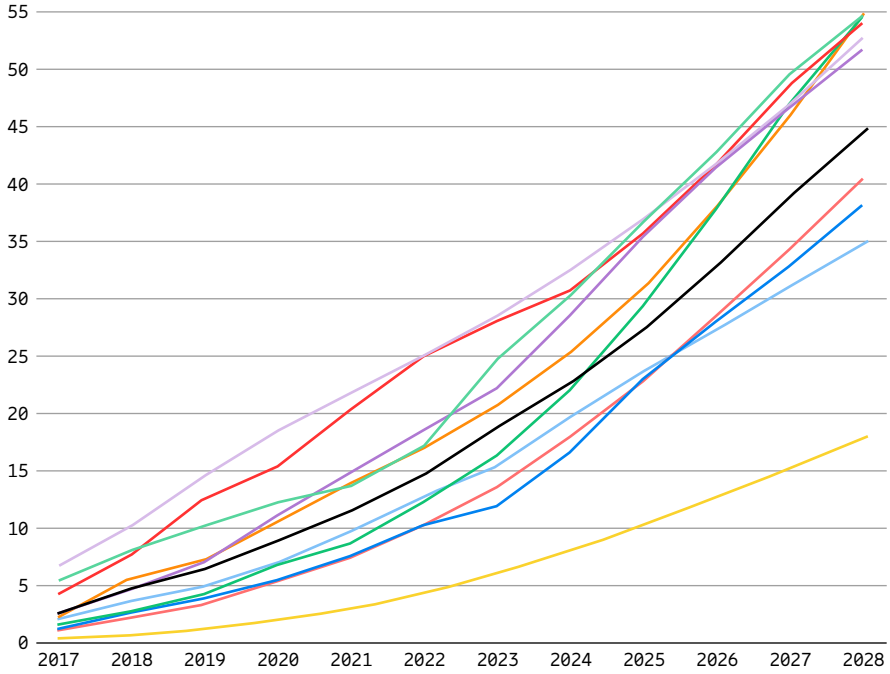
Traffic growth can be highly volatile between years and can vary significantly between countries, depending on local market dynamics. Globally, the growth in mobile data traffic per smartphone can be attributed to three main drivers: improved device capabilities, an increase in data-intensive content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

These differences are reflected, for example, in the difference between the Sub-Saharan Africa region, where the average monthly mobile data usage per smartphone is estimated to be 4.6 GB, and the Gulf Cooperation Council (GCC) countries which will have 25 GB per smartphone by the end of 2022. The global monthly average usage per smartphone is anticipated to be 19 GB in 2023 and is forecast to reach 46 GB by the end of 2028.

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 55 GB in 2028. The unlimited data plans and improved 5G network coverage and capacity increasingly attract new 5G subscribers. The data traffic generated per minute of use will increase significantly in line with the expected uptake of gaming, XR, and video-based apps. These experiences require higher video resolutions, increased uplink traffic, and more data from devices off-loaded to cloud computing resources to satisfy users. In 2028, we predict that 5G subscription penetration in North America will be the highest of all regions, exceeding 90 percent.

Figure 20: Mobile data traffic per smartphone (GB per month)



Regions	2022	2028	CAGR 2022–2028
North America	17.4	55	21%
North East Asia	17	55	21%
South East Asia and Oceania	12.5	54	28%
India, Nepal, Bhutan	25	54	14%
GCC	25	53	11%
Western Europe	19	52	18%
Global average	15	46	21%
Latin America	10.5	41	25%
Middle East and North Africa[1]	11	38	24%
Central and Eastern Europe	13	35	18%
Sub-Saharan Africa	4.6	18	26%

In **Western Europe**, service usage and traffic growth are expected to follow a similar pattern to that anticipated for North America. Although the more fragmented market situation has led to later mass-market adoption of 5G, by 2028, traffic usage per smartphone is projected to reach 52 GB per month – close to the usage in North America at that time.

The **North East Asia** region's share of total global mobile data traffic is expected to be around 30 percent in 2028. In the region, 5G subscribers currently use, on average, 2–3 times more data than 4G subscribers. As more 4G subscribers migrate to 5G, average mobile data traffic per smartphone will increase and reach 55 GB per month in 2028. Video is the dominant traffic type. For example, in South Korea, video traffic share increased from 55 percent in 2019 to 60 percent in 2022, and traffic volume increased by 2.75 times. 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 growth will continue as more subscribers are transitioned to 4G, and 5G coverage expands in the period leading to 2028 with average data traffic per smartphone rising by 24 percent annually.

In the **GCC** countries, despite modest growth in subscriber and smartphone connections, monthly data traffic per smartphone will almost double to around 53 GB between 2022 and 2028. Emergent use cases for 5G will also yield traffic growth from industries as service providers explore various monetization avenues.

Data traffic growth in **Sub-Saharan Africa** will be driven by a combination of a higher number of connections, greater coverage by mobile broadband-capable networks, device affordability and attractive service offerings. Service providers in many parts of the continent are in the process of migrating customers from legacy 2G/3G networks to 4G networks, which will result in average monthly data traffic per smartphone expected to be 18 GB by 2028. Despite it only constituting a small share of the total subscriber base, 5G subscriptions reaching 150 million in 2028 will contribute to data traffic growth in Sub-Saharan Africa.

In **India, Nepal and Bhutan**, mobile networks continue to play a pivotal role in driving social and economic inclusion. 5G will play a crucial role in achieving India's digital inclusion goals especially for bringing broadband to rural and remote homes. In fact, enhanced mobile broadband is serving as the foundation for the Government's "Digital India" vision by enabling people to access public services.

The average data traffic per smartphone in the India region – together with GCC – is the highest globally. It is projected to grow from 25 GB per month in 2022 to around 54 GB per month in 2028 – a CAGR of 14 percent. Total mobile data traffic in the India region is estimated to grow from 18 EB per month in 2022 to 53 EB per month in 2028, growing at a CAGR of 19 percent. This is driven by high growth in the number of smartphone users and the increase in average usage per smartphone. The smartphone subscriptions in India as a percentage of total mobile subscriptions are expected to grow from 77 percent in 2022 to 94 percent in 2028.

Mobile data traffic per smartphone continues to grow strongly in **South East Asia and Oceania** and is expected to reach around 54 GB per month in 2028 – a CAGR of 28 percent making it the region with the highest growth.

Latin America is expected to follow a similar trend to 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 41 GB per month in 2028.

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, monthly average data traffic per smartphone is expected to increase from 13 GB to around 35 GB per month.

It is important to bear in mind that there are significant variations in monthly data consumption within all regions, with some 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.

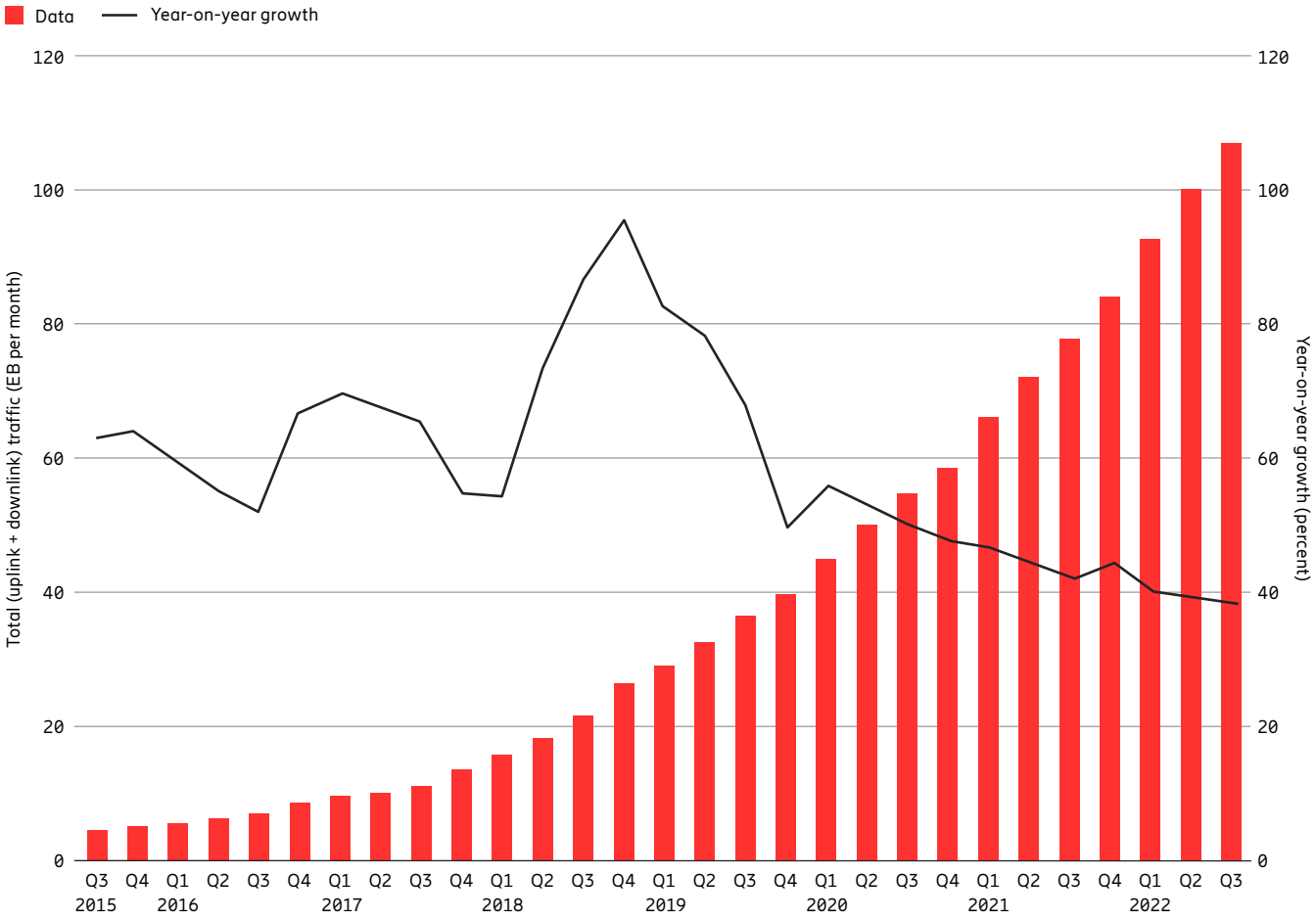
Mobile network traffic doubled in last two years

Mobile network data traffic grew 38 percent between Q3 2021 and Q3 2022.

The quarter-on-quarter mobile network data traffic growth between Q2 2022 and Q3 2022 was around 7 percent. Total monthly global mobile network data traffic reached around 108 EB. In absolute numbers, this means that mobile network traffic has almost doubled in just 2 years, from 55 EB per month in Q3 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 – more detailed analysis of traffic types can be found on page 25. Figure 21 shows the net addition and total global monthly network data traffic from Q3 2015 to Q3 2022, along with the year-on-year percentage growth for mobile network data traffic.

Figure 21: Global mobile network data traffic and year-on-year growth (EB per month)



Source: Ericsson traffic measurements (Q3 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.

Video content rules

Video constitutes around 70 percent of all global mobile network traffic in 2022. Traffic measurements in a sample of networks show how video streaming from popular social media platforms makes up the largest part of video traffic.

Users are spending more time streaming and sharing videos. The largest and fastest-growing mobile data traffic segment globally is video, in social media and video-on-demand services, with around a 70 percent share of traffic in 2022. This is expected to increase by around 30 percent annually until the end of 2028, when it is forecast to account for 80 percent of global mobile data traffic. Social networking[1] is the second-largest traffic type at around 9 percent in 2022.

The uptake of XR devices and applications has the potential to significantly alter the relative volumes of different types of mobile traffic.

Social media video dominates

Video traffic growth is primarily driven by service uptake from a small number of global streaming providers. YouTube dominated in the early years of 4G, accounting for 40–60 percent of the total video traffic volume in many mobile networks. It was the most popular video service in the UK, US and Japan among smartphone users. At the time, subscription-based video services were becoming increasingly popular with smartphone users, facilitated by better network speeds, and improving device capabilities. Today, social media users across the world frequently share videos, send messages and post links.

Figure 23 shows the share of video traffic per service provider based on measurements in a few selected commercial 4G and 5G networks in Europe, Asia and the Americas. It shows that video streaming from the top 4 social media platforms makes up the largest part of video traffic in those networks with 40–95 percent. Global streaming video-on-demand traffic is in the 10–30 percent range.

Figure 22: Mobile data traffic by application category per month

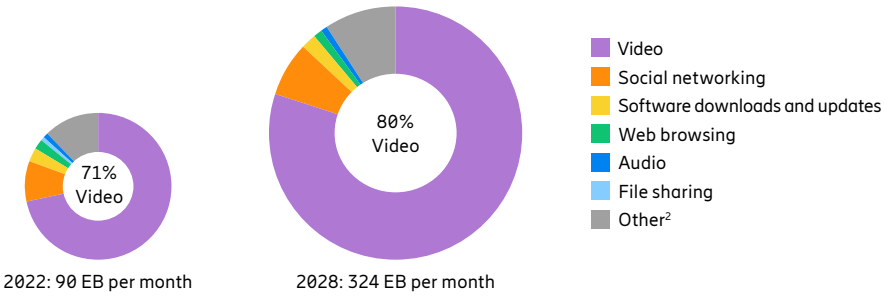
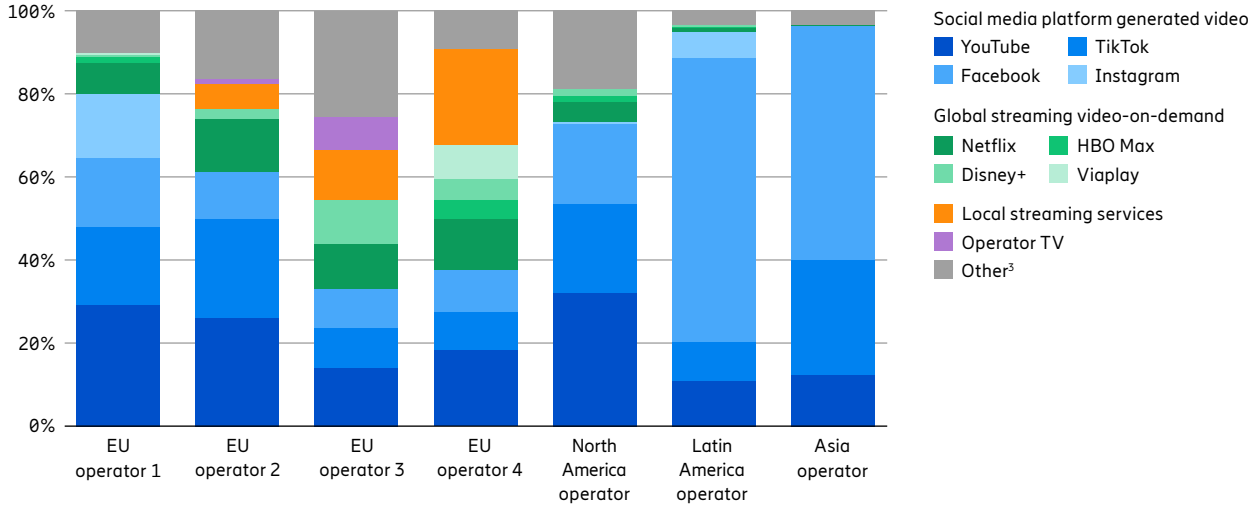


Figure 23: Streaming video service providers' share of total video traffic in networks



[1] Traffic from embedded video in the "Social networking" and "Web browsing" categories is included in the application category, "Video".
[2] "Other" includes uncategorized traffic and traffic from services that have too small a share to be significant compared to the categorized segments in this figure.
[3] "Other" includes video traffic that was not possible to identify as a specific service or has too small a share to be significant compared to the specified services.

Articles

Many service providers are now asking how to use advanced network technology to build networks that can not only carry more data, but can do so in a sustainable and responsible way that benefits society. Our articles explore how, through utilizing the technology or the direct efforts of service providers, the industry can cut emissions in order to play a role in reaching global sustainability goals, enable energy-saving technologies and systems, or even contribute toward creating an advanced, interconnected public safety ecosystem.

The telecoms sector has a vital role to play in reaching Net Zero. This article explores how e& is contributing to breaking the energy curve by modernizing its network, and how initial site deployments have already proved that huge energy savings are possible.

First responders have traditionally relied on voice, but mobile solutions unlock advanced capabilities. Here's how Erillisverkot Group and partners are collaborating to create Virve 2, the next-generation public safety network that's helping to build a safer Finland.

Reaching Net Zero is vital for halting climate change. Dematerialization through digitalization is key for reaching this goal, and decision-makers within enterprises are already recognizing the benefits – not only for sustainability, but also for profitability and productivity.

Network modernization – on the quest for Net Zero

e& (formerly known as Etisalat Group) considers innovative mobile networks and ICT solutions to be crucial in supporting both direct and indirect reduction of carbon emissions across its own and other industrial sectors' value chains.

Key insights

- The telecommunications sector has a key role to play in addressing global sustainability goals, both by reducing its own emissions and through its potential to reduce carbon emissions across other industries.
- To break the trend of increasing energy usage in mobile networks, growing data traffic needs to be managed with smart modernization combined with a balanced approach to network performance and use of energy-saving functionality.
- Through initial site deployments, etisalat by e& has already proved it's possible to reduce energy usage by up to 52 percent and save 7.6 tons of CO2 emissions per site, per year.

A fast-growing number of service providers and equipment vendors are committing to achieve Net Zero carbon emissions across their value chain by 2050. In October 2021, the UAE proclaimed its "Net Zero by 2050" initiative, in line with the 2016 Paris Agreement targeting Net Zero[1] greenhouse gas (GHG) emissions in the country by 2050. As part of the initiative, the telecommunications sector is playing an important role by contributing a sustainable infrastructure build-out and enabling new smart services for consumers, enterprises and industries that will contribute to the reduction of GHG emissions.

e& is committed to accelerating digital innovation in the marketplace toward a more sustainable economy, by providing end-to-end digital vertical propositions to enable smarter developments in areas such as education, healthcare and transportation.

Environmental management – committing to Net Zero operations by 2030

e& has pledged its commitment to achieving Net Zero within its Group's own operations in the UAE for Scope 1 and 2 emissions by 2030, focusing on key initiatives to reduce its carbon footprint through improving energy efficiency and sourcing renewable energy, among other initiatives.[2]

Hatem Dowidar, Group CEO at e&, says: "To reach Net Zero, e& is committed to accelerating the decarbonization of activities while focusing on mobile network modernization with the deployment of the latest generation of energy-efficient radio equipment (both hardware and software), increased use of renewable energy sources and carbon-offsetting initiatives that are vital to achieve targets."

e& has a sustainability framework, supported by a set of improvement programs and KPIs, to guide its operating companies' business strategies and operations across the Middle East, Africa and Asia. The framework encompasses a range of initiatives to contribute to the UAE climate action ambitions and United Nations' Sustainable Development Goals (UN SDGs).

One of the five pillars of e&'s sustainability framework is environmental management, which aims to develop more sustainable products and enhance its operations for improved environmental efficiencies through energy, water and waste management. Mobile network modernization with deployment of more energy-efficient equipment and increased use of renewable energy sources is vital to achieve targets.

e& is addressing this by:

- deploying the latest generation of energy-efficient radio equipment (hardware, software)
- minimizing use of diesel generators in favor of renewable energy sources for off-grid cell sites
- maximizing use of hybrid technology for off-grid sites where diesel is already in use
- maximizing the number of sites with free cooling to reduce energy consumption
- replacing older rectifiers with new, highly efficient rectifiers
- utilizing site sleep mode during low-traffic periods

e& (formerly known as Etisalat Group) is one of the world's leading technology and investment conglomerates. Founded in Abu Dhabi more than four decades ago as the UAE's first telecommunications company, the Group now operates in 16 countries across the Middle East, Asia and Africa.

e& provides innovative digital solutions, smart connectivity and next-generation technologies to a variety of customer segments through its business pillars: etisalat by e&, e& international, e& life, e& enterprise and e& capital.

[1] ITU standard defines 'Net Zero' as a future state where all emissions that can be reduced are reduced, with like-for-like or permanent removals applied by carbon-removal technologies to balance the remaining emissions.

[2] Scope 1 refers to GHG emissions that occur from sources that are controlled or owned by an organization. Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity, steam, heat or cooling.

Energy-efficient mobile networks

Mobile data traffic in the Gulf Cooperation Council region is currently growing at an average of around 20 percent per year,[3] driven primarily by the rising number of connected people and an increasing use of data-intense services, such as media consumption. The uptake of new services as the digital society develops will further drive growth in data consumption in the coming years. e& considers 5G to be a cornerstone for building a digital economy, where new innovative services for consumers, enterprises and industries can be a catalyst for a sustainable development of society by optimizing the utilization of time and materials. In this context, network modernization is needed to manage expected growth and minimize increasing energy consumption.

For each new generation of mobile technology, from 2G through to 5G, the energy needed to transfer each bit of data through the network has lessened. For example, replacing 2G/3G with 4G is significantly increasing the capacity for the same spectrum. It also enables the use of more efficient energy-saving functionalities, offered by the 4G standard. 5G technologies are designed for high capacity and low network energy consumption, including significantly improved support for energy savings during low-to-medium traffic periods.

Minimizing the mobile network environmental footprint

etisalat by e& has devised an environmental management policy focusing on reducing energy consumption. Minimizing the environmental footprint of its mobile network is part of this policy, which is being addressed through the deployment of a state-of-the-art modern network resulting in high energy efficiency. etisalat by e& is deploying the latest generation of radio base stations and new software features to minimize environmental footprint while elevating network performance quality.

A range of improvements have been realized through modernizing an existing site that had 2G, 3G and 4G radios installed, with a new-generation, multi-standard, multi-sector, and multi-band radio that supports 2G-to-5G mobile standards. Under the same network coverage and performance requirements, the modernized site shows lower operational cost and reduced equipment footprint, while being ready for 5G. Initial deployment resulted in up to 52 percent energy consumption reduction compared to previously deployed radios at the pilot site. The reduction in energy consumption is equivalent to 7.6 tons of CO2 emissions per site, per year for the high-tier sites configured with 4 LTE carriers.

Recycling decommissioned, end-of-life electrical equipment is also considered an important measure to reduce the potential environmental impact from electronic waste when modernizing the network.

e& will continue to work on reducing CO2 emissions across its operations, as part of its commitments to contribute to a greener ICT sector and its climate change mitigation efforts.

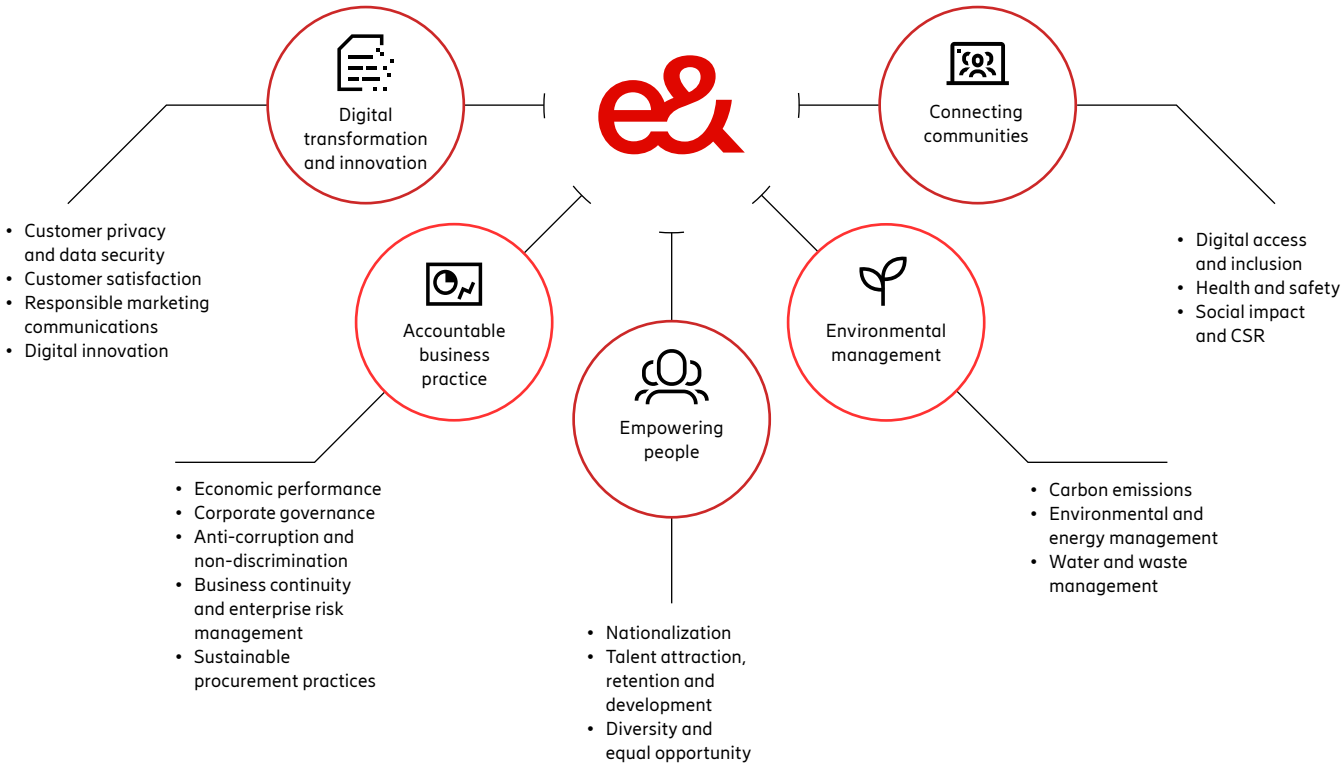
Modernized site equipment has already led to a 52-percent energy consumption reduction compared to previously deployed radios.

52%

Initial deployments have proved savings of up to 7.6 tons of CO2 emissions reduction per site, per year.

7.6 tons

Figure 24: e& sustainability framework



[3] Source: Ericsson Mobility Visualizer.

Balancing performance with efficiency

The increase in mobile networks' energy consumption is closely correlated with building out geographical coverage for new radio technologies. Data traffic is not evenly distributed across a mobile network. Typically, 50–70 percent of radio base station sites carry 25 percent of the total traffic. These low-load sites are often over-dimensioned, that is, operating at sub-optimal capacity utilization levels with unnecessary high energy consumption. Precise dimensioning with the right radio site hardware for each traffic segment can reduce energy consumption while maintaining network performance.

Latest-generation radio base stations can have up to 50 percent lower energy consumption compared to the previous generation. Modernizing the network in this way leads to a smaller footprint and less weight while providing higher capacity and better performance, which all contribute to improved energy efficiency for transferring data traffic across the network. Modernization in low traffic areas can yield a short payback period even when only considering the energy savings.

Reducing energy consumption with maintained network performance

For service providers, energy is typically the third-largest network-related operating expense. A range of software features, such as transmitter micro sleep (switching off radio transmitters when no transmission is required), deep sleep (hibernating radios during low-traffic hours) and low-energy schedulers can enable huge energy savings without degrading network performance. These energy-reducing software solutions make use of load variations and allow the power consumption of modern radio equipment to vary up to 97 percent between full-traffic and no-traffic hours. Finding the right balance of network performance and energy performance/efficiency as data traffic grows and new services are introduced helps service providers to break the energy curve. This requires a combination of replacing old equipment with the latest technology and hardware, activating energy-saving software and operating site infrastructure intelligently, for example by implementing predictive maintenance methods on site.

Figure 25: Typical mobile network traffic distribution

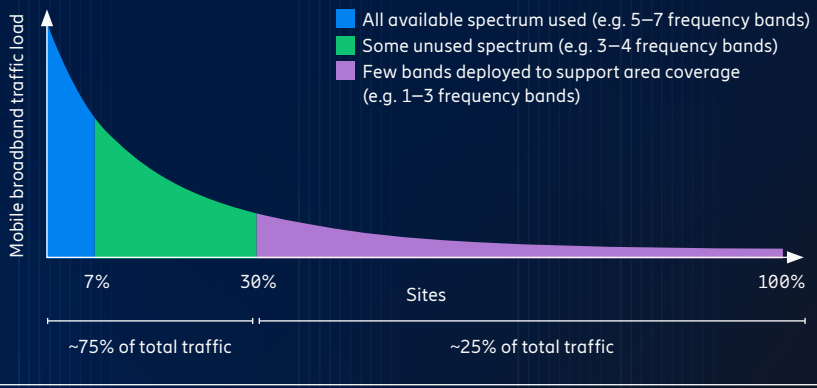


Figure 26: Optimizing power consumption across different traffic loads

Cooperation and collaboration: Building Finland's next-generation public safety network

To protect society, critical situations demand cooperation, efficient organization and highly reliable communications between authorities. A resilient mission-critical network enables Erillisverkot Group to manage and control its broadband network, safeguard information security and protect data integrity.

Key insights

- First responders rely on voice, but this is evolving as mobile solutions over 4G and 5G enable additional capabilities such as video or data sharing, AR and drones for situational awareness.
- To deliver the same coverage and resilience as voice, Erillisverkot Group collaborated with partners to create Virve 2, a next-generation Public Protection and Disaster Relief (PPDR) network initiative.
- Finland encourages cross-party cooperation between emergency services and other authorities and connectivity through Virve 2 is a key enabler for data sharing, transparency and accessing common systems.

The need for reliable mobile broadband

In any emergency situation, instant, reliable and stable communication is key to enable and support successful emergency operations. First responders like firefighters, emergency medical service personnel or police officers need to be able to rely on fast, secure connectivity to save lives.

Erillisverkot Group is a non-profit company owned by the state of Finland. It was founded in 1999 to operate and, at a later stage, to own the TETRA-based nationwide public safety mobile service, Virve. The largest user groups on Virve are the fire and rescue services, social and healthcare services, police, defence forces, Border Guard, customs, railway operators, the Emergency Response Centre Agency and other authorities and companies. Voice, especially group calling, is still very important, but public safety agencies are increasingly turning to mobile solutions due to the capabilities provided by 4G and 5G, such as the secure and speedy sharing of data, images and video. Virve is unable to offer these data services on a similar level as voice, leading end-user organizations to utilize commercial mobile broadband networks in operational situations. Commercial networks in Finland do offer high-quality mobile broadband services, but do not meet the demands of public safety when it comes to priority, coverage and resilience.

Virve 2: Building a safer Finland

To deliver the required data services in addition to and with the same coverage and resilience as voice, Erillisverkot Group, with selected partners, is building a next-generation PPDR network initiative. This is called Virve 2, and it is one of the most significant Finnish government ICT projects of this decade. It will safeguard the daily operational continuity of critical national infrastructure, and therefore ensure that the public safety authorities can operate smoothly in all situations now and in the future. The program expects all current Virve services to be completely migrated to Virve 2 during the second half of this decade, with the existing services running in parallel until the migration is complete.

Virve 2 will be based on 4G/5G technology, and is expected to provide improved cost efficiencies and more flexibility and agility in service delivery, as no longer will one size fit all requirements. For example, multiple subscription types will need to be supported including data only, voice and data, and IoT connections. The range of devices will also increase and continually evolve with service offerings from standard smartphones to fully ruggedized devices and in-vehicle devices. The network will be introduced in phases during the transition, from initial data-only services, to the migration of voice services for prioritized group calls and push-to-talk, then finally to serve as a platform for future innovations. That "one size does not fit all" is illustrated by the police force's mobile offices that enable them to administer nearly all tasks at the roadside to avoid visits to the police station. To deliver the mobile office, they are currently utilizing the TETRA network for mission-critical voice and narrow-band data, supporting 2 million group calls and 70 million short data service messages per week, and an additional commercial mobile network for non-critical voice and data for in-vehicle computers and printers. Different subscriptions and devices are required from Virve 2 compared to the current situation, where one radio model is often the solution for every need.

ERILLISVERKOT

This article was written in cooperation with Erillisverkot Group, a Finnish state-owned special-purpose company that provides services for organizations responsible for the safety and functioning of society in the fields of communications, mission control and securing critical infrastructure.

Building on 3GPP technologies

To meet those demands, public safety agencies are increasingly turning to mobile 3GPP-based solutions due to the capabilities provided by 4G and 5G along with many different applications for effective sharing and cooperation, such as the secure and speedy sharing of data, images and video. Erillisverkot Group is leading the way by evolving their PPDR network, Virve 2, which will be based on commercial mobile 3GPP technology with enhancements to meet security, availability and resilience requirements.

Globally, 3GPP technologies used to build commercial 4G and 5G networks today bring many advantages for public safety network operators. This includes the ability to take advantage of open competition in the supply chain, reusing commercial investments and leveraging the global economies of scale that will drive cost efficiencies, compared to bespoke solutions. Seamless integration with the established ecosystem built around 3GPP technologies brings tangible benefits, such as being able to access new and improving network capabilities like higher data rates and lower latency, built-in security and the vast range of devices within the ecosystem. The PPDR will place additional demands on the ecosystem, driving continuous growth to address specific needs, like ruggedized devices for operation in extreme climate conditions, like the sub-zero temperatures in Finland, and terminals with specific form and function for ease of operation in the field for applications like push-to-talk.

Reliable mobile broadband networks with sufficient geographical coverage are a prerequisite for effective cooperation when dealing with larger incidents. Building out the new data services on commercially deployed networks will bring advantages including faster service deployment and environmental benefits, as well as cost efficiencies. Today, Finland already has strong data networks that can be used to commence services much faster than building a new network, allowing resources to focus on the additional requirements for network hardening and build-out to meet coverage needs. There are both cost efficiencies and environmental benefits with a full migration through the removal of the legacy network, and better utilization of existing infrastructure compared to a new overlay network.

Importance of modernization across the ecosystem

Mission-critical broadband technologies play a key role in efficient public safety communications. But to fully realize the successful deployment and adoption of services, the whole ecosystem that these networks are designed to support must also evolve and align. Operations will become more efficient as the laws within which networks operate, trust between organizations, common ICT systems and transparent cooperation within the national ecosystem develop.

Legal framework

Finland is geographically large, but has a population of just 5.6 million people. Laws play a key role in enabling efficient operations and cooperation between parties, such as by enabling the police, Border Guard and customs to do each other's work. For example, the Border Guard's coastguard can carry out water transport traffic control in the Baltic Sea. In the same way, customs officers can carry out similar monitoring of drivers, vehicles and snow mobiles in sparsely populated areas like Lapland. Laws must also not limit effective public safety activities, for example by limiting the use of location information. The use of location information of patrols plays a key role in assigning available resources and patrols to a specific task. Another simple update to the law was changing the size of paper a police ticket could be issued on, enabling even motor cyclist enforcement officers to have all the resources with them to handle the full task at the site and avoid a visit to the local police office. However, it is always important when legislation is updated to ensure privacy protection and ethics are fully considered.

Trust between organizations

A good level of trust between individuals and organizations is a prerequisite so that different organizations can cooperate effectively to achieve efficiency in operations. If public safety organizations are created in a simple way with a clear purpose, this helps build trust and avoid any unnecessary competition between organizations. In Northern Europe, the level of trust in societies has traditionally been high, making it easy to build good cooperation between public safety authorities and individuals.

Common ICT systems
If several organizations (police, Border Guard and customs) do the same work, the best results are achieved if management and communication systems are common or deeply integrated and information is shared across organizations. In Finland, the police follow this model, operating as a single organization with common leadership and communication protocols throughout the entire country. With this model, lending resources to the other areas of the country is easier. The latest 4G and 5G networks and integrated IT systems combined with automated processes are enabling this efficient and effective cooperation across organizations.

Transparent cooperation
Better, closer and more effective cooperation is achievable if the points mentioned above support the work. The best cooperation results are also achievable if it is possible to work and solve tasks right away, on the road, without visits to offices or stations.

A platform for innovation
A key learning from the journey so far with Erillisverkot Group is that to be able to successfully deploy new solutions and service offerings, consideration for the full ecosystem of the environment within which it operates must be fully aligned. It is only when all the component parts are aligned that the full potential of the technology can be realized. The network has a priority in providing data services and migrating existing services to Virve 2, ensuring instant, reliable, and stable communication that safeguards information security and protects data integrity. However, once these capabilities are supported by advanced network features like higher data speeds, lower latency and positioning accuracy, it will open up new opportunities like AR in fire fighters' helmets or drones building a clear picture of emergency situations in sparsely populated areas. Virve 2 will provide an innovation platform, addressing new and unknown use-cases; this is just the beginning of the journey.

Digitalization enables enterprises to reach Net Zero

Enterprise decision-makers view ICT as a facilitator of their journey toward Net Zero through dematerialization, mobile workplaces, and efficient, renewable and resilient energy supplies.

Key insights

- Dematerialization through digitalization is one of the key enablers for reaching Net Zero, and the ICT industry will play an important contributory role.
- Decision-makers already recognize the benefits of digitalization and dematerialization for profitability, productivity and environmental sustainability.
- However, the path to Net Zero will not be a straight line, as commitments to sustainability goals must be harmonized with the need to create resilient systems in an uncertain world.

The journey to Net Zero

There is a need to halve global greenhouse gas emissions by 2030 and reach Net Zero emissions by 2050 at the latest. An approach that reduces environmental impact is to decrease material usage. The ICT sector, through digitalization, can facilitate enterprises' journeys to Net Zero. ICT solutions have the potential to lessen the need for material usage by substituting physical products with digital products and services, within the ICT and other sectors.

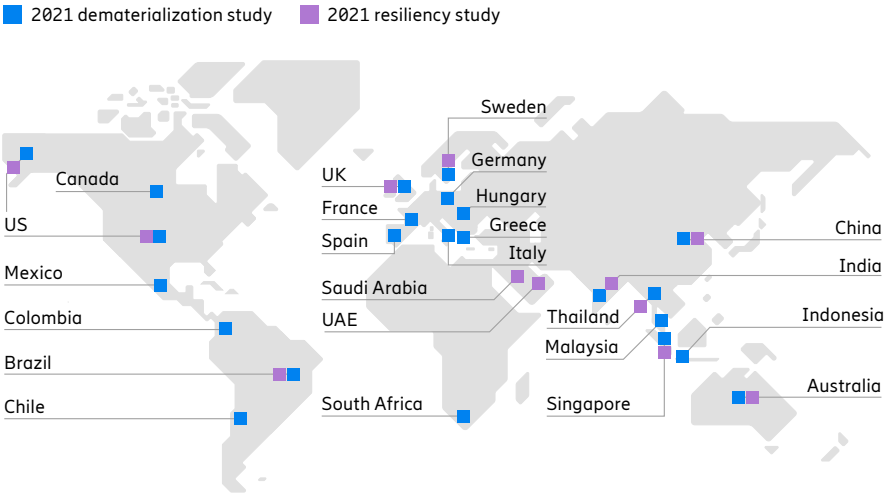
Dematerialization of enterprises

Dematerialization can lead to increased value and reduced consumption of natural resources, enabling enterprises to "create more with less". In fact, an Ericsson report on dematerialization[1] shows that ICT decision-makers agree dematerialized enterprises that are capable of adapting to the evolving needs of customers will be the norm by 2030. (Here, "decision-makers" refers to upper-level managers, including C-level, that have substantial influence or final say on companies' strategies.) Of the decision-makers surveyed, 68 percent agree that the willingness to transform will be of the utmost importance for the success of companies by 2030.

In the report, "dematerialization front-runner enterprises" have been defined as the top one-third of all surveyed enterprises that have reported the most progress in their dematerialization efforts. As shown in Figure 28, these are more agile and streamlined, more environmentally sustainable but also financially stronger. They also use cloud services to a higher degree and see the need for more remote work in the future.

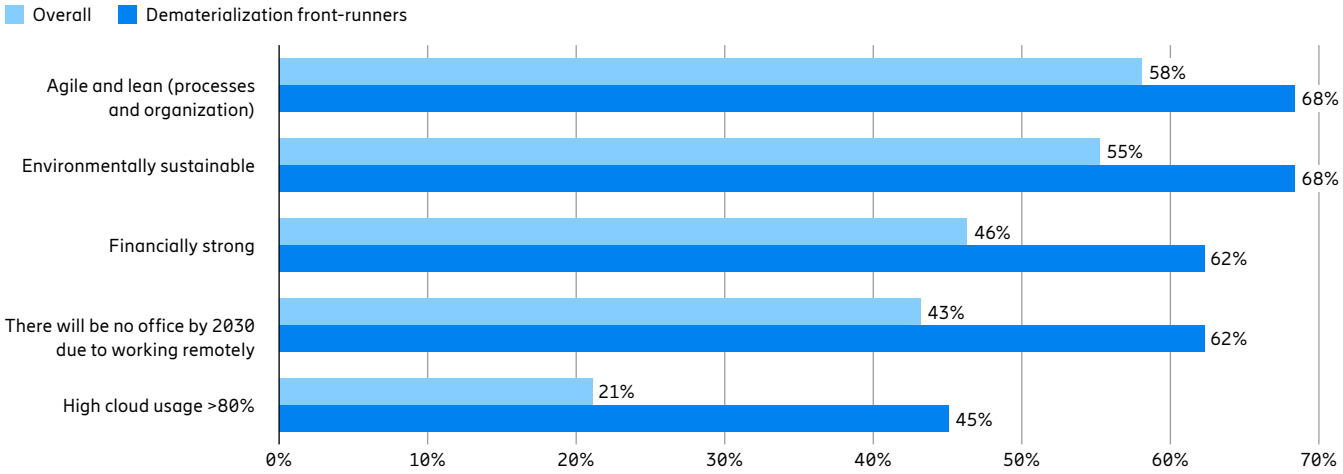
Therefore, in the future, greater numbers of dematerialized enterprises leveraging cloud, AI and mobile technologies are expected to become more adaptable. Approximately 6 in 10 decision-makers agree the key contributors to dematerialization at their respective enterprises are cloud infrastructure, selling software and services rather than physical products and using online training courses and documents. Nearly half of decision-makers agree that improved productivity and profitability are key benefits of dematerialization and around 40 percent say the same for environmental sustainability. This should be seen as a win–win situation that benefits both enterprises and the environment.

Figure 27: Countries included in the enterprises studies



[1] Ericsson Consumer & IndustryLab, The dematerialization path to profitability and sustainability (Feb 2021).

Figure 28: Share of decision-makers that agree each statement is true for their respective enterprises



The mobile workplace

With less work taking place at company premises, enterprises must be able to provide their employees with full access to processes and tools, regardless of the device they use or whether they are at home or out and about. As enterprises become more mobile, cellular and cloud technologies have a pivotal role to play.

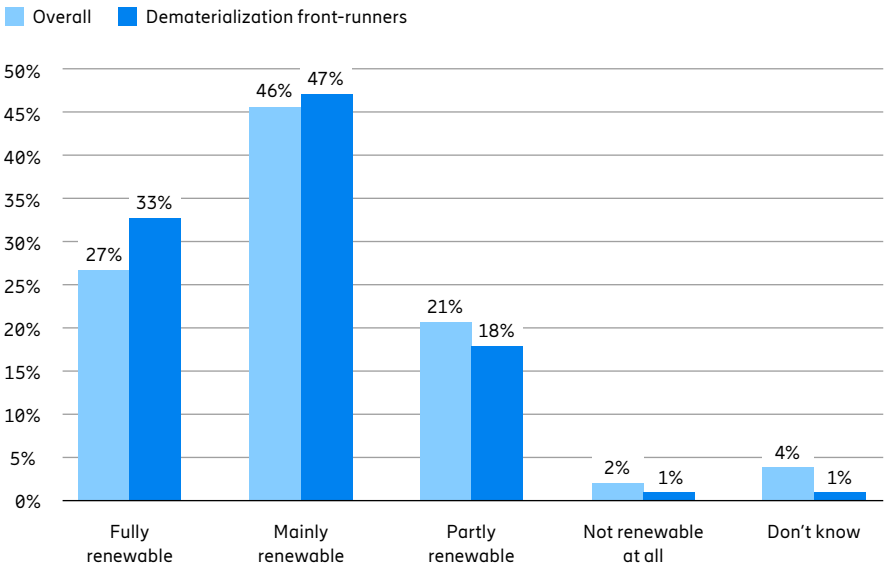
Overall, 8 in 10 ICT decision-makers expect significant energy savings due to the usage of multi-cloud solutions by 2030, not only for their own enterprises but for society as a whole.[2]

Decision-makers and white-collar workers see a need for more immersive online collaboration and meeting tools going forward. In fact, more than 6 in 10 enterprises expect to use 5G devices and almost as many expect to use AR and VR devices by 2030. Over 80 percent of the surveyed enterprise decision-makers have already invested in technologies that allow more flexible remote working. Here, cellular connectivity, such as 5G, is seen as a key enabler.

Connectivity and automation enabling renewable and resilient energy supplies

In addition to increased dematerialization, switching to more renewable energy and energy-efficient solutions, such as cloud architectures, can aid the journey to becoming a Net Zero enterprise. Today, more than half of the surveyed enterprises already use renewable energy for most, if not all, of their electricity needs, for example by installing solar panels.

Figure 29: Decision-makers' expectations for the use of renewable energy for the operational part of their respective enterprises by 2030



By 2030, this is expected to increase to almost 3 in 4, while only 2 percent think they will not use any renewable energy at all.

In response to a more volatile world and increasing energy prices, enterprises are investing in independent renewable electricity production facilities based on solar or wind energy. More than half of decision-makers say shifting investments to renewable energy could make their companies more resilient against price shocks and energy disruptions. Additionally, 76 percent of decision-makers agree it is essential to have resilient power and electricity supplies since many enterprises are heavily energy-dependent, and electricity is also a core enabler for ICT.

The transition toward renewable energy has its own set of challenges and barriers, with one in four decision-makers expecting those economic barriers will be too significant. Other barriers mentioned by one in five decision-makers were the lack of necessary technology, and the lack of incentives and tax breaks.

When moving in this direction, it is important to have a strategy for handling excess energy. As shown in the report "Bringing 5G to power", today's power grids will need to evolve in order to handle the challenges brought about by the more volatile energy supply of tomorrow.[3] Connectivity and automation can deliver higher reliability and better protection of the power grid, unleashing high potential values. Cellular communication is therefore an important enabler to support a shift to renewable energy sources and to balance a more volatile energy system.

[2] Ericsson Consumer & IndustryLab, The dematerialization path to profitability and sustainability (Feb 2021).
[3] Ericsson Consumer & IndustryLab, Bringing 5G to power (March 2020).

Investing to achieve harmony between sustainability and resilience

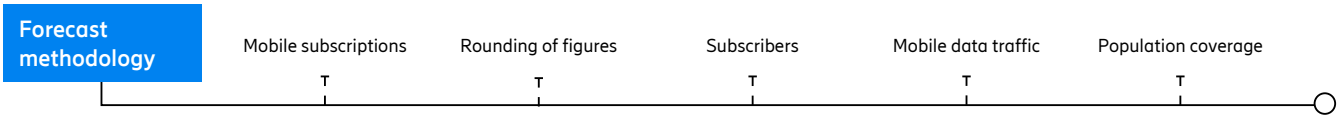
Enterprises have a long journey ahead toward a Net Zero future, and different strategies must be taken by enterprises attempting to become sustainable. In addition, in the "Time to rethink resilience" report, enterprises expect disruptive events to be more frequent and severe in the future.[4] Four times more decision-makers agree than disagree about this; their concerns include events such as pandemics, military conflicts, and energy crises. This is forcing enterprises to become more prepared and resilient for future events.

The ambitions of enterprises to become more sustainable could face a conflict, especially in times of crisis, as the need to improve resilience increases as well. The resilience report shows that increased exposure of disruptive events makes companies prefer the redundant and more resource-intensive solutions they are familiar with. This contrasts with the sustainability goals of reducing energy consumption and the depletion of natural resources. Thereby, efficiency efforts may be affected by enterprises' need to build up redundancy solutions. To break the vicious cycle of increased redundancy, energy usage and natural resources, additional focus must be placed on dematerialization through digitalization, and a society-wide focus on long term resilience that can be achieved in harmony with sustainability ambitions. Almost half of enterprises surveyed in the "Time to rethink resilience" report always consider both efficiency and redundancy to find the best trade-off between handling disruptive events and long-term sustainability. Therefore, it is important for enterprises to have strategies in both the short and long term. Investments in digitalization and conscious prioritization between efficiency and redundancy are examples of strategies that help enterprise to improve their resilience and sustainability.

It is evident that dematerialization through digitalization contributes to the journey to Net Zero, but also to decreased costs and higher profitability for enterprises. The role of ICT is undeniable within this context, but it is not clear if this transformation will happen in line with the exponential road map.[5]

[4] Ericsson Consumer & IndustryLab, Future of Enterprises #3 – Time to rethink resilience.
[5] Exponential Roadmap, exponentialroadmap.org (January 2020).

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

2CC: Two component carrier

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

4CC: Four component carrier

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

Net Zero: Defined in ITU standards as a future state where all emissions that can be reduced are reduced, with like-for-like or permanent removals applied by carbon-removal technologies to balance the remaining emissions

NR: New Radio as defined by 3GPP Release 15

NR-DC: NR-NR Dual connectivity

NSA 5G: Non-standalone 5G is a 5G Radio Access Network (RAN) that operates on a legacy 4G/LTE core

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	2021	2022	Forecast 2028	CAGR* 2022–2028	Unit
Worldwide mobile subscriptions	8,210	8,390	9,230	2%	million
• Smartphone subscriptions	6,260	6,600	7,790	3%	million
• Mobile PC, tablet and mobile router subscriptions	390	410	680	9%	million
• Mobile broadband subscriptions	6,780	7,120	8,590	3%	million
• Mobile subscriptions, GSM/EDGE-only	1,290	1,130	470	-14%	million
• Mobile subscriptions, WCDMA/HSPA	1,320	1,040	180	-25%	million
• Mobile subscriptions, LTE	5,030	5,160	3,580	-6%	million
• Mobile subscriptions, 5G	548	1,050	4,970	30%	million
• Fixed wireless access connections	88	107	300	19%	million
Fixed broadband connections	**1,360**	**1,450**	**1,800**	**4%**	**million**
Mobile data traffic					
• Data traffic per smartphone	12	15	46	21%	GB/month
• Data traffic per mobile PC	17	20	31	7%	GB/month
• Data traffic per tablet	9.6	11	27	16%	GB/month
Total data traffic**					
Mobile data traffic	68	90	324	24%	EB/month
• Smartphones	65	87	314	24%	EB/month
• Mobile PCs and routers	0.6	0.9	3.1	23%	EB/month
• Tablets	2.2	2.5	6.7	18%	EB/month
Fixed wireless access	17	25	128	32%	EB/month
Total mobile network traffic	85	115	452	26%	EB/month
Total fixed data traffic	220	270	600	14%	EB/month

Regional key figures

Mobile subscriptions	2021	2022	Forecast 2028	CAGR* 2022–2028	Unit
North America	390	400	460	2%	million
Latin America	690	710	790	2%	million
Western Europe	540	550	560	0%	million
Central and Eastern Europe	570	570	570	0%	million
North East Asia	2,120	2,170	2,300	1%	million
China[1]	1,660	1,700	1,750	1%	million
South East Asia and Oceania	1,150	1,170	1,290	2%	million
India, Nepal and Bhutan	1,140	1,160	1,290	2%	million
Middle East and North Africa	750	760	880	2%	million
Gulf Cooperation Council (GCC)[2]	76	77	83	1%	million
Sub-Saharan Africa	850	890	1,100	4%	million

Smartphone subscriptions	2021	2022	Forecast 2028	CAGR* 2022–2028	Unit
North America	310	320	330	1%	million
Latin America	540	570	670	3%	million
Western Europe	430	440	440	0%	million
Central and Eastern Europe	410	420	430	0%	million
North East Asia	1,920	1,990	2,160	1%	million
China[1]	1,520	1,570	1,660	1%	million
South East Asia and Oceania	860	910	1,120	3%	million
India, Nepal and Bhutan	800	890	1,210	5%	million
Middle East and North Africa	630	680	760	2%	million
GCC[2]	63	65	73	2%	million
Sub-Saharan Africa	350	380	710	11%	million

Regional key figures

LTE subscriptions	2021	2022	Forecast 2028	CAGR* 2022–2028	Unit
North America	290	250	40	-26%	million
Latin America	460	520	290	-9%	million
Western Europe	450	450	70	-27%	million
Central and Eastern Europe	360	420	320	-5%	million
North East Asia	1,590	1,350	560	-14%	million
China[1]	1,210	980	390	-14%	million
South East Asia and Oceania	560	650	590	-2%	million
India, Nepal and Bhutan	780	840	570	-6%	million
Middle East and North Africa	360	430	550	4%	million
GCC[2]	61	55	8	-28%	million
Sub-Saharan Africa	181	260	600	15%	million

5G subscriptions	2021	2022	Forecast 2028	CAGR* 2022–2028	Unit
North America	79	141	420	20%	million
Latin America	5	19	400	N/A	million
Western Europe	32	63	490	41%	million
Central and Eastern Europe	1	4	240	N/A	million
North East Asia	408	728	1,710	15%	million
China[1]	357	644	1,400	14%	million
South East Asia and Oceania	10	29	620	N/A	million
India, Nepal and Bhutan	0	31	690	N/A	million
Middle East and North Africa	10	24	270	N/A	million
GCC[2]	6	15	71	30%	million
Sub-Saharan Africa	3	7	150	N/A	million

Data traffic per smartphone	2021	2022	Forecast 2028	CAGR* 2022–2028	Unit
North America	14	17	55	21%	GB/month
Latin America	7.7	10.5	41	25%	GB/month
Western Europe	15	19	52	18%	GB/month
Central and Eastern Europe	9.9	13	35	18%	GB/month
North East Asia	14	17	55	21%	GB/month
China[1]	15	18	47	18%	GB/month
South East Asia and Oceania	9.1	12.5	54	28%	GB/month
India, Nepal and Bhutan	20	25	54	14%	GB/month
Middle East and North Africa	7.8	11	38	24%	GB/month
GCC[2]	22	25	53	13%	GB/month
Sub-Saharan Africa	3.3	4.6	18	26%	GB/month

Mobile data traffic	2021	2022	Forecast 2028	CAGR* 2022–2028	Unit
North America	4.8	6.0	21	23%	EB/month
Latin America	3.7	5.3	24	28%	EB/month
Western Europe	6.1	7.8	22	19%	EB/month
Central and Eastern Europe	3.3	4.3	12	18%	EB/month
North East Asia	23	30	100	22%	EB/month
China[1]	20	26	88	23%	EB/month
South East Asia and Oceania	7.3	11	55	32%	EB/month
India, Nepal and Bhutan	14	18	53	19%	EB/month
Middle East and North Africa	4.5	6.4	26	27%	EB/month
GCC[2]	1.1	1.3	3.0	15%	EB/month
Sub-Saharan Africa	1.0	1.6	11	39%	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 and enterprises to capture the full value of connectivity. The company's portfolio spans the following business areas: Networks, Cloud Software and Services, Enterprise Wireless Solutions, Global Communications Platform, 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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