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CONTENTS

Regulators in some mature telecoms markets are starting to react to operators' retail pricing practices

Gilles Monniaux, Principal and Ian Streule, Partner

Increasing competition has allowed regulators to reduce the use of retail price regulation over time

For many years, the trend in mature telecoms markets in developed countries has been for regulators to reduce the use of retail price regulation in preference for wholesale price regulation or even deregulation, leaving the "invisible hand" of competition to do its job.

The results of this trend are shown by the declining list of relevant product and service markets susceptible to ex-ante regulation within the European Union (EU): in 2003,[1] there were 18 markets (7 of which were retail markets) but by 2020,[2] this had fallen to only 2 markets (of which none where retail).

Recent retail pricing practices are starting to lead to reactions from some regulators

Telecoms markets in developed countries have been characterised for many years by high market penetration, competition around headline prices for specific flagship products and the need for high network investment in new technologies such as fibre broadband and 5G. Some operators have responded to these challenges to their revenue growth by adopting some new retail pricing practices that, while legal (as long as done transparently), could be considered to be contentious or unfair given the current concerns about the cost of living, particularly for poorer customers. Some regulators have started to react to these practices (see Figure 1).

Practice	Description	Examples of regulators' reactions
Above-inflation annual price increases	The operator increases prices, either when customers are in-contract or out-of-contract, by substantially more than inflation (for example, inflation + x%).	• Ofcom in the UK announced a review of inflation-linked telecoms price rises.[3] • AGCOM in Italy is consulting on a regulation that would ban price increases above inflation and provide for a price decrease in the event of negative inflation (deflation).[4] • HAKOM in Croatia issued an opinion related to the possibility of harmonising the prices of public communication services with the annual rate inflation (price indexation).[5]
Add-on fees (also known as junk fees in North America)	The operator charges add-on fees for services such as: • domestic roaming (for example, in the USA) • international roaming • out-of-plan usage (also known as 'overage charges' in North America) • service cancellation.	• The FTC in the USA announced that it was exploring a rule to crack down on junk fees.[6] • CRTC in Canada received a new policy direction from the federal government that requires it to "address unacceptable sales practices and improve transparency and clarity of service pricing."[7] • International roaming between EU member states has been regulated since 2007 by the European Commission (EC), with the final stage of this being a retail pricing constraint ("roam like at home") because the wholesale price regulation had not had the desired effect.[8] • Ofcom in the UK proposed new rules in July 2023 to introduce new roaming alert protections for consumers and small businesses.[9]

Practice	Description	Examples of regulators' reaction
Potentially socially disadvantageous pricing structure	The operators' price structures may not support socially disadvantaged consumers because there is more competition for 'flagship' products, or because their social tariffs are not marketed/used or are too narrowly targeted.	• Ofcom was concerned that single-play, voice-only customers were not gaining the benefits of competition and took ex-ante regulatory action (it eventually negotiated commitments with BT, rather than imposing formal remedies).[10] • The House of Lords in the UK held a hearing in March 2023 on digital exclusion and the cost of living, where the role of social tariffs was discussed.[11] • Ofcom in the UK has asked providers that are not offering a social tariff to do so, and for providers to promote these tariffs to low-income households and to consumers on government benefits.[12]
Loyalty penalty[13]	The operator charges more to existing customers than new customers for the same service.	• Ofcom in the UK announced agreements with several telecoms providers to ensure out-of-contract customers could get the same deals for broadband services as those available to new customers, if they agree to a new service contract.[14] • The Irish parliament has introduced a bill to amend the Consumer Protection Act that would ban "(charging) consumers who are renewing their subscription a higher fee than the trader charges consumers who are new subscribers."[15]

Figure 1: Examples of contentious retail pricing practices and reactions from some regulators [Source: Analysys Mason, 2023]

While a return to retail regulation in general is unlikely, regulators are likely to continue focusing on specific retail pricing practices

The controversial retail pricing practices of some operators in mature markets have attracted reactions from regulators and policy makers in the form of inquiries or further regulations.

This is not, however, likely to be a precursor for a general return of retail regulation for the following reasons.

- In some countries, competition from challenger operators is acting as a disincentive to engage in contentious or unfair retail pricing practices for fear of losing market share.
- Regulators want to protect consumers while not disincentivising investment in new technologies such as fibre broadband and 5G.
- Regulators realise that heavy-handed interventions can be a case of "the cure being worse than the disease."
- In practical terms, reintroducing retail price regulation is not straightforward (for example, as noted above, under the EU Framework, the recommendation on relevant markets susceptible to ex-ante regulation does not include retail markets).

Instead, regulators are likely to continue to focus on operators' controversial retail pricing practices, both through general consumer protections (such as transparency) and by concentrating on pricing practices that are seen to result in the worst impacts in terms of fairness and equality for the poorest in society.

This is a fine balance to strike, and will need a combination of industry engagement, proportionate regulation, fair business practice and a collaborative approach to solving some of the cost pressures and economic issues in today's macroeconomic environment. Expert commercial pricing, socioeconomic and regulatory advice can assist.

Questions? Please contact Gilles Monniaux or Ian Streule at web_enquiries@analysysmason.com

> "After many years of price declines, and with a cost-of-living crisis, there is emerging evidence that regulators in some mature telecoms markets are focusing more on retail prices.

[1] EUR-Lex (11 February 2003), Document 32003H0311.

[2] EUR-Lex (18 December 2020), Document 32020H2245.

[3] Ofcom (2023), Ofcom to review inflation-linked telecoms price rises.

[4] Autorità per le Garanzie nelle Comunicazioni (4 April 2023), Delibera 89-23-CONS - Documento - AGCOM.

[5] Hakom (2022), Predmet: Stručno mišljenje o mogućnosti uvođenja usklađenja cijena javnih komunikacijskih usluga s godišnjom stopom inflacije.

[6] Federal Trade Commission (20 October 2022), Federal Trade Commission Explores Rule Cracking Down on Junk Fees.

[7] Government of Canada (26 May 2022), Summary of the Government of Canada's new policy direction to the CRTC.

[8] European Commission, The history of Roaming.

[9] Ofcom (20 July 2023), New mobile roaming alert protections for UK holidaymakers.

[10] Medium (26 October 2017), Ofcom has intervened to cut the bills of loyal landline-only customers.

[11] UK Parliament (7 March 2023), Digital exclusion and the cost of living - Oral evidence.

[12] Ofcom (15 February 2022), Millions of low-income families missing out on £144 annual broadband saving.

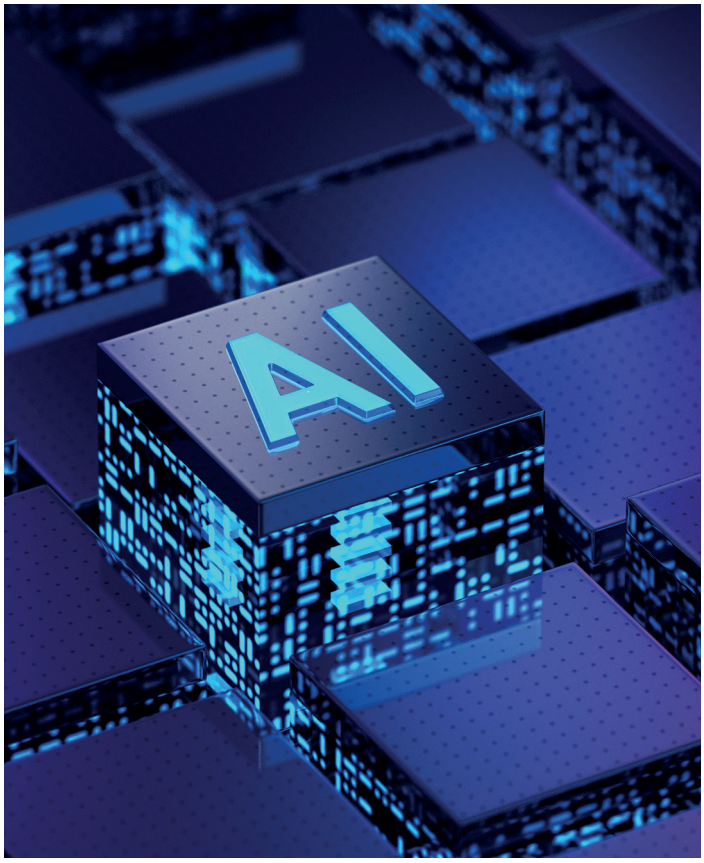
[13] For more information, see Analysys Mason's Protecting consumers from themselves.

[14] Ofcom (9 January 2020), Ofcom's 2019 Fairness for Customers highlights.

[15] Houses of the Oireachtas (18 February 2021), Consumer Protection (Loyalty Penalty and Customer Complaints) Bill 2021.

[16] For more information, see Analysys Mason's Challenger operators in Europe have gained subscriber market share by keeping prices flat.

[17] For more information, see Analysys Mason's Retail price caps: sometimes the cure is worse than the disease.



How AI can affect the colocation market

Stéphane Piot, Partner and Sylvain Loizeau, Principal

Recent advancements in artificial intelligence (AI) could have a significant impact on various industries. As organisations adopt AI-driven applications and processes, the demand for robust cloud services that can support the related training and inference workloads will continue to increase. This article explores the main impacts that these developments will have on data-centre infrastructure.

AI workloads will require new server hardware

Faster interconnections

AI workloads frequently involve multi-node computing, where distributed systems collaborate to handle complex calculations. These distributed systems require high-bandwidth low-latency interconnections, to limit, as much as possible, the bottleneck effects that are linked to the communication between compute nodes. For a given central/graphic/tensor processing unit system architecture, the friction can be reduced in two ways:

- by increasing the density of compute and memory chipsets on server boards (intra-board and intra-rack)
- by deploying networks based on standards such as InfiniBand that feature dedicated high-speed fibre-optic-based interconnections (inter-rack).

AI-dedicated processors

Total compute requirements for training large AI models are high. As an example, recent large language models have around 100 billion parameters and take around 1000 petaflop/s.days to train (that is, a notional compute power of 30 petaflop/s could train the model in around 33 days).

Training and inference workloads for AI models involve complex matrix computations, but the time and resources required for such workloads can be reduced by using specialised processors that are designed for the task. Traditional central processing units (CPUs) are relatively inefficient at performing matrix and tensor calculations and more-specialised processors are replacing them for AI workloads. Graphics processing units (GPUs) that were originally created for rendering 3D graphics but are capable of 'general-purpose' calculations were the first to be used because they can speed up AI workflows. To further increase speeds, AI-dedicated application specific integrated circuits (ASICs), such as tensor processing units (TPUs), have been developed. All these specialised processors excel at performing AI-related computation. However, they are expensive, are in short supply and require a lot of electrical power. Indeed, data-centre specialist Danseb Consulting considers that relationships with chip makers will be important, with a co-location provider recently interviewed noting that "to support AI, you need to have a partnership with NVIDIA".

Higher density of compute power

The combination of a high density of processors within server boards and racks with the use of high-power GPUs and AI-specific processors is driving desired rack power density to new heights. Indeed, a rack of GPUs can draw up to 50kW,[1] far above the current average of ~10kW per rack.[2] Although ASICs such as TPUs are designed to be more power-efficient than GPUs, data-centre operators should expect an increase in power density, which has practical implications. Danseb Consulting considers that "the compute required for AI creates a significant opportunity for the data-centre industry", as evidenced by the recent increase in demand for racks delivering above 30kW for AI applications.

This architectural shift will have multiple impacts on data-centre infrastructure

Upgrade of power distribution

The increase in rack power density will lead data-centre facilities to require more power overall (to avoid running out of power while the data halls are half full …). Therefore, data-centre operators will need to:

- upgrade power distribution systems including power conditioners and transformers, back-up generators and uninterruptible power supply (UPS) systems
- discuss the increased demands on the electrical power grid with the relevant utility companies.

Upgrade of cooling technology

The increase in rack power density will also increase the amount of heat that will have to be dissipated. Currently, data centres mostly use traditional air-cooling methods, which can support an energy density of up to 20kW per rack.[3] As rack density increases beyond this point, data centres will probably need to enhance their cooling systems – for example, by upgrading their cold sources, such as chillers or cooling towers. Advanced heat exchangers can also improve the efficiency of cooling systems by optimising the transfer of heat between hot and cold sources.

In addition, data-centre operators may also consider emerging technologies such as:

- direct-to-chip liquid cooling, which involves running liquid coolant directly through microchannels that are integrated within the processor, removing heat at its source
- immersion cooling, which involves submerging racks in dielectric fluid, removing the need for air-conditioning infrastructure.

Liquid-cooled systems are believed to support an energy density of up to 100kW per rack5 and Alibaba estimates that immersion cooling could reduce power consumption by 36% from an air-cooled facility with 1.5 power usage effectiveness (PUE) and has deployed this technology in its Hangzhou data centre.[4]

[1] phoenixNAP (USA, 2021), Why Density per Rack is Going Up. Available at: https://phoenixnap.com/blog/rack-density-increasing.

[2] Uptime Institute (USA, 2020), Rack Density is Rising. Available at: https://journal.uptimeinstitute.com/rack-density-is-rising.

[3] Schneider Electric – Data Science Center, Five Reasons to Adopt Liquid Cooling (Schneider Electric, 2019; White paper 279).

[4] Alibaba Group (China, 2018), OCP Summit – Immersion Cooling for Green Computing. Available at: www.opencompute.org/files/Immersion-Cooling-for-Green-Computing-V1.0.pdf.

> “ The infrastructural and architectural shifts triggered by the development of AI-based workflows will have significant implications for the colocation market.

The implications for the colocation market are profound

These infrastructural and architectural shifts have significant implications for the colocation market.

- Upgrading existing data-centre facilities to meet the demands of AI workloads can be complex and capex-intensive, especially in areas/facilities with limited space (to accommodate extra cooling/power conditioning) and power availability (because local substations could be at capacity).
- The installation of advanced cooling technologies requires careful planning, especially for facilities that are already running, and substantial investment, particularly if such upgrades are to be performed on hyperscale facilities.
- Dark fibre interconnections within and between data centres will enable users to connect their AI compute nodes and workflows efficiently and with the protocol of their choice (for example, InfiniBand).
- Emerging use cases will require low-latency processing for AI inference and some could also benefit from the use of edge facilities.

Undoubtedly, the rapid advancement of AI could bring positive change to many industries.

At Analysys Mason, we have been at the forefront of the telecoms and technology sector for the past 35 years, helping clients to tackle complex challenges in digital infrastructure and regulation.

Questions?

We are eager to hear your thoughts on the impact of AI on data centre infrastructure. For more information and to discuss how we can help your organisation to navigate this evolving landscape, please contact Stéphane Piot or Sylvain Loizeau at web_enquiries@analysysmason.com

The UK FTTP consolidation cycle

Alex Pericleous, Principal and Jack Walpole, Associate Consultant

The telecoms fibre-to-the-premises (FTTP) market has grown significantly in recent years, driven in part by the shift towards remote working and the increasing demand for ultra-high-speed broadband from streaming video, online collaboration, cloud services and other online data-intensive activities. The combination of government support, regulatory changes, technological innovation and the ability to mobilise investment has created a favourable environment for the growth of alternative network providers (altnets) in the UK FTTP market, offering competitive alternatives to the established players such as BT and Virgin Media O2.

Fibre altnets have been effectively competing in the market by building their own networks, often focusing on specific geographical areas, offering fast and reliable services, and frequently being the first FTTP option available in these areas. This altnet deployment has led to increased competition in the broadband market, with consumers benefiting from improved availability, greater choice and lower prices. On a broader perspective, the rise of the altnets with their innovation in FTTP deployment has been beneficial and has accelerated the overall development of the UK's digital economy and critical infrastructure.

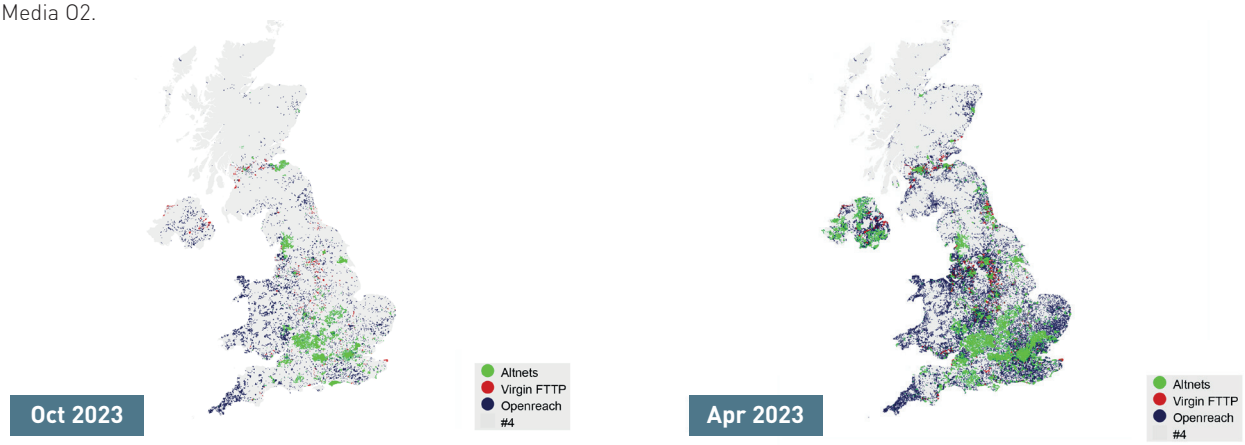


Figure 1: FTTP deployment evolution, UK [Source: Analysys Mason, 2023]

The rapid growth of altnets, however, has led to concerns about their own sustainability. Many altnets are still early-stage companies and face significant challenges in securing funding, resourcing projects, deploying networks (particularly dealing with overbuild by larger, established, operators), developing brand awareness, and selling to (and connecting) end users. These challenges can limit their ability to acquire customers and compete with the larger, more established fixed broadband providers, ultimately hindering their chances of achieving profitability and ensuring long-term viability.

Preliminary indications of market consolidation have started to surface. Notably, just a few altnets have received funding. Since 2021, approximately 70% of capital raised by UK challenger FTTP operators has been allocated to just three companies: Cityfibre (accounting for approximately GBP6 billion, ~60% of total), Netomnia (~7%), and Gigaclear (~4%). Other large altnets such as Hyperoptic and Community Fibre have also secured capital prior to this period and are backed by financial institutions with considerable financial strength. The relative concentration of recent funding among these larger players suggests that the market is increasingly supporting a narrower subset of altnets believed to be long-term winners, enabling them to expand their deployments or acquire existing players. In response, many smaller altnets are now considering merger opportunities in order to benefit from greater combined scale.

Merger and acquisition (M&A) activity among FTTP players has intensified, with the number of transactions since 2021 matching the cumulative count of the previous decade, and in terms of value,

> Gaining insight into industry consolidation and the underlying dynamics is crucial for stakeholders to navigate uncertainties effectively and position themselves for optimal outcomes.

surpassing it by approximately 3.5 times (GBP146 million). Most acquirers have been altnets themselves, including Community Fiber, Connexin, Glide and Voneus. Many investors now have multiple UK altnets in their portfolios and may target consolidation of these companies to drive revenue and cost synergies, as seen earlier this year through the consolidation of the four altnets owned by Fern Trading.

In the coming months, some altnets may face challenges in raising new capital. We are also aware that some debt processes are taking longer to reach closure than before. This could result in some altnets running low on cash and lead to proactive consolidation, or distressed asset sales. Trooli, is one such altnet that found it difficult to raise additional capital to support its roll-out and was reported to have been taken over by Vauban Infrastructure Partners in early 2023.

An interesting development has been Cityfibre's recent agreements to wholesale on other altnets' networks. This is also a form of market concentration at the wholesale layer which reduces the likelihood of overbuild and could ultimately lead to an amalgamation of the stakeholders.

Taking a broader view of the industry, FTTP has disrupted fixed broadband through innovative deployment strategies and product differentiation, leading to the emergence of numerous new players. The valuation dynamics have gradually shifted from network deployment (homes passed) to customer acquisition (homes connected), necessitating strong brands, effective marketing, perseverance, and perhaps, deeper pockets for sustained success.

A Harvard Business Review (HBR) article[1] has set out a generic industry consolidation cycle as being in four phases:

- opening
- scale
- focus
- balance and alliance.

In the scaling phase, market participants are seeking economies of scale: weaker players leave the market or, more likely given the economics of network deployment, are acquired by stronger entities, which may in turn lead to increased adoption rates and other economies of scale. This phase also often fosters increased collaboration and partnerships among players as they seek to achieve operational efficiencies (again economies of scale). In our view, the UK FTTP market is currently well into the 'scale' phase of the consolidation lifecycle.

The substantial investment required to deploy FTTP networks (the barrier to entry for this industry) and the ability to convert capital expenditure into revenue (that is, customer take-up which leads to revenue first and then profitability) are key drivers that determine the speed at which the industry moves through the first two consolidation phases. Rumours of larger consolidations, the megadeals, may signify that M&A activities are accelerating, and/or that the market is moving towards the 'focus' phase. Recent speculation regarding a potential Virgin Media O2 takeover of CityFibre is one such example.

Business consolidation cycles are complex and influenced by multiple factors including economic and market conditions, technological advancements, the regulatory environment and capital availability. This confluence of drivers extends well beyond the control of individual companies. Given this, market participants need to identify and monitor the overall trajectory of the market, understand the critical success factors, explore possible scenarios, and focus on the strategic options available to them.

Analysys Mason's strategy and transaction support practice can assist FTTP companies in successfully navigating the ongoing consolidation cycle. We offer in-depth analysis of market trends and consolidation drivers, helping companies to identify potential acquisition targets or merger partners. Our expertise extends to conducting comprehensive due diligence and valuations, as well as developing integration plans, post-merger strategies, cross-functional integration programme assurance and transformation support. With our team's extensive experience in the telecoms industry, we deliver tailored solutions to meet the unique needs of our clients. For more information, contact Alex Pericleous.

Questions? Please contact Alex Pericleous or Jack Walpole at web_enquiries@analysysmason.com

[1] https://hbr.org/2002/12/the-consolidation-curve

Study assesses impact of spectrum deployment on carbon emissions from 5G infrastructure roll-out

Janette Stewart, Partner, Sylvain Loizeau, Principal and Julia Allford, Consultant

There is a current policy debate about the possible future uses of spectrum in the upper 6GHz frequency band (6425–7125MHz) in Europe. In addition, the mobile industry has indicated a requirement for additional 5G mid-band spectrum to meet future traffic demands. The upper 6GHz band is one that is being considered for this purpose, in some countries.[1]

Analysys Mason's study investigated the carbon impact of mobile networks evolving to have more mid-band (for example, upper 6GHz) spectrum on existing sites, together with some densification, compared to building more base stations ('further densifying'), to meet future market demands without having further mid-band spectrum available.

This study therefore provides a different perspective compared to other studies already undertaken on use of the upper 6GHz band, which have variously considered factors such as infrastructure deployment, financial viability, impact of spectrum in terms of coverage and QoS, etc.

Study assumptions

In our study, we do not model mobile networks at their national scale, but we have modelled two representative environments – a typical European city and a European rural location. In the European city, we modelled the future connectivity needs for mobile broadband (MBB) services, and in the European rural area, we assumed a combined use of mobile networks for MBB plus 5G-based fixed-wireless access (FWA), delivering broadband connectivity to homes and businesses.

The models do not represent specific locations, but hypothetical areas, defined based on modelled characteristics such as population density and occupants per household. We made assumptions about current mobile infrastructure deployment using typical urban and rural inter-site distances and considered how these deployments would need to evolve to meet future connectivity targets, either with more mid-band spectrum, or without. The future targets were based on European connectivity policy (the Digital Decade Policy Programme) together with objectives defined by the ITU for 5G deployment – that by 2030, MBB users might require downlink speeds of 100Mbit/s and uplink speeds of 50Mbit/s (which is in line with ITU targets for 5G), and for FWA, 1Gbit/s downlink (which is in line with European targets as per the Digital Decade Policy Programme).

The study was focused on the infrastructure-related carbon emissions – that is, carbon emissions in the production and operation of base stations. It did not consider the carbon impact of mobile devices, nor did it consider the enablement impact of mobile networks on other sectors (for example, by enabling other sectors to improve their efficiency with real-time or remote operations, etc). More specifically, the overall aim was to consider whether having more mid-band spectrum available assists in meeting the future connectivity targets with fewer additional macrocell sites and small cells needed. Our modelling scenarios thus compared the number of sites (macro, and small cells) needed to deliver future connectivity targets to a segment of users (defined by an 'activity factor' in our report) with, and without, additional mid-band spectrum. The characteristics of the mid-band spectrum such as bandwidth and spectral efficiencies were aligned with expectations for the upper 6GHz band.

We estimated the annualised carbon costs of the deployment scenarios with and without the upper 6GHz being attributed to mobile. The carbon costs were a combination of embodied cost, which is the construction and installation stage of the incremental base stations, plus recurring costs of operating the base station in terms of powering and maintaining the additional sites. We assume that passive equipment (for example, the sites themselves) has a lifetime of 20 years whereas active equipment (for example, antennas and radios) has a lifetime of 8 years. When adding new sites into our model, we assume those new sites are not only equipped with the upper mid-band spectrum that the study is considering, but that they would also be equipped with radios that operate using the existing bands already assigned for mobile use. Hence the embodied cost of building a new site includes building the site as well as passive and active equipment for all mobile bands deployed on the site. The recurring carbon cost (that is, the additional power needed to run the site) is split between existing mobile bands, existing 5G mid-band (that is, in the 3.5GHz band) and the upper mid-band. The recurring cost has a fixed and a variable component, reflecting the fact that power consumption is dependent on the network load.

We followed a traditional capacity modelling approach in which we calculated the capacity of base stations based on spectrum deployed (we assume a typical European portfolio of low, mid and high bands, plus small cells), spectral efficiency and demand assumptions (which are based on the evolution of 5G penetration and user requirements to reach the target levels in 2032).

Key findings

The study results show that although the carbon emissions of 5G base stations increase due to adding upper 6GHz radios to existing base stations, the carbon effect of deploying more base station sites (that is, densifying the network grid) is greater (due to increased number of sites, which have a carbon impact both in constructing and running the new sites) than the carbon effect of adding spectrum to existing sites (with a lesser degree of densification). Thus, carbon emissions are lower in the scenario in which the upper 6GHz band is available because fewer macrocell sites and small cells are needed for future connectivity.

The main results of the study are as follows (Figure 1 and Figure 2).

It should be noted that the recurring carbon costs shown as negative in the figures below are the incremental carbon costs of deploying the upper mid-band spectrum. The spectrum roll-out in our model is completed by 2030 – the diagrams below show the modelled outputs up to 2030, and assume this final roll-out applies thereafter to 2032 (shown by the grey bars for 2031 and 2032).

'Upper mid bands' refers to spectrum in the 3.5GHz range, which is already available to European mobile network operators (MNOs) and is being used today for 5G services. 'Additional upper mid bands' refers to further upper mid-band spectrum that would be available to European MNOs if the upper 6GHz band was to be available for 5G use. We assume that the spectral efficiency of the additional upper mid bands is higher than that of the current upper mid bands, in light of expected technology improvement by the time additional upper mid band spectrum is deployed (which, in our model, is 2027). Recurring carbon costs for the additional upper mid band spectrum are assumed to be similar to the current upper mid band, comprised of a fixed and a variable component (with the variable component being dependent on network loading).

Without adding the upper 6GHz spectrum to the network deployment, our study shows that significant network densification may be required. This might also be beyond the practical limits of densification. This is because densification either via additional macrocells or via small cells, presents practical challenges such as finding suitable locations, sufficient space on sites, public resistance to proliferation of sites, and technical challenges such as increased interference.

Questions? Please contact Janette Stewart, Sylvain Loizeau or Julia Allford at web_enquiries@analysysmason.com

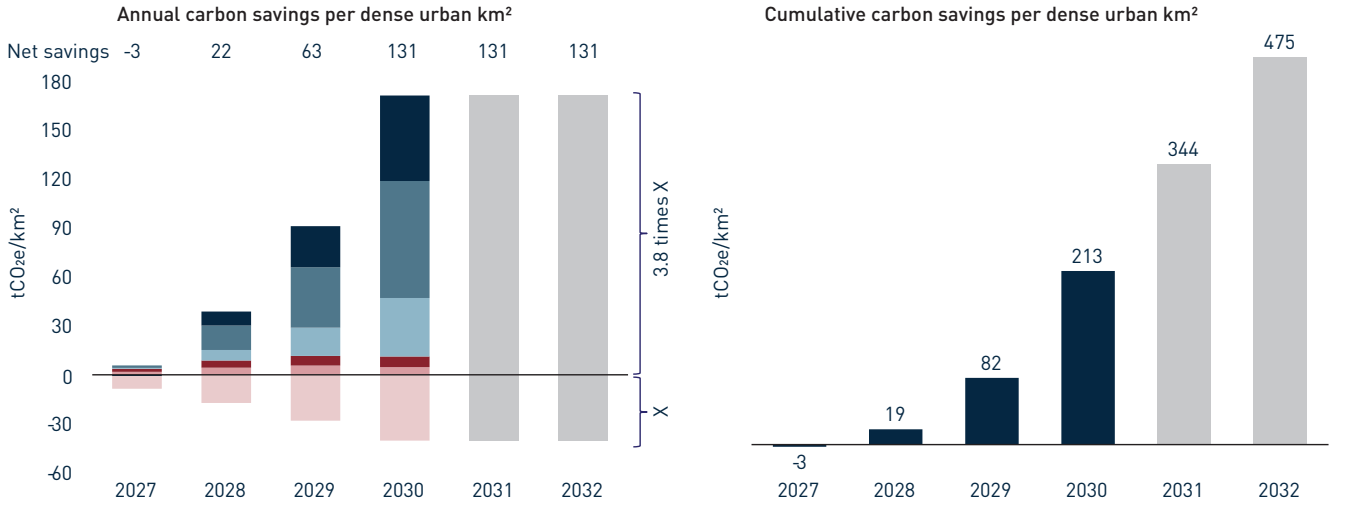


Figure 1: Annual carbon impact and cumulative carbon savings per dense urban km² [Source: Analysys Mason, 2023]

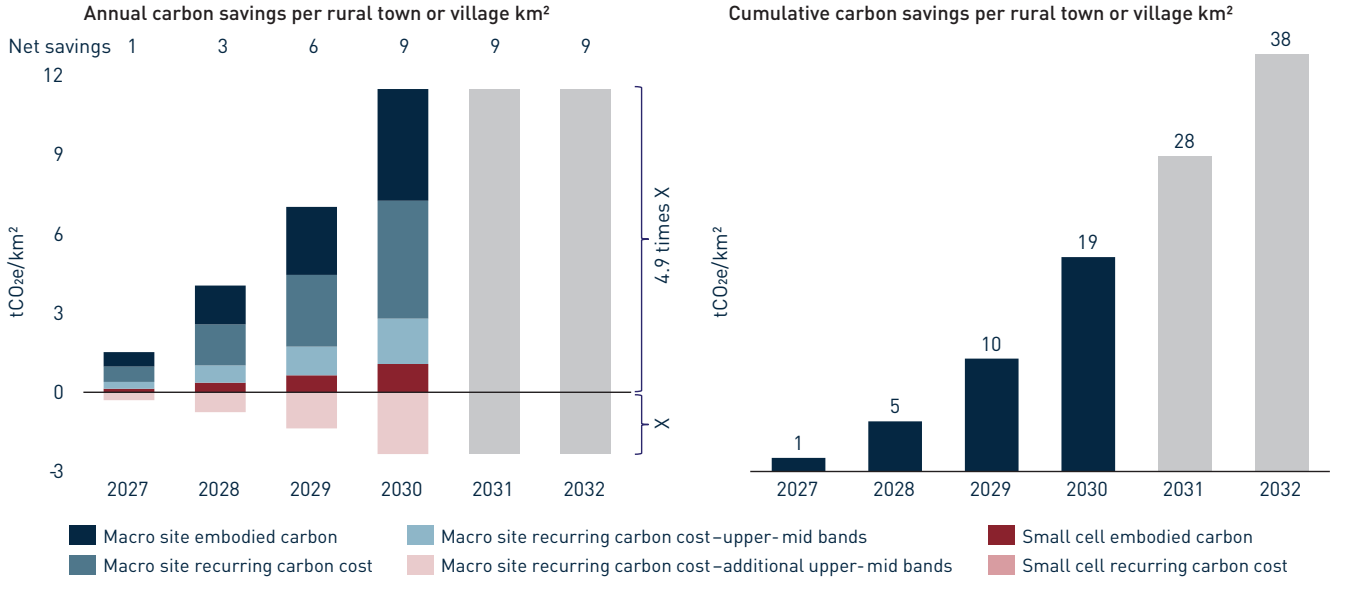
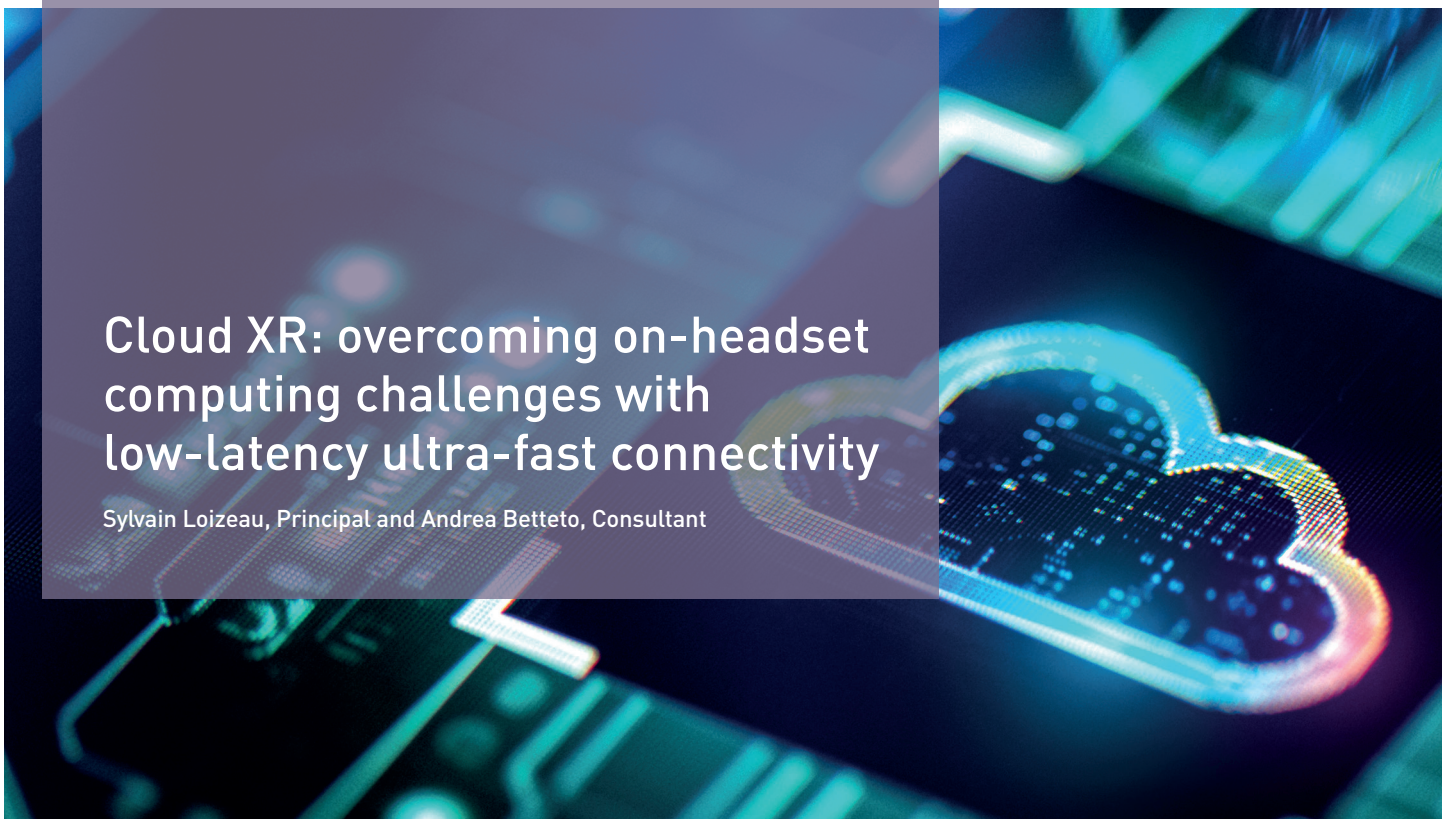


Figure 2: Annual carbon impact and cumulative carbon savings per rural town or village km² [Source: Analysys Mason, 2023]

[1] Future spectrum for mobile use in the context of the ITU's definition of 'International Mobile Telecommunications' has been widely debated in the lead up to the 2023 World Radiocommunications Conference (WRC-23). Our study was not related to estimating future spectrum needs, but a summary of what the mobile industry has previously estimated as an additional spectrum need can be found here: GSMA (June 2022), *GSMA Reveals 5G Spectrum Needs for 2030 Across Low, Mid, and High Bands.*



Cloud XR: overcoming on-headset computing challenges with low-latency ultra-fast connectivity

Sylvain Loizeau, Principal and Andrea Betteto, Consultant

Extended reality (XR) is an emerging term that encompasses all forms of immersive experiences such as virtual reality (VR) and augmented reality (AR). Real-time XR applications require significant computing power; for rendering graphics and interpreting the user's environment.

The combination of these requirements leads to the need for extensive compute power to render these realistic virtual worlds. The current paradigm is that computation and rendering happen in the same place as the use cases. As a result, two approaches to delivering this compute power are used.

- **A standalone approach** uses the headset's onboard computing power to perform all calculations. Examples of this include Apple's Vision Pro, Meta's Quest and Microsoft's B2B-focused Hololens.
- **A tethered approach** uses high-end computers or consoles connected to the headset via wired or local wireless networks (for example, Wi-Fi). Examples of this include Sony's PSVR2 headset and Steam's Index VR.

Both approaches have constraints that may limit the attractiveness of these future platforms. Onboard processing power is limited, compared to standalone computers/consoles, leading to graphics that are generally subpar compared to state-of-the-art virtual environments. This can limit attractiveness of the applications, especially for B2C users. In addition, headsets with onboard processing tend to be bulkier, to accommodate the larger battery and cooling.

Conversely, when using external computing resources, headsets generally require a physical connection to a computer or console (for power and data), which can be clunky when using immersive applications. Local area connectivity is also possible, assuming the Wi-Fi network offers sufficient performance, which is far from guaranteed today, especially in interference-prone dense urban areas and considering that the network performance must be sustained at all times.

Real-time cloud computing, such as cloud XR, could drive the widespread adoption of VR/AR

One solution to offset some of these problems is cloud XR. In this model, computing and rendering are offloaded to the cloud, and the headset is merely a head-mounted screen with an array of sensors and connectivity. This model could combine the best of the tethered and standalone approaches by offering:

- high-fidelity calculation for graphics, physics, data processing and AI agents etc., thanks to the greater processing power offered by cloud computing
- a lighter device in a more compact form factor, due to lower on-device processing needs, which would improve the device battery life and mobility of users, not only within local environments but potentially outdoors and basically anywhere that has high-throughput, low-latency and reliable wireless network coverage.

It should be noted that the above features are expected to progressively allow for more discreet form factors and easy-to-wear headsets (for example, they could be similar to a pair of glasses), which are arguably more likely to succeed than the current bulky form factors. In addition, the lack of upfront costs for acquiring the computing equipment, combined with the probable decline of headset prices with economies of scale (especially screens and sensors), has the potential to democratise XR applications.

Cloud XR (Figure 1) requires high-quality connectivity to enable the shift of computing power from home-based devices to the cloud, which may represent a major barrier to its widespread adoption.

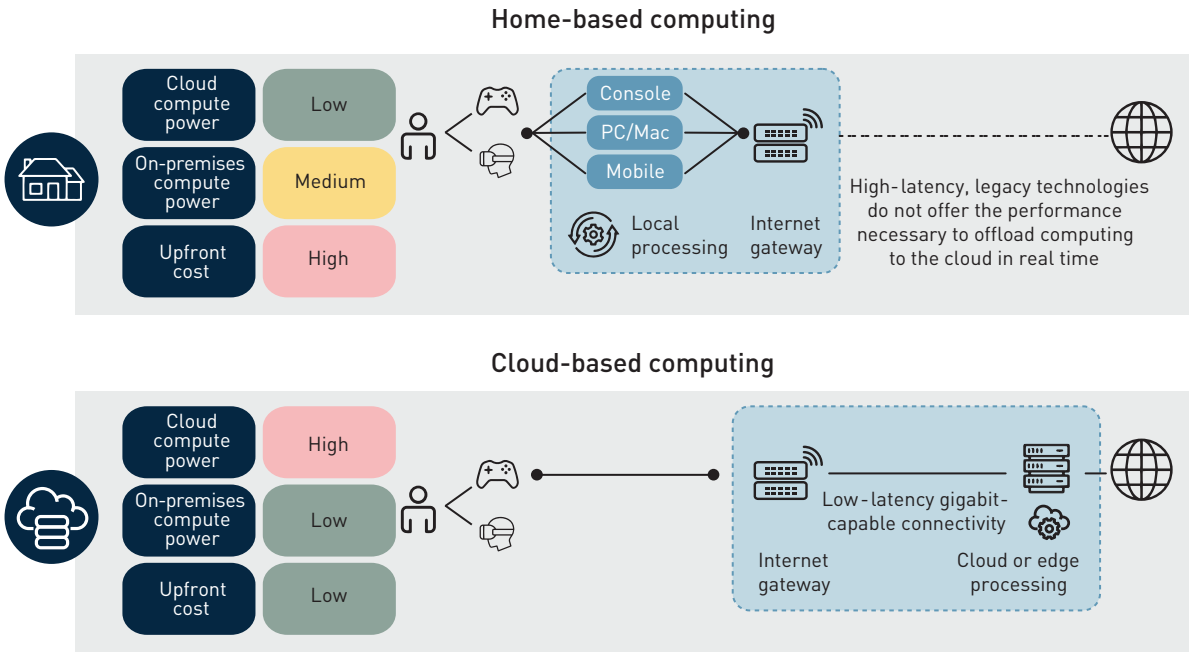


Figure 1: Comparison of home- and cloud-based XR applications [Source: Analysys Mason, 2023]

Cloud XR has clear parallels with cloud gaming, with the caveat that the network requirements are similar, but cloud XR applications need even higher bandwidth and lower latency. As reported in the latest Analysys Mason consumer survey, we expect cloud gaming to soon move beyond early adoption and into the mainstream, fostered by fixed access network technologies, such as FTTH and modern Wi-Fi (6 and 6E), that are becoming more widespread. These fixed networks already support implementations of cloud XR, based on VR only, as demonstrated by the first commercially available solutions, such as Shadow VR or Plutosphere. As these in-home applications progressively develop, they will in turn foster a market for more advanced XR applications, both B2C and B2B. These applications will also be able to extend out of home, thanks to advanced standalone 5G networks, creating an opportunity for a variety of use cases beyond gaming.[1]

All in all, cloud XR could revolutionise many B2B and B2C applications. The advent of new wireless technologies that cater to both local- and wide-area networking could enable new use cases.

TMT stakeholders need to understand the complex cloud XR value chain to take advantage of the investment opportunities

Just like the case of cloud gaming discussed above, cloud XR requires a complex ecosystem of telecoms, media and technology (TMT) players to work together. Here are some of the main questions that industry stakeholders should address.

- How can application and content providers take advantage of the availability of relevant headset and cloud technologies to realise the revenue potential of these new augmented experiences, both B2B and B2C?
- Will network providers be able to capitalise upon these new experiences to increase the attractiveness of, and revenue from, their next-generation networks, for instance by bundling services and network slices?
- How can cloud infrastructure providers and investors get a view of this burgeoning ecosystem that helps them to improve their ability to prioritise their investment in terms of data-centre facilities, hardware and software?
- What do technology companies need to understand about the potentially disruptive trends that accompany cloud XR (new screen technologies, new sensors, new connectivity chips, ultra-energy efficiency…) and could produce new industry champions?

At Analysys Mason, we have spent the last 35 years working with clients across the TMT space tackling some of the sector's most challenging issues, from digital infrastructure to regulation. We look forward to tackling these questions with you and discussing your thoughts on cloud XR opportunities and challenges.

Questions? Please contact Sylvain Loizeau or Andrea Betteto at web_enquiries@analysysmason.com

> “Cloud XR could revolutionise many B2B and B2C applications and the advent of new wireless technologies has the potential to enable new use cases.

[1] Standardisation bodies are already workingbon XR use cases; for instance, 3GPP has been actively targeting XR applications for 5G since Release 17 (March 2022), with the intention of expanding upon such applications in subsequent releases.

Greenhouse gas reporting requirements create an opportunity for the space and satellite industry

Sarah Halpin, Research Analyst

After two decades of sustained growth, the interactive entertainment industry is now bigger than movies

Space and satellite organisations have their own environmental, social and governance (ESG) strategies and aims but should also see the data that is required for ESG reporting as a significant revenue opportunity. Recent examples of partnerships based on satellite data being used to help companies to address ESG strategic goals include those such as Planet Labs' partnership with risk assessment firm Moody's and ICEYE's work on flood risk management and mitigation. However, space and satellite companies, such as those in the Earth Observation segment, will also have a significant opportunity to provide data on emissions to their peers within their own industry.

NSR, an Analysys Mason company, recently conducted a survey of 67 space and satellite companies to find out more about their ESG-related strategies. Of these companies, we expect that 70% will need to report on their greenhouse gas (GHG) emissions to meet at least one regulatory requirement within the next 5 years.

As part of this study, NSR also analysed the published ESG strategies of 31 space industry players. This analysis identified that most of the ESG objectives that were related to the environment were designed to address regulatory or social pressures for carbon-neutrality (Figure 1), and that all could use advances in space-based analytics to help to measure and monitor these goals.

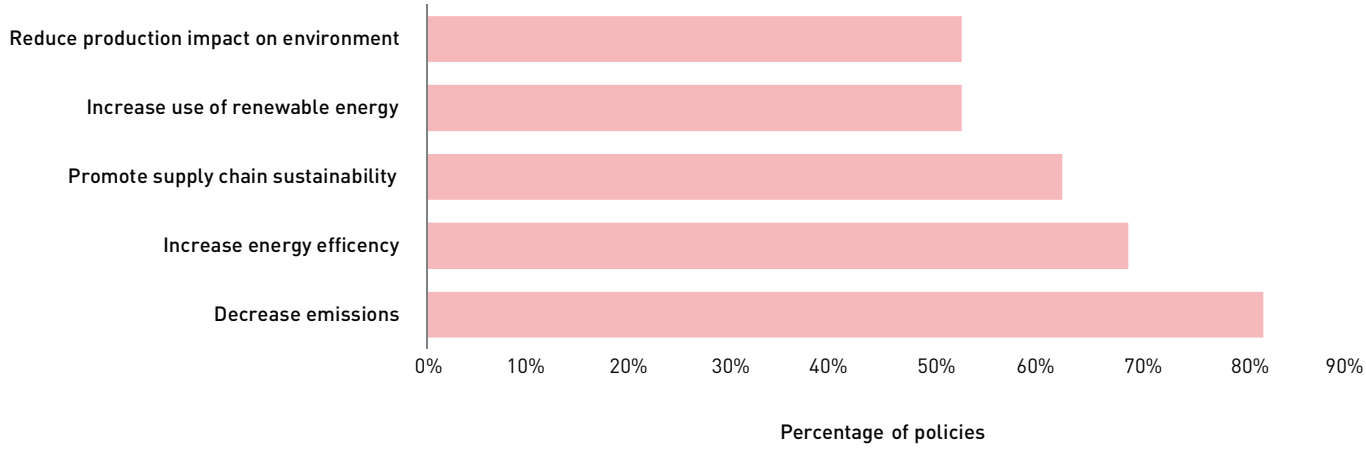
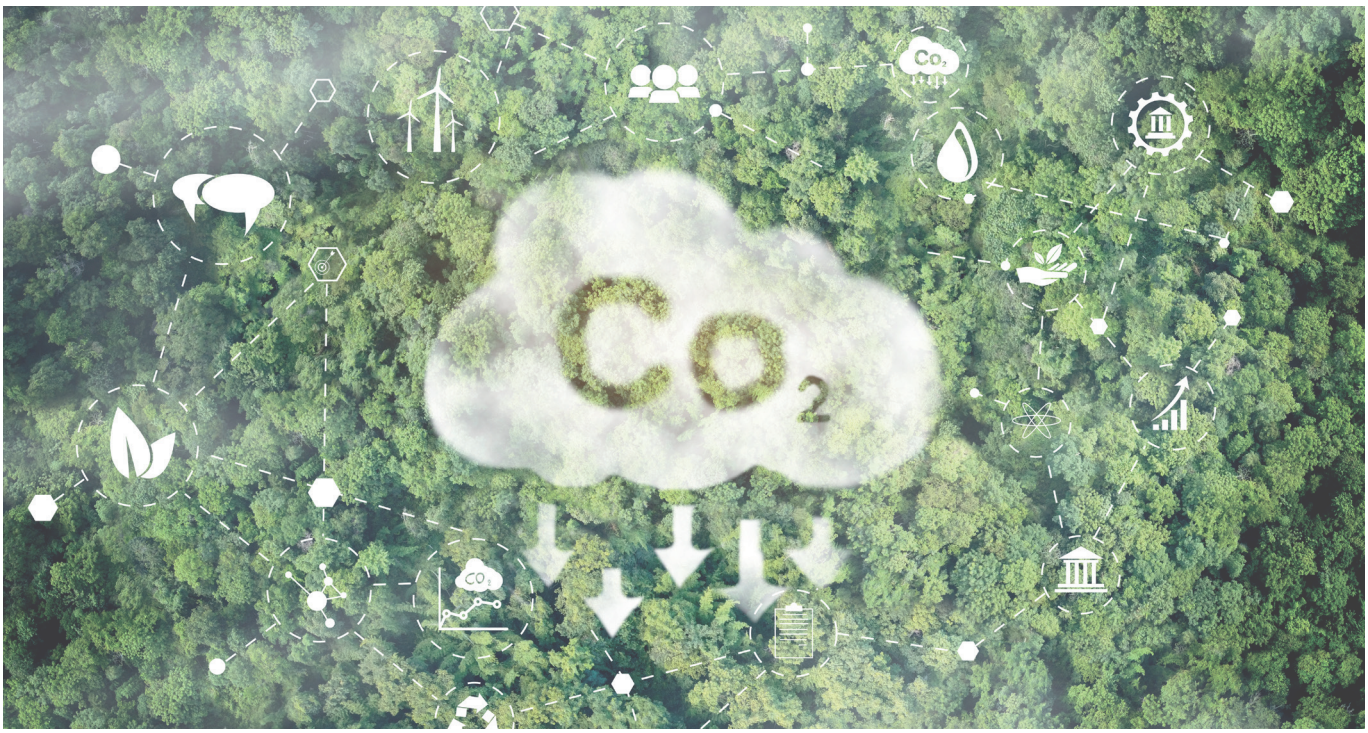


Figure 1: GHG-related goals mentioned in ESG policies in the space and satellite industry, January 2023 [Source: Analysys Mason, 2023]



As GHG emissions monitoring becomes mandatory worldwide, the space and satellite industry will be well-placed to provide data inputs.

Space and satellite companies have an opportunity to provide data on emissions to their peers in the industry

Advances in space-based earth observation data and related analytics can be harnessed to help to measure and monitor environmental goals. NSR's Space ESG Assessment report notes that with the right impact and price-point, the Earth Observation segment of the space industry is well-positioned to gain significant revenue from serving the GHG emission data market. Companies in this segment use satellite-related imaging data to monitor aspects of Earth such as carbon emissions, land-use or environmental impacts. Existing reporting has used known standards, reported emission statistics and historical data, but a market for data is now forming in which there is an opportunity for satellite players. The recent increase in the availability of earth observation data has significantly reduced the price for end users, which is making satellite data more accessible to newer and smaller players in the space industry that are seeking to address GHG-related regulatory requirements.

We expect interest in this field to continue to increase. Data providers in the Earth Observation segment should be prepared to communicate and demonstrate the full range of satellite offerings. For at least some players, this will be a new area of industrial engagement, and service providers will need to be able to promote their services, such as the ability to validate technological emissions calculations, provide actual seasonal variation numbers (particularly useful for energy and land use) and make available precise information as newer technology comes online. Companies need to know about new service options if they are to purchase them.

The bottom line

The total addressable market for companies in the Earth Observation segment of the space and satellite industry will increase as the industry continues to respond to ESG regulatory developments.

NSR, an Analysys Mason company, provides satellite and space market research and consulting services. It specialises in identifying growth opportunities in four industry sectors:

- satellite communications
- satellite and space applications
- financial analysis
- satellite and space infrastructure.

Questions? Please contact Sarah Halpin at web_enquiries@analysysmason.com

> “Space and satellite organisations have their own ESG aims but could also supply the data that other companies in the industry need for ESG reporting, which could be a significant revenue opportunity.

The market is poised for eSIMs to become ubiquitous, and operators should capitalise on their potential

Eulalia Marin, Principal Analyst

eSIMs are now available in more than 190 countries worldwide but awareness and adoption remain low, partly due to operators' reluctance to promote the digital solution over fears of increased churn and revenue loss.

Operators broadly understand the risks posed by eSIMs. eSIMs make it easier for customers to switch between operators and lower the barriers for new MVNOs to enter the market, potentially resulting in higher churn and increased price pressure. If customers switch to an eSIM when they are travelling, roaming revenue could also decline. eSIMs are also likely to encourage consumers to buy from digital channels, rather than physical stores, where the bulk of operator sales take place.

While these risks are inevitable, the adoption of eSIMs brings many benefits for operators including the digitalisation of the customer journey, operational efficiencies and new revenue opportunities.

The adoption of eSIMs creates new revenue opportunities for mobile operators

Bundling multiple mobile users into a single contract is a commonplace practice for mobile operators. Multi-SIM bundles enable customers to add secondary SIM cards to their primary phone plan, allowing them to share their plan's allowance with additional SIM cards. This feature, mainly directed at families, can also be used by a single customer with multiple devices.

Multi-device data bundles are centred around a primary phone plan which allows customers to add extra connected devices for a fixed monthly fee. The customers each have a unique mobile number, and the data allowances included in the main plan are shared among all the devices included in the bundle.

Traditionally, the most common option for eSIM bundles has been to add an eSIM-enabled smartwatch to a user's smartphone plan, but operators are exploring more flexible bundling options that allow users to add a broader range of eSIM-enabled devices such as tablets, laptops and other consumer IoT devices, such as connected car dongles (Figure 1) to their phone plans. In an effort to attract new customers, operators are offering price discounts on companion device plans when bundled with a primary smartphone, along with a separate data allowance.

Operator (country)	Multi-device offer details
Movistar (Spain)	• Movistar multi-SIM customers can add up to three SIMs/eSIMs to a smartphone plan for the fixed price of EUR8 (USD8.62) per month regardless of the number of SIMs/eSIMs added. • The airtime and data allowances in the primary plan is shared among all the associ-ated devices yet data consumption from secondary devices is restricted to 20GB per month.
Vodafone (UK)	• Vodafone's OneNumber bundle allows users to add up to three eSIM devices to their smartphone plan. • Smartwatches can be added to the bundle for GBP7.5 per month (USD9.16). Cus-tomers adding a tablet to the bundle receive a GBP3.5 (USD4.27) monthly discount on their tablet plan.
Verizon (US)	Verizon smartphone customers can share their data allowance with an eSIM-enabled smartwatch for USD10 per month. Verizon also offers discounted device plans: • tablets: USD20–30 per month (final retail price: USD80–90) • hotspot: USD20–80 per month (final retail price: USD90–110) • connected car: USD20 per month (final retail price: USD75)

Figure 1: Examples of contentious retail pricing practices and reactions from some regulators [Source: Analysys Mason, 2023]

> Preliminary indications of market consolidation have started to surface. Notably, just a few altnets have received funding.

Multi-device service bundling can help improve service experience and increase customer loyalty, which can help balance the increased risk of churn brought by the implementation of eSIM technology.

Operators can leverage eSIMs to reduce costs and to improve customer experience

The digital transformation of customer engagement has become a priority for most operators looking to improve operational efficiency and customer experience. eSIMs enable the provision of a full digital service experience where the customer acquisition and onboarding processes are managed using digital channels.

While traditional customer support channels are still more commonly used by consumers worldwide than digital channels, customers' preference for digital channels for sales and customer support has been growing steadily in recent years (as shown in our report, Mobile digital experience: consumer survey).

Operators are increasingly enabling in-app activation features on their customer-care apps to streamline their onboarding processes. T-Mobile USA, for instance, has added an Easy Switch function to its app to allow prospective clients with an unlocked eSIM-compatible smartphone to switch service providers faster and in a more hassle-free way.

eSIMs' potential to reduce customer adoption barriers and increase churn can also be advantageous to operators as it can help them to attract new customers more efficiently. Operators can use eSIM technology to attract customers to their own networks. By offering a test-drive, operators can convince users on competing networks to subscribe to their services.

Unlike traditional network test drives, where the operator has to send a physical SIM card to the prospective customer, eSIMs allow the entire registration process to be handled through the operator's app. eSIM test drives also enable prospective customers to use their current network provider and the one they are testing simultaneously without using a different handset, telephone number or service plan.

eSIM test drives can be helpful for challenger operators looking to showcase their strengths, mainly when these are linked to network performance and coverage. In the USA, where most operators use coverage and speeds to promote their service plans, eSIM trials have become relatively common, particularly among low-cost direct-to-consumer, app-centric brands targeting digital natives such as US Mobile, Visible or MVNO Google-Fi. The adoption of eSIM technology in the consumer market brings many challenges for operators. However, its advancement is inevitable, and operators should be exploring how to maximise its potential.

Questions? Please contact Eulalia Marin at web_enquiries@analysysmason.com

Global leaders in TMT management consulting

Analysys Mason is the world's leading management consultancy focused on telecoms, media and technology (TMT). We give clarity and confidence in answering our clients' biggest commercial questions: What strategy will best enhance value? What implementation plan will be most successful? What is the optimal positioning for five years' time?

We bring together commercial and technical expertise across four interconnected consultancy practices strengthened by globally respected research:

- **Strategy**

  We cover all aspects of strategy development and review based on a highly analytical and data-driven approach. Our propositions include corporate growth strategy (organic and inorganic), business unit strategy (including consumer and enterprise products), and infrastructure strategy (including capex optimisation through data analytics).

- **Transaction support**

  We provide robust commercial and technical due diligence support for TMT debt and equity financing, M&A and IPO processes. We support the full M&A cycle from opportunity scouting through to post-merger integration.

- **Transformation**

  We help structure and operate major IT, digital and business transformation programmes. We also have deep expertise around what it takes to avoid the pitfalls of and maximise the success of complex change programmes.

- **Regulation and policy**

  We play a leading role in helping to formulate and examine policy and regulation related to TMT. We support governments, regulators and the whole telecoms sector in a rapidly changing world increasingly shaped by digitalisation.

- **Subscription research**

  We evaluate the key topics driving the TMT industry and quantify the impact on operators and vendors worldwide. Clients rely on our research as an essential resource for strategic planning, investment and benchmarking.

Global reach, local insight

Our advice is rooted in deep domain knowledge that combines global reach and local insight into markets to help our clients achieve their goals. Our service offerings are fully integrated across all five key strengths. This allows us to make sense of a complex TMT landscape and create valuable insights in ways that cannot be matched by narrower domain specialists or generalist consultants that lack our depth of experience.

Working with private- and public-sector clients in 140+ countries, we are committed to advancing TMT's role as a critical enabler of global economic, environmental and social transformation – and to contributing to a world where technology delivers for all.

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