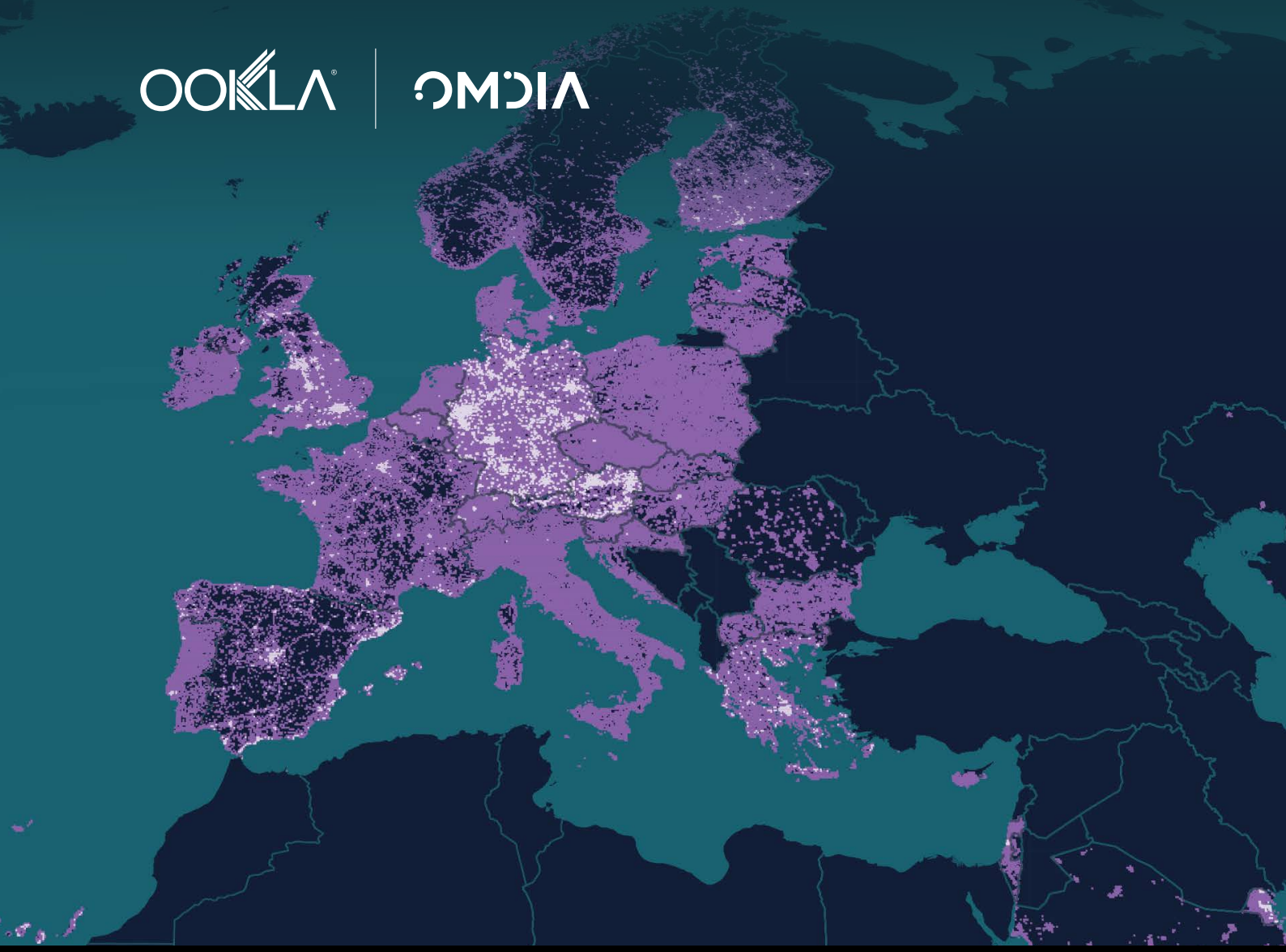
A Global Evaluation of Europe's Digital Competitiveness in 5G Standalone



Executive summary

This report offers a comprehensive evaluation of Europe's digital competitiveness in the deployment and commercialization of 5G Standalone (SA) networks—a key pillar of the European Commission's emerging pro-growth industrial strategy intended to differentiate the bloc by delivering world-class mobile network infrastructure. Developed independently in collaboration with Omdia and leveraging Ookla's industry-leading network intelligence, this analysis benchmarks Europe's progress in deploying and monetizing 5G SA networks against key global regions such as North America and Asia.

The report aims to provide data-driven insights to inform policymakers and industry stakeholders as they work to improve Europe's digital competitiveness and secure its position in the global 5G landscape.

Key takeaways:

1. **Europe severely lags other major regions in 5G SA rollout and performance:** While Europe has set the most ambitious 5G infrastructure targets of any advanced liberal economy, it currently features the poorest outcomes in terms of 5G SA performance among major regions. In Q4 2024, China (80%), India (52%), and the United States (24%) led the world in 5G SA availability based on Speedtest® sample share, markedly ahead of Europe (2%). The region also lagged behind its peers on other key metrics, with the median European consumer experiencing 5G SA download speeds of 221.17 Mbps—lower than those in the Americas (384.42 Mbps) and both Developed (237.04 Mbps) and Emerging (259.73 Mbps) Asia Pacific. The interplay of earlier deployments, a more diversified multi-band spectrum strategy, and greater operator willingness to invest in the 5G core to monetize new use cases have driven rollouts at a faster pace in regions outside Europe.

2. **Europe exhibits significant disparities in 5G SA deployment among member states:** Within Europe, while 5G SA rollout progress remains highly varied, the best outcomes have been observed in countries that have specific policies intended to incentivize 5G SA deployment. Germany, the United Kingdom, and Spain—all four-player markets benefiting from targeted 5G SA-specific fiscal stimuli or coverage obligations—lead Europe in terms of 5G SA rollout across multiple operators. Meanwhile, Southern and Central European countries have supplanted the Nordics at the forefront of this phase of the 5G cycle, with Greece (547.52 Mbps) leading on median download speed in Q4 2024 thanks to its 3.5 GHz usage, and Spain and Austria excelling in rural 5G SA coverage on the back of intensive deployment of the 700 MHz band.

3. **For Europe, the performance improvements unlocked by 5G SA demonstrate the strategic importance of the technology in driving digital competitiveness:** Globally, 5G SA networks are delivering significantly improved performance across key metrics compared to the non-standalone architecture. In Q4 2024, median latency—a key beneficiary of transitioning to the 5G core—was nearly 20% lower on 5G SA networks compared to 5G Non-Standalone (NSA) networks in Europe and China, and more than 25% lower in the United States and Japan. Similarly, median download speeds on 5G SA were more than 57% higher in Europe and 84% higher in China than those on non-standalone networks. Notwithstanding these improvements, 5G SA's full potential remains largely untapped in Europe. Advanced uplink capabilities unlocked by the technology—such as higher-order MIMO and carrier aggregation—remain limited to a few operators in leading markets like the United States, highlighting the still nascent profile of the device and equipment ecosystems for 5G SA.

4. **To capture the full monetization potential of the technology, European operators need to adapt their business models and cater to new verticals:** While 5G investments in Europe have yet to yield significant monetization, operators in other regions are leveraging the enhanced performance and flexibility of the new 5G core to drive tariff and service innovation. They are focusing on consumer segmentation with performance-oriented tariff upsells and developing tailored network slices to deliver new services across diverse enterprise verticals. European operators at the forefront of business model evolution with 5G SA—such as BT's EE in the UK, Deutsche Telekom in Germany, Elisa in Finland, and 3 in Austria—are leveraging the technology to consolidate their positions at the premium end of the market and stimulate average revenue per user (ARPU) growth.

The European Commission is positioning 5G SA at the core of its pro-growth industrial strategy to enhance the bloc's global competitiveness in key sectors. However, despite setting more ambitious infrastructure targets than other advanced economies, Europe's deployment of the technology continues to lag, with rollout varying significantly across member states.

Contents

Foreword on Ookla and Omdia's collaboration

This report, a flagship output of the strategic collaboration between Ookla and Omdia, combines Ookla's industry-leading network intelligence and competitive benchmarking with Omdia's best-in-class expertise in telecoms market analysis. It delivers an independent assessment of the state of 5G SA in Europe relative to other leading global regions—providing a holistic view from network performance to business strategies for monetizing the technology for consumers and enterprises.

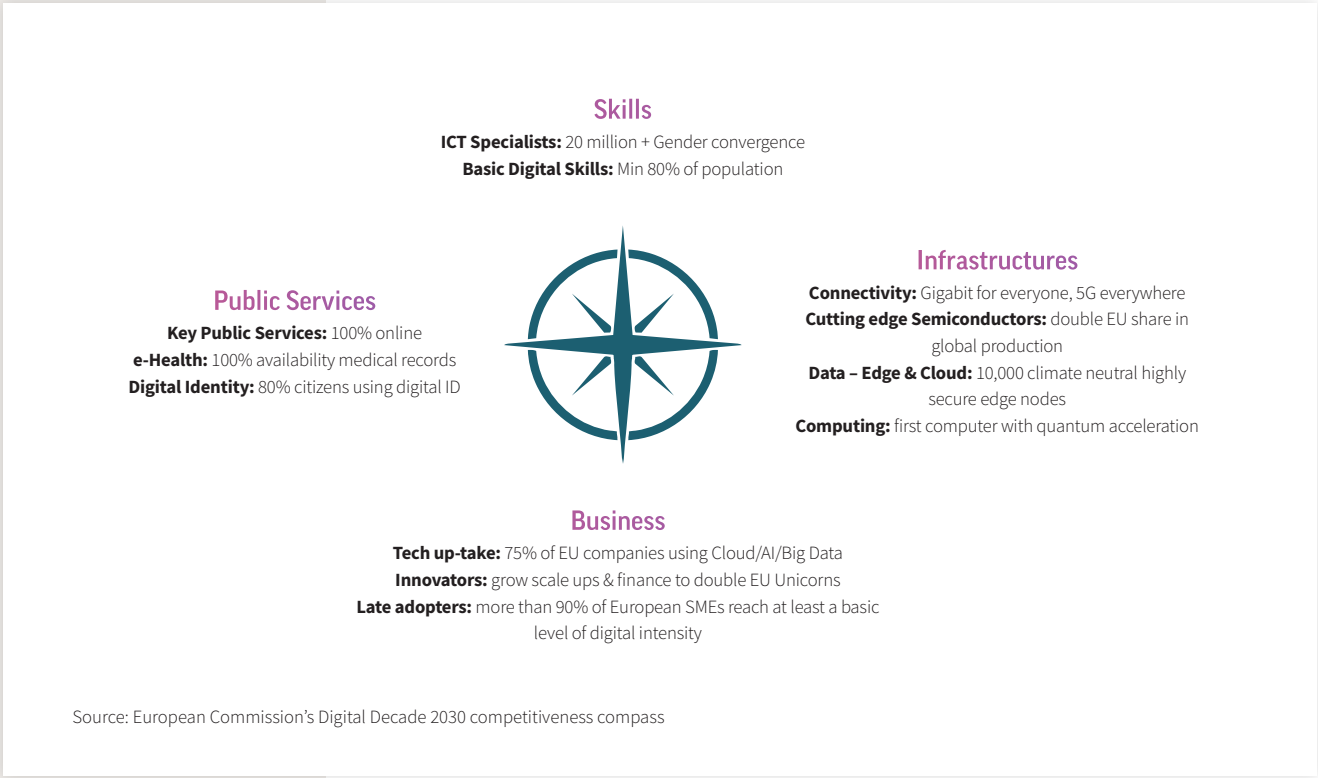
Background on 5G SA's technology context

The commercialisation and deployment of 5G SA represents a critical next step for European operators, arriving at the midpoint in the broader 5G technology and investment cycle. This evolution builds on the transition from 5G NSA, which was first launched in the region in Switzerland in 2019 and has since become the dominant 5G configuration in Europe and around the world. The NSA architecture, which relies on the existing 4G Evolved Packet Core (EPC), has enabled operators to quickly and cost-effectively deploy 5G by upgrading the radio access network (RAN) to realize the performance benefits of the new air interface.

Transitioning to 5G SA eliminates the dependence on the 4G control plane, paving the way for a flexible, cloud-native 5G core. This shift not only delivers cost efficiencies, scalability, and agility for operators but also unlocks advanced network capabilities—including ultra-reliable low-latency communication (URLLC), massive IoT support (mMTC), enhanced edge connectivity, and network slicing.

The role of 5G SA in advancing European competitiveness

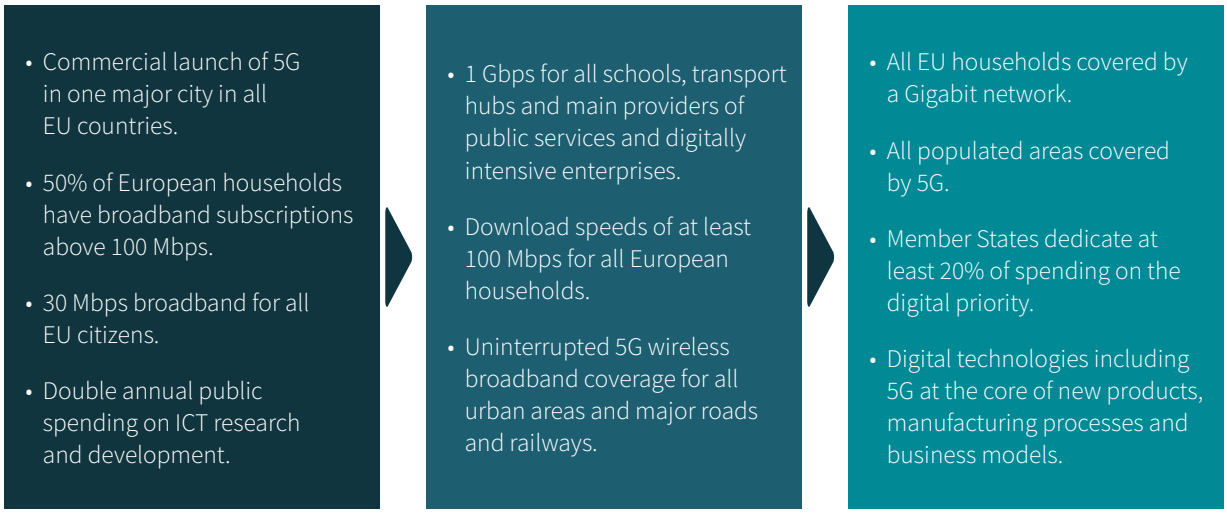
Mobile networks form the backbone of modern digital infrastructure. High-quality, ubiquitous connectivity supports a wide range of applications—from video conferencing and telemedicine to real-time data analytics and AI services that drive productivity and innovation. The Draghi report positioned Europe's competitiveness in mobile network infrastructure as a central plank of an emerging pro-growth industrial strategy aimed at strengthening the continent's global position in key strategic industries.



Source: European Commission's Digital Decade 2030 competitiveness compass

The European Commission's commitment to high-performing mobile networks long predates the Draghi report, most notably through the Digital Decade program. This flagship policy initiative outlines a suite of targets aimed at driving "a successful digital transformation" across European society, businesses and the environment by the end of this decade.

The deployment of next-generation telecoms networks underpins the entire policy agenda. The Commission's Digital Decade infrastructure targets—universal access to gigabit-class broadband services and 100% 5G population coverage throughout the EU by 2030—are highly ambitious, surpassing the goals set by many other liberal economies. Few advanced non-European economies have mandated such expansive 5G deployment, and no country outside Europe has achieved this yet.



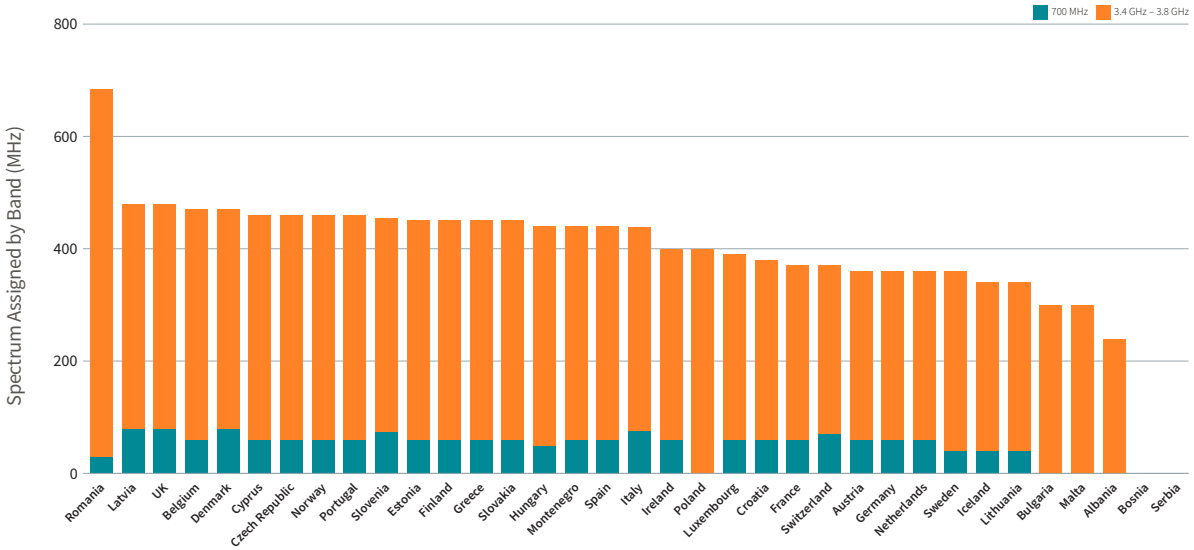
Source: Evolution of the European Commission's 5G policy targets

The Commission closely monitors progress to guide member states on their trajectory toward meeting the targets and to support competitive benchmarking against leading economies in North America, the Middle East and Asia. The latest data indicates that Europe is making substantial progress in several key areas, including the allocation of dedicated low and mid-band spectrum for 5G and the expansion of full-fiber networks.

Despite this progress, however, concerns persist over the state of Europe's telecoms infrastructure and its ability to compete with global peers—especially regarding the availability and performance of mobile networks midway through the 5G cycle. The Draghi report underscored these concerns, concluding that extensive market fragmentation, limited pan-European scalability and excessive regulatory intervention have resulted in capital expenditure per capita that is less than half that of the US and Japan. Ookla previously **published extensive research** on the impact of Europe's relatively less concentrated mobile market structure on mobile network performance.

Europe Achieves Significant Progress in Allocating Low and Mid-band Spectrum for 5G

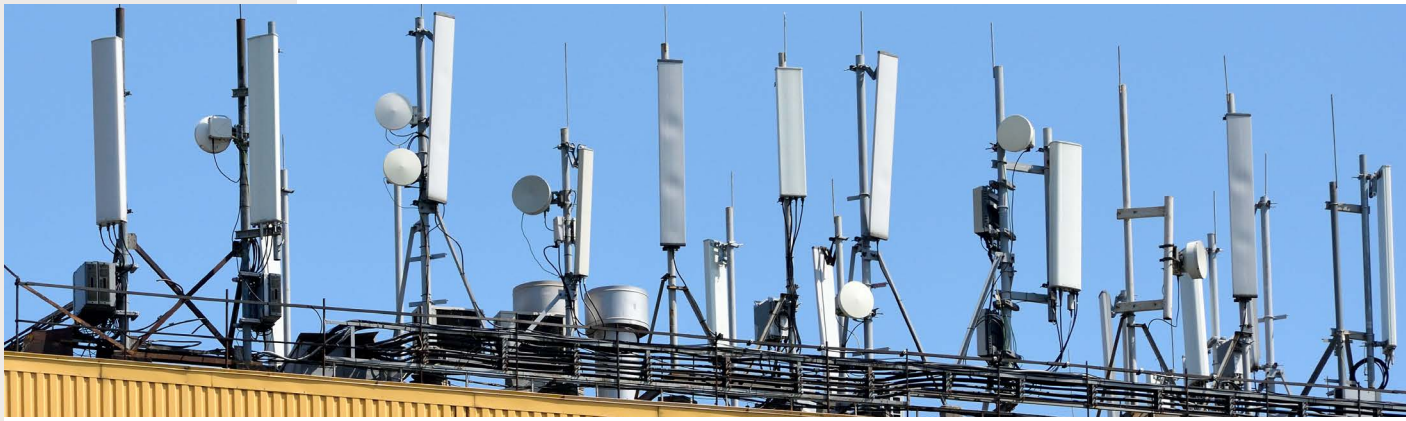
Analysis of Connect Europe data | November 2024



As 5G rollouts mature in advanced economies around the world, the balance of policy focus is shifting towards monitoring the commercialization of the standalone architecture. In response, the Commission has championed measures to accelerate private investment in 5G SA, highlighting network slicing—a flagship capability of cloud-native core networks—as a key potential driver of its broader industrial strategy in sectors such as precision manufacturing, defence and clean energy.

Up until this point, high-quality public data examining Europe's progress in 5G SA—and benchmarking its competitive position relative to other global regions—has been scarce. In its **latest annual report**, Connect Europe, the trade body representing Europe's telecoms operators, noted that "there is limited information available about the extent of operators' rollout of 5G SA."

For the first time, and with the aim of supporting both the monitoring of European digital competitiveness and the Commission's broader adoption of a pro-growth industrial strategy incorporating telecoms infrastructure, this report makes public extensive data and research on the performance and availability of 5G SA across advanced economies in Europe, North America and Asia.



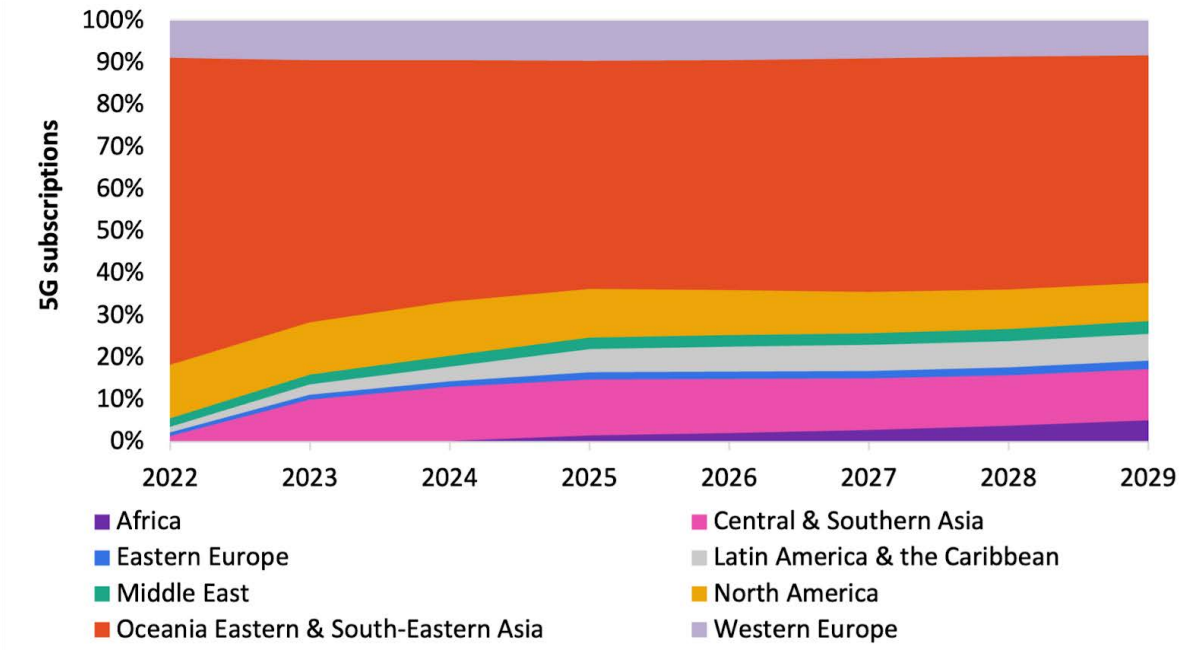
The status of telecoms investments in Europe

Challenging macroeconomic conditions, technical complexity, and skills gaps have slowed 5G SA commercialization in Europe

Operators have historically upgraded their mobile networks to the next generation (G) about once every 10 years. However, of equal importance to these 10-year cycles, are inter-generational refinements to mobile broadband specifications, delivered by the 3GPP standards group, which seek to elevate mobile network performance and functionality, in order to meet or surpass the ITU's IMT targets for each generation.

In a bid to accelerate 5G's introduction and rollout, given the deployment complexities and lack of 5G core maturity at the time, the industry made the decision to derisk investments and fast-track 5G via the NSA configuration. 5G NSA is a stepping stone towards true 5G, introducing 5G New Radio (5G NR) capabilities in the RAN, but relying on the existing 4G network (including 4G EPC).

5G Mobile Subscriptions by Region, 2022-29



Source: Omdia

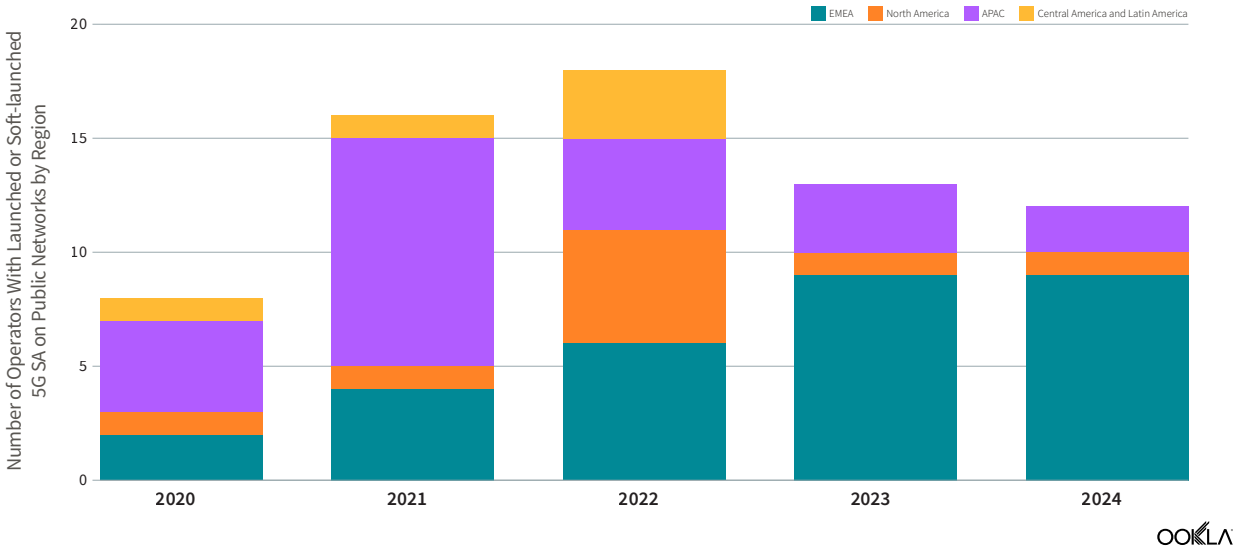
Given it is built using cloud native technologies, the 5G core is far more complex than that of previous generations. Building and operating a cloud native core requires operators to change their ways of working and develop more internal software skillsets among their employee base. Cloud native will make new automation tools available that will improve the networks' operational agility and improve service scaling, which will help operators make better use of their network assets.

For these reasons, deploying the cloud native core has been challenging for many operators. They are faced with several strategic choices, such as building a single stack or a multi-vendor stack and they have to make a decision that is right for them according to their in-house resources and capabilities. Upskilling or hiring staff with the necessary skillsets brings its own challenges.

While there are technical challenges of rolling out a cloud native core, it's clear that operators will benefit from efficient resource allocation for delivering services. Network slicing, a much-talked-about 5G enabler, will ensure specific key performance indicators (KPIs) are orchestrated and delivered to different use cases. Additionally, network slicing is key for expanding operators' revenue in particular in the enterprise and B2B environments.

While Operators in APAC Led the First Wave of 5G SA Commercialization, Activity in Europe, the Middle East, and Africa Has Picked Up

Analysis of GSA data | January 2025

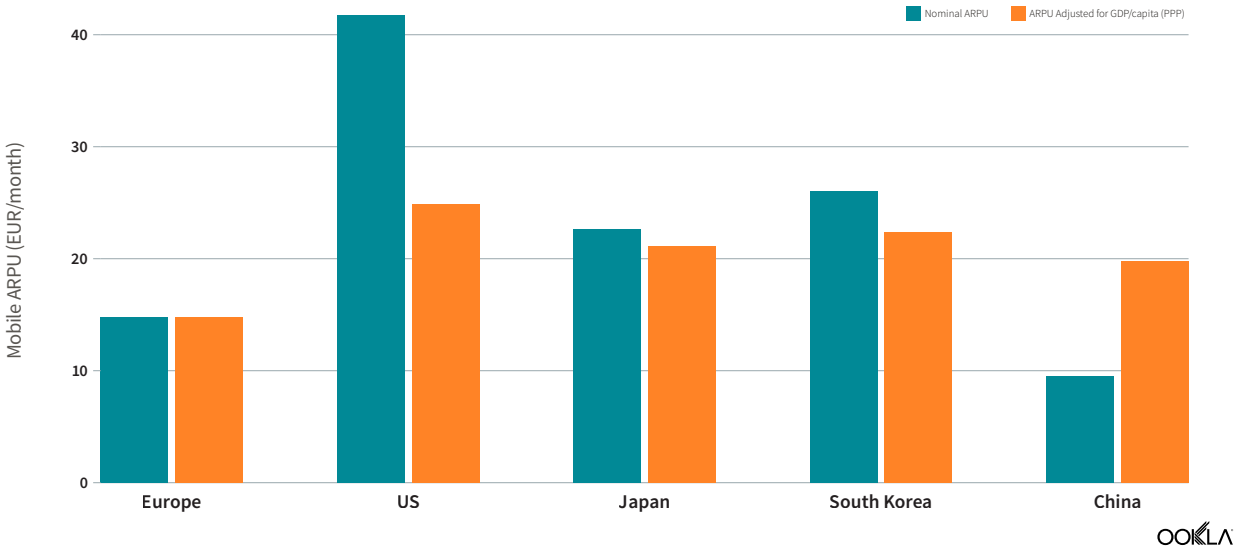


Since the beginning of 5G network rollouts in 2019, more than 320 operators have deployed 5G NR, however, the majority of these remain in the NSA architecture. As a result, many of the benefits of a full 5G architecture were delayed. For operators to recoup their 5G investments and roll out services beyond just mobile broadband, however, they must invest in a 5G SA core and create an end-to-end 5G network. The cloud native 5G core will deliver improved agility, reliability and scalability compared to 4G networks.

The 5G tech cycle has also occurred at a point of slowing revenue growth within the telecoms sector, as markets have become saturated, and operators have struggled to drive sustainable incremental revenues. This has thrown the required investment to support 5G deployment and upgrades into sharp relief. According to Omdia's WCIS database, global average revenue per user (ARPU) declined 45% over the last decade. It further forecasts that global ARPU will decline with a five-year CAGR of -1.3% through 2028, from $6.10 in 2023 to $5.72 in 2028. The declining ARPU situation that operators, including those in Europe are facing, has all but challenged their investment decisions.

Mobile ARPU in Europe is Substantially Below Comparator Countries When Adjusted for GDP/Capita Differences

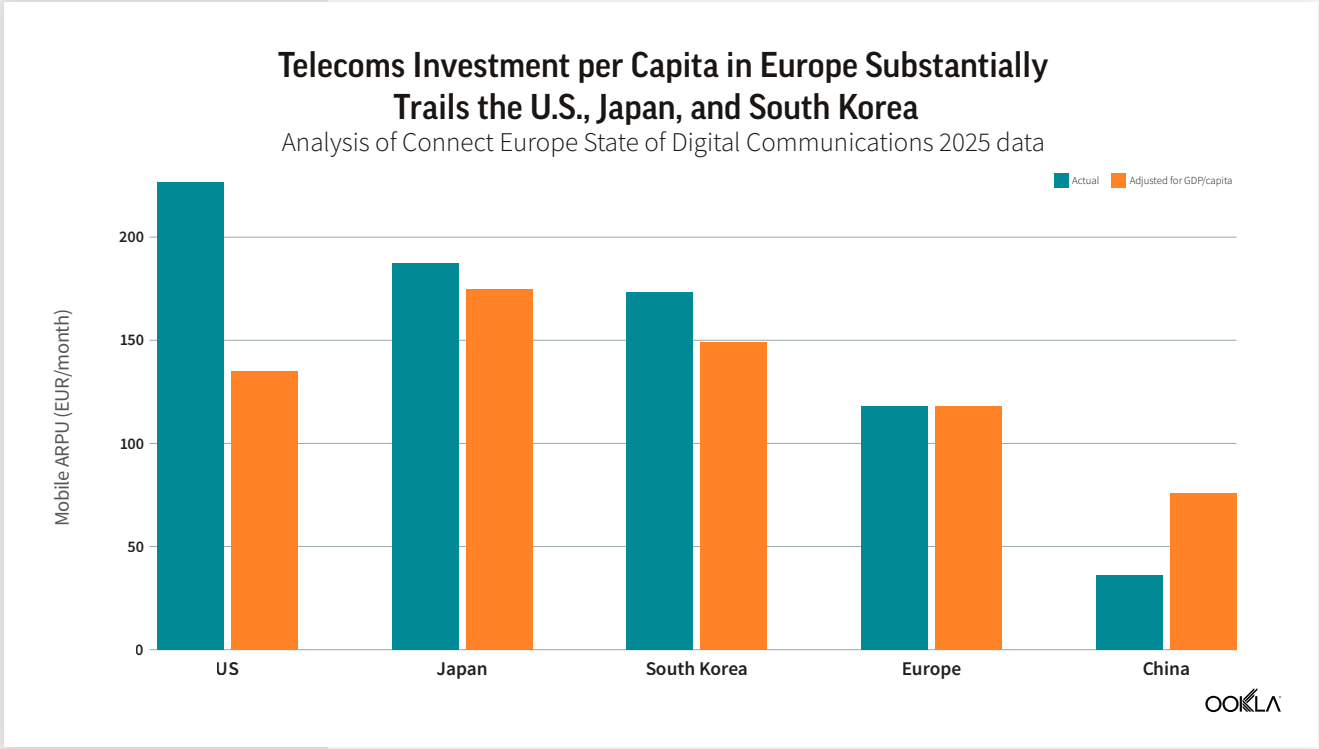
Analysis of Connect Europe State of Digital Communications 2025 data



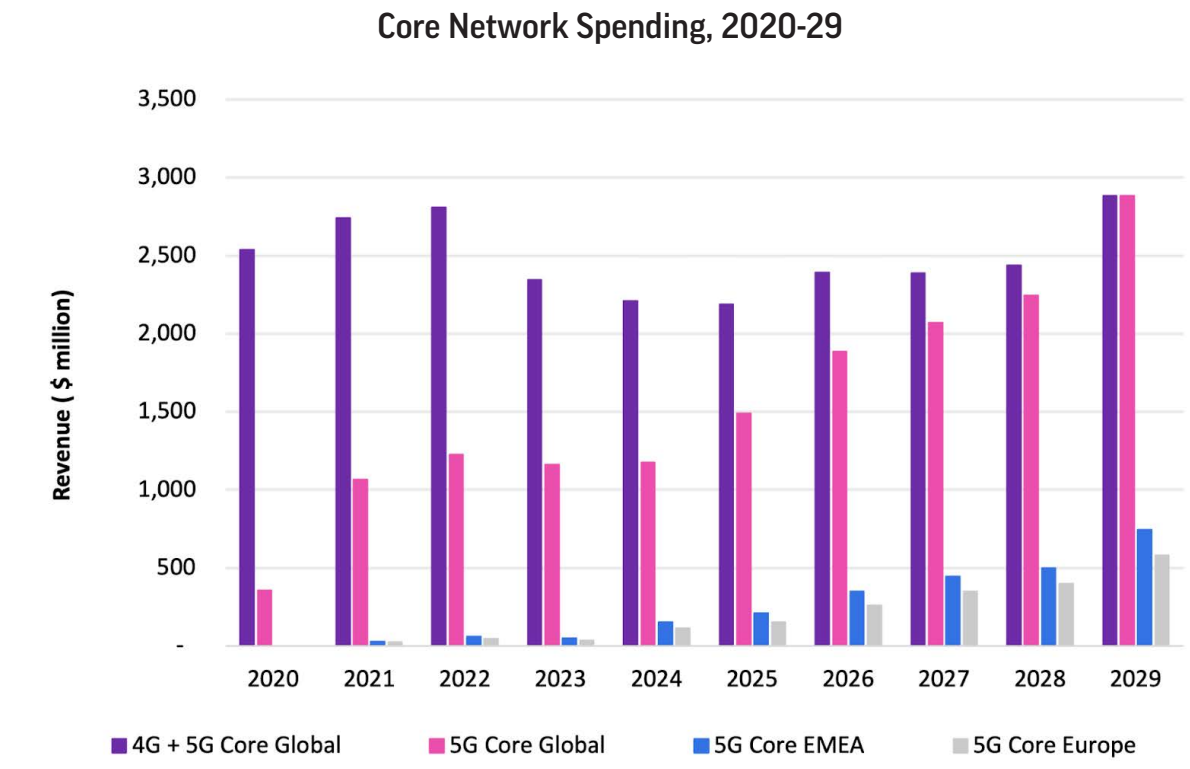
Recent macroeconomic headwinds—especially rising interest rates that have driven up the cost of capital—have forced operators to reassess their investment strategies. In a high cost of capital environment, operators are compelled to delay or trade off capital expenditures more aggressively than they would under more favorable conditions. When faced with choices among investments in fiber, 5G RAN, and 5G core, the 5G core frequently loses out, since operators can still launch a "5G" network by leveraging alternative technologies. There is also a lack of 5G SA-compatible devices, especially devices with User Equipment Routing Selection Policy (URSP) technology, which allows a device to dynamically select a slice (or multiple slices) provisioned by an operator. Only Android 12/iOS 17 devices and above support the technology.

While capital spending on the 5G core transition is now increasing rapidly, European operators will remain committed to strict cost discipline

Based on Omdia's Q3 2024 quarterly core software market share and forecast, the research firm believes that the global core market revenue from both 4G and 5G network functions will grow with a five-year CAGR of 3.2% between 2023 and 2028. When considering the spending in 5G core software, the forecasted growth with a five-year CAGR during the same period is of 17.0%.

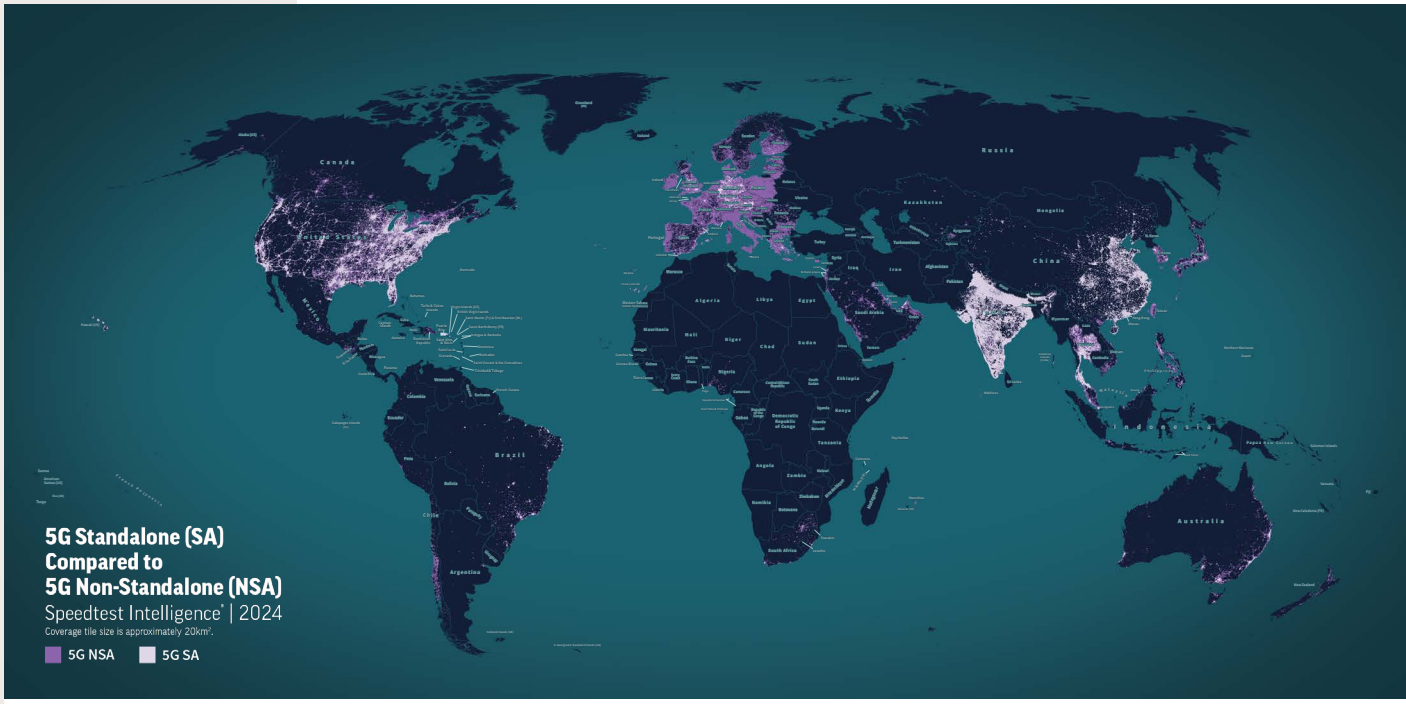


Omdia forecasts that 5G core spending in EMEA will grow with a five-year CAGR of 26.2% between 2023 and 2028. Nonetheless, as a prerequisite, deploying the 5G core also requires a good 5G radio coverage, to avoid a degraded experience where the 5G coverage is limited or nonexistent, and where the user falls back on 4G-LTE or 2G/3G. This means operators must invest in 5G RAN, which is usually considered the highest capex draining activity for an operator. While 5G is known for very high throughput speeds using mid-band (and particularly C-band) spectrum, these bands need to be complemented by sub-GHz spectrum deployment, in order to offer improved in-building and wide area coverage. This rollout has been slow in many European markets, with 5G availability in all countries outside the Nordics remaining significantly lower than that in the United States and China, according to Q4 2024 **Speedtest Intelligence**® data.



While the 5G SA core will cater for mobility functions and data throughput, there are a large number of other network functions that make up the composition of the core. Some of those include the signaling network functions, such as the service communications proxy (SCP) and network repository function (NRF) which will help create operational efficiencies for operators. Others, such as the network exposure function (NEF) and network data analytics function (NWDAF) will facilitate operators to roll out new use cases on their monetization journeys.

Despite the challenges, Omdia believes that most operators in the region will continue to exercise strict cost discipline. Nonetheless, Omdia expects spending in 5G SA core to more than double by 2026 and continue apace during the rest of the forecast period as customer data usage continues to grow.



The state of regional competitiveness in 5G SA around the world

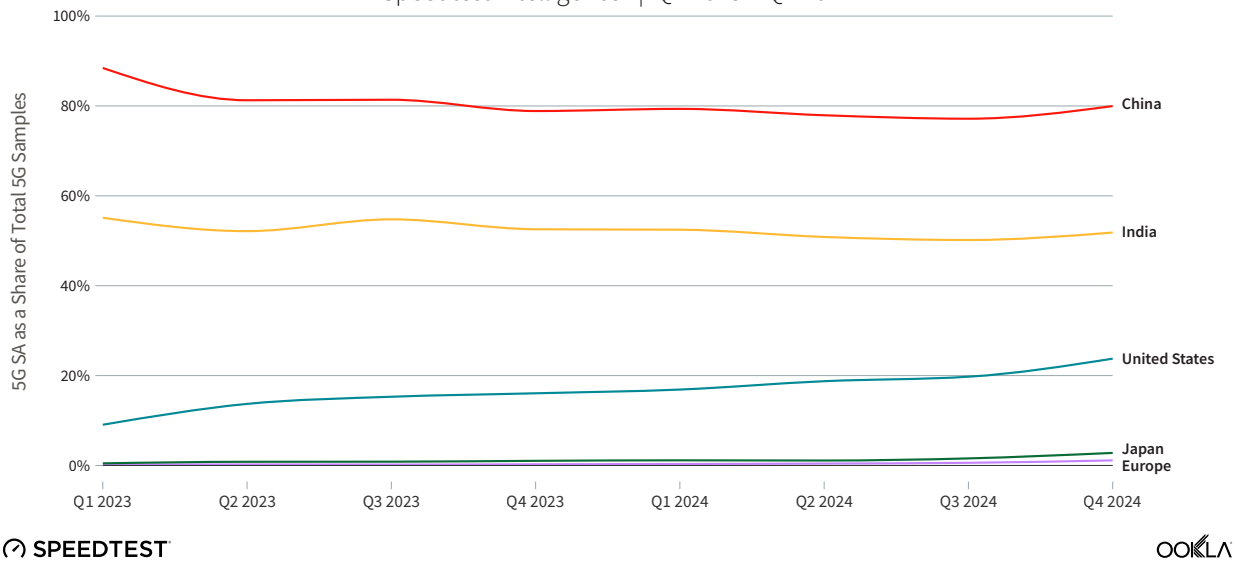
Recent uptick in European 5G SA launches belies stark underperformance in rollout relative to Asia Pacific and the Americas

The profile of commercial 5G SA launches has shifted markedly in the last two years. While early adoption of the 5G core was concentrated in the Asia-Pacific (APAC) region, Europe, the Middle East and Africa (EMEA) has emerged as the primary center of launch activity as the technology matures. EMEA dominated new launches with 9 commercial deployments in both 2023 and 2024, representing 70% and 75% of global rollouts respectively. This regional shift reflects both EMEA's fragmented operator landscape (with over 30 operators in the EU alone compared to just four in the US and China) and its more cautious approach to transitioning to the 5G core.

The number of countries globally with multiple operators offering commercial 5G SA services remains limited, resulting in highly asymmetric access to the technology across subscribers of different operators. This is evident even in leading countries like the United States and India, where high 5G SA availability is concentrated in a single operator—T-Mobile and Reliance Jio respectively—driven by aggressive nationwide low-band deployment. In Jio's case, this was further bolstered by its unique decision to skip the NSA architecture entirely in favor of a full 5G SA rollout.

The Disparity in 5G SA Rollout Progress Between China, India, and the Rest of the World Remains Significant

Speedtest Intelligence® | Q1 2023 – Q4 2024



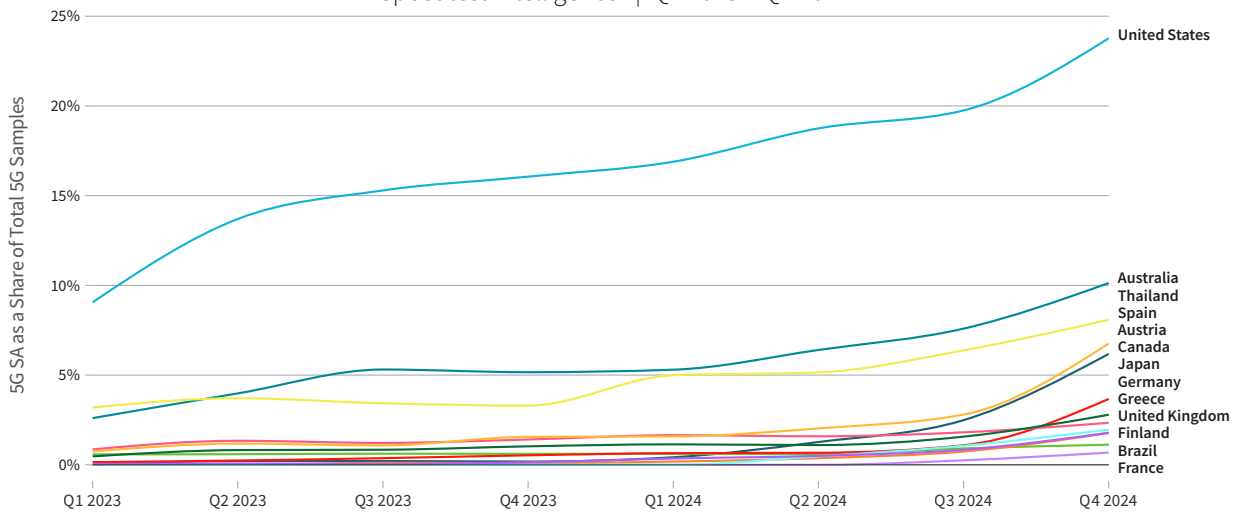
Despite the slowdown in commercial launch activity in APAC, the region remains at the forefront of 5G SA adoption. China stands out as one of, if not the only, global market where all mobile operators provide extensive commercial 5G SA service nationwide. As a result, it has built a substantial global lead in 5G SA availability and adoption, with approximately 80% of all Speedtest samples from China in the past two years originating on 5G networks using 5G SA technology, demonstrating widespread SA access across the country's entire mobile subscriber base [1].

The primacy of China in 5G SA is notable because it breaks from the telecom leadership tradition of countries like South Korea, which pioneered commercialization of the 5G NSA architecture but have been slow to shift to 5G SA. By Q4 2024, KT remained the sole operator offering nationwide commercial 5G SA service in the country, with its focus on mid-band spectrum deployment limiting overall availability of the technology.

[1] A higher 5G SA sample share serves as a proxy for greater 5G SA availability—the proportion of network users with 5G-active devices who spend the majority of their time connected to 5G SA networks. As with any availability metric, factors such as tariff-provisioned access to 5G SA may influence differences between operators and countries beyond the scale of network rollout, making it a strong indicator of the median consumer experience.

Outside of China, the United States Has Established a Significant Global Lead in 5G SA Rollout

Speedtest Intelligence® | Q1 2023 – Q4 2024



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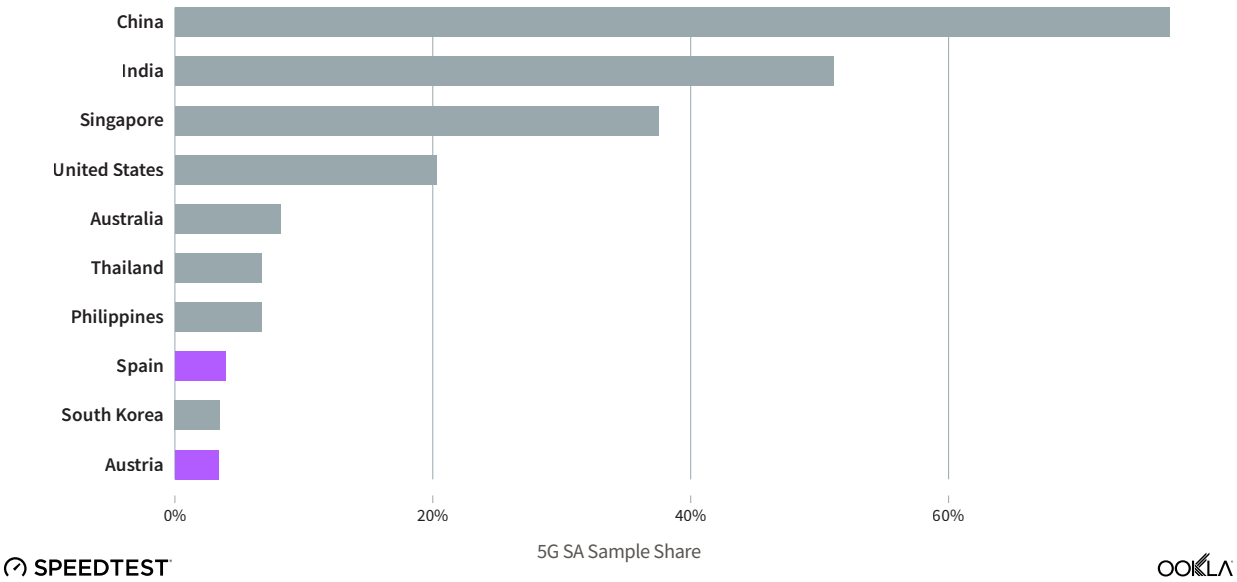
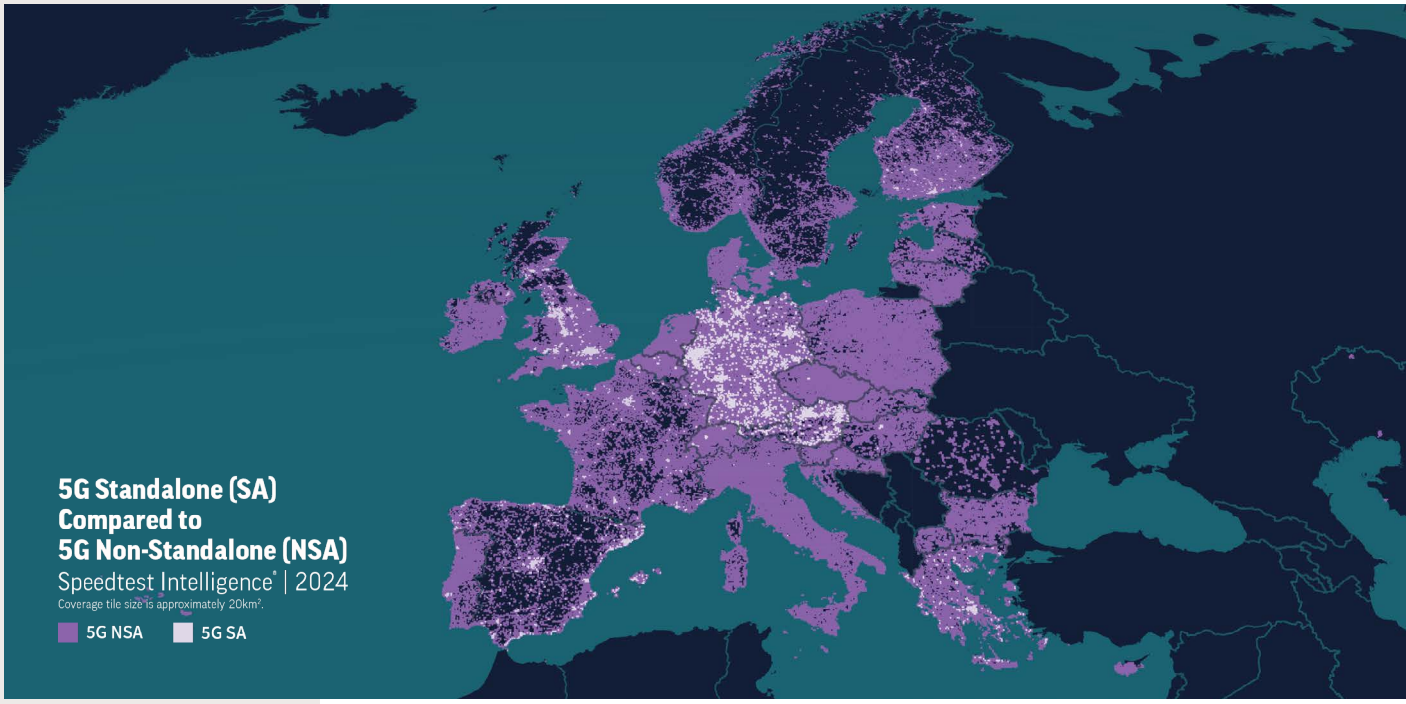
Beyond China and India, other APAC countries exhibiting high 5G SA adoption relative to the global average in Q4 2024 include Australia (exceeding 10% 5G SA sample share), where all operators have launched the technology to a varying extent, and Thailand (over 8%). Globally, the strong performance of the United States and Australia reflects a broader pattern of above-average 5G SA adoption across Anglosphere nations, with the United Kingdom and Canada also outperforming regional averages.

Only Two European Countries Make the Global Top 10 for 5G SA Sample Share

Speedtest Intelligence® | Q4 2024



The flurry of commercial launch activity across Europe over the past two years belies the region's severe underperformance in 5G SA adoption relative to similarly advanced markets in the Americas and APAC, underscoring the limited extent of national-scale 5G SA deployments by most European operators. In Q4 2024, the 5G SA sample share in Europe exceeded 2% for the first time—a fraction of the 24% recorded in the United States during the same period.

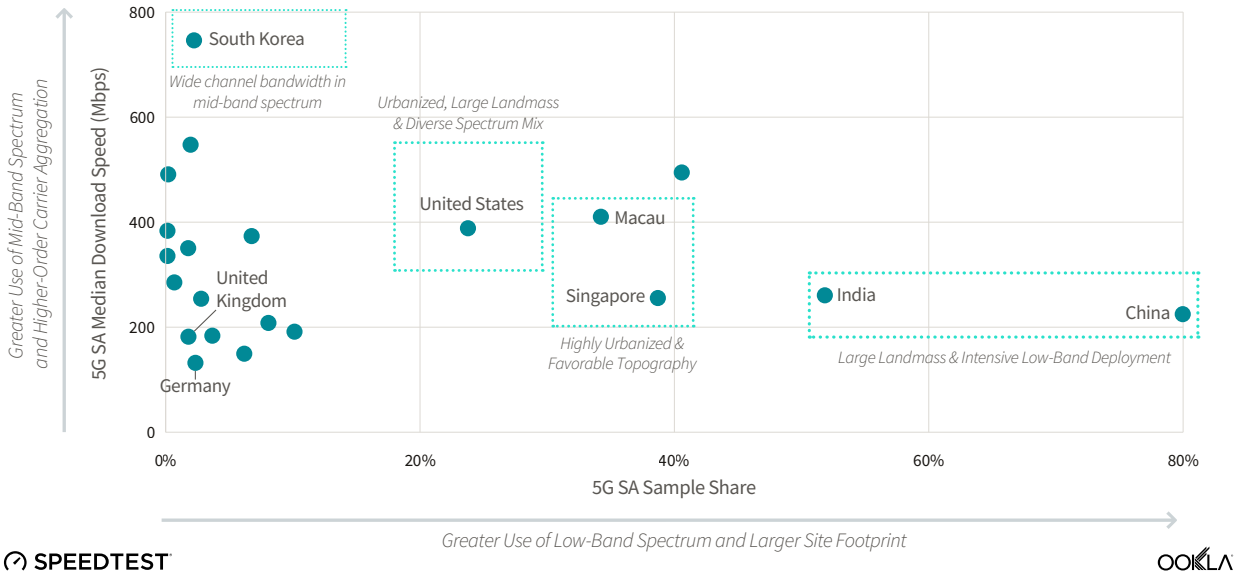


Europe lags its regional developed peers in 5G SA performance

Among the countries that have undertaken large-scale commercial rollouts of 5G SA, performance outcomes vary significantly, shaped by factors such as spectrum allocation, network density and configuration. Analysis of crowd-sourced Speedtest Intelligence data and controlled testing from **RootMetrics®**, an Ookla company, reveals that the full performance potential of 5G SA remains largely unrealized in most markets. Advanced network capabilities enabled by the technology—particularly in the uplink, such as higher-order MIMO and carrier aggregation—remain limited to a handful of operators in leading markets like the United States, underscoring the still nascent profile of the device and equipment ecosystems for 5G SA.

Spectrum Mix, Demographics, and Market Conditions Shape Global 5G SA Outcomes

Speedtest Intelligence® | Q4 2024



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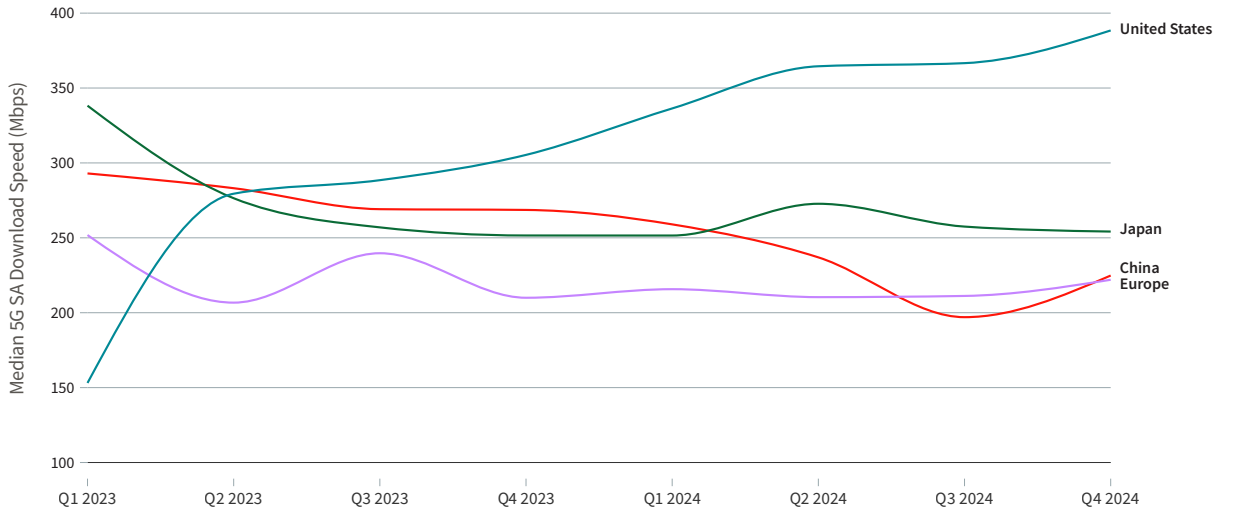
Despite this fragmentation, however, Speedtest Intelligence data confirms that 5G SA is delivering significant performance gains over 5G NSA networks across several key metrics in all markets where it has been widely commercialized. In Q4 2024, median latency—a key beneficiary of transitioning to the 5G core—was nearly 20% lower on 5G SA than on 5G NSA networks in Europe and China, and more than 25% lower in the United States and Japan.

Similar improvements have been observed in download performance, with median download speeds on 5G SA higher than those on 5G NSA networks in Q4 2024 by more than 57% in Europe and 84% in China—equivalent to 1.6 times and 1.8 times faster, respectively. In Japan and the United States, the uplift is even greater, with speeds reaching 2.1 times and 2.2 times those of 5G NSA networks in the same period.

However, it is important to note that at least some of these gains likely result from factors beyond the direct performance improvements of the technology itself. These include lower traffic load on 5G SA networks, more advanced modem capabilities, and, in some cases, higher tariff-provisioned speeds on 5G SA-compatible devices included in the SA data.

The United States Has Established an Early Lead in 5G SA Download Speed

Speedtest Intelligence® | Q1 2023 – Q4 2024



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At the regional level, Europe lags behind its peers on several 5G SA performance indicators, raising concerns about the bloc's competitiveness in the technology. Speedtest Intelligence data reveals that in Q4 2024, the median consumer in Europe saw the lowest 5G SA download speeds at 221.17 Mbps among a sample of countries across leading regions, compared to 384.42 Mbps in the Americas, 259.73 Mbps in Emerging Asia Pacific and 237.04 Mbps in Developed Asia Pacific [2].

[2] Country sample selected based on having a high share of regional 5G SA samples. The Americas sample includes the United States, Canada, and Brazil; Developed Asia comprises Australia, Singapore, Japan, Hong Kong, Macau, South Korea, and China; and Emerging Asia consists of India, Thailand, the Philippines, and Malaysia. South Korea is excluded from the Developed Asia sample for median latency calculations.

Europe Trails Other Regions in 5G SA Download Speeds

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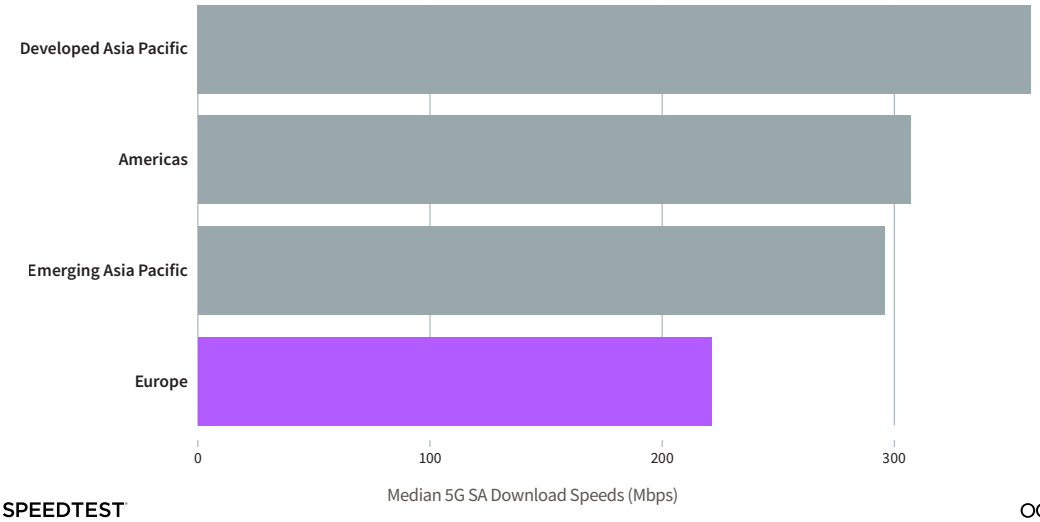

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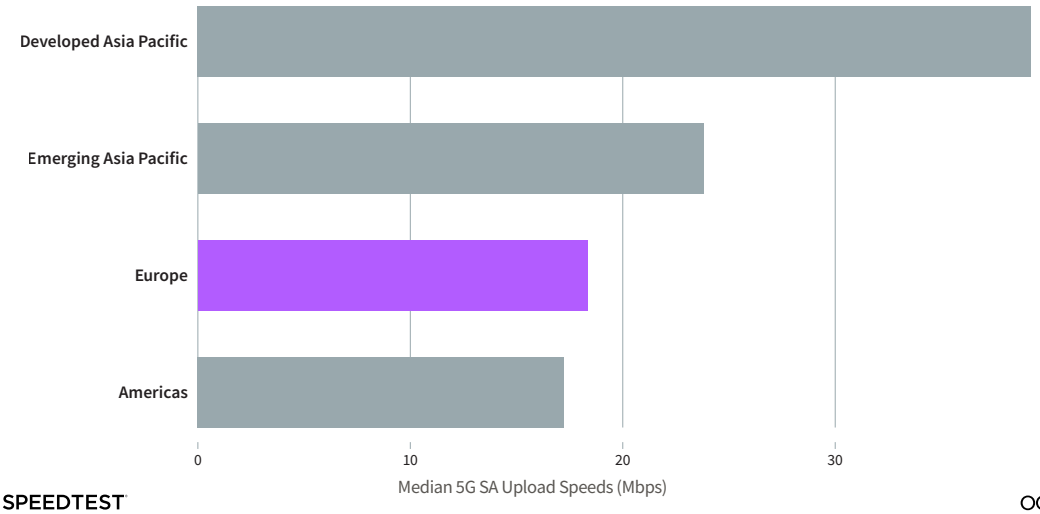
Developed Asia's lead in 5G SA download speed performance is driven by several factors: its favorable geography—with small, flat areas in markets like Singapore and Macau—and its demographics, such as the very high urbanization and population density seen in areas like Hong Kong. The combination of these inherent structural advantages and the intensive deployment of wide, contiguous blocks of mid-band spectrum has yielded exceptional download speeds. In South Korea, for example, median download speeds on 5G SA reached 746.25 Mbps in Q4 2024—the highest in the world—thanks to the exclusive use of the 3.5 GHz band.

Europe Trails Other Regions in 5G SA Upload Speeds

Speedtest Intelligence® | Q4 2024



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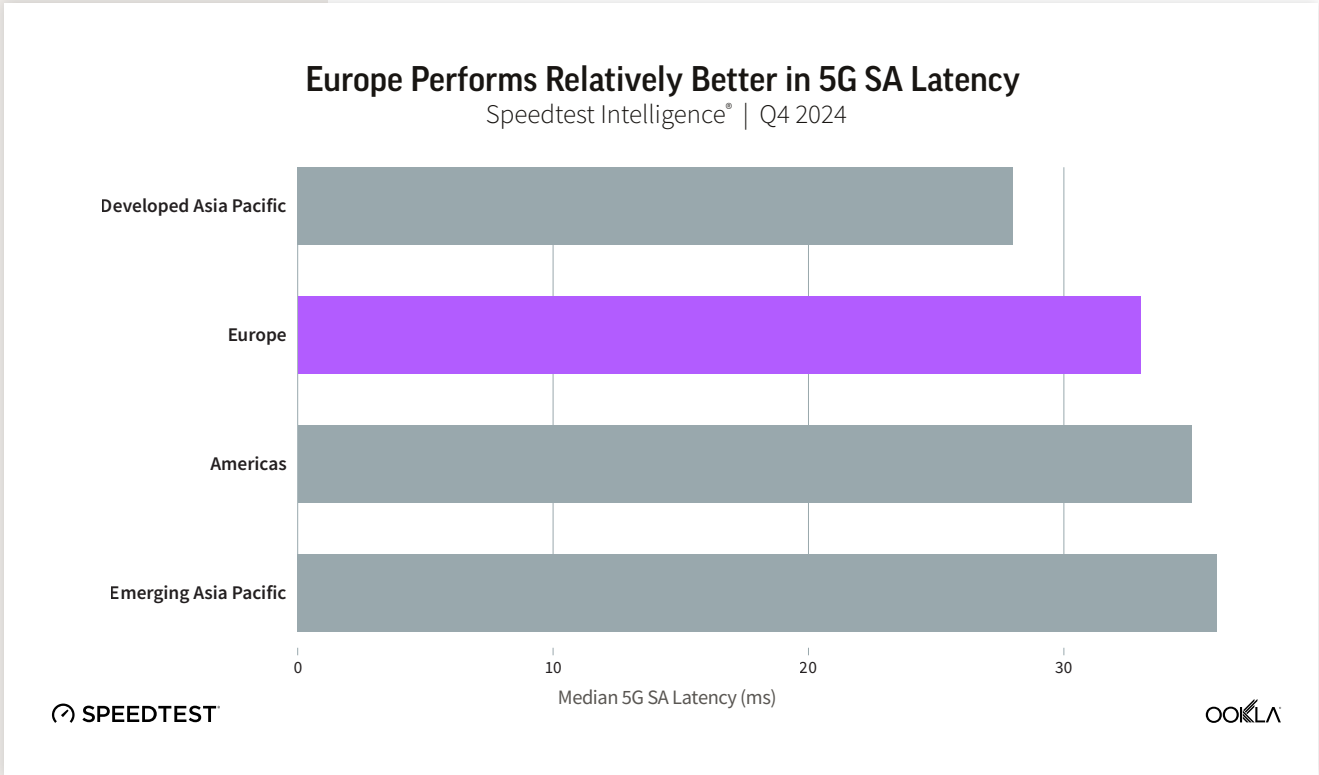
For countries that exhibit more challenging and varied topographic conditions, most notably the United States and China, the merits of a multi-band spectrum strategy for 5G SA are clear. The United States, in particular, has distinguished itself by achieving significantly higher 5G SA availability compared to Europe, along with superior median download speeds (388.44 Mbps in Q4 2024).

T-Mobile's post-merger 5G SA buildout—the first globally—prioritized both breadth, via its nationwide 600 MHz rollout (initially starting with 5G NSA in 2019 before launching 5G SA in 2020), and depth, through mid-band deployments in the 2.5 GHz band. This vaunted "layer cake" strategy has enabled the operator to leverage features such as carrier aggregation and Voice over NR (VoNR) more extensively on its maturing 5G SA network than most other operators around the world, lending it a competitive advantage in both 5G availability and performance metrics such as download speed and latency.

Beyond median download and upload speeds, and in a more positive development for Europe, the region has established a relatively more competitive position in 5G SA latency. In Q4 2024, the average country-wide median latency in Europe was 32 milliseconds (ms)—the lowest among major regions after Developed Asia Pacific—compared to 35 ms in the Americas and 36 ms in Emerging Asia Pacific.



Europe's strong performance on 5G SA latency represents an important competitive differentiator that, unlike some other performance metrics, cannot be achieved simply by deploying more spectrum or sites. While the lower traffic load and smaller footprint of 5G SA networks in the region may contribute, the very high levels of fiber penetration for backhaul and the strategic decision of operators to invest in dedicated, cloud-native 5G cores (rather than hybrid approaches that integrate legacy or virtualized components alongside newer cloud-native elements) may also be important factors driving better outcomes in Europe.

The disparities in 5G SA competitiveness lingering in Europe

Southern Europe supplants the Nordics at the start of the 5G SA cycle

The availability of 5G SA networks continues to vary significantly across Europe, with differences in commercial launches and coverage outcomes reflecting the diverse market conditions and operator strategies across the continent. The rollout patterns of 5G SA have largely followed the trajectory of 5G NSA deployments more than five years ago, with Western and Central European countries at the forefront, driven by strong spectrum availability and the maturation of network investment cycles.

However, as the industry moves into the mid-point of the 5G cycle with 5G SA, Southern Europe has taken on a more prominent role, while the Nordics have been less central compared to their leading position in the initial wave of non-standalone commercialization. For instance, large-scale 5G SA deployments have been observed in multiple Southern European countries such as Spain, Portugal and Greece, while Finland remains the only Nordic country to date with a substantial 5G SA footprint [3].

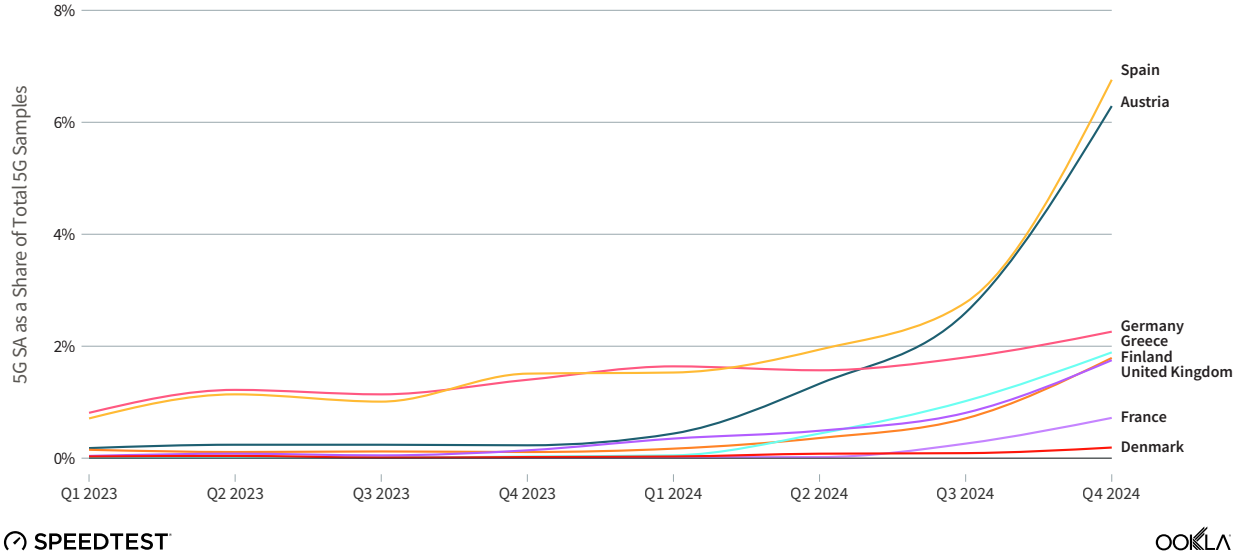
The slow pace of 5G SA commercialization in the Nordics contrasts with the region's otherwise strong performance in metrics relating to 5G NSA availability, detailed in **research** published by Ookla, which has been driven by progressive spectrum policies that incentivized intensive deployment of the 700 MHz band and enabled higher levels of infrastructure sharing than typically seen across Europe.

While several factors may explain why the Nordics have diverged from other European leaders in 5G SA commercialization, it is notable that operators in the region have generally performed better financially during the 5G cycle, as evidenced by **stronger ARPU growth** than their counterparts elsewhere. This financial strength, combined with a **more concentrated market structure** and a robust 4G anchor (even before RAN refreshes spurred by NSA commercialization), may have dampened the competitive pressure to transition swiftly to 5G SA in the Nordics.

[3] 5G SA deployments have been observed in Nordic countries like Denmark; however, Speedtest Intelligence data indicates that nationwide availability remains limited compared to Southern Europe.

Spain and Austria Lead Europe's 5G SA Rollout in Urban Areas as Expansion Accelerated at the end of 2024

Speedtest Intelligence® | Q1 2023 – Q4 2024



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Europe's largest economies, the United Kingdom and Germany, have emerged as the continent's leaders in 5G SA commercialization, with both featuring four-player mobile markets characterized by low to moderate levels of market concentration and ARPU relative to the European average. Notably, they remain the only European countries where at least three operators have undertaken large-scale 5G SA commercialization by the start of 2025.

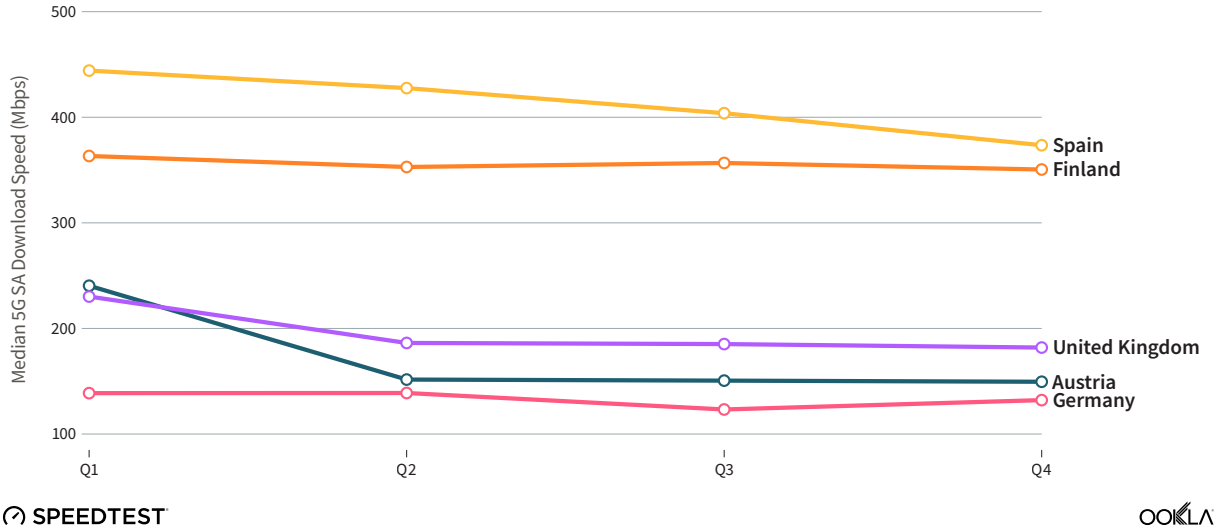
As with the 5G NSA architecture, the number of mobile operators commercializing 5G SA remains an imperfect standalone proxy for assessing progress in metrics that impact end users and Europe's overall competitiveness in mobile infrastructure—particularly the geographic reach and performance of 5G SA networks.

Variations in spectrum configurations continue to shape 5G outcomes in Europe

Differences in spectrum configuration and availability—both between countries and among operators within those countries that have commercialised 5G SA—remain a key factor driving the variation in 5G SA reach and performance across Europe, irrespective of headline commercialization progress.

5G SA Performance Variations Reflect Differences in Spectrum Mix Across Countries and Operators

Speedtest Intelligence® | 2024



The deployment of 5G SA in dedicated mid-band spectrum, particularly in the 3.5 GHz band with wide contiguous blocks, has propelled Southern European countries such as Greece (547.52 Mbps), Portugal (491.08 Mbps) and Spain (373.52 Mbps) to leading positions in median 5G SA download speeds across Europe, based on analysis of Speedtest Intelligence data for Q4 2024. The allocation of prime mid-band spectrum to 5G SA networks in these countries has been instrumental in sustaining the step-change in performance initially unlocked through its deployment in the EN-DC (dual connectivity) architecture under earlier deployments of 5G NSA.

Variations in spectrum configurations continue to shape 5G outcomes in Europe

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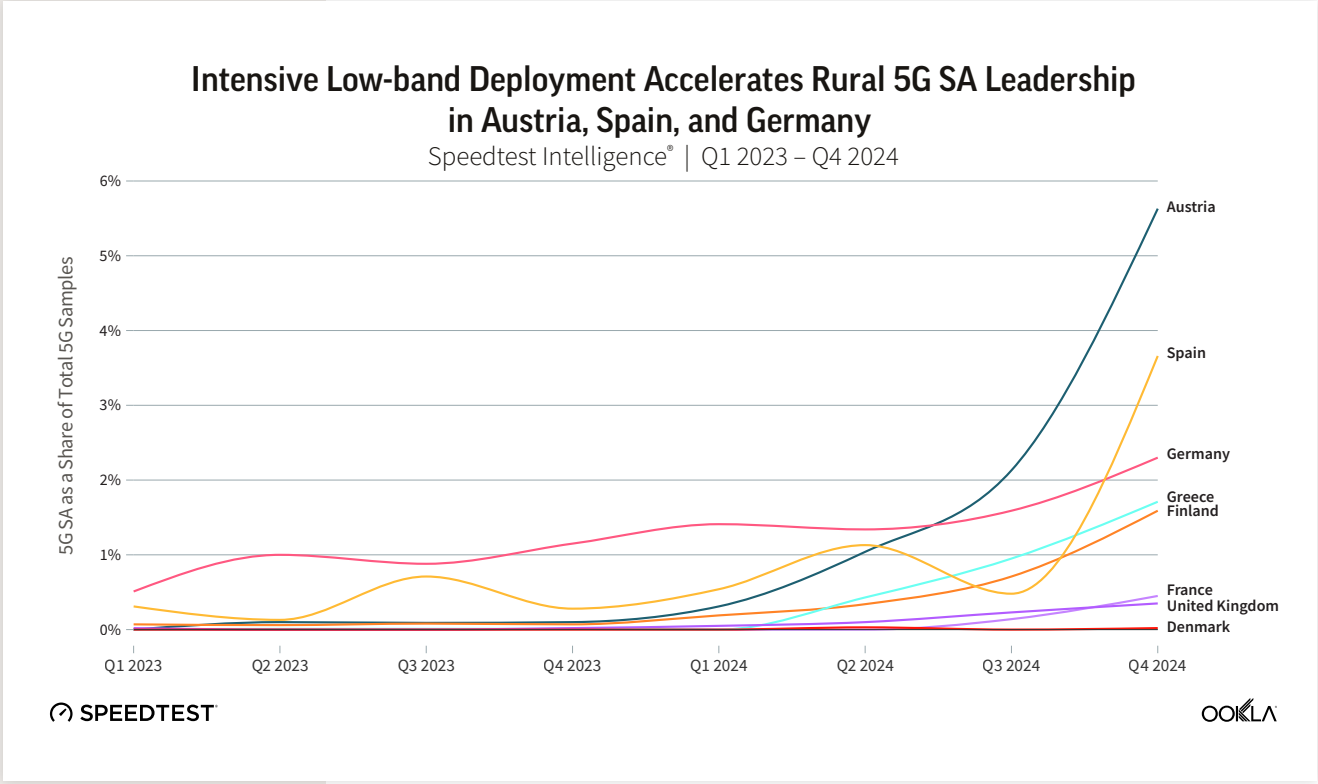
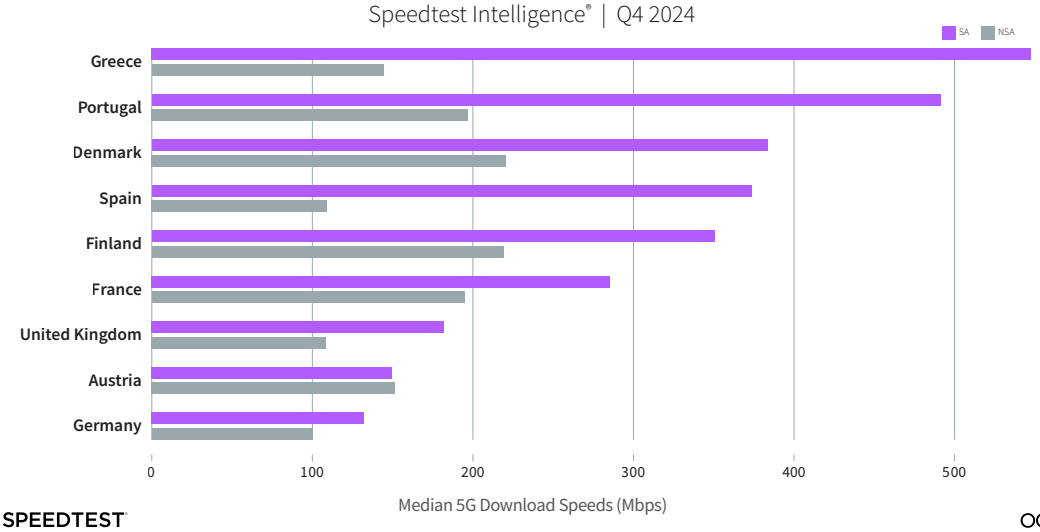


The widespread deployment of low-band spectrum, particularly in the 700 MHz band, on 5G SA networks has positioned countries such as Austria and Germany as leaders in 5G SA reach. The favourable propagation characteristics of low-band spectrum are key to increasing the proportion of time users spend on the 5G core, particularly in rural areas and deep indoor environments. In countries that have made more intensive use of this spectrum these characteristics have helped distribute the latency and energy efficiency benefits of 5G SA more broadly.

Mid-band Deployments Propel Southern European Countries to the Forefront of 5G SA Download Speeds

Speedtest Intelligence® | Q4 2024



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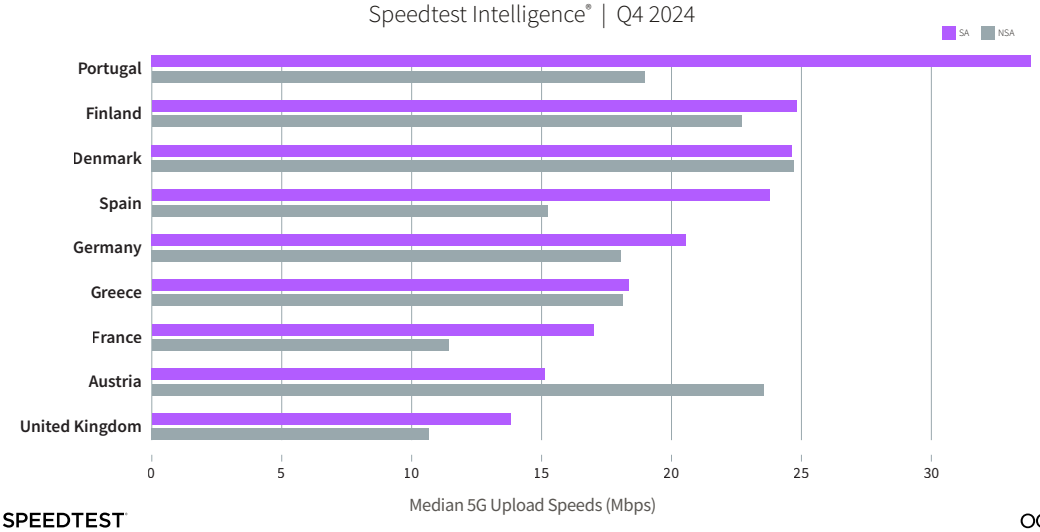
The disproportionate reliance on low-band spectrum in countries like Germany and Austria has resulted in lower median download speeds on 5G SA. In Q4 2024, mobile users in Germany (132.12 Mbps) and Austria (151.51 Mbps) recorded some of the lowest 5G SA download speeds in Europe, with performance levels closely resembling those of 5G NSA networks in these countries.

Limited Commercialization of Advanced Uplink Features Early in the 5G SA Cycle Has Led to Mixed Performance Outcomes

Speedtest Intelligence® | Q4 2024



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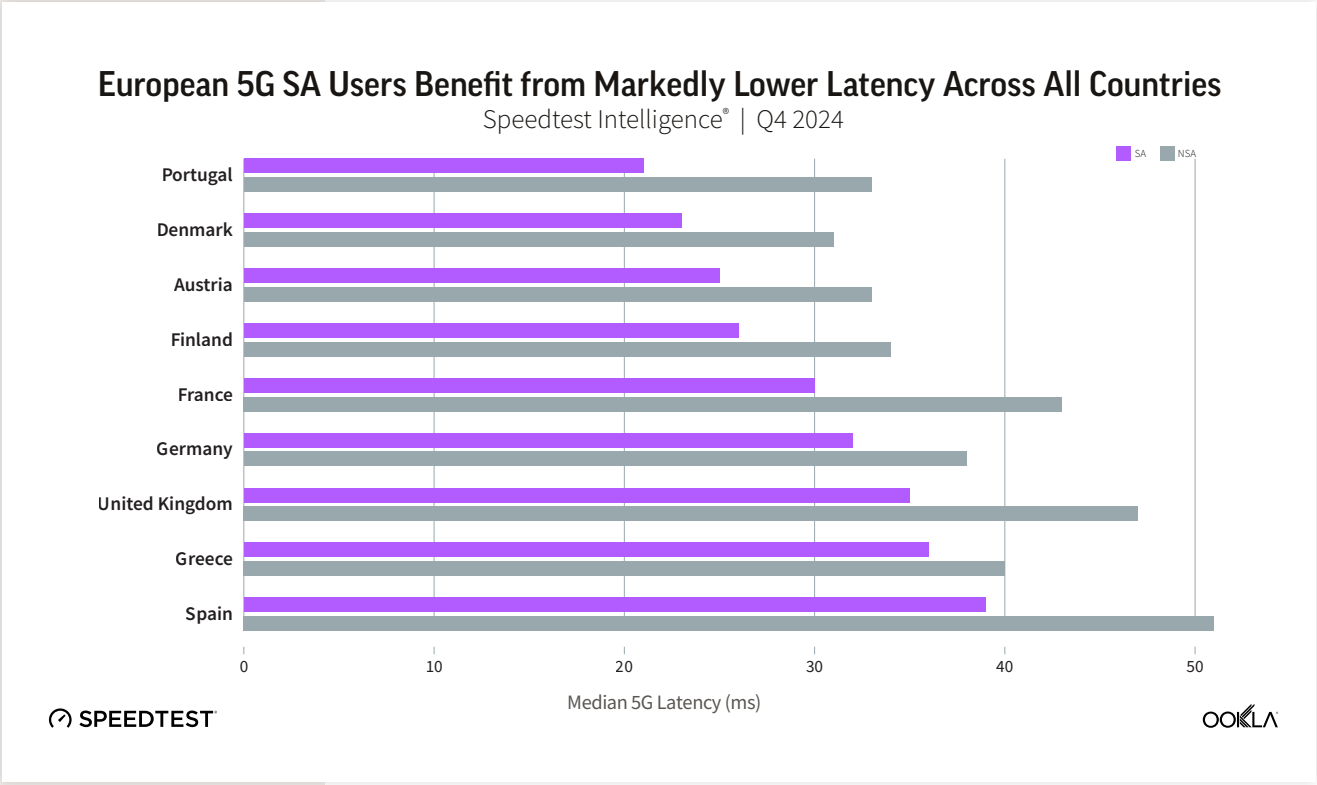
A balanced spectrum strategy—leveraging multiple bands with complementary propagation and bandwidth characteristics—continues to deliver the best outcomes for 5G SA performance and network reach in Europe. This is exemplified by the case of Spain, which ranks among Europe's leaders in both 5G SA download speed and network reach, driven by combined deployment in 700 MHz and 3.5 GHz bands.

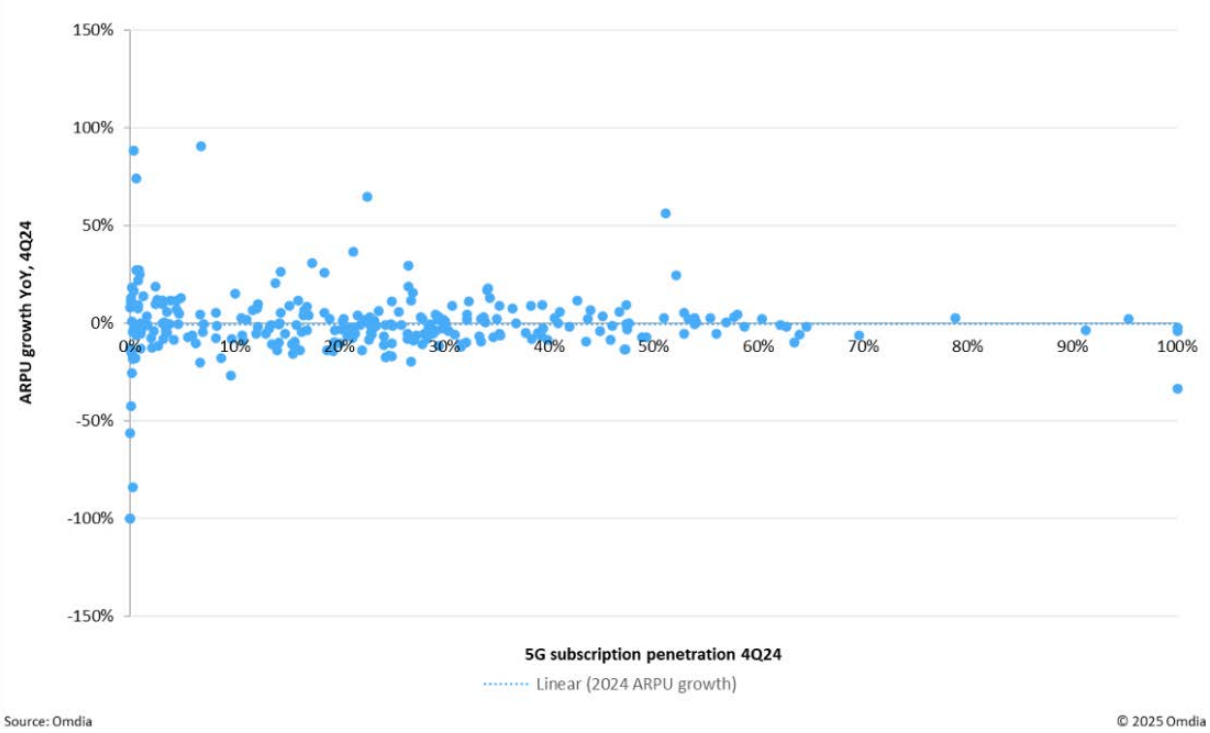


At the operator level, BT's EE has adopted a highly diversified spectrum strategy in the UK, allocating as much as five or six spectrum carriers to its 5G SA deployments across large parts of major cities. By aggregating multiple carriers across low- and mid-band spectrum, EE has executed one of the most comprehensive 5G SA deployments in Europe. Controlled testing by RootMetrics in Birmingham demonstrated that this deep spectrum allocation (up to 115 MHz) has translated into both high median download speeds and a significant proportion of time spent on 5G SA.

The business models underpinning competitiveness in 5G SA

The failure of European operators to achieve significant monetization from the 5G NSA architecture has played a key role in dampening the appetite for timely investments in transitioning to the 5G core. The question on many lips within the industry, following the initial 5G NSA deployment, was what benefits 5G SA would bring, how these benefits could be positioned to end users, and ultimately, how they could be monetized.

5G Subscription Take Up Versus ARPU Growth by Operator, 2024



Source: Omdia

European operators generally lagged their regional peers early in the 5G cycle—particularly in widely commercializing new solutions such as fixed wireless access (FWA). FWA emerged as a key driver of broadband subscription and revenue growth for T-Mobile and Verizon in the US and advanced segmentation based on performance-oriented tariffs. There are some signs that leading European operators are now embracing more innovative business models to expand their subscription base and unlock new revenue streams. These solutions are emerging from both challenger brands, which aim to grow subscription share, and premium brands, which target higher ARPU.

Enterprise 5G SA use cases & monetization

Network slicing is one use case that is gaining traction, particularly in the enterprise. Many operators that have deployed 5G networks have already made announcements about network slicing. Whether it is testing, in trials, partnerships, 5G labs, or commercial launches, these operators are seeking potential new revenue streams. Key examples of enterprise use cases include:

Military, first responders and public safety

Far EasTone Taiwan

In Taiwan, Far EasTone deployed a 5G smart patrol car network slicing solution for the Kaohsiung City Police Department. Its primary purpose is to enhance license plate recognition capabilities with a highly secure and resilient network slice. Equipped with high-resolution photography devices, patrol cars use AI image analysis to identify reported stolen vehicles. This announcement is similar to other initiatives (from Telefonica, T-Mobile US with T-Priority, and Verizon) to link network slicing and public safety. By offering guaranteed QoS and prioritizing critical communications, operators can position themselves to serve emergency services and other public-sector use cases via public networks.

Telia Norway showcases 5G network slicing capabilities for the Norwegian Armed Forces

On August 30, 2023, Telia Norway and the Norwegian Defense Materiel Agency showcased how a private slice can be used to establish a public-based private network for the Norwegian Armed Forces. The Norwegian Armed Forces' mobile traffic is isolated from other public network traffic, allowing it to be routed to specific locations, such as its own data centers, even while using the same base stations and core network.

This approach enables efficient use of public mobile networks while maintaining a high level of security. Telia explained that the new network will allow the Armed Forces to use advanced 5G capabilities. For instance, it supports disk sharing—a technology that dynamically allocates and rapidly distributes storage resources across the network, ensuring mission-critical data is readily accessible. In addition, the network facilitates virtual private mobile networks and delivers very low latency, features that are essential for military applications such as command and control, situational awareness, emergency communication, and remote operations.

At the same time, Telia demonstrated how network slicing can work on Terrestrial Trunked Radio (TETRA) in case of emergencies. Network slicing allows its network to be separated and prioritized, making it possible to establish communication groups that include both dedicated emergency network terminals and regular smartphones.

Media and broadcasting companies & events

The media and broadcasting sector is currently the most popular focus for operators exploring network slicing. Operators such as Vodafone UK, Verizon, SFR, Deutsche Telekom, Virgin Media O2, and T-Mobile have all made announcements in this space. Deutsche Telekom's partnership with video streaming provider RTL Deutschland exemplifies many of these initiatives, using network slicing to guarantee optimal performance during live event broadcasts.

Network slicing can deliver guaranteed high uplink throughput, ultra-low latency, and robust reliability—key to transmitting multiple high-resolution video streams even amid congestion—and ensure real-time audio and video synchronization, minimizing delays from capture to broadcast.

The potential in this sector is substantial, extending beyond traditional broadcasting. Although demand may fluctuate throughout the year, large events such as sports games or concerts present significant monetization opportunities for operators. As data consumption continues to rise during these events, operators can offer slicing services to media, event, and TV companies to ensure broadcast and event communication remains reliable, while also offering additional services to attendees.

Vodafone UK supporting the Glastonbury Festival with network slicing

At the 2024 Glastonbury Festival, Vodafone allocated part of its network to connect 102 payment machines using network slicing. Working with EBC, a beverage vendor, Vodafone set up a temporary network slice for three weeks. This improved the speed of card transactions and ensured that performances were not affected by network traffic. As a result, festival-goers were able to spend more time enjoying the show.

The 2024 festival attracted 200,000 attendees, featured over 100 stages, and included nearly 1,000 trading stalls, generating 225 TB of data on Vodafone's network—an increase of 33% compared with the previous year. This amount of data can become an issue in terms of the stability of the network's performance, slowing down

transactions during the event. EBC managed 10 onsite bars at the festival, each equipped with multiple card machines. The demonstration connected three of these sites through a network slice, supporting a total of 102 tills. During peak periods, each till processed two transactions per minute.

Vodafone used a FWA slice for this experiment. The operator estimates that without real-time connectivity for authorizing card payments, 4% of the revenue can be lost owing to fraudulent transactions.

Orange France deployed private 5G SA during the Olympic Games

To ensure smooth operations, support live broadcasts, and enhance the spectator experience, large-scale sporting events depend on a variety of robust connectivity and IT solutions. As the exclusive provider for Olympic Broadcasting Services (OBS), Orange established an advanced network infrastructure across 120 locations in France for the Paris 2024 Olympic and Paralympic Games (examined in **earlier Ookla research** on network performance during the event). The operator installed a private 5G SA network to transmit live feeds from several cameras at these sites, reducing reliance on the public network and improving performance in the uplink. The operator also connected 200 smartphone cameras on 85 boats during the Olympic opening ceremony to its 5G SA private network, providing coverage with high quality video streaming.

MASORANGE Spain deployed private 5G SA at the Port of Barcelona

In July 2024, MASORANGE deployed a fully operational private 5G SA network at the Port of Barcelona. The project is backed by a US$2.72 million investment over a five-year period. The telco indicated that the network setup, which is covering the entire Port of Barcelona and the two surrounding nautical miles around the port, provides a range of benefits that directly impact the efficiency of port operations.

A key advantage is the presence of a support system in case the main network infrastructure encounters issues. Enhanced connectivity powered by low latency and high data transmission capabilities facilitates smooth and efficient operation of equipment and machinery at the port. The network also provides for a straightforward installation of cameras and sensors in areas without fiber access. Regarding security aspects and improvements, the port features an extensive communication network that includes more than 400 CCTV cameras and a network of aerial surveillance drones, all distributed throughout the port area.

Network slicing is not a one-size-fits-all solution; both Wi-Fi and private wireless networks will co-exist in the 5G SA cycle

Although promising, network slicing technology is not ideal for all verticals. Private or hybrid networks are often more effective for industries that require substantial control and security within limited coverage areas—especially where public network densification isn't economically viable. However, even within these environments, slicing can be leveraged. For example, a manufacturing facility might allocate a dedicated low-latency slice to critical machines requiring near real-time responsiveness, while simultaneously provisioning a separate high-bandwidth slice for its security systems (such as computer vision applications) where a slightly higher latency—say, an extra 50–100 ms—is acceptable.

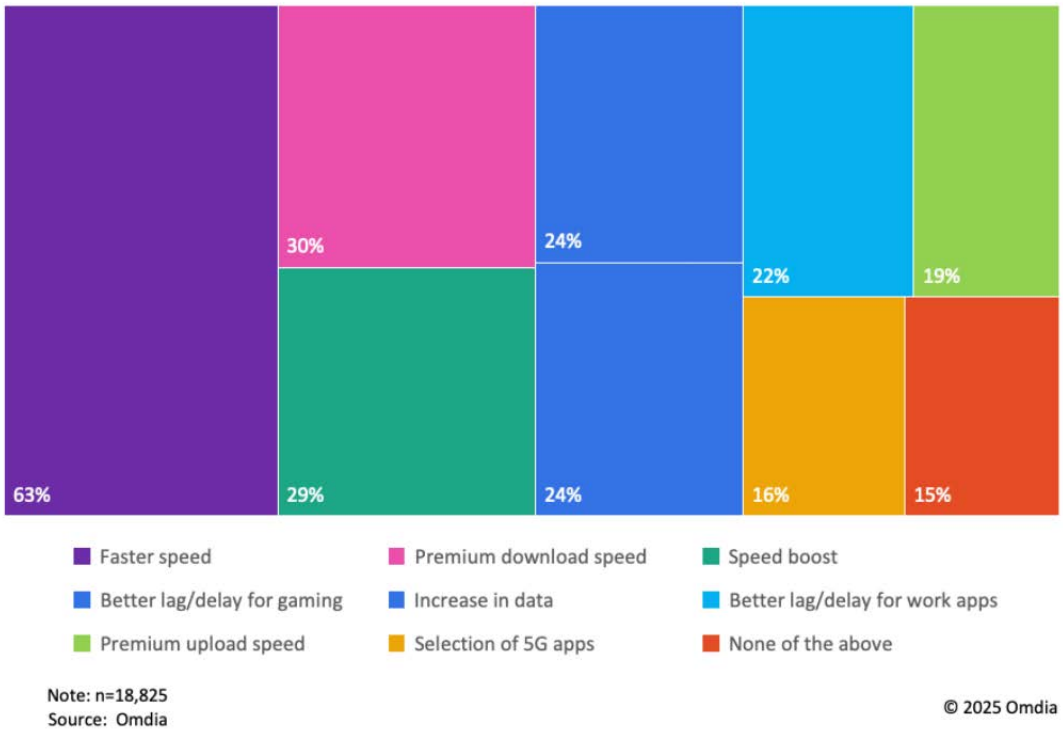
Larger enterprises can factor in the cost of a fully dedicated private wireless network, when weighing up their technology options, and looking at private wireless network utility versus alternatives such as Wi-Fi or public networks.

As a result, enterprises in typical target sectors for enterprise telecoms and IoT, such as manufacturing, logistics, and energy sectors may not be the primary targets for operators looking to monetize network slicing. Conversely, network slicing can be highly advantageous for enterprises that need to cover large areas, providing high-performance network access to numerous employees spread across large regions or ensuring optimal network performance during peak times, such as at festivals or large concerts in major venues. While major events such as the Olympics are a prime target for operators and other industry players offering private wireless solutions, smaller more remote events may benefit from network slicing via public networks.

Consumer 5G SA use cases & monetization

While most attention on monetizing 5G SA has centered on enterprise opportunities, dedicated 5G network slices targeting various consumer segments are gradually emerging, both in Europe and other markets around the world. Consumer monetization strategies for 5G SA vary, ranging from incremental revenue gains (Singtel) to customer retention (Deutsche Telekom and EE) and upselling (3 Austria, Elisa Finland, Vodafone UK).

What features/benefits of 5G would you be willing to pay more for?



Note: n=18,825
Source: Omdia

Some examples of consumer use cases for 5G SA include:

Singtel (Singapore)

In 2023, Singtel launched Express Pass, which consists of 5G Video Pass and 5G Event Pass.

- 5G Video Pass promises "data priority on video apps," so users "can enjoy the smoothest streams for all your video entertainment." The pass includes an Amazon Prime subscription and 20GB of data a month. It costs US$5.96 a month (with a six-month contract) or US$7.45 a month (without a contract).
- 5G Event Pass offers "data priority on all apps" for a US$3.73 one-time charge. For example, the pass was available for use at Pandang and Marina Bay for Singapore National Day on August 9, 2024. Passes were also issued for Singapore's F1, New Year's Eve Countdown, and concerts (for example, Taylor Swift in March 2024). The go-to-market message is: "You can now find your friend quickly in the crowd, share the best moments when they happen, and even book a ride home with no problem." Meanwhile, during the Australian Open 2024, live streaming of the tennis was prioritized over Singtel's CAST app.

Deutsche Telekom

In October 2024, T-Mobile Germany launched 5G+ Gaming, based on network slicing. The slice offers reduced latency (of less than 20 ms), to ensure a more responsive, smooth gaming experience. More than 100 cloud gaming apps are guaranteed high priority in busy cells. 5G+ Gaming uses Ludium's Sora Stream cloud gaming platform (which includes Fortnite, PUBG, Rocket League, etc), as opposed to DT curating its own app which it did with Magenta Gaming service that is now defunct. The service is free until April 2025, thereafter users need to pay Sora Stream US$10.45 a month directly. In other words, this is a bundling/ churn retention strategy for T-Mobile, as opposed to an incremental revenue opportunity. T-Mobile is reportedly working on other slices for video conferencing and AR/ VR apps.

Not all telcos that have migrated to 5G SA have spun off dedicated network slices for specific consumer segments like gamers or concertgoers. In September 2024, EE launched its 5G SA proposition in the UK, offering consumers on new 5G premium plans a free "VIP connection" when the network is busy as part of a rebranded consumer offering, prioritizing premium bundled services. Vodafone UK, on the other hand, markets "5G Ultra," its 5G SA offering as enabling "up to 25% improved phone battery life" and average speeds of 15-200 Mbps. This is reserved for those that upgraded to a 5G SA smartphone and have a pay-monthly plan. Meanwhile, Elisa in Finland has taken advantage of 5G SA's faster speed to launch a new "fastest connection" speed tier offer for 5G smartphone users.

FWA Solutions Leveraging 5G SA's Enhanced Performance Capabilities

3 Austria

3 Austria is leveraging its 5G SA network, which it markets as 5G+, by offering speed guarantees for FWA using network slicing. The guarantee is to provide "at least 50% of the maximum download speed" included in the unlimited data plan (24 months). There are three peak rates - 150Mbps, 250Mbps, and 500Mbps - which mean speed guarantees of up to 75Mbps, 125Mbps, and 250Mbps during busy or congested periods. The onus is on the consumer to check that they are receiving the guaranteed bandwidth, should they choose.

Meanwhile, other operators, including Reliance Jio in India and Elisa in Finland, have migrated their 5G FWA traffic to a dedicated network slice. Canada's Rogers Wireless also plans to follow suit in 2025, stating that by separating its fixed and mobile traffic with slicing, this optimization will "ensure a more consistent and reliable network experience for both residential and mobile users."

Orange France launched FWA solution backed by 5G SA

In response to Free Mobile's launch of 5G SA in France on a national scale in the 700 MHz band, in October 2024, Orange launched FWA service supported by 5G SA to enhance its connectivity solutions in areas lacking readily available fiber infrastructure. The service is marketed as 5G+ Home broadband. This connectivity solution can provide customers with network speeds of up to 1Gbps. Orange aims to close and replace all copper lines with alternative solutions by end-2030. As a result, this 5G SA FWA solution will play an important role in accelerating customer migration to high-speed networks during the copper phase-out period.

Policy initiatives aimed at boosting European competitiveness in 5G SA

There are numerous funding mechanisms in use in Europe. For example, at the EU level, the digital part of the Connecting Europe Facility (CEF Digital) is a €1.83bn (US$2 billion) infrastructure investment program to support Europe's digital transition. Its goal is to develop the following:

- Deploy and deliver access to very high-capacity networks, including 5G, in areas deemed to be socioeconomic drivers
- Expand uninterrupted 5G network coverage to all major transport paths, including trans-European transport networks
- Provide CEF funding to cover the deployment of 5G SA infrastructure

The EU-funded Recovery, Transformation, and Resilience Plan, which runs for six years (from 2021 to 2026) and totals €723 billion (US$747.98 billion)—comprising €338 billion (US$349.68 billion) in grants and €385 billion (US$398.38 billion) in low-interest loans—can be used by Member States in their national Recovery and Resilience Plans to roll out 5G networks.

In Italy €6.7bn (US$6.94 billion) of investment in recovery and resilience was used to facilitate the deployment of very-high-capacity networks, including 5G and fiber, while in Spain €4bn (US$4.1 billion) of investment was assigned to boost fixed and 5G connectivity.

The European Commission has continued its effort to stimulate indigenous industry and shore up the bloc's telecoms supply chain, aiming to reduce reliance on non-EU vendors. In 2024, these efforts continued to take shape through a series of "**Large Scale Pilots**", including grant calls for proposals that support 5G SA pilots along cross-border transport corridors and the development of smart communities. The pilots are designed to facilitate the deployment and adoption of 5G SA networks that "meet the very stringent requirements of innovative use cases in terms of very-high reliability, security, low latency, communication symmetry, and high throughput."

These financial supports are designed to facilitate the deployment of extensive 5G SA infrastructure and promote the integration of complementary technologies that the Commission has identified as essential for European strategic competitiveness, including edge computing.

UNICO Spain example

Spain has established itself as a European leader in the mobilization of policy tools specifically designed to accelerate the deployment of 5G SA, with a particular focus on supporting network buildouts in rural areas where commercial factors have historically inhibited large-scale operator deployments.

In July 2020, the Spanish government announced the Spain Digital 2025 Agenda, which aims to provide 100% coverage of 100Mbps connectivity and prepare 100% of the radio spectrum for 5G by 2025. A budget of around €140bn (US$144.84 billion) has been allocated to this initiative. Funding has been made available through the Universalization of Digital Infrastructures for Cohesion Program (UNICO). The new UNICO Broadband Program supersedes the longstanding National New Generation Broadband Extension Program (PEBA-NGA) and focuses on deploying broadband services in gray and white areas of the country.

In June 2022, the Spanish government announced plans to allocate a subsidy of €150m (US$155.18 million) to finance the building of 4G and 5G passive infrastructure in underserved parts of the country. A total of 73,000 rural zones lacking coverage were identified with operators invited to bid for "UNICO 5G" funds to install towers in all four geographical regions by the end of 2024.

In June 2023, the government announced a €500m (US$517.38 million) allocation for rural 5G backhaul equipment deployment through the UNICO-5G Active Networks initiative. This falls under the UNICO Rural Demand program, available until at least December 31, 2027. The funds are being used to roll out networks in towns containing fewer than 10,000 residents to install necessary active and passive equipment and additional backhaul infrastructure for the provision of 5G SA services, where appropriate.

The objective of the UNICO-5G Active Networks program is to install essential active and passive equipment and, when suitable, supplementary backhaul infrastructure to support the delivery of 5G SA services. The funds are designated to operators holding licenses in the 5G bands with the aim of motivating them to implement the technology in smaller municipalities. The timeline for completion of this project is June 30, 2025. In July 2023, Lyntia and Avatel were the major beneficiaries within the UNICO 5G rural towers project. They received total funding of €274.2 million (US$283.67 million) to deliver connectivity to 58 provinces with a population of fewer than 10,000 residents.

In October 2023, MINECO announced €544m (US$562.8 million) in new funding for 5G networks in towns with fewer than 10,000 residents to roll out. The "5G Redes Activas" project aims to push the total government investment in 5G infrastructure to over €1 billion (US$1.03 billion).

The "5G Redes Activas" program requires operators to provide minimum download speeds of 100Mbps to qualify for funding for both backhaul and passive infrastructure needed for 5G SA (standalone) services. The funding aims to bridge the urban-rural connectivity gap and achieve early targets for June 2025. Applications were open until October 31, 2023, covering 50 Spanish provinces under the UNICO program and the EU's Recovery, Transformation, and Resilience Plan.

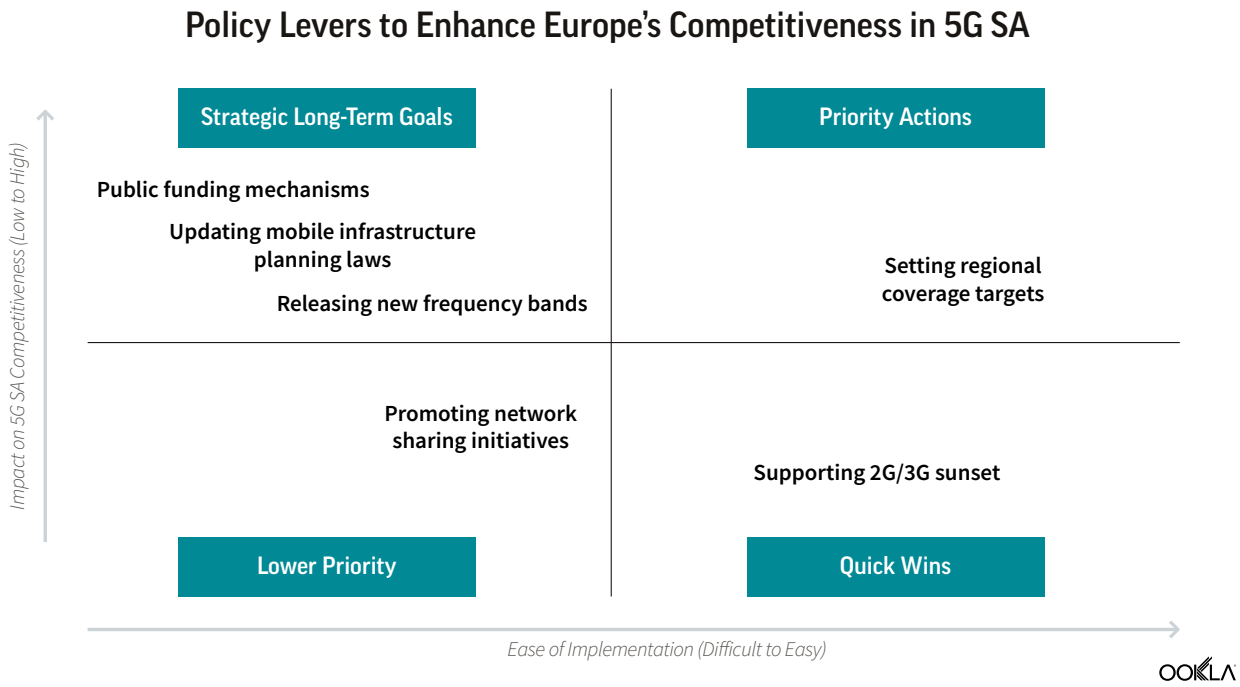
Following this, in May 2024, MINECO allocated €508m (US$525.55 million) to enhance 5G coverage in rural areas. This funding is part of a €544m (US$562.80 million.) program announced in 2023, now increased to a total of €566m (US$585.56 million). Beneficiaries include Telefónica, MasOrange, Vodafone, and Avatel-Xfera. Telefónica received €298m (US$308.30 million) for 4,123 locations, MasOrange received €115m (US$118.97 million) for 1,505 locations, Vodafone Spain received €66m (US$68.28 million) for 1,220 locations, and Avatel-Xfera received €28m (US$28.97 million) for 482 locations. The three major operators agreed to share the 700MHz band to improve coverage.

Additionally, by the end of August 2024, the government introduced a new investment plan with a €90 million (US$93.11 million) subsidy for expanding 5G networks in rural areas. The funding is part of the EU Recovery and Resilience Facility and uses the remaining funds from the "5G Redes Activas" scheme, which had a total budget of €566m (US$585.56 million). The program will subsidize 90% of the costs for 5G antennas (on 700MHz and 3.5GHz bands) and fiber backhaul for towers.

The steps needed to level up Europe's competitiveness in 5G SA

There are a number of challenges operators face when looking to deploy 5G SA which can be resolved with intervention from regulators and governments including adoption rates, switching off 2G and 3G networks as duplication of resources reduces ROI, planning constraints, as well as whether sufficient financial resources will be available to ensure ubiquitous 5G coverage.

A range of regulatory tools and demand side and supply side public policies can be used to improve 5G coverage. Some regulatory policies which are seen as best practice in encouraging the deployment of very high-capacity wireless networks include:



Examples of some of these best practices include:

1. EU coverage targets

In February 2021, the EU set connectivity objectives for 2025 which individual member states should work towards achieving. These include delivering uninterrupted 5G coverage in all urban areas and major terrestrial transport paths. The EU has also set goals for 2030, which include 100% of populated areas covered by 5G.

2. Incorporating targets in National broadband plans/Digital Strategies

In the Netherlands, the Council of Ministers approved a new digital economy strategy in November 2022 aiming to provide all citizens and companies with access to internet connections with speeds of 1 Gbps by 2030, up from the existing coverage of 90%. Furthermore, the government's objective is to provide complete 5G coverage in all the populated areas throughout the country, following the auction and deployment in C-band spectrum, which began in 2024.

Meanwhile, the UK has set out a target of covering all populated areas with standalone 5G by 2030, previously the UK set a target of providing 5G coverage to most of the population by 2027. The target was revealed in the UK Wireless Infrastructure Strategy in April 2023 which sets out a new policy framework to encourage the deployment and adoption of 5G and advanced wireless connectivity, as well as the government's 6G strategy.

The strategy affirms the government's goal of extending 4G coverage to 95% of the population by 2025 (it currently stands at 92%) and sets a target for the country to achieve nationwide coverage of Standalone (SA) 5G by 2030, as well as outlining the policy framework that will be implemented to support operators in achieving these targets. The main focus of the strategy is on removing barriers to investment and stimulating demand. Its approach to reducing regulatory barriers includes:

- Asking Ofcom to review and set out a clear evidence-based and forward-looking rationale for its approach to setting spectrum fees by the end of 2023
- Working with Ofcom and industry to refarm spectrum where it is not being used efficiently
- Ensuring spectrum governance arrangements are working as intended
- Maximizing the UK's influence at international spectrum negotiations, with the alignment of international and domestic spectrum frameworks, where possible
- Ensuring eligible mobile network operators benefit from the relief available in Freeports, Investment Zones, and other economic areas with similar regimes.

The government is looking to encourage 5G investment by supporting local authorities to identify industrial and public sector demand for advanced wireless connectivity and build a clear business case for investing in it. It also aims to support new entrant providers and scale up existing provisions, such as through neutral host operators and private network providers.

Policies are just one part of the strategy; they also include plans for £40 million (US$41.38 million) of funding to establish 5G Innovation Regions across the UK, which are tasked with encouraging 5G take-up in the public sector and businesses. This will involve the establishment of a regional taskforce to encourage take-up and investment at the local level, and a specific aim to ensure new hospitals have access to 5G or similar advanced wireless connectivity.

In Germany, the government adopted its Gigabit Strategy 2030 in July 2022, which aims to expand fiber network coverage to all households and cover all areas where people live, work, and travel with the latest mobile communications standard by 2030. With regard to 5G, the strategy aims to achieve nationwide, uninterrupted voice and data communication by 2026 and improve coverage on railway lines. The strategy also proposes to:

- Simplify building and site permits, with the possibility of initiating construction before the building permit is granted
- Reduce the statutory limit of distances for cell towers
- Waive the requirement for a permit when modifying existing cell towers as well as the construction of new mobile towers.

3. Coverage obligations and financial incentives as part of spectrum auctions

In France, the auction of the 3.4–3.8GHz bands in 2020 included the obligation that licensees should offer 5G in at least two cities before the end of 2020. Each network must deploy 3,000 5G sites by 2022, 8,000 sites by 2024, and 10,500 sites by 2025. About 25% of sites deployed in 2024–25 should be in areas outside the main clusters, and at least 75% of 5G sites should offer a bit rate of at least 240Mbps by 2022, gradually increasing to 100% by 2030.

In Spain the 700MHz band auction in 2021 included obligations to activate 5G services in 450 localities by the end of2025. Around 30% of these localities must be covered by the end of2022 and 70% by July 2024.

During the spectrum auction in Norway that concluded in September 2021, Nkom set a voluntary obligation for operators. It stated that operators that expand their broadband networks to reach at least a download speed of 100Mbps and an upload speed of 10Mbps to a predefined list of buildings in certain underserved areas would receive an additional discount on the spectrum fees. As of February 2023, 1,752 such buildings were covered by a 5G network. As a result, the operators had received discounts of around NOK12m (US$1.06 million).

In the 2019 spectrum auction in Germany, the regulator set coverage obligations that included covering 98% of households and all motorways, federal roads, and busy railway lines with at least 100 Mbps mobile broadband speed by the end of 2022. The operators were also obligated to set up 1,000 5G base stations and an additional 500 base stations with at least 100Mbps speed in underserved areas.

4. Incorporated in merger remedies

The UK Vodafone/Three merger, which is set to close in the first half of 2025, includes a requirement to invest £11 billion (US$11.38 billion) in the network over the next eight years and time-limited price caps on key tariffs pending roll-out of the 5G standalone network. The joint venture must develop a 5G standalone network, expand network capacity and improve geographic coverage with a particular focus on rural and underserved areas. Enforceable milestones have been agreed to ensure adherence to the investment program, with a notable focus on input-based commitments relating to delivery of the physical network measured on the basis of number of sites and spectrum deployed.

5. Releasing new frequency bands

The EU designated the 700MHz, 3.6GHz and 26GHz bands as pioneer bands for 5G deployment which provided a focus for member states, ensuring momentum picked up to prioritize planning or assigning the spectrum to operators.

6. Updates to regulation

On January 1, 2021, the Act on Electronic Communication Services entered into force in Finland. The key aim of the reformed act is to improve the availability of broadband networks and communication services, as well as improve the security of telecom networks. The revised act introduced measures to encourage network investment, such as extending the validity of network licenses that are already granted, imposing new network licensing procedures on certain frequencies, enabling the renewal of network licenses without an open application procedure, and facilitating simplified procedures for the construction of 5G base stations.

Meanwhile, the EU's European Electronics Communications Code aims to stimulate competition and increased investment in 5G. Under the code, Member States must provide operators with predictable regulation for radio spectrum licensing for wireless broadband for at least 20 years to promote investment specifically in 5G connectivity.

7. Updated mobile infrastructure planning laws

In March 2022, the UK government announced amendments to the Town and Country Planning (General Permitted Development) Order 2015 and introduced new rules to boost 4G and 5G coverage in rural areas. The aim is to eliminate "not spots," which are areas with no network coverage. The reform to the planning law allows telecom operators to upgrade their existing infrastructure to expand mobile coverage, instead of building new masts. Operators can now upgrade existing masts and build new ones up to five meters taller and two meters wider.

8. Network-sharing initiatives

There are a number of network-sharing initiatives in Europe aimed at ensuring the hardest to reach areas are covered by 5G networks. Examples include countries such as Spain and France. Bouygues Telecom and SFR have been sharing their networks to provide 2G, 3G and 4G services in a portion of France since 2014. In January 2023, Arcep received three new contractual amendments signed by both parties whose main purpose was to extend the 5G sharing agreement and deploy new cell sites on the shared network. The amendments include:

- Having the network sharing, excluding spectrum sharing, initially implemented for 2G, 3G and 4G technologies, to be expanded to include 5G technology. The technical, operational and financial terms governing shared 5G network operation are set out in detail; and
- A new increase in shared network's density, with the addition of new cell sites. The geographical scope remains unchanged.

9. Policies to shutdown 2G & 3G in order to free up resources for 5G

In December 2021, the UK government announced its Telecoms Supply Chain Diversification Strategy. As part of the strategy, it plans for operators to phase out 2G and 3G mobile networks by 2033, freeing up spectrum that can be used to roll out 5G as well as future technologies such as 6G.

Conclusion

Europe is at an important crossroads in its 5G journey. Despite setting the most ambitious infrastructure targets among advanced liberal economies, the bloc continues to lag behind its developed peers in key measures of network reach and performance with 5G SA—a technology it has positioned as central to its emerging pro-growth industrial strategy and the broader European competitiveness compass.

A confluence of challenges—including a depressed investment environment, reliance on legacy business models, skills shortages, technical barriers, and insufficient targeted government support—continues to impede the wide-scale deployment and monetization of 5G SA networks in Europe.

Leading markets such as Germany, Spain, and the United Kingdom have made notable strides through targeted fiscal measures and strategic coverage obligations. However, the isolated nature of these successes highlights the urgent need for a more coordinated, pan-European strategy to accelerate 5G SA deployment and adoption as a distinct objective, separate from the bloc's broader 5G coverage goals.

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Further reading

A Reality Check on Telecoms Consolidation in Europe: Can it Boost the Bloc's Digital Competitiveness? (Ookla)

Faster Speeds and the Promise of New Use Cases is Driving 5G SA Adoption (Ookla)

The Path to "Full" 5G: Challenges and Opportunities in Standalone 5G Deployment (Ookla)

The Envy of Europe: Nordics Lead in 5G Availability and Network Sunsets (Ookla)

Controlled Network Testing in one of the World's Top Performing Cities – Seoul (Ookla)

National Broadband and Digital Strategies Tracker – 2024 (Omdia)

Enterprise 5G Monetization: Survey Insights 2024 (Omdia)

2025 Trends to Watch: Enterprise 5G – the Year of Monetization (Omdia)

2025 Trends to Watch: Core Networks (Omdia)

Core Market Tracker – 4Q24 Data & Analysis (Omdia)

5G-Advanced: The real monetization opportunity (Omdia)

2025 Trends to Watch: 5G-Advanced and New Network Monetization (Omdia)