GSMA™
Intelligence

Global Mobile Trends 2023

Navigating an uncertain world

February 2023

gsmaintelligence.com @GSMAi

GSMA

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

We invite you to find out more at gsma.com

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GSMA Intelligence

GSMA Intelligence is the definitive source of global mobile operator data, analysis and forecasts, and publisher of authoritative industry reports and research. Our data covers every operator group, network and MVNO in every country worldwide – from Afghanistan to Zimbabwe. It is the most accurate and complete set of industry metrics available, comprising tens of millions of individual data points, updated daily.

GSMA Intelligence is relied on by leading operators, vendors, regulators, financial institutions and third-party industry players, to support strategic decision-making and long-term investment planning. The data is used as an industry reference point and is frequently cited by the media and by the industry itself.

Our team of analysts and experts produce regular thought-leading research reports across a range of industry topics.

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GLOBAL MOBILE TRENDS

Much has changed since our first publication of Global Mobile Trends in 2016. Technology has advanced, companies have come and gone, and a pandemic has affected everyone.

As ever, the Global Mobile Trends research seeks to understand the most important developments in telecoms and the broader TMT space, and explain what they mean for people, companies and governments.

GLOBAL MOBILE TRENDS

Five key takeaways

Five key takeaways

2022 was the year 5G went mainstream

REASONS

- Easing of pandemic effects
- Lower device prices
- Improved network coverage
- Fewer supply-chain issues

DATA POINT

5G has passed **1 billion** subscribers. Take-up is proceeding faster than with any previous mobile network generation (4G took around 2 years longer).

Private networks and edge have come of age

REASONS

- Enterprise demand for guaranteed connectivity
- Low-latency applications
- A gateway to 5G standalone (5G SA)
- Proof points and a virtuous circle

DATA POINT

63% of operators say private networks are critical to their enterprise success. **86%** say the same for 5G SA.

The metaverse is being built, but will they come?

REASONS

- A devices 'third wave'
- Facebook/Meta pivot
- Gaming success

DATA POINT

The metaverse has no firm market size, but estimates are up to **$150 billion**. Meta has committed to invest nearly $20 billion in 2023. Operators remain guarded, with only **7%** rating it a significant business opportunity.

Sustainability is the number one priority

REASONS

- Exposure to global market volatility
- Climate change
- Business sense

DATA POINT

Almost **85%** of operators rate energy efficiency as the top priority in network transformation.

Satellite is a glass half full

REASONS

- 400 million people still without mobile broadband coverage
- Pragmatism reigns

DATA POINT

The revenue upside potential is **$30 billion by 2035** (3% of telecoms industry revenue)

GLOBAL MOBILE TRENDS

Five key takeaways

5G in 2023

Entering the next phase

csg

TOPIC OVERVIEW

5G in 2023

Why it matters

5G availability spreads across the world

- 5G commercialisation gathers pace
- Networks established in developed markets
- Emerging markets: the next stage of 5G launches

Over half of mobile connections on 5G by 2030

- Global 5G connections surpass 5 billion
- Majority of mobile connections on 5G
- North America, East Asia and GCC markets continue to lead on adoption

Is FWA a long-term alternative to fibre?

- Consumer appeal for 5G FWA
- Factors for successful rollouts
- FWA connections total 41 million in 2025

5G standalone: a promising outlook

- URLLC and network slicing: key for operators
- Rollouts underway in pioneer markets
- Significant plans around the rest of the world

5G-Advanced and the return of multicast

- Multicast services: a priority for operators
- The B2B push continues
- Have AR and VR been overhyped?

Regional perspective

Considerations ahead

WHY 5G MATTERS IN 2023

The next phase of 5G

Financials

Revenue generation: Every new technology generation brings a new wave of capex demand, but we have not seen a corresponding increase in revenue since 3G. This helps explain why two thirds of surveyed operators saw revenue generation or cost savings as their number one goal in 2022. Key to growth are meeting the requirements of consumer use cases (including 5G FWA) and serving enterprise customers with solutions such as network slicing.

Data traffic

Growth in data usage: According to Ericsson, data traffic will grow fourfold between 2022 and 2028. Existing networks would struggle to meet demand in areas where it is at its greatest.

mmWave: While often lauded for its speed, a further benefit of mmWave is its huge capacity in dense urban areas, with factors such as low propagation less of an issue.

Changing demand

Consumers will demand 5G: 70% of consumers in a GSMA Intelligence survey claimed that ability to connect to 5G was either important or very important. As activities such as online gaming and streaming become more popular, consumers will demand the best possible experience.

Enterprise requirements go further: Networks need to be ready to support businesses as they complete their digital transformation, in areas such as artificial intelligence and automation.

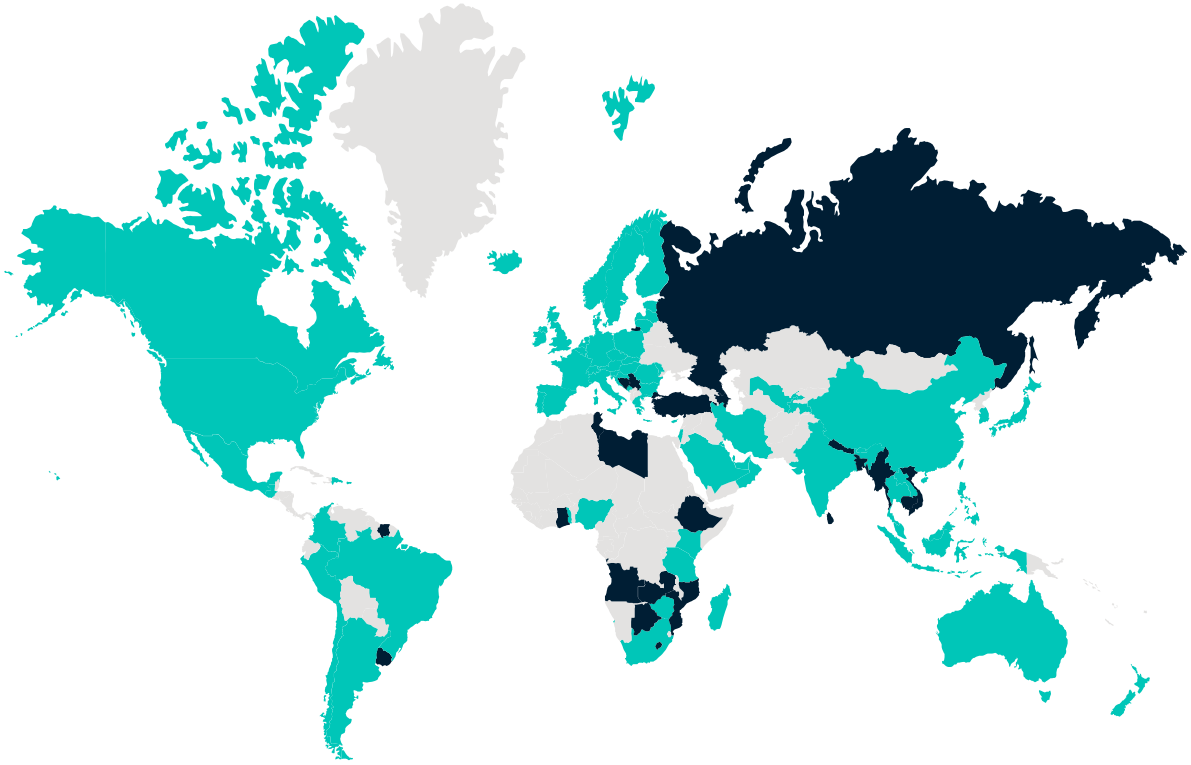
5G availability spreads across the world

Launches begin in emerging markets

- 5G adoption varies significantly around the world but is now available in most countries.
- Across North America, East Asia and the GCC markets, networks are already firmly established, and operators are looking at what comes next. While European operators started later and adoption is not yet at the same level, 5G networks are in place across the region.
- The next stage of 5G deployments has started, with launches in many emerging markets. The recent launches in India and Nigeria signal a huge number of potential new subscribers.

5G commercialisation gathers pace around the world

Data correct to 1 October 2022



Live 5G network Planned 5G network

Note: Status assigned where an operator has stated a commitment/timeline (planned), or announced a commercial 5G launch (live). Status defined as live where at least one operator has commercially launched 5G services.

Source GSMA Intelligence

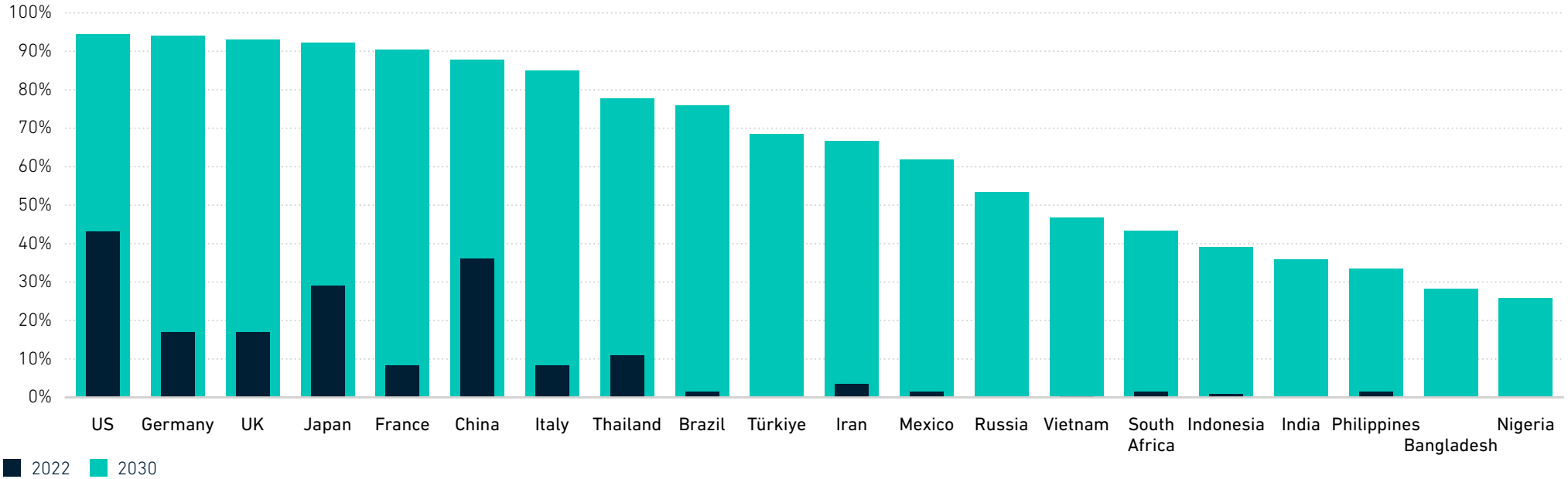
Over half of mobile connections on 5G by 2030

North America leads but Europe is closing the gap

- North America, East Asia and GCC markets will continue to lead on 5G adoption. With 5G already established, operators are now rolling out standalone networks.
- While Europe is currently behind, expanding coverage and 5G devices moving into the mainstream will help reduce the gap.
- In Asia Pacific, several large markets are yet to launch 5G, bringing down the average for the region. Ambitious rollout plans in India are set to change this.
- Operators in Latin America took a wait-and-see approach to 5G but are now recording growth in coverage and connections.

5G to spread globally across subscriber base

5G as a percentage of total connections for the top 20 markets by 5G size (connections) in 2030



Source GSMA Intelligence

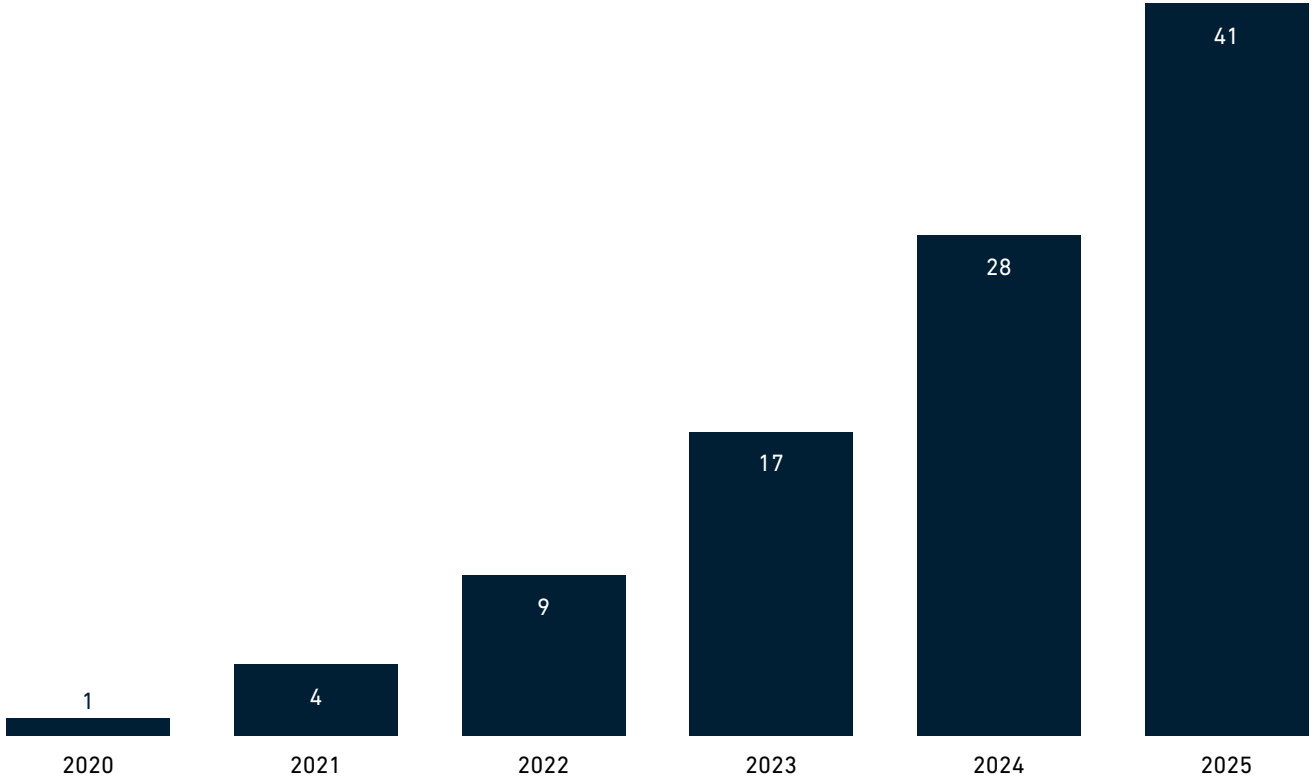
Is FWA a long-term alternative to fibre?

Connections growing but market conditions need to be right

- In the GSMA Intelligence Consumers in Focus Survey, 42% of consumers saw 5G fixed wireless access (FWA) as an appealing proposition. The outlook for the technology rests on a combination of factors though, including the pace of 5G network rollout, spectrum availability and refarming, and the marketing and pricing strategies of operators. With energy consumption high on the agenda and converged operators primarily focusing on fibre for home broadband, there is no guarantee of perpetual growth in FWA.
- Nevertheless, over the next four years, 5G FWA connections will grow by around 90% per year (on average, across the 52 countries that have either launched or announced a 5G FWA service). As 5G rollout starts in more developing markets, the list of fast-growth markets will expand, with further operators benefiting from the 5G FWA opportunity.

Connections growing globally for FWA

Global 5G FWA connections (million)



Data correct to 30 June 2022.

Source GSMA Intelligence

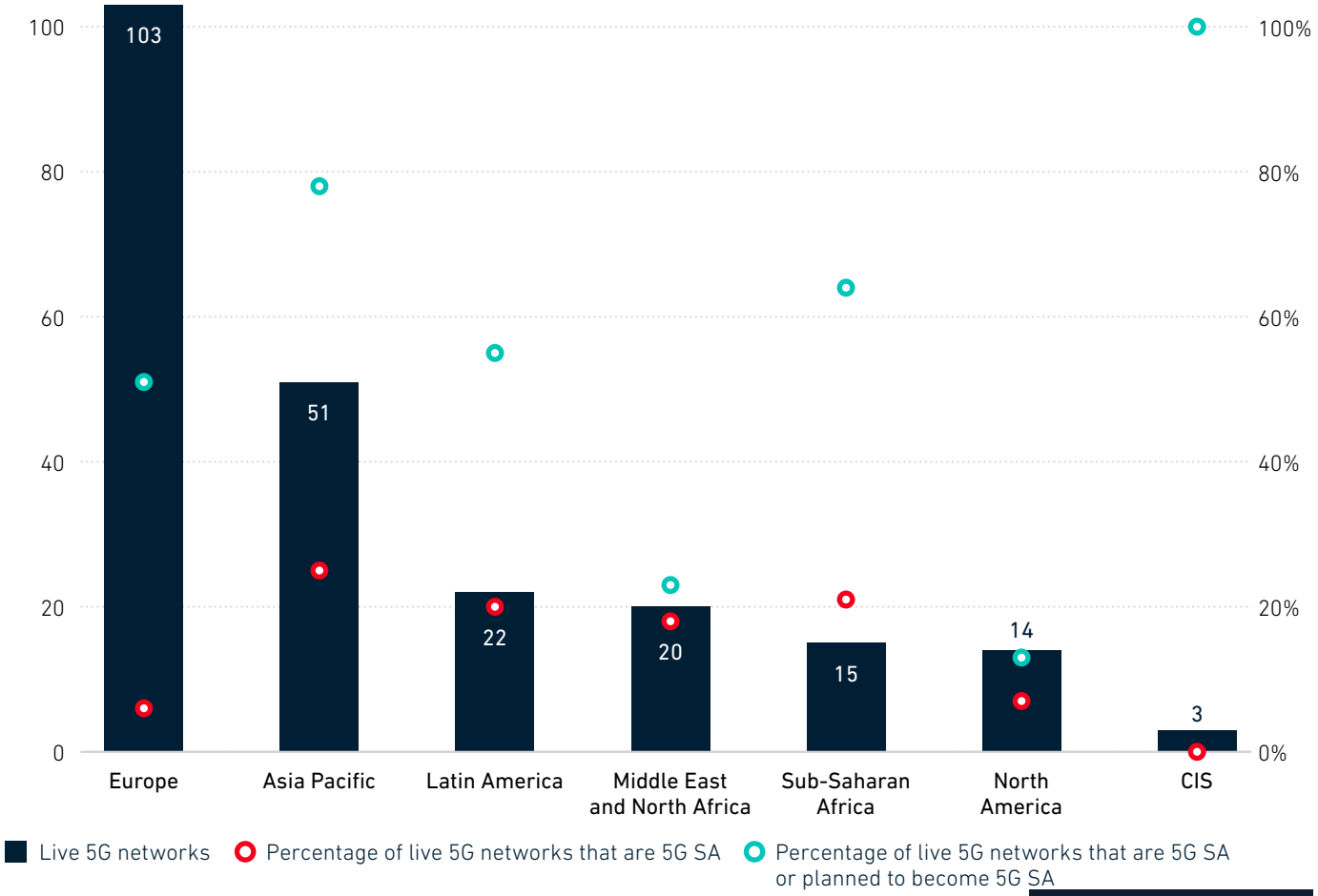
5G standalone: a promising outlook

But plans need to play out to expectations

- With the first stage of 5G rollouts completed and focus shifting to enterprise use cases, 5G standalone (5G SA) will be essential to delivering the real benefits of 5G. The GSMA Intelligence Operators in Focus Survey confirmed that network slicing and ultra-reliable, low-latency communications (URLLC) are key considerations for 5G rollouts.
- It therefore makes sense that the number of standalone networks has been expanding, particularly among 5G early adopters in North America and East Asia.
- While rollouts are at an earlier stage across the rest of the world, plans suggest this is set to change.

5G network rollout progress

Data as of Q3 2022



Source GSMA Intelligence

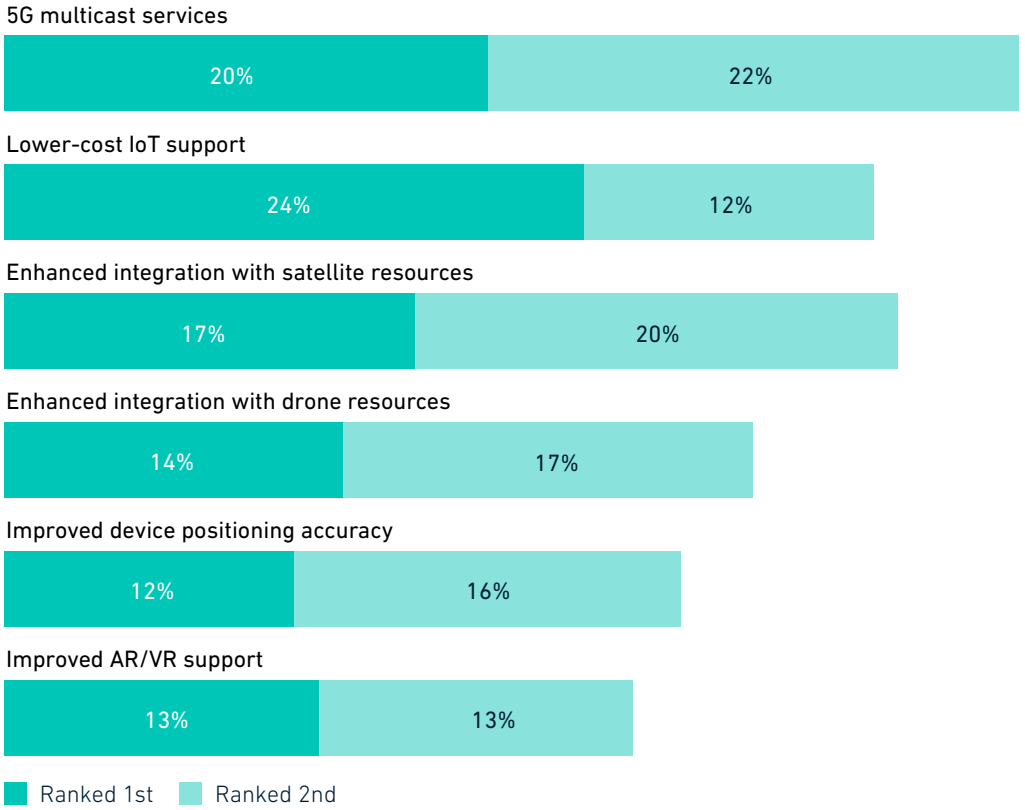
5G-Advanced and the return of multicast

New capabilities and use cases under trial

- 5G-Advanced is the next version of the 5G standard, augmented with new capabilities and (by extension) use cases.
- The GSMA Intelligence Network Transformation Survey suggests more than half of operators would deploy 5G-Advanced within two years. While past experience tells us to be suspicious of overly optimistic expectations, the opportunities presented by 5G-Advanced are clearly on the radar.
- **Multicast services** delivered over mobile networks have been possible for years but have never gained commercial success. An interest in 5G-Advanced supporting multicast services could indicate willingness to explore the space, potentially targeting new areas such as automotive.
- **Low-cost IoT** was another top priority for 5G-Advanced, aligning with a continued push on B2B services. Current IoT solutions are evidently too costly, but it will take time to scale new 5G-Advanced IoT capabilities.

Multicast tops 5G-Advanced technology feature priorities for operators

Which 5G-Advanced technology features are most important to your network transformation priorities? Rank top two.



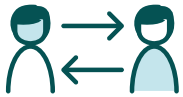
Source GSMA Intelligence Operators in Focus: Network Transformation Survey 2022

Grow Your Business without Limits

Take your current tech investments to the future so they can scale up for 5G.

5G networks will be intent-based and automated, key capabilities such as multi-party service delivery, partner management and settlement need to be just as flexible, dynamic and automated with real-time network-level integration.

CSG Encompass is the only solution designed and built to manage multi-sided business models for the communications industry, unifying the commerce journeys of Communications Service Providers (CSPs), their partners and their customers.
The platform reduces the complexity of B2B2X ecosystems, expanding CSPs portfolios with a multitude of partners.

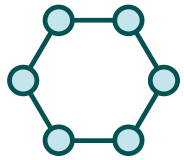


Power up partner management

Efficiently onboard and manage partners and their products, giving them everything they need so you can collaborate and win together.

Cut quote-to-cash time by 30%

Delight your customers with dynamic and accurate quoting and right-first-time order fulfillment. Spend less time fixing avoidable issues and more time helping customers.



Support complex B2B2X monetization

Support the multi-layered partner relationships, account hierarchies, settlements and charging models needed to build a thriving B2B2X ecosystem.

**No matter where you're starting from, CSG Encompass has your commercialization requirements covered.
Let CSG take your current tech investments to the future so they can scale up for 5G.
To learn more, go to www.csgi.com/encompass.**

Regional perspective

Europe

- European markets are not showing the same levels of adoption reported by leading markets, where operators have moved beyond 5G non-standalone (NSA) and are rolling out 5G SA. A key factor here is fragmentation and low ARPU induced by competition levels, leading to less investment.

China

- The huge population, regulatory focus and attractive tariffs have led to China becoming a global 5G leader. At the end of 2022, China accounted for 60% of 5G connections globally.

Africa

- African 5G launches have in most cases come later than elsewhere in the world. With less capex available for network upgrades and handset costs still expensive for many, affordability remains prohibitive for the average consumer.

Considerations for the year ahead

Will consumer 5G provide a return on investment to operators?

- Despite billions in investment, in most cases ARPU has not seen corresponding growth, with fierce competition discouraging pricing premiums.
- Around 50% of consumers in the GSMA Intelligence Consumers in Focus Survey claimed to be interested in add-on services, representing an opportunity for incremental growth. Nevertheless, the enterprise segment remains the major 5G opportunity.

Will we see real growth in emerging markets?

- The reducing cost of handsets, together with tariffs often priced without a premium, is resulting in faster adoption for 5G than that seen with 4G. The low penetration of fibre in emerging markets provides a promising landscape for 5G growth.

Is AR/VR overhyped?

- AR/VR was regularly cited as a main use case for 5G, but the GSMA Intelligence Operators in Focus Survey suggests it is not a priority among operators.
- Sales of AR/VR headsets remain flat. A reduction in headset pricing and an increase in content are needed before AR/VR moves to the mainstream.

GLOBAL MOBILE TRENDS

The digital consumer in the 5G era

Driving the 'wow' factor

csg

TOPIC OVERVIEW

The digital consumer in the 5G era

Why it matters

Consumer intent to upgrade to 5G increases
- Encouraging signs for adoption
- Consumer experience with 5G networks
- Consumer willingness to pay more for 5G

Bundling gains with 5G consumers
- 5G consumer interest in bundling non-connectivity offerings
- Customer segmentation
- Seamless consumer experience

5G-compatible smartphones increase in popularity
- Consumer interest in 5G smartphones
- Leading features when choosing smartphones
- The smartphone as a platform

Digital entertainment – a key 5G consumer use case
- Gaming over 5G: consumer appeal and engagement
- Video over 5G: consumer appeal and engagement
- Video streaming on Wi-Fi versus 5G

5G enabling the metaverse and XR: early stages
- 5G's impact on metaverse/XR
- VR device adoption among consumers
- Content development

Regional perspective

Considerations ahead

WHY THE DIGITAL CONSUMER MATTERS IN 2023

Understanding the digital consumer is key to the success of 5G

5G monetisation

The monetisation imperative grows: As 5G adoption grows from 1 billion to 1.5 billion connections over the next year, the monetisation imperative will escalate. To that end, it will be important to assess what makes the new wave of 5G consumers different to early adopters, and the impact of increased 5G adoption on data traffic and ARPU levels.

Innovative tariff structures: Digital consumer insights will help operators devise innovative 5G tariffs beyond the inaugural tariffs focussed on data consumption.

Non-core revenue stream (aided by 5G)

Opportunities beyond 5G connectivity: For consumers, the link between connectivity, mobile devices and services has never been stronger. Understanding 5G consumers' interest in adding digital services, digital content and non-smartphone device plans to mobile contracts can help operators' efforts around non-core revenue.

Customer segmentation is key: Insights (e.g. by age, income and location) will be key to driving uptake of bundled offerings, including delivering a personalised experience.

Cutting-edge applications

Identifying metaverse and XR opportunities: The metaverse and extended reality (XR) promise to be the next big opportunity. Operators will need to understand consumers' perceptions and expectations of these emerging technologies in order to drive a 'wow' factor.

Aiding XR device adoption: Based on 5G consumers' interest, operators can consider offering 5G plans that bundle XR devices, especially those with eSIM capability, linking them to a main smartphone subscription.

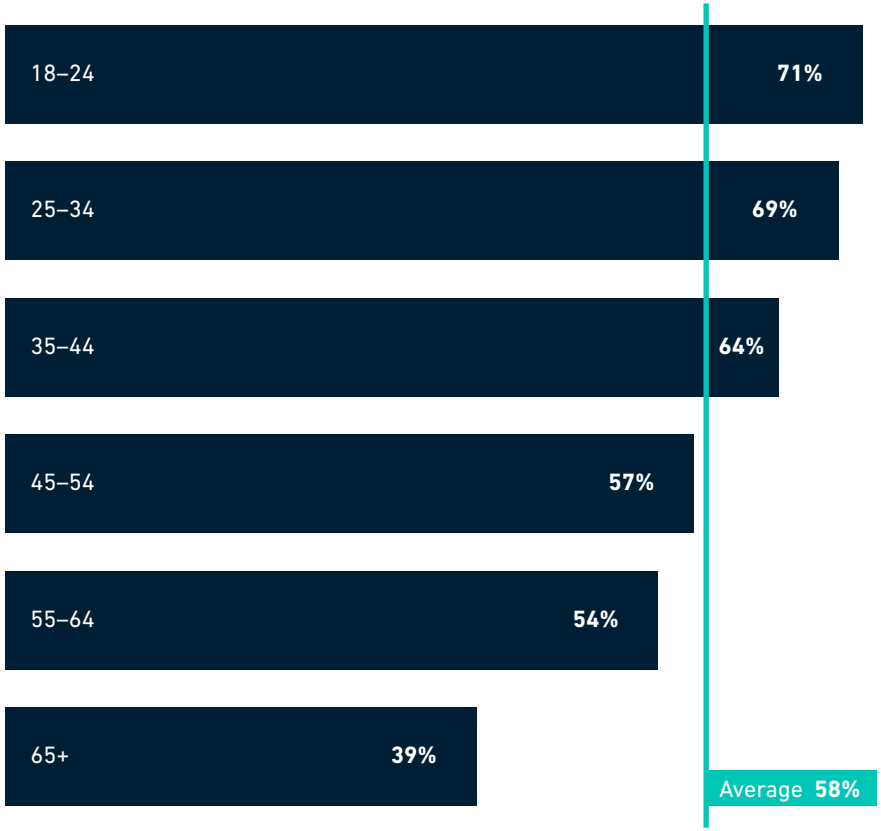
Consumer intent to upgrade to 5G increases

5G consumer adoption goes global

- According to GSMA Intelligence survey data, around 58% of smartphone owners are already using 5G or intend to upgrade to 5G – an increase of 9 pp year-on-year. Across all countries, consumer intent to upgrade to 5G is higher than average among the 18–24 and 25–34 age groups – unsurprising given that younger adults generally lead in the adoption of new technologies.
- In 2023, 5G mobile services will be launched in 30 new markets. Many of these will be developing markets across Africa and Asia.
- In an encouraging sign for 5G adoption, according to the survey, more than half the early 5G consumers were happy with their 5G network experience so far, with faster speeds the top reason. Consumers intending to upgrade to 5G were also willing to pay extra for their mobile subscription compared to what they pay for their current 4G subscription.
- However, speeds are not what will ultimately sustain pricing premiums (and therefore revenue growth). A 'wow' factor is required to attract new customers or incentivise existing ones towards higher spend. XR is a candidate here, with the potential to usher in a new age of (immersive) consumer experiences that benefit from 5G's advanced capabilities in areas such as speed, latency and capacity.

Consumer intent to upgrade to 5G is higher among younger adults

Proportion of smartphone users who are already using 5G or intend to upgrade to 5G (aggregate by age group)



Survey conducted in November 2021 covering Brazil, China, France, Germany, India, Italy, Japan, South Korea, UK and US. India not included here, as commercial 5G services were not available at the time of survey.

Source GSMA Intelligence Consumers in Focus Survey 2021

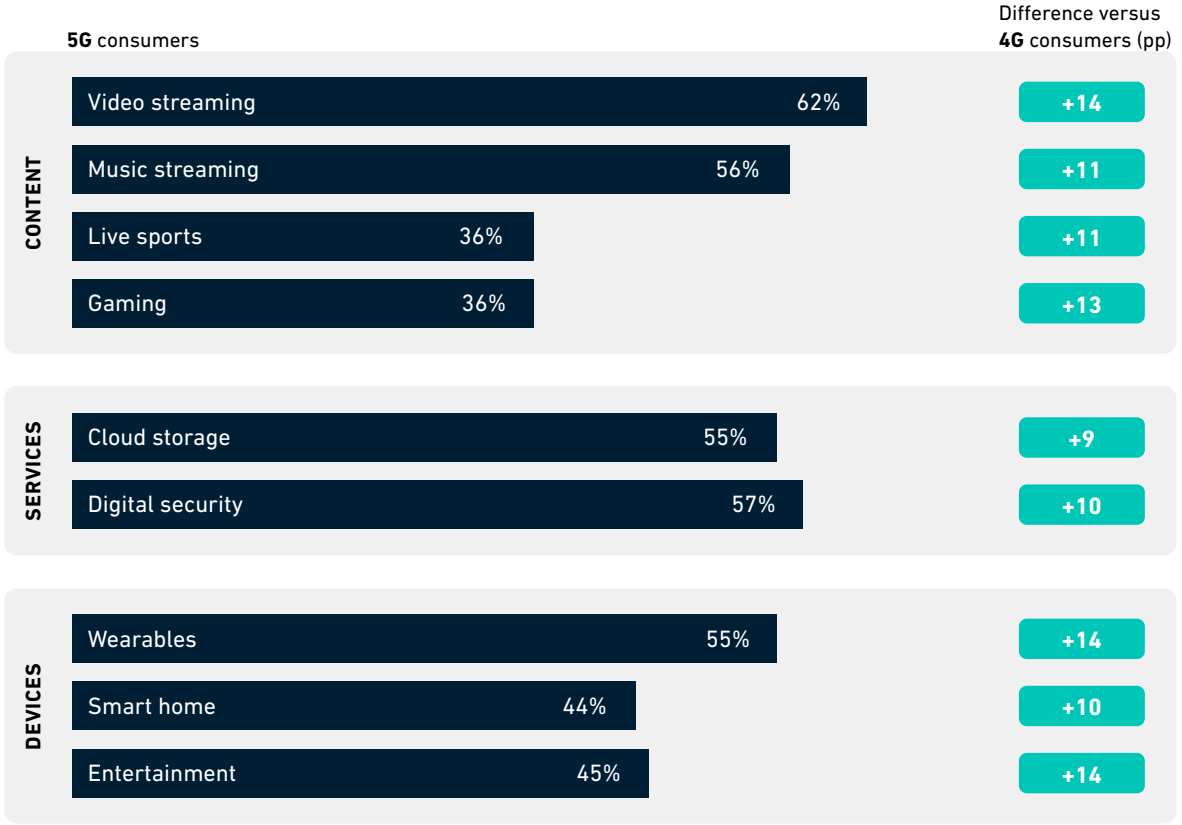
Bundling gains with 5G consumers

5G increases interest but customer segmentation is key

- 5G consumers are more interested than 4G consumers in adding services and content to their contracts. The average score for 5G users across nine categories of add-on was 50%, compared to 38% for 4G users.
- Customer segmentation is crucial to driving higher uptake of 5G bundles. Gaming is a notable example. While 36% of all 5G users are interested in gaming, the 18–24 and 25–34 age groups score 60% and 52% respectively.
- A seamless consumer experience will also be key to supporting bundle adoption. This means quick, hassle-free service activation, easy-to-access and prompt service support, and clear and transparent billing.
- The prevalent business model for offering bundles involves a commercial partnership with a service/content provider, though some operators have launched their own non-connectivity services to strengthen revenue diversification.
- 5G FWA provides operators with new bundling opportunities by opening up the home broadband market to them.

5G consumers find content and services more appealing for bundling than 4G consumers

Percentage of contract mobile subscribers who have added or are interested in adding the following to their contract subscriptions (aggregate)



Base: smartphone users who are most frequently connected to 5G or 4G networks

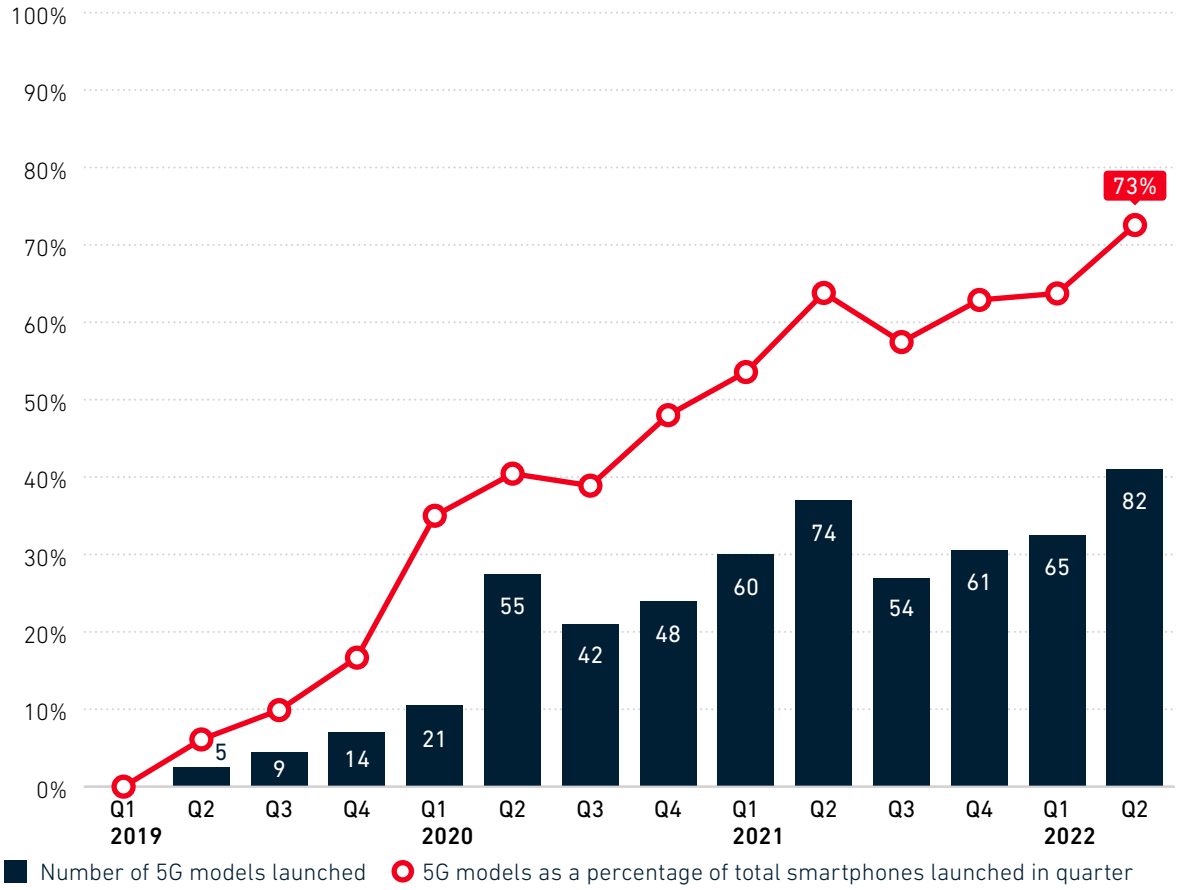
Source GSMA Intelligence Consumers in Focus Survey 2021

5G-compatible smartphones grow in popularity

The importance of 5G in purchasing criteria continues to grow

- The importance of 5G (ability to connect to 5G) in smartphone purchasing criteria has increased slightly year on year, with 70% of consumers indicating in 2022 that it will be an important feature when choosing their next phone (rising to 78% among high-spend mobile users).
- As 5G smartphones typically provide the most recent battery and camera innovation (some of the most important purchasing criteria) and better experience for digital services, the importance of 5G will continue to grow. This is reflected in the expanding range of handsets available.
- While smartphone hardware innovation is important, the value for consumers will increasingly lie in two areas beyond the smartphone itself:
  - smartphones as a central control platform for other devices
  - smartphones as the platform most frequently used for digital entertainment and services.
- The further anticipated price declines in 5G smartphones (Apple being a possible exception) should help with take-up.

In tune with customer demand, the majority of new smartphones now support 5G



Source GSMA Intelligence

Digital entertainment – a key 5G consumer use case

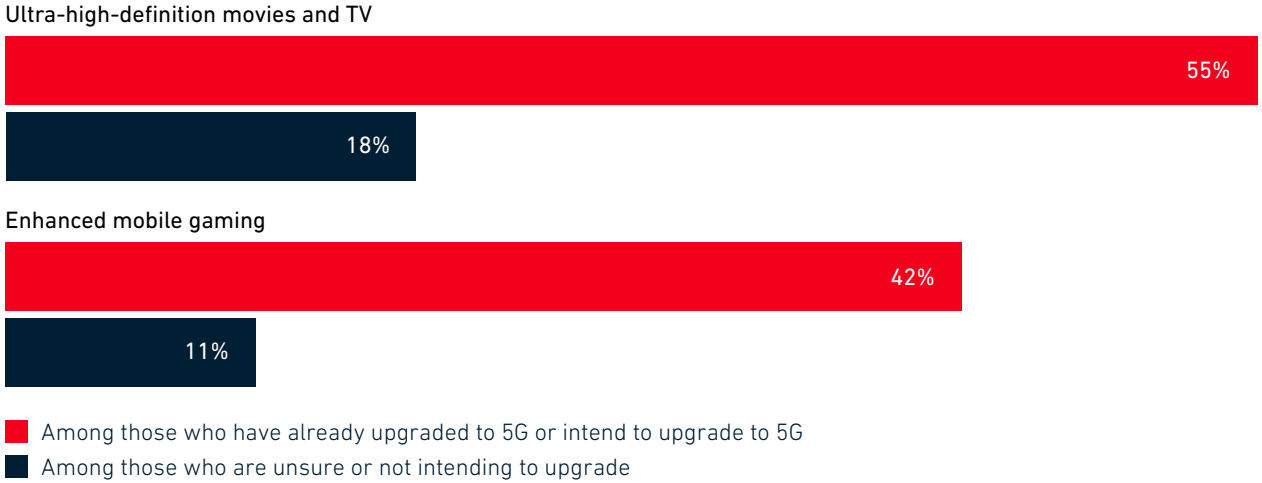
Video and gaming are the leading forms of entertainment

- Digital entertainment is a key 5G consumer use case, with greater appeal among 5G consumers (smartphone users who have already upgraded to 5G or intend to do so) than consumers without 5G.
- 5G consumers are also more engaged with video and gaming, with 67%/46% and 53%/25% watching free/paid-for video and playing free/paid-for games at least once per week, respectively. Operators have two B2C routes (the free/paid-for models) to benefit from 5G consumer interest in digital entertainment.
- 5G consumers also tend to use more mobile connectivity (i.e. less Wi-Fi) than their 4G counterparts when watching video, which could have positive implications for 5G mobile ARPU.

5G consumers find video and gaming more appealing as 5G use cases...

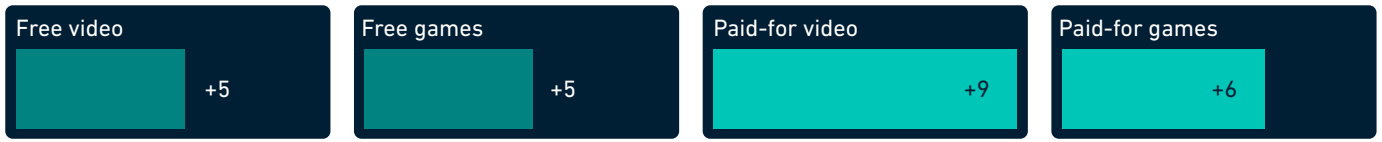
Percentage of smartphone users who find the following 5G use cases or 5G-enhanced services extremely or very appealing (aggregate)

Base: smartphone users who are most frequently connected to 5G or 4G networks



...and engage more with them

Percentage-point increase in share of 5G consumers who consume digital entertainment content on their smartphones at least once per week, compared to 4G consumers



Source GSMA Intelligence Consumers in Focus Survey 2021

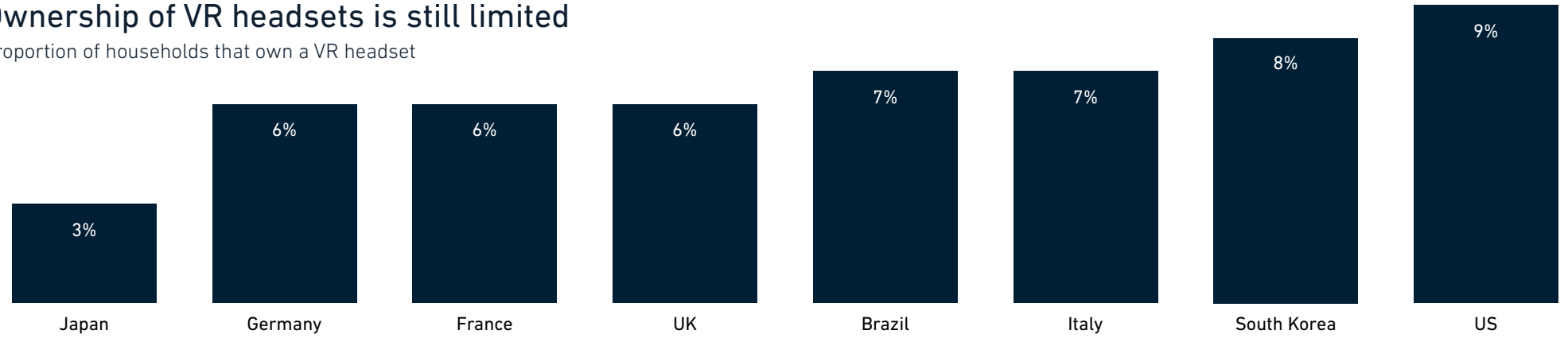
5G enabling the metaverse and XR: early stages

Mobile 5G will serve as the foundation

- 5G and associated network innovations such as edge and slicing provide the high-capacity, low-latency, high-reliability, customisable services that XR and a fully fledged metaverse need to succeed. Mobile 5G (and future network generations) will serve as a key foundation for the metaverse and XR, underpinning consumer engagement and helping content and app ecosystems to flourish.
- However, consumer XR device adoption (mainly VR headsets) continues to languish. According to the GSMA Intelligence Consumers in Focus Survey, only 6% of households (on average globally) own a VR headset. The arrival of the metaverse has rekindled hopes for wider adoption – but, in order to realise this, XR content development will need to keep pace.
- We expect a flurry of metaverse/XR content developments in 2023, with gaming, video and music at the forefront. Proto-metaverses such as Roblox and Fortnite will continue with content innovation, while new metaverse platform owners will prioritise content availability.
- User-generated content will be another promising area for content supply. Partnerships (e.g. with media studios) will also be key to boosting content libraries.

Ownership of VR headsets is still limited

Proportion of households that own a VR headset



Source GSMA Intelligence Consumers in Focus Survey 2021

Drive Customer Retention and Loyalty Through Extraordinary Experiences

Wow your customers and unlock the possibilities of 5G

We live in a time where customers demand extraordinary experiences. In the competitive landscape of telecommunications, your business is expected to measure up to the experiences delivered by digital natives. Seamless and personalized consumer experiences, at scale, are critical to supporting 5G bundle offering adoption.

CSG Xponent Ignite for Telecommunications is a customer experience solution built specifically for the industry, based on 40+ years of working across 400+ clients.

CSG Xponent Ignite for Telecommunications allows you to:

1. Build a business case
2. Connect siloed data with pre-configured integrations
3. Implement Industry-specific, pre-built journeys

Quickly Go Live:

- Renew and upgrade contracts
- Promo roll-off
- Purchase devices, bundles and offers
- Service appointments notifications
- Make complaints
- Pay late fees and settle collections

Unlock a new reality. Transform your vision of better CX into extraordinary experiences that rival streaming and wireless services with CSG Xponent Ignite. Let CSG help you reimagine customer experience in ways you never thought possible. Learn more at: www.csgi.com/ignite_telco

Regional perspective

US

- Consumers in the US show higher intent to upgrade to 5G than those in other developed markets such as Germany, Japan and the UK.
- Various factors explain this, including the extent of 5G network availability, the level of operator commercial/ marketing push, and consumers' willingness to migrate to new technologies (European consumers tend to do so at a slower pace – a trend seen with 4G).

China

- In the Consumers in Focus Survey, 5G consumers in China were the most interested in bundling non-connectivity offerings with their mobile contracts. This relatively higher interest was also seen when it came to 5G use cases.
- Consumers in China are among the most satisfied with their 5G network experience and most used to service bundling through their experience of super-apps such as WeChat.

Southeast Asia

- 5G smartphones are positioned across a range of pricing options, aiding 5G adoption. Original device manufacturers (ODMs) can further help adoption by bringing greater 5G smartphone choice at the value end.
- The ODM model is gaining traction in China and other Far East economies such as Vietnam, where manufacturing scale and chipset supply have enabled a lower cost structure. This provides diversification to operators aiming to offer a wider range.

Considerations for the year ahead

Can operators better segment 5G tariff structures?

- To maximise 5G's monetisation potential, operators will need to design innovative 5G tariffs to target niche customer segments. Examples include the speed-tiered 5G tariffs employed by operators such as Vodafone Spain.

Can 5G interest move to services, not just speeds?

- Partnerships, customer segmentation and a seamless consumer experience (including self-service) will be crucial for operators to successfully establish 5G bundling. For converged operators, 5G bundling will sync with their 'n-play' efforts.

Can the metaverse solve the proverbial 'chicken and egg' problem?

- As well as contributing through 5G technology developments, operators will aid progress on the content front. Examples here include SK Telecom's content development efforts for its Ifland metaverse platform, and operators' participation in the Niantic Planet-Scale AR Alliance.

GLOBAL MOBILE TRENDS

HUAWEI

Mobile network automation

Embracing improved efficiency and experience

TOPIC OVERVIEW

Mobile network automation

Why it matters

The impact of 5G
- 5G as a trigger for new networks and services
- Increasing service expectations and demands
- 5G in a multi-network world

Automation tackling complexity
- Increasingly complex networks
- Increasingly complex services
- Increasingly complex supplier ecosystems

The three Ss
- Sustainability: a traditional automation focus
- Security: automating risk mitigation
- Spectrum: sharing, diversity and quality

Operators: automation's worst enemy?
- Internal coordination and ownership
- Access to data and resources
- Employee bias against automation tools

Regional perspective

Considerations ahead

WHY MOBILE NETWORK AUTOMATION MATTERS IN 2023

Automation is critical for operators to execute on their business goals

Mainstream 5G

Moving past 1 billion connections: The next wave of 5G takes the tech to new users and markets, adding service and network complexity, which automation can mitigate.

2023 and the year of 5G SA: As 5G SA scales (adding new network capabilities for new services), network and service complexity will grow too.

5G and the three Ss: The top network priorities – sustainability, security and spectrum – will become more important as 5G evolves, with automation promising a supporting role.

Opex versus capex

Saving money in a downturn: Faced with global economic headwinds, operators will look to focus on containing spend.

Acknowledging cost centres: Capex may grab more headlines, but opex is a much bigger cost centre. Operators recognise automation as the top opex reduction technology.

Automation, expertise and skills: The role of automation as a tool to augment human skills and counter expertise gaps is well known. As service and network complexity rise, this will only escalate.

Networks supporting services

Saving money/making money: Cost-cutting priorities aside, new revenues and user experience remain the top strategic imperatives for operators.

Automation, enterprises, APIs: New service creation at scale – to diverse enterprise verticals, and through opening network capabilities to developers via open APIs – plays to automation's value.

Service quality: Monetising services will require quality and scaled assurance – areas where automation can help.

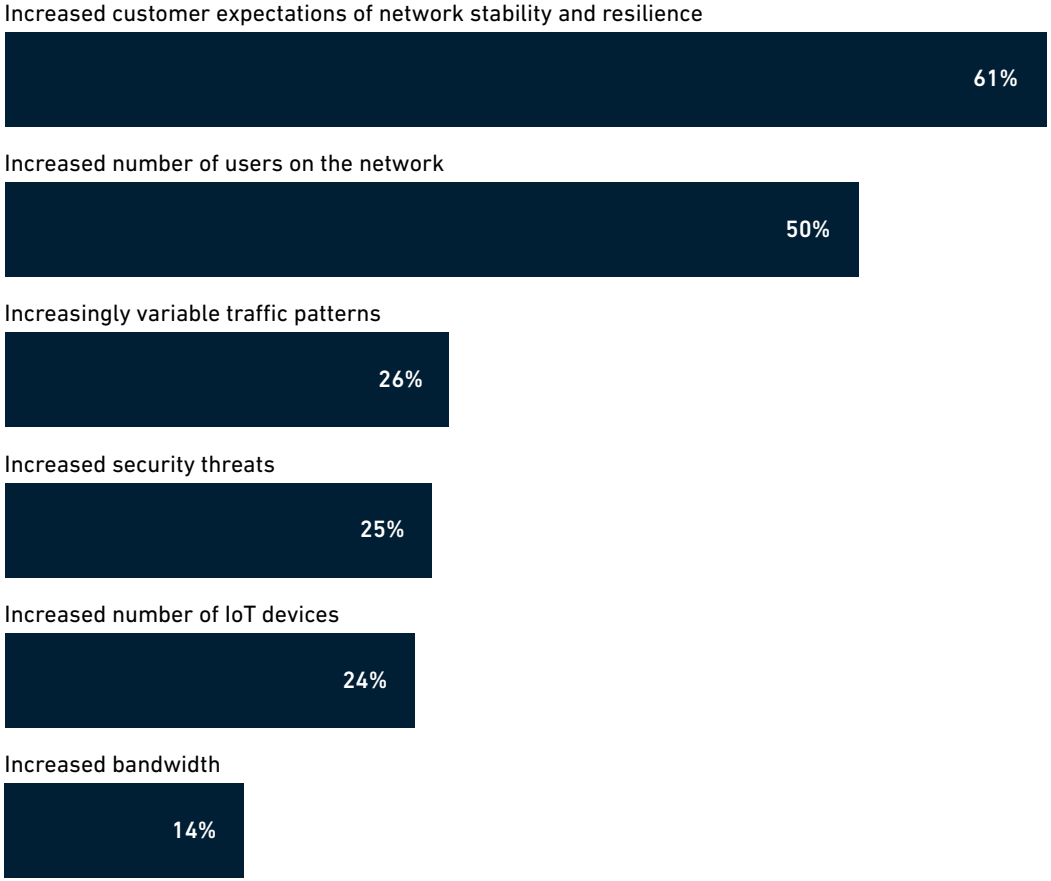
The impact of 5G

New networks, new services and the need to automate

- As 5G is deployed, and users increasingly rely on it, user load and quality expectations dominate network strategies.
- User scale requires end-to-end thinking, from the network/service planning and deployment phase to maintenance and operations. Introducing automation into each is critical to ensure 5G scales in a timely, reliable and cost-effective manner.
- Delivering on quality expectations requires a focus on the basics: planning, deployment and operations. In the 5G era, it also requires a focus on reliability along with coverage management, QoS detection, and threat mitigation support – all of which depend on automation for efficient delivery.

User load and quality expectations are driving operators' network plans

What are the top customer demands currently driving your network transformation strategy? Select top two.



Source GSMA Intelligence Operators in Focus: Network Transformation Survey 2022

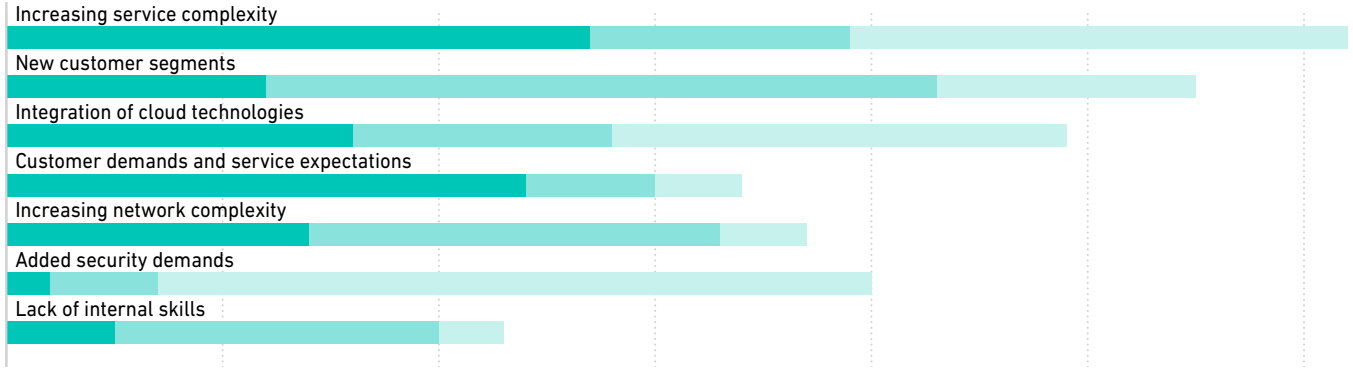
Automation tackling complexity

Networks, services and ecosystems are getting complicated

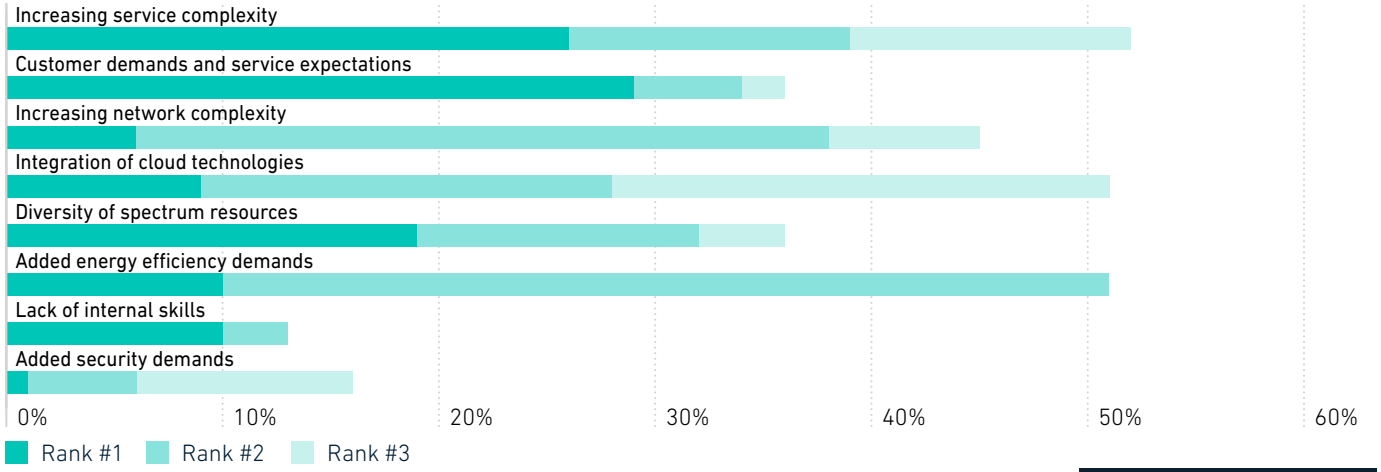
- Automation is often positioned as a tool for dealing with complexity; this is reflected in the way operators see service – and especially network – automation.
- From managing multiple technology generations and multiple spectrum bands, to implementing new core architectures that embrace cloud, edge and virtualisation, the complexity operators must deal with today is clear.
- 5G standalone will bring new service innovation and complexity with strict performance requirements, driving a need for service automation. At the same time, as networks increasingly decouple software from hardware, operations and maintenance complexity will increase, making automation a necessity.

Complexity tops the drivers of automation

What are the primary drivers of automation (support, rollout, operations) supporting your **service offerings and delivery?**



What are the primary drivers of automation (support deployment, operations) across your **network assets?**



Source GSMA Intelligence

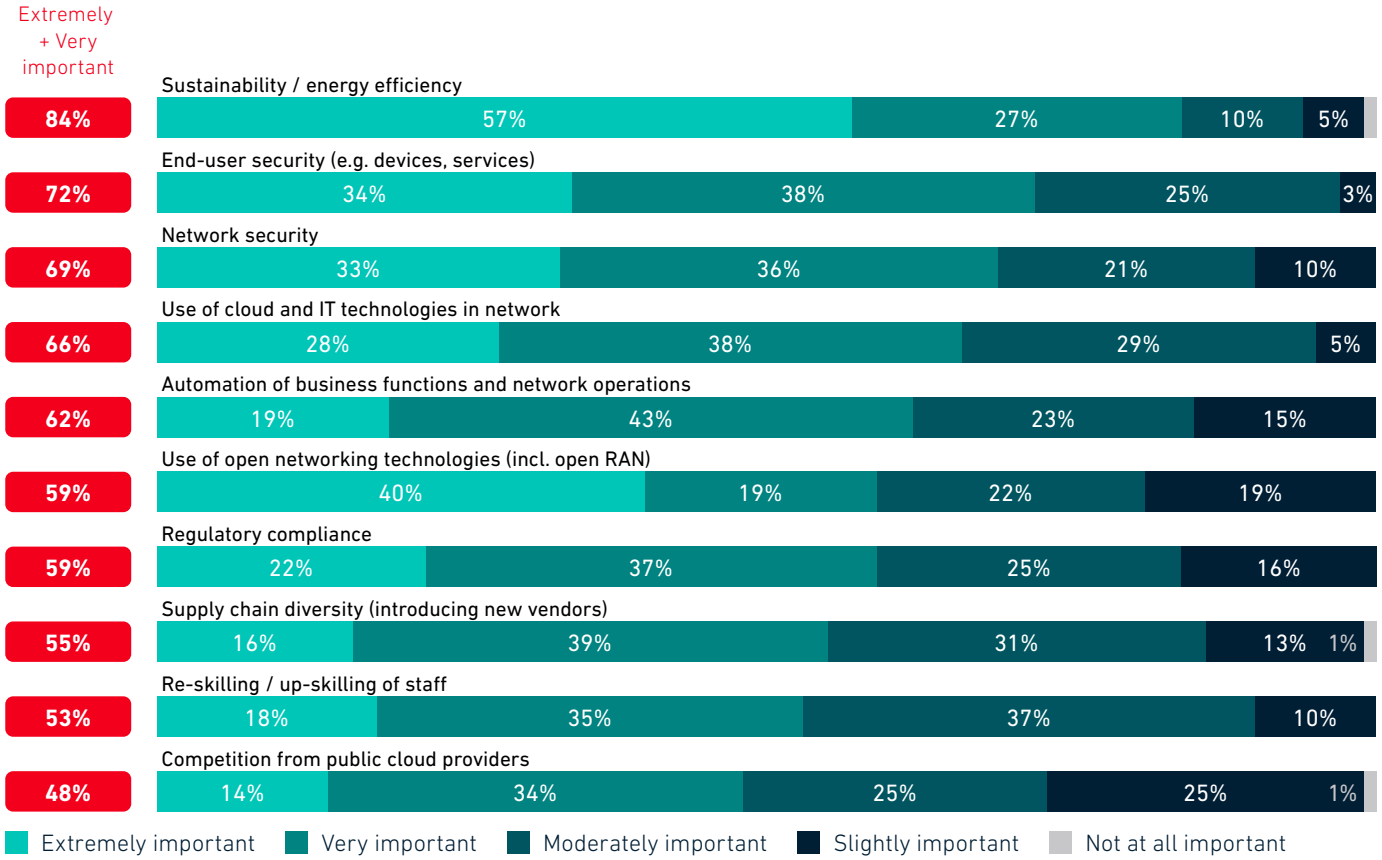
The three Ss

Automation supports sustainability, security and spectrum

- Sustainability and security are top network priorities, with spectrum (a perennial priority) seeing an elevated focus in 2023 against the backdrop of World Radiocommunication Conference 2023 (WRC-23).
- **Sustainability** and **security** are not new concerns. Suppliers have therefore prepared plenty of automation support: examples include network sleep, energy-efficient user management, threat mitigation and detection, and feature rollout support to guard against threats.
- The intersection of **spectrum** and networks represents a complex network dynamic with plenty of room for automated support, including multi-band operations, antenna and cell parameter optimisation and spectrum-aware radio planning – all alongside traditional self-optimising network (SON) functions.

Sustainability and security are high network transformation priorities for operators

How important are the following priorities as a part of your network transformation strategy?



Source GSMA Intelligence Operators in Focus: Network Transformation Survey 2022

Operators: automation's worst enemy?

Processes, bias, project ownership – internal obstacles abound

- Deployment of automation by operators can be held back by a variety of dynamics, from an unclear return on investment to a lack of faith in the automation technologies and suppliers.
- Internal issues dominate. Lack of automation expertise, automation project ownership and administration, as well as a bias against automated processes, represent two of the top three obstacles to deploying automation.
- While return on investment (RoI) concerns could temper interest in automation, the fact that most barriers are internal issues signals that operators are in control of whether or not automation moves forward, with C-suite involvement likely key to driving it forward.

Internal issues dominate obstacles to service and network automation, according to operators

	NO.1 OBSTACLE	NO.2 OBSTACLE	NO.3 OBSTACLE
Network automation: RAN	Uncertain RoI	**Employee bias**	**Unclear internal ownership**
Network automation: core/edge	**Unclear internal ownership**	Uncertain RoI	**Internal expertise**
Network automation: transport	**Unclear internal ownership**	Technology maturity	Uncertain RoI
Service automation: rollout	**Internal expertise**	Uncertain RoI	**Unclear internal ownership**
Service automation: assurance	**Internal expertise**	Uncertain RoI	**Unclear internal ownership**

Source GSMA Intelligence

Huawei Autonomous Driving Network

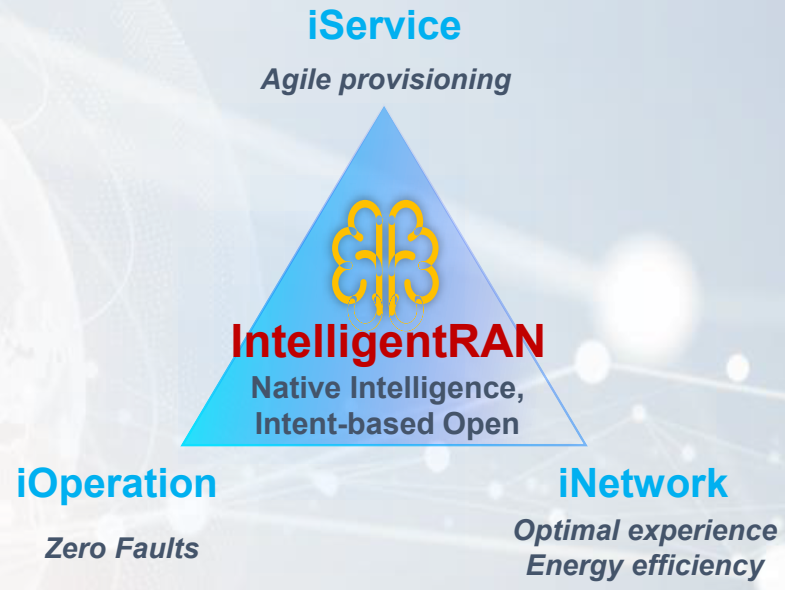
Intelligent RAN & Core Network Unleash New Potential of Network Autonomy

IntelligentRAN

The continuous evolution of 5G brings cross-generational service experience and has created many new types of services, but also brings three top challenges which calls for a more intelligent wireless network:

- Increasing complexity of wireless networks
- 100 times increased traffic versus slight increase energy consumption requirement
- Diversified service SLA requirements require more agile service operation

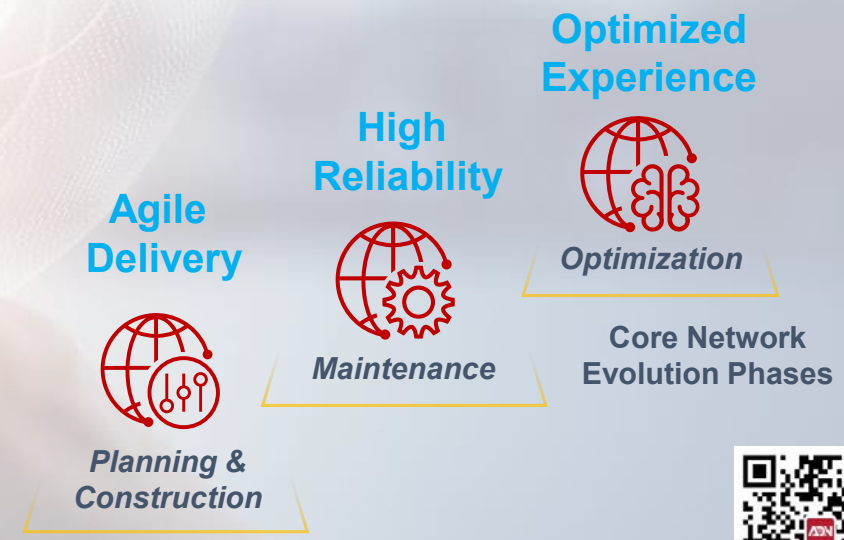
Huawei IntelligentRAN solutions include iFaultCare, iPowerStar, iHashBAND, and 5GtoX Suite, which empowers operators to achieve intelligent service operations, intelligent network optimization, intelligent and simplified O&M, and speeding up the evolution to wireless autonomous networks.



IntelligentCore

Huawei ADN solution addresses all-scenario challenges of 5G core network among network planning, construction, maintenance and optimization, delivers self-X network capabilities and zero-X customer experience.

- **Agile delivery** enables cloud-native E2E secure, efficient, and flexible delivery experience based on Intent-driven technologies
- **High reliability** transfers network O&M from passive response to proactive risk prevention and control
- **Optimized Experience** Delivery optimal service quality, facilitate 5G success.

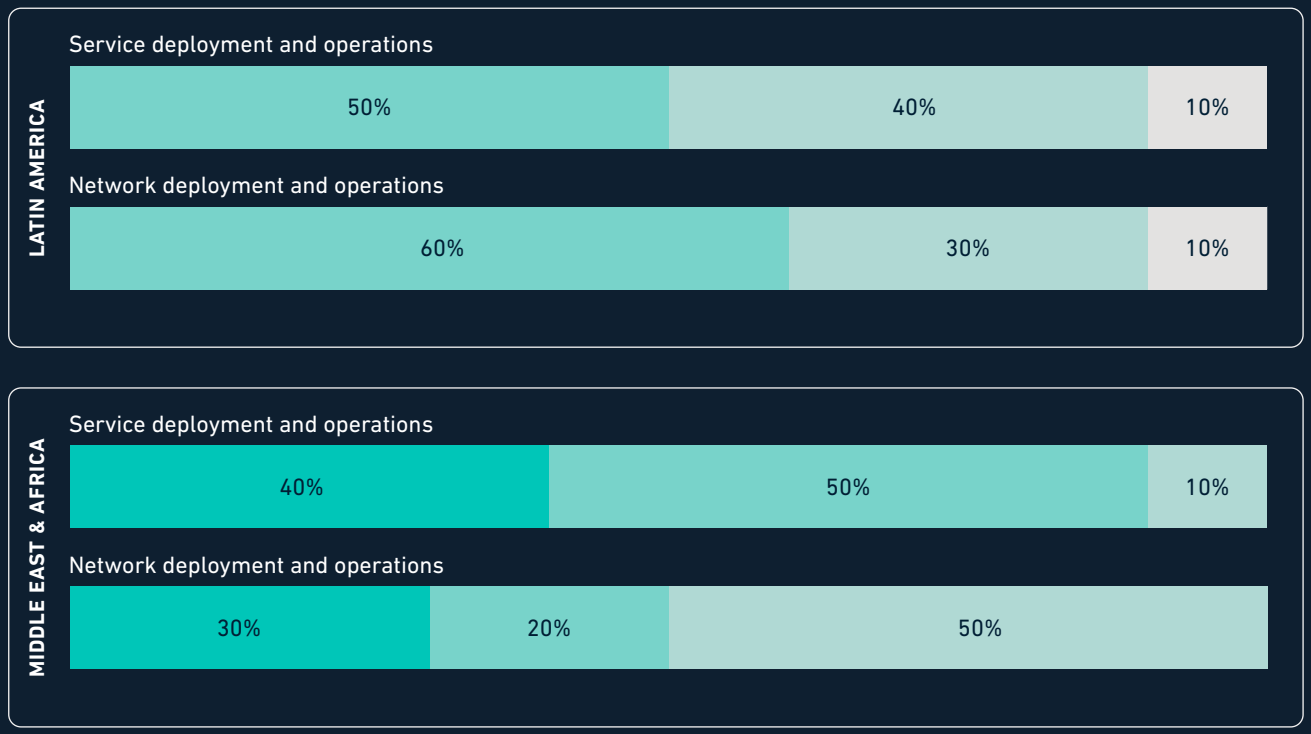


Regional perspective

- The role automation plays in bringing 5G to reality is diverse, including 5G deployment, the management of different network generations and spectrum bands, and the rollout and management of new 5G services at scale.
- Operators in the **Middle East and Africa** (MEA) see this link – potentially reflecting Middle East operators being 5G leaders, planning for complex new 5G services, and recognising the need for automation as a result.
- While **Latin American** operators see automation as important to 5G, their views are clearly subdued compared to their MEA counterparts. 2023 will reveal how these views evolve.

Automation views among operators in Latin America subdued versus Middle East and Africa

How important are network and service deployment/operations automation to your success in 5G?



Source GSMA Intelligence

Considerations for the year ahead

How will 5G-Advanced and 6G drive the automation discussion forward?

- Complex service support is driving operator views on automation along with ecosystem discussions around 5G-Advanced and 6G. Will that continue in 2023?
- A core tenet of 6G R&D has been the vision of an AI-native RAN, with parameters tweaked in real time, essentially automating RAN optimisation on an ongoing basis.
- Early discussion of new mobile technology generations is more likely to focus on technical innovation, with less focus on rollout and operation support such as automation.

Which 2023 use cases and service trends have the opportunity to 'move the needle' on automation?

- The next phase of 5G will be marked by new users in new markets. Many of these are less mature, requiring cost-efficient network and service operations.
- Delivering the low-latency connections that the metaverse requires, at scale, cannot be done manually. But will network or ecosystem considerations garner more attention?
- Against the backdrop of high-profile network outages in 2022, service performance and experience are top drivers across RAN, core, network and service automation.

Intelligence versus automation: where will operators find synergies across the core and RAN?

- Beyond automating processes, use of AI and ML in network operations promises ongoing efficiencies but could be held up if only seen as part of automation exercises.
- 2023 promises massive RAN investment, likely driving a focus on automation. RAN intelligence will also be key to continuous quality assurance and improvement.
- Outside the RAN, intelligent core operations may be more important as operators optimise and virtualise their services, while embracing cloud and edge.

GLOBAL MOBILE TRENDS

HUAWEI

The mobile edge and network slicing

Growing momentum behind long-term 5G promises

TOPIC OVERVIEW

The mobile edge and network slicing

Why it matters

Scaling private wireless networks	• Unique versus mass-market demands • Unique versus mass-market solutions • Foundational edge compute and slices
The advancing cloud	• Cloud moves in the mobile network • Multi-cloud beyond distributed cloud • Friends, enemies and pragmatism
Making the consumer case	• The story to date: B2B • Opportunities ahead: B2C • The API play
Getting edge and slicing off the ground	• No scale without automation • Role of operators in slicing • Misconceptions at the edge
Making operators care about slicing	• Reminder: it's all about revenue generation • How much is realtime charging needed? • Slicing, edge and service inventories

Regional perspective

Considerations ahead

WHY MOBILE EDGE AND NETWORK SLICING MATTER IN 2023

Monetising 5G cannot be based on connectivity alone

2023: the year of standalone

Standalone (SA) plans – for real this time: After many years of planned SA momentum, operator launches and commitments suggest 2023 will see deployments scale.

SA tech benefits: While not critical for edge services, SA does enable slicing more flexibly than possible with non-standalone (NSA), making it the second-ranked benefit of SA among operators.

SA business benefits: Improved massive IoT, slicing and low-latency capabilities all equate to better support for enterprise verticals and operator revenue expansion.

Launches drive launches

Value of momentum: As trials become commercial services, the value of a technology is made visible, supporting momentum – if only due to competitive pressures.

Cloud, edge and private wireless: Private wireless networks are on an upward trend – partly driven by cloud players – with edge computing a core component.

Below-the-radar slicing: Slicing has been slowing ramping up as part of private wireless (particularly in China) and in a number of high-profile trials in 2022, setting up 2023 for further growth.

Security, security, security

End-user and network priorities: After sustainability, the top network transformation tech priorities for 2023 are end-user security and network security.

Sovereignty and control: For users with strict data security demands, edge nodes allow data to remain on-premises but represent components that need to be secured themselves.

Slicing separation and security: Functionally discrete slices secure traffic, but the complex processes and infrastructure required to do so will need to be secured too.

Scaling private wireless networks

Slicing and edge as core components of customised networks

- 5G promises to flexibly serve consumer and enterprise customers. However, specific vertical requirements may be best served by custom network builds, as demonstrated by the myriad announced private network launches.
- Vertical-specific demand speaks to the private wireless network value proposition, and a key challenge. Bespoke requirements imply a lack of templates for creating or selling private networks, adding to costs and diverging from the standardised solutions that operators prefer.
- Edge compute and slicing represent foundational technologies than can be built on in a private network. For example, edge nodes can be deployed in an enterprise, giving operators a common anchor from which to deliver services. Slicing, in turn, supports differentiation of services within a controlled network. Both represent assets that can be deployed in a repeatable manner, regardless of vertical requirements.

Operators are already deploying 5G edge computing across different use cases

Source GSMA Intelligence

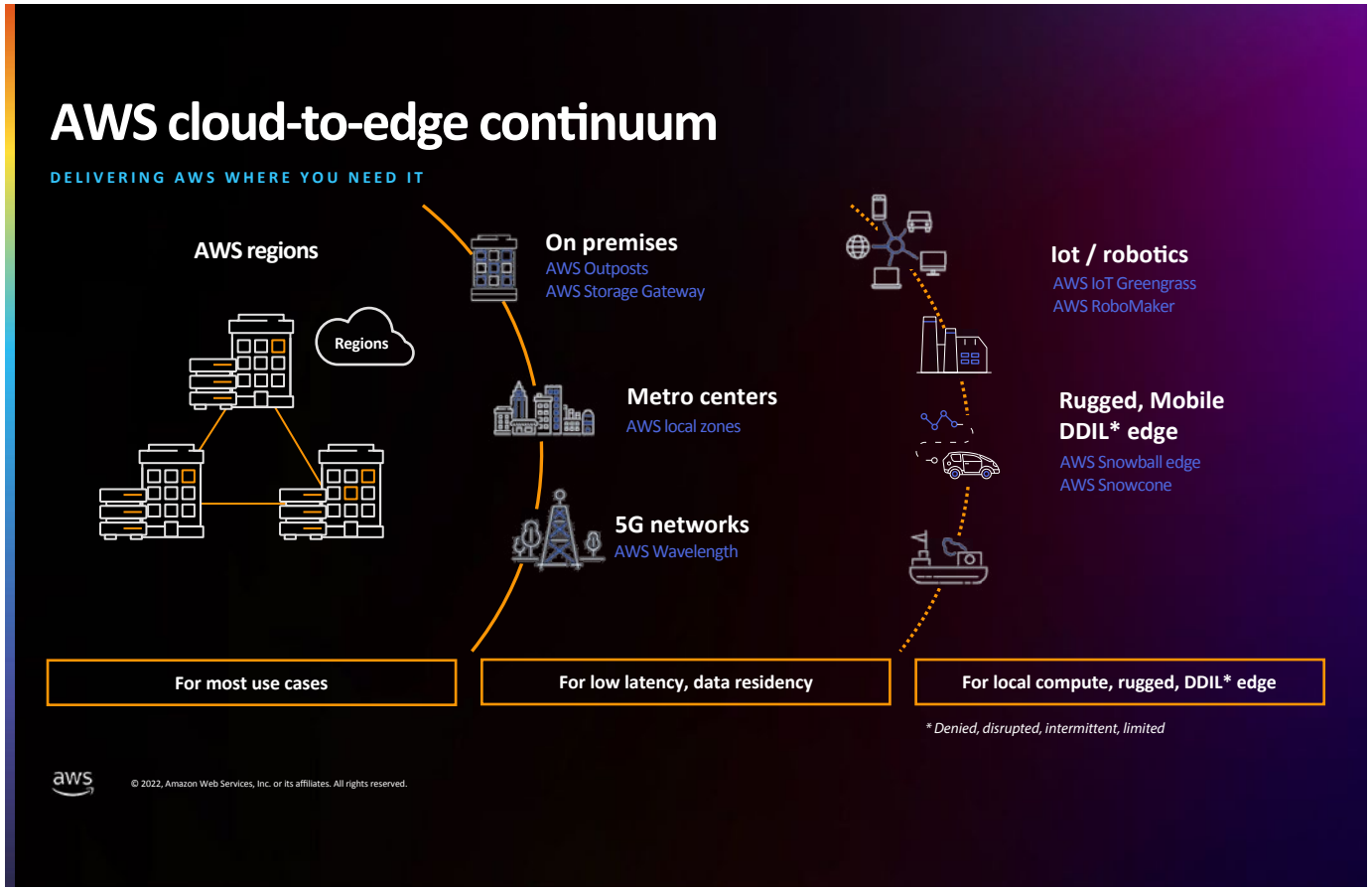
The advancing cloud

Sliced and distributed, cloud's role continues to evolve

- Edge networking garnered attention with the advent of 5G, with various players involved. Cloud players, in particular, have been pushing their assets close to the network edge, leveraging developer ecosystems.
- Delivering to strict performance requirements will require network slices to be end to end. As operator and enterprise workloads increasingly integrate cloud and edge assets, network slices will need to traverse them.
- The question of whether telco or cloud players will dominate the edge (or slicing) is irrelevant; the two will increasingly partner, serving diverse roles across diverse workloads. For latency-sensitive use cases, an operator's ability to site edge nodes in the access network will remain an advantage.

The position of cloud providers in edge and slicing architectures

AWS example



Source Amazon Web Services

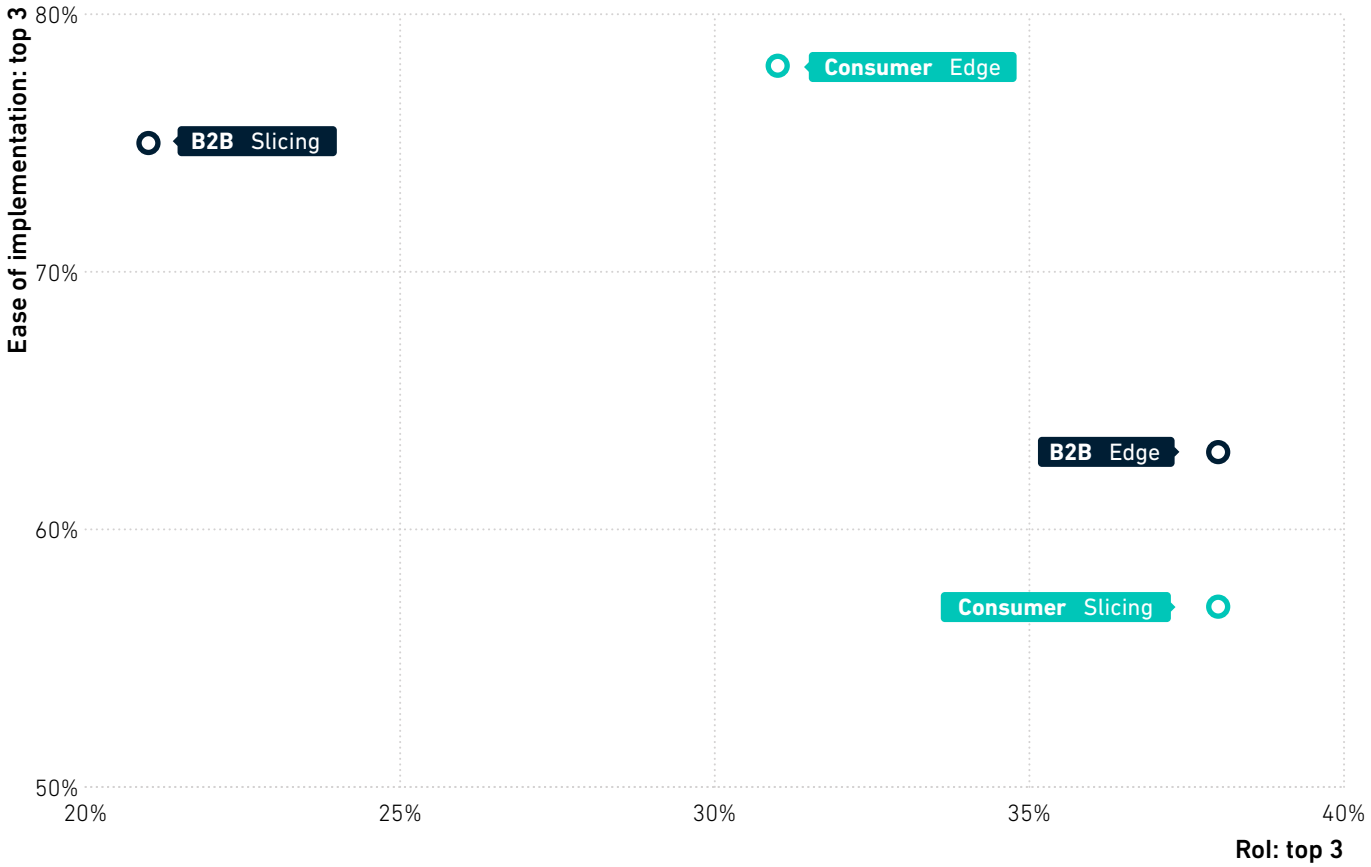
Making the consumer case

Is there more to slicing and edge than enterprise use cases?

- Slicing and edge compute are most often associated with B2B use cases; it is easier to link the benefits they bring to enterprise requirements, and it is easier to justify investments when supporting new (B2B) revenues.
- Myriad consumer use cases could be enabled by slicing and edge compute, including immersive content (metaverse), low-latency gaming and differentiated quality packages. All can be monetised.
- Operators believe consumer-focused slicing and edge applications can generate a return on a par with enterprise applications. This view aligns with the greater B2C business traction operators enjoy. However, industry narratives need to reflect the view to ensure the B2C value is not overlooked in practice.

Slicing and edge can enable consumer as well as enterprise use cases

As you evolve your network to better serve enterprises and consumers, how do you think about edge computing and network slicing?



Source GSMA Intelligence Operators in Focus: Network Transformation Survey 2022

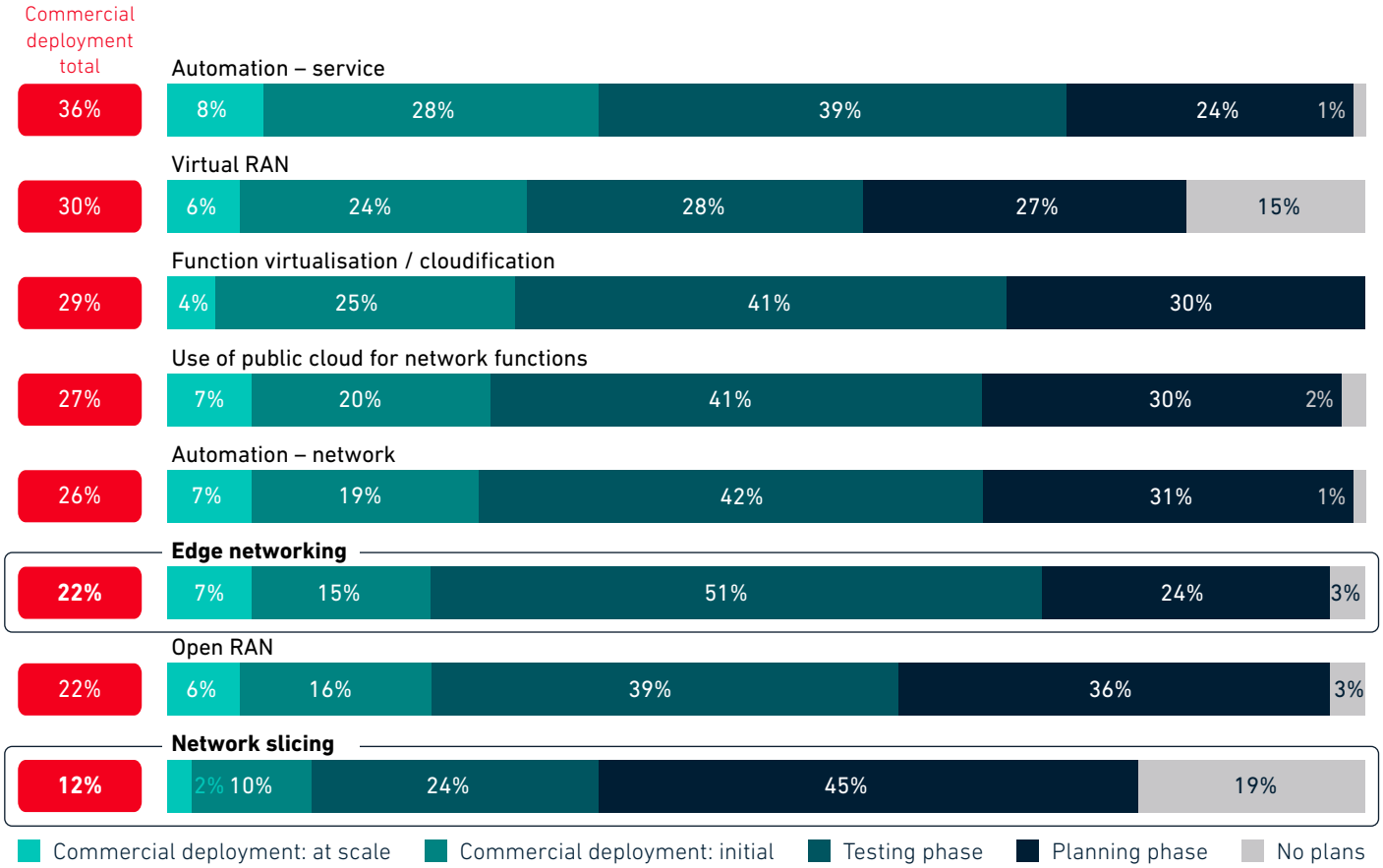
Getting edge and slicing off the ground

The only way is up

- Edge compute and network slicing are not new technologies; both have been part of mobile network and service innovation since before 5G.
- Despite a history of solution development, deployment of edge and slicing is still in its infancy. Less than a quarter of operators claim commercial edge solutions, with around 10% having a commercial slicing offer (mostly not at scale).
- Internal challenges (including unclear project ownership and skills gaps) represent the biggest deployment hurdle, while an unclear return on investment is the single biggest issue for both edge and slicing. Unless both see progress in 2023, the role of operators in driving them forward may be limited, leaving an opportunity for cloud providers and others.

Edge and slicing deployment is still in its infancy among operators

Where are you in the process of adopting the following technologies?



Source GSMA Intelligence Operators in Focus: Network Transformation Survey 2022

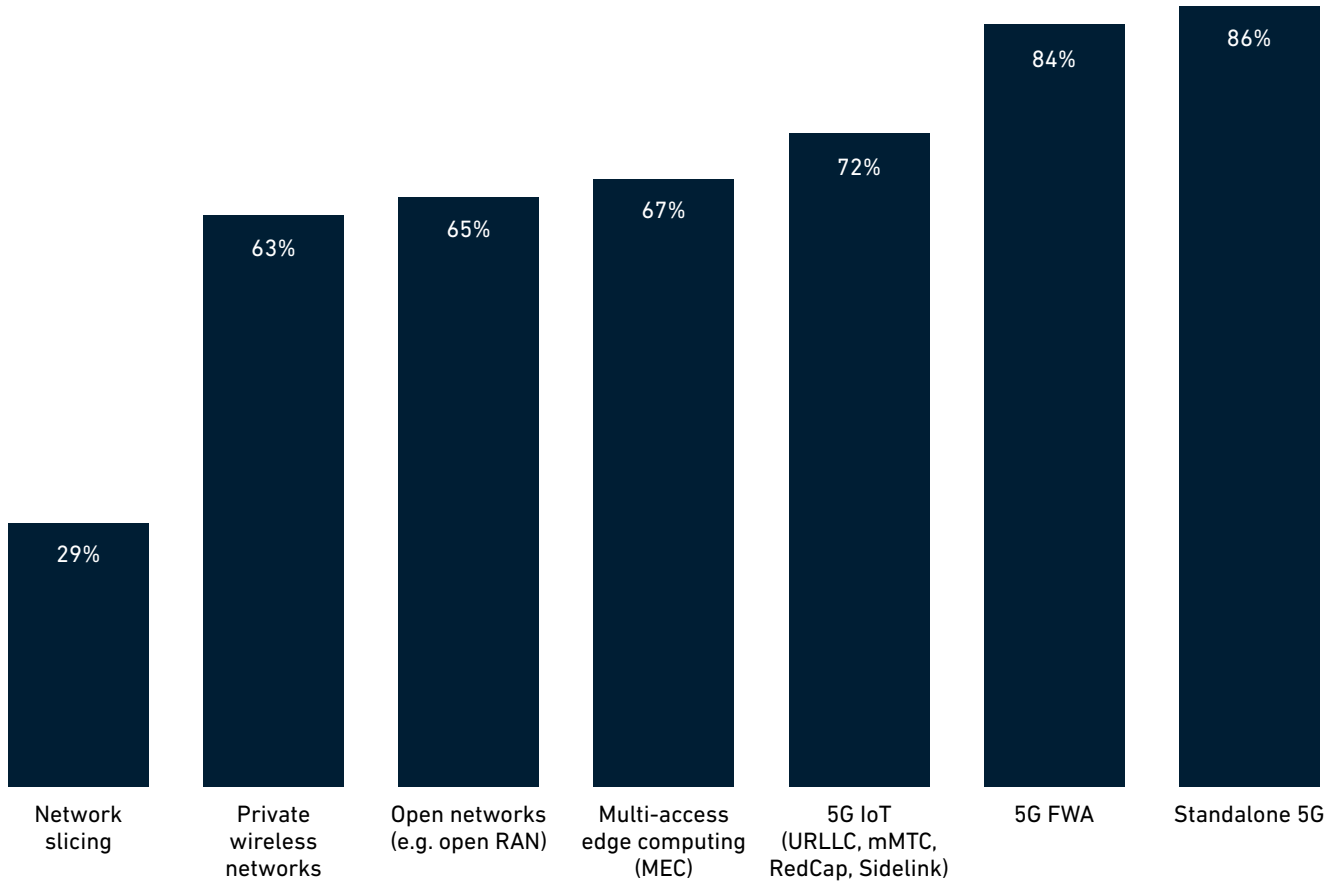
Making operators care about slicing

Deployments lead to learning, which leads to more deployment

- Despite B2C opportunities, vertical-specific enterprise requirements should be a major driver of network slicing deployments. However, operators ranked slicing low as a technology for driving B2B success.
- Lack of operator interest in slicing explains the limited progress with deployments. It also feeds into deployment obstacles, fuelling return on investment concerns and making it more difficult to solve internal challenges.
- Interest in edge compute (supported by cloud players and private networks) ensures its deployment. However, a lack of slicing momentum robs operators of a messaging opportunity to potential customers, along with important learnings on how to best apply and monetise it. Meanwhile, operators that are progressing with slicing (as in China) could gain a competitive advantage.

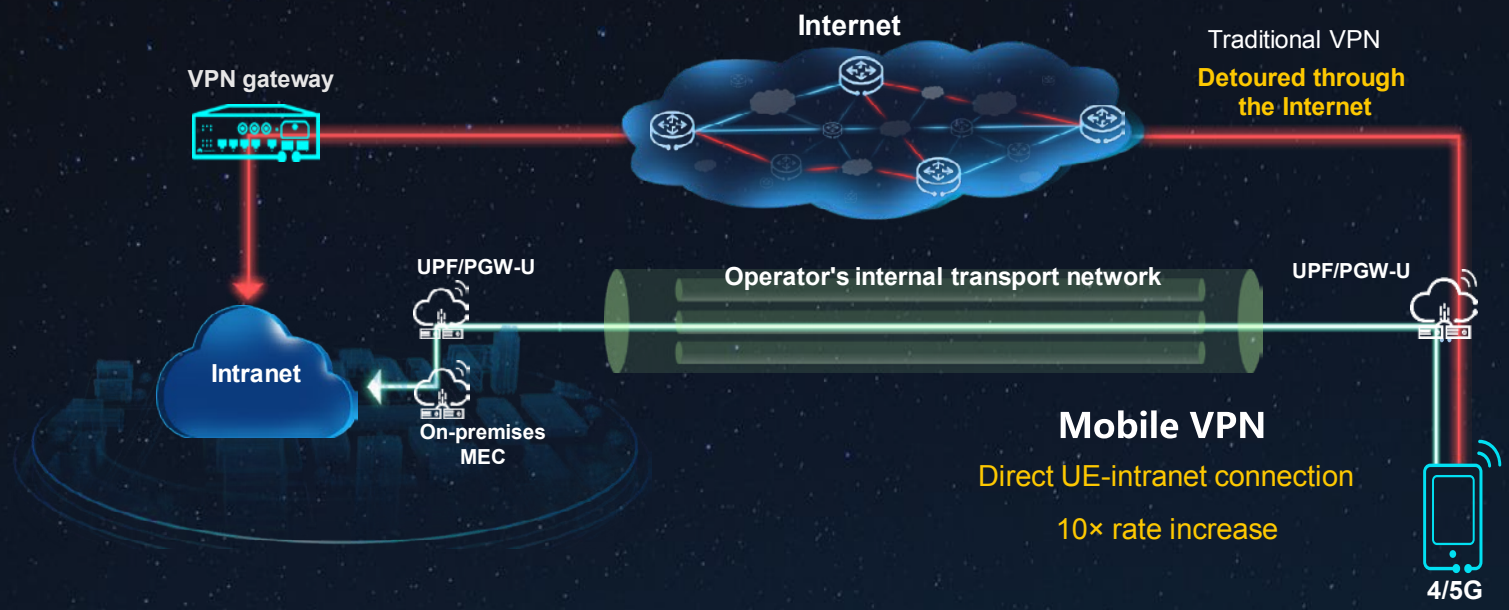
Operators rank slicing low for enterprise success

5G capability / technology priority ranking (extremely or very important to success of enterprise offerings)



Source GSMA Intelligence Operators in Focus: Network Transformation Survey 2022

Mobile VPN: On-Demand Network Allows Access Anytime and Anywhere



5G SA

- Easy access, better experience
- 5G ULCL
- 10× download speed

4G/NSA Access

- Seamless network switchover
- 4G ULCL
- 10× Population coverage

Multi-Campus

- Steering traffic through optimal route
- Dynamic ULCL
- Network efficiency improved by 50%

HUAWEI

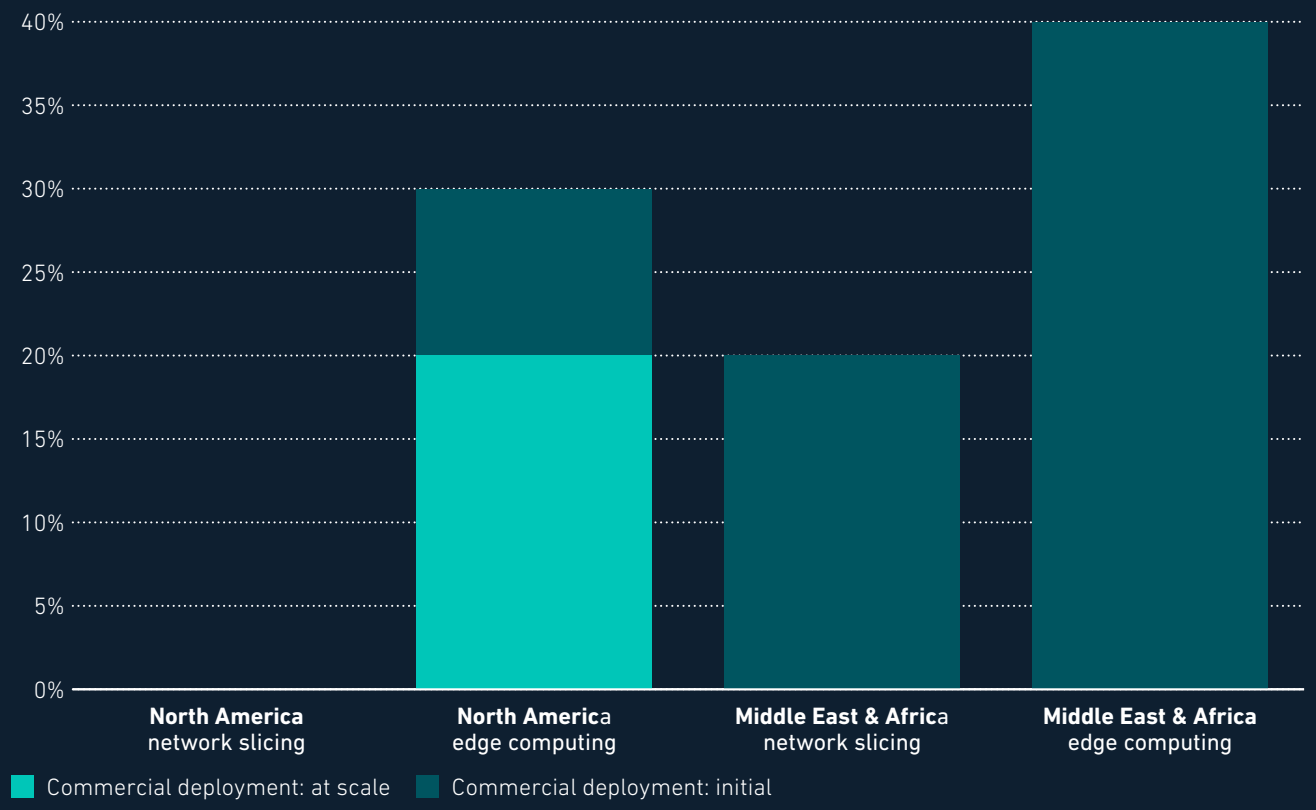
Find more: https://www.gsma.com/5GHub/vpn

Regional perspective

- With myriad announced cloud partnerships, it is not surprising that North American operators lead edge deployments. More notable are slicing and edge plans in the Middle East & Africa, in line with a strong Middle East B2B 5G focus.
- North American operators are likely under-representing their slicing progress. Nonetheless, they are clearly behind other regions and risk losing out on early learnings.
- Asia Pacific and European operators might claim less commercial momentum with edge and slicing, but this is partly a function of the larger number of operators in those regions. Scaled slicing and edge offers in China and larger European countries position them well.

Slicing and edge computing commercial deployments: North America versus Middle East & Africa

Percentage of operators



Source GSMA Intelligence Operators in Focus: Network Transformation Survey 2022

Considerations for the year ahead

What specific problems need to be solved to scale edge and slicing? Globally or in specific regions?

- As 5G scales uniquely across different markets, the greatest driver will be the introduction of new, innovative services – B2B and B2C.
- From a technology perspective, broader slicing support in mobile devices is key. So too is the ability to deploy custom slices in a repeatable, efficient manner.
- Edge momentum has been established. As it matures, sorting out the interaction between diverse nodes and workloads (located in different places) will become a larger issue.

What network innovations can we expect in 2023 to support edge and slicing?

- New deployments of 5G SA will clearly simplify slicing rollouts. They should also drive more traction in vertical markets, which will benefit edge and slicing alike.
- If the slicing problem to be solved is simplification of slice creation and deployment, automation of end-to-end slice process will be a focus for most solution providers.
- The transition from virtualisation to cloud-native functions is still underway, driven (in part) by 5G. Further progress will feed into slicing and edge.

Are edge computing and network slicing truly critical to the success of 5G?

- Edge and slicing are both relatively access agnostic; edge can be applied in 4G, 5G or even 3G networks, while 4G networks can be sliced alongside 5G networks.
- The first wave of 5G momentum – up through 1 billion connections at the end of 2022 – took place without meaningful slicing, and with edge in a scale-up phase.
- As 5G moves into new markets and existing deployments evolve, basic connectivity and eMBB services could carry it forward but would not tap its full potential.

GLOBAL MOBILE TRENDS

csg

API monetisation

Aiming for more than the sum of its parts

TOPIC OVERVIEW

API monetisation

Why it matters

Unleashing network capabilities
- 5G value beyond faster speeds
- Unique versus mass-market solutions
- Foundational edge compute and slices

Capabilities that matter
- 5G brings many new capabilities
- Which will matter to developers?
- Which can be more easily exposed?

Telco cloud or telco + cloud?
- The story to date: B2B
- Opportunities ahead: B2C
- The API play

Monetising means charging
- Reminder: it's all about revenue generation
- How much is realtime charging needed?
- Slicing, edge and service inventories

APIs versus open versus security
- Security as a top operator concern
- The role of 'open' in scaling API usage
- Is 'open' necessarily less secure?

Regional perspective

Considerations ahead

WHY API MONETISATION MATTERS IN 2023

Monetising 5G cannot be based on connectivity alone

5G revenue stagnation

Revenue aspirations: Beyond support for ever-increasing data demand and new mobile data use cases, new revenue generation was a foundational driver for 5G.

Revenue realities: Examples of 5G being used to grow revenues have been limited, with 5G FWA a standout against ability to charge more for 5G mobile.

Revenue potential: Providing developers with access to network capabilities via open APIs could unleash 5G capabilities but also deliver an important new revenue stream for 5G network builders.

Second wave of 5G

5G's next launch phase: Following impressive early 5G uptake, 2023 marks the start of new momentum in high-growth markets including India and Sub-Saharan Africa.

5G's next tech and service phase: Beyond new market launches, deployment of standalone 5G should pick up, along with a renewed push into B2B services.

5G capabilities and users: Service and 5G technology expansion set the stage for new capabilities and users who want them. Network APIs open for developers to access would support that.

Ecosystem paves the way

Past as present: Fully executing on the value of mobile networks by tapping into the developer community is not a new concept.

New signs: 2022 saw new interest such as Ericsson's aims around Vonage's developer ecosystem; Dish Network courting developers; and the formation of CAMARA (Telco Global API Alliance).

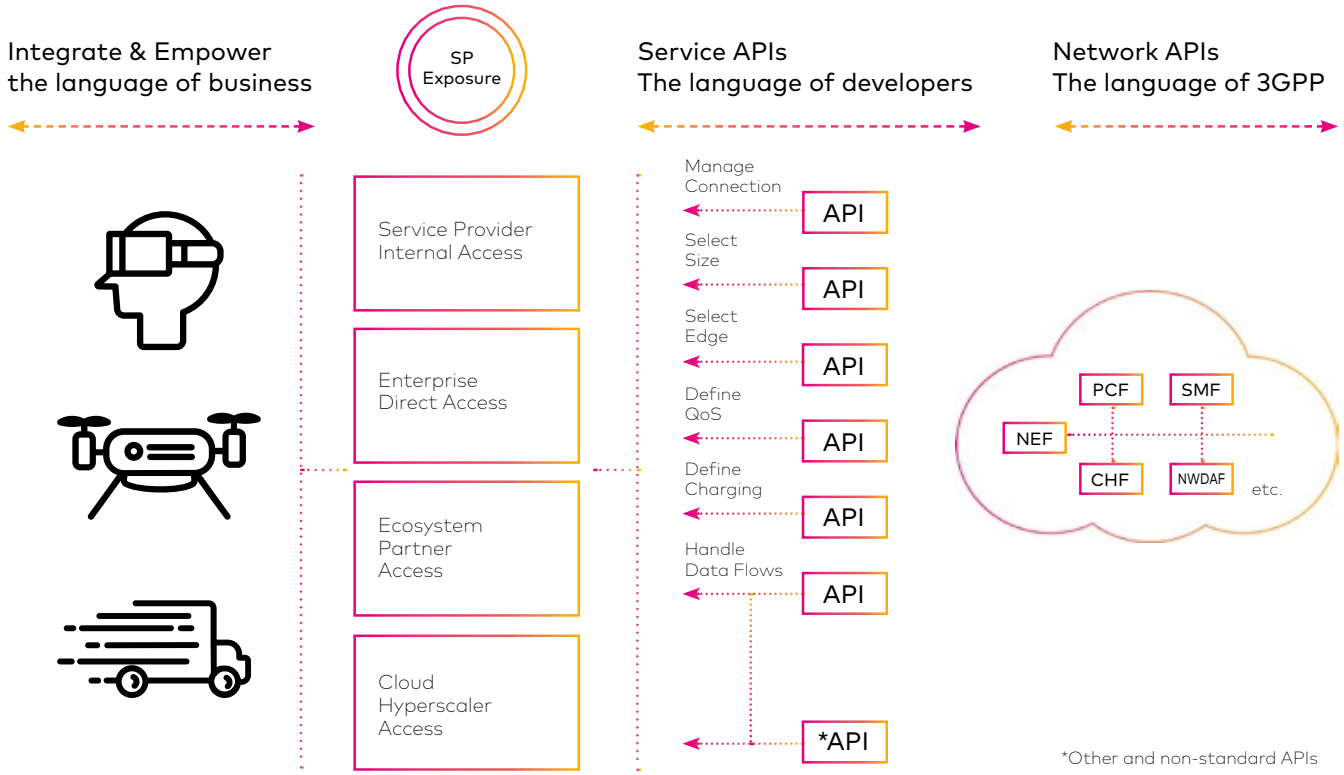
Follow the leader: Building on early momentum and messaging, along with 5G revenue pressures, the state of API monetisation ecosystem support should become clearer as the year progresses.

Unleashing network capabilities

The critical value of 5G is the core API monetisation rationale

- While high-speed connectivity is part of 5G's value proposition, this was always one piece of the story; delivering new capabilities – such as lower latency and higher reliability – was a central 5G tenet from inception.
- New 5G network capabilities were aimed at expanding the base of mobile use cases – generating new revenue streams by meeting specific customer demand and monetising 5G network investments in the process.
- Allowing developers to directly tap into network capabilities via exposed APIs (which connect into network functions) promises to scale the use of these capabilities (removing the need to connect directly with individual developers or applications) and develop their monetisation in the process.

Scaling use of network capabilities via exposed APIs: Amdocs NEF example



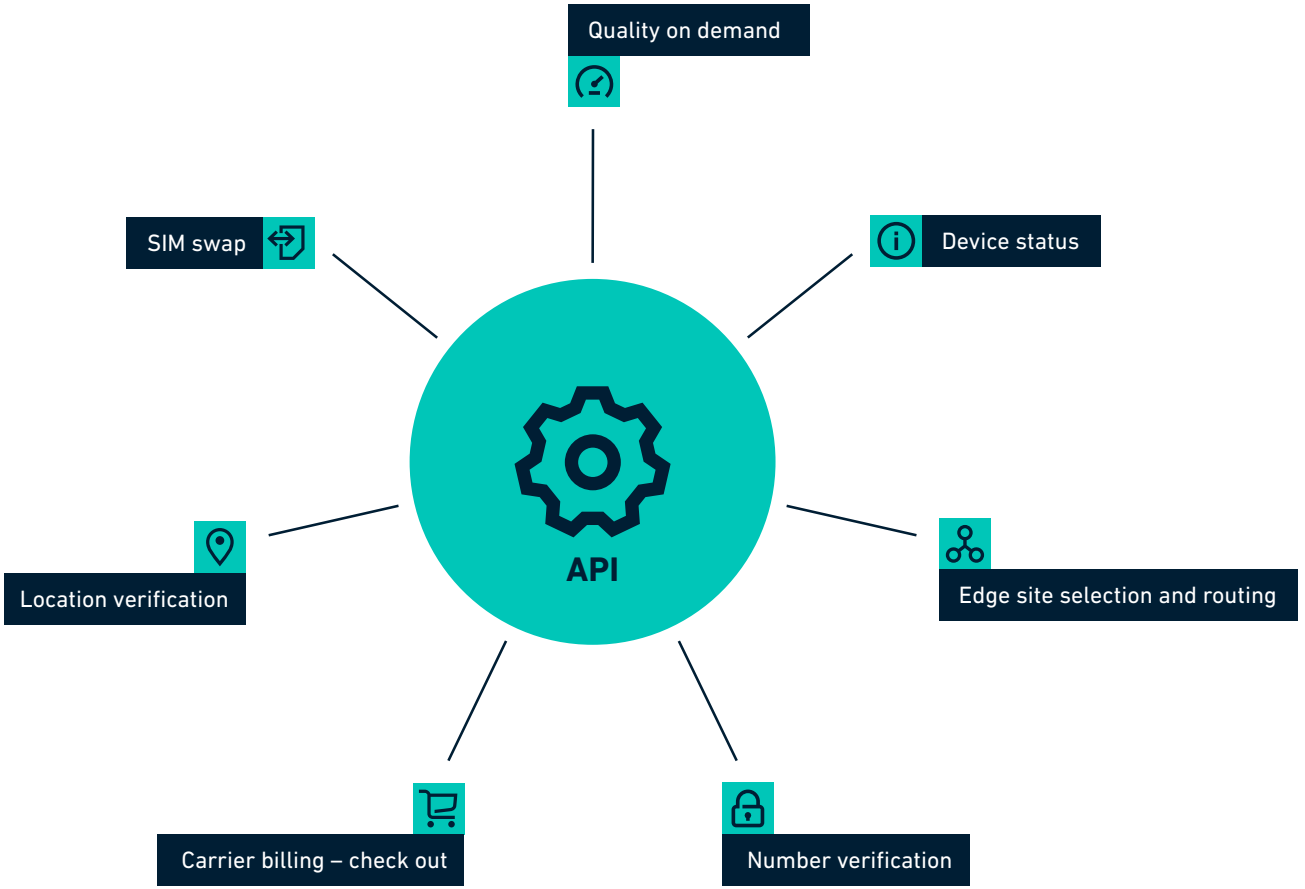
Source Amdocs Network Exposure Function (NEF) Data Sheet

Capabilities that matter

Where to focus among so many network capabilities?

- With or without 5G, there are lots of network capabilities that might be exposed to developers, hyperscalers, internal service provider teams, or directly to enterprises. These include location, quality of service (QoS), carrier billing and device status.
- While the universe of network capabilities that could be exposed is near-infinite, initial efforts to scale API monetisation will need to focus on a select few. Operators will need to learn where demand lies and the technical realities involved. Developers will need to learn how to leverage the APIs.
- Decisions on what capabilities to expose will ultimately rely on how broadly useful they are, how well they can be monetised, and universal versus unique 5G features.

A range of network capabilities



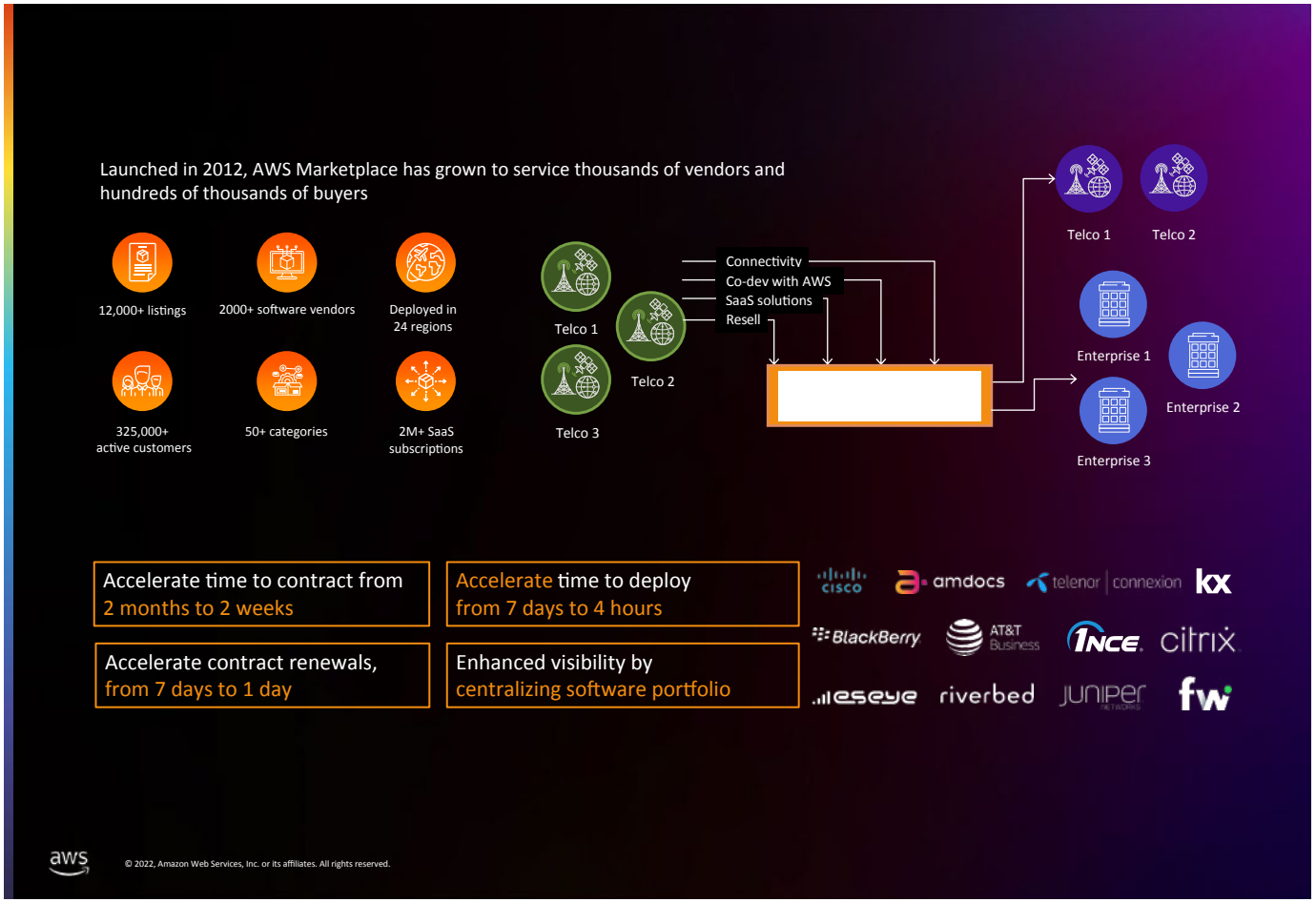
Source GSMA

Telco cloud or telco + cloud?

As operators embrace cloud, cloud will embrace API exposure

- For several years, major public cloud service providers have been building tighter relationships with – and value propositions for – the telecoms vertical, helping support network builds, hosting network functions, delivering edge capacity, and directly connecting into telco networks as a result.
- Whereas relationships with operators may be a relatively recent phenomenon, cloud providers have an entrenched position with developers (who know how to build for them) and enterprises (who know how to integrate with developer partners).
- Public cloud providers have an established position with developers, and connections into many telco networks. They are already delivering marketplaces that can connect the two worlds. They could prove a natural channel for operators to scale their API monetisation efforts.

Cloud as the bridge: AWS Marketplace example



Source Amazon Web Services

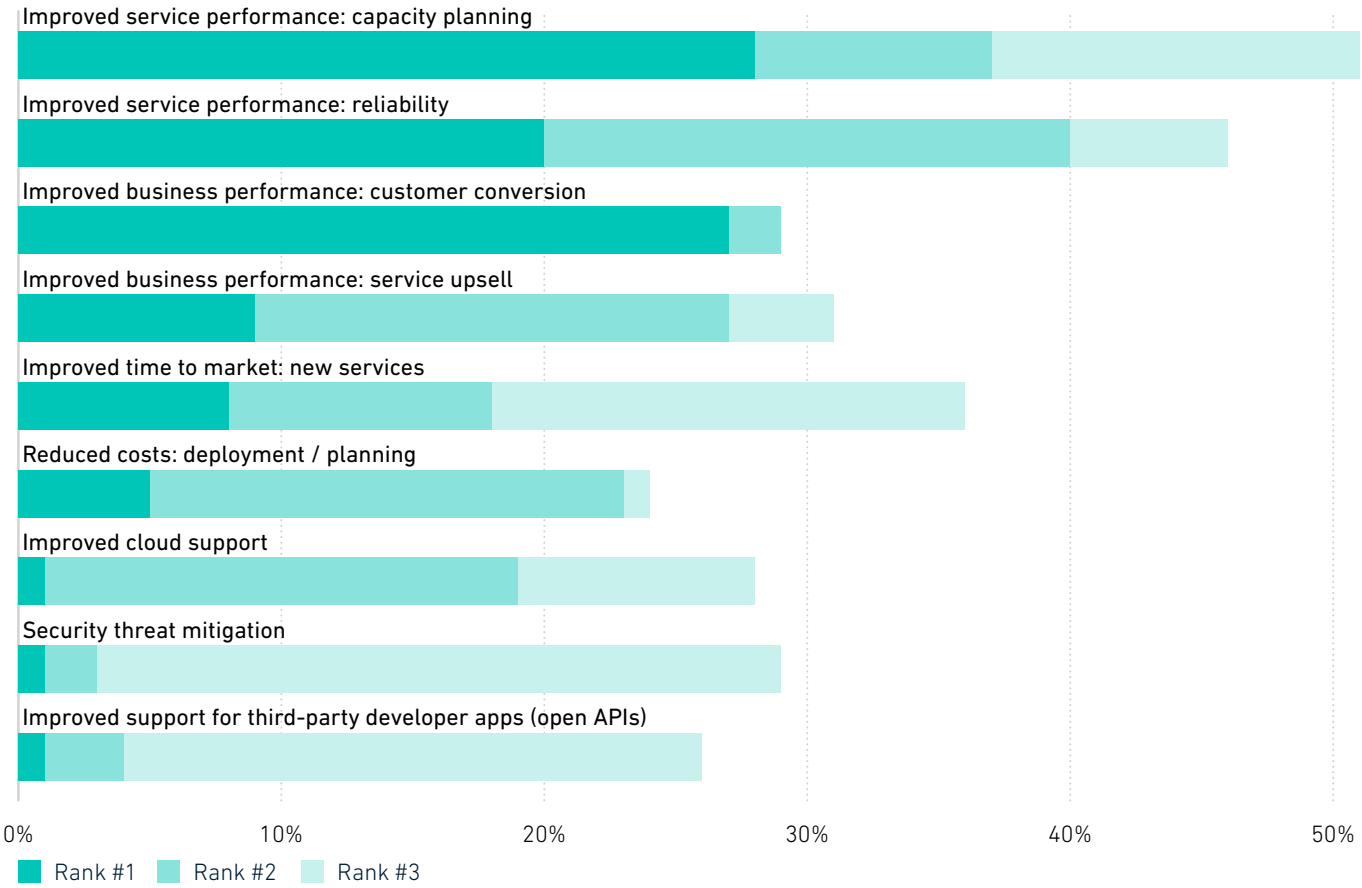
Monetising means charging

In opening network capabilities, the revenue opportunity can't be ignored

- Making network capability APIs easily usable by a broad range of developers and other stakeholders is the means to a larger goal – monetising network capabilities (including 5G features) and justifying further network investment.
- Where a goal of API exposure is monetisation, billing and charging considerations need to be integrated into solutions and strategies early in order to expose API availability alongside cost of use, to ensure that usage is paid for and to support flexible pricing.
- From a service rollout automation perspective, support for third-party developers does not factor much into operator thinking. If the same applies to plans around billing and charging support, this could represent a larger future problem to be solved.

Support for third-party developers does not factor much into operator thinking

What are the primary benefits driving service rollout automation investments within your organisation?



Source GSMA Intelligence Operators in Focus: Network Transformation Survey 2022

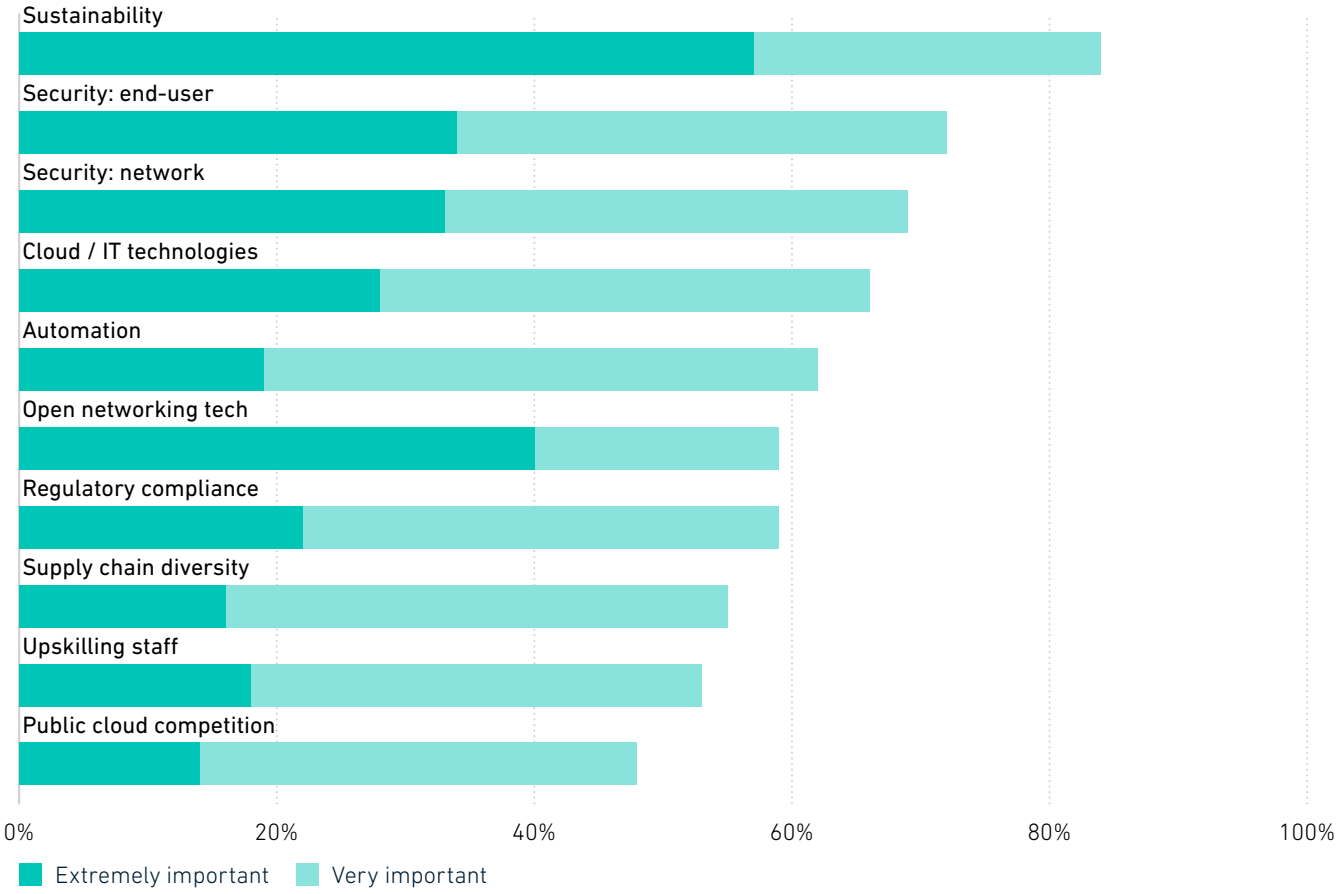
APIs versus open versus security

'Open' comes with security challenges and concerns

- After sustainability (elevated in importance against the backdrop of rising energy costs), security represents the highest operator network transformation priority – whether network or end-user security.
- Opening access to network APIs and capabilities is critical to scale usage but comes with clear security concerns. Allowing third parties to access key network capabilities could represent a new threat vector with regard to user authentication, data exposure and so on.
- To scale the use of network APIs while still complying with operator demand, security will need to factor into the story, with an end-to-end focus including user management, 5G security mechanisms, cloud providers, billing and charging infrastructure security.

Security ranks highly in operators' network transformation priorities

How important are the following priorities as a part of your network transformation strategy?



Source GSMA Intelligence Operators in Focus: Network Transformation Survey 2022

Monetize B2B2X Ecosystems and Stay Ahead of Competition

As Communication Service Providers (CSPs) continue their transformation to digital business models for B2B and B2B2X, they recognize that complexity is unavoidable when building rich, sophisticated multi-party business models. Those providers who strategically manage that complexity, along with building opportunities will be the ones who thrive in the new digital economy. Are you ready to make that change?

Whether you're providing your client the means to deliver business solutions to their customers or are allowing your customers to expand their relationships with a catalog of offerings and upgrades, CSG can help.

Rich and comprehensive platform

Leverage sophisticated quote-to-cash capabilities for your multi-sided business models and your ever-growing partner network.

Open and standardized principles

Encompass is built on 3GPP, TM Forum and MEF architecture principles, so you can future proof your business for any use case or partner with open APIs.

Telco industry expertise

With 30+ years of experience in telecom business transformation, you can rely on CSG to deliver the results you need.

Let CSG help you reimagine your customers' experience in ways you never thought possible to keep your customers coming back for more.

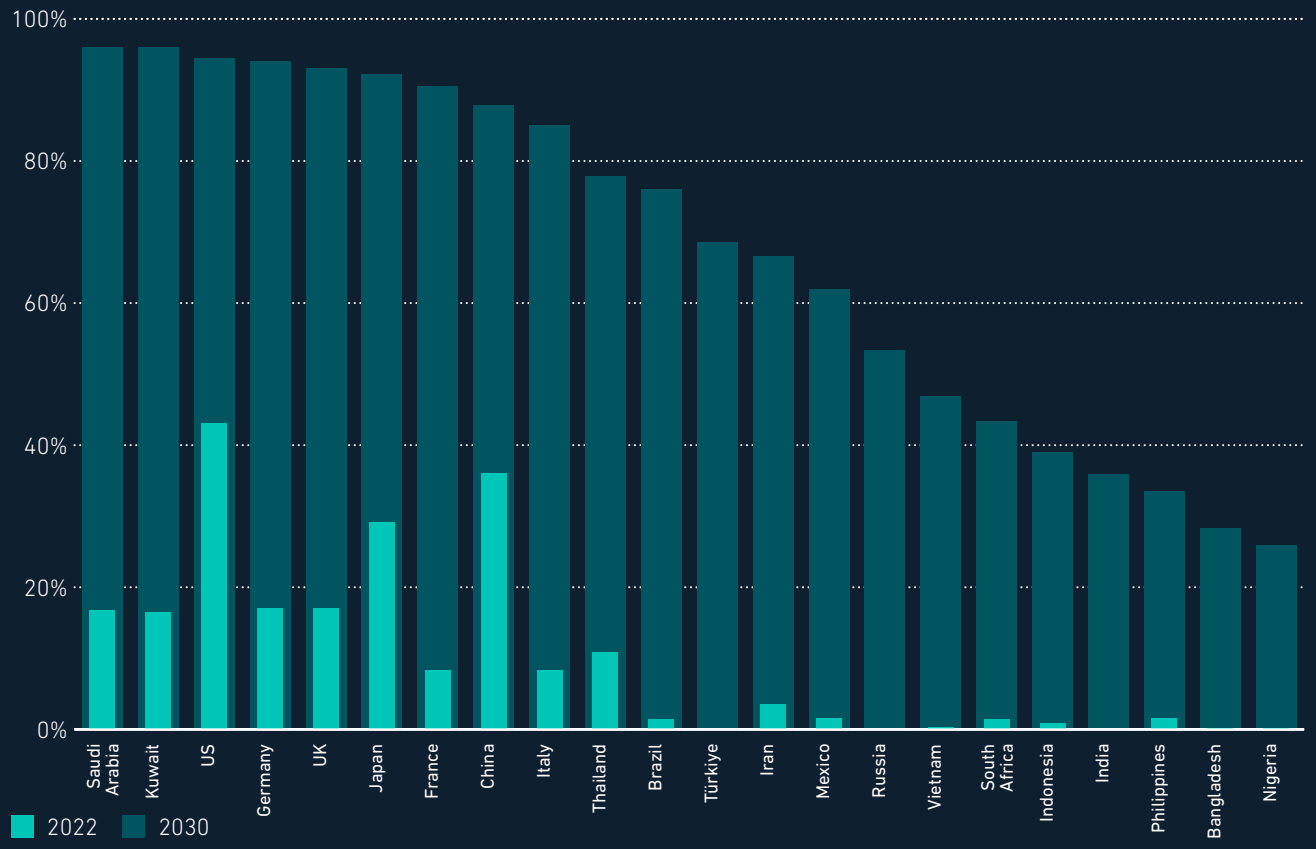
To learn more, go to www.csgi.com/encompass.

Regional perspective

- API monetisation efforts will benefit from 5G adoption, tapping into 5G capabilities and the new business thinking that accompanies them. While 5G has scaled faster than any other mobile broadband technology, it is still early days for many markets.
- Initial API monetisation efforts should centre on relatively more mature 5G markets, despite long-term 5G potential across the globe.
- Early API monetisation efforts will also be critical in setting the stage for broader global traction in the long term, delivering important commercial and technical lessons that should benefit the second wave of 5G markets.

5G adoption is growing but it is early days for some markets

5G as a percentage of connections (20 selected markets)



Source GSMA Intelligence

Considerations for the year ahead

Will new attempts to monetise network capabilities meet a different fate to past attempts?

- The concept of exposing and monetising network capabilities is not new. Past attempts on an industry or operator level largely failed to meet lofty expectations.
- Diverse dynamics could position current attempts for success, including the maturity of the app economy and developer ecosystems, 5G capabilities, and operator focus on 5G monetisation.
- As 2023 comes to a close, momentum around network capability exposure and API monetisation will provide an indication of whether this focus will fizzle out or endure.

Can operators collaborate for scale?

- Network capability monetisation efforts will only succeed if they engage developers. Developers will look for those efforts to scale across a large user base.
- User scale is a direct function of network scale. Monetisation efforts that touch multiple networks promise to reach a broad user base.
- If multi-network reach is key to delivering the user scale needed to engage developers, collaboration across operators could drive the opportunity.

Do operators have the tools to fully monetise (as opposed to simply expose) network capabilities and APIs?

- Exposing network capabilities to developers is not the same as generating revenues from that exposure. It is only one piece of the puzzle.
- Monetising use of network APIs and capabilities will require diverse assets, including usage-based charging, automated provisioning/testing support and usage visibility.
- Ecosystem support with monetising API usage (not just exposing APIs) will impact how money is made – in the long term, if not in the near term.

GLOBAL MOBILE TRENDS

Satellite and non-terrestrial networks

From star wars to soft landing

TOPIC OVERVIEW

Satellite and non-terrestrial networks

Why it matters

Space is becoming a crowded place	• LEO revolution • Economics
Closing the coverage gap	• Sizing the coverage versus usage gap • Geographical comparisons
Terrestrial can't do it alone	• Cost challenges with terrestrial expansion • Pragmatism reigns
Africa and South Asia offer the clearest plays	• Consumer revenue uplift • Regional breakdowns
The B2B opportunity spans multiple sectors	• B2B flying under the radar • Enterprise revenue uplift • Sector breakdown

Regional perspective

Considerations ahead

WHY SATELLITE MATTERS IN 2023

A pragmatic win–win

The coverage gap remains

The gap: For all the expansion of 3G and 4G networks, 400 million people (around 5% of the global population) live outside the range of a mobile broadband network.

Economics: While expansion of terrestrial base stations could bridge some of this gap, there will be diminishing returns as the costs get prohibitively expensive for the least populated regions.

The options are there

Numbers: Satellites in orbit will number more than 8,000 (compared to 2,000–3,000 historically) once SpaceX and OneWeb's constellations reach full deployment. This offers to mobile operators a structural rise in connectivity capacity from space.

Wholesale versus retail: In the past, there were some suspicions on the intent of satellite groups, but most partnership models are now wholesale for backhaul, with operators owning the customer relationship – a win–win.

Revenue uplift

Consumers: Closing the coverage gap would offer an uplift of around $30 billion to the telecoms sector by 2035, or 3% of existing revenues.

IoT/enterprise: The B2B dimension is also significant. In the GSMA Intelligence Enterprise in Focus Survey, 15–20% of companies indicate they either use, or would consider using, satellite connectivity.

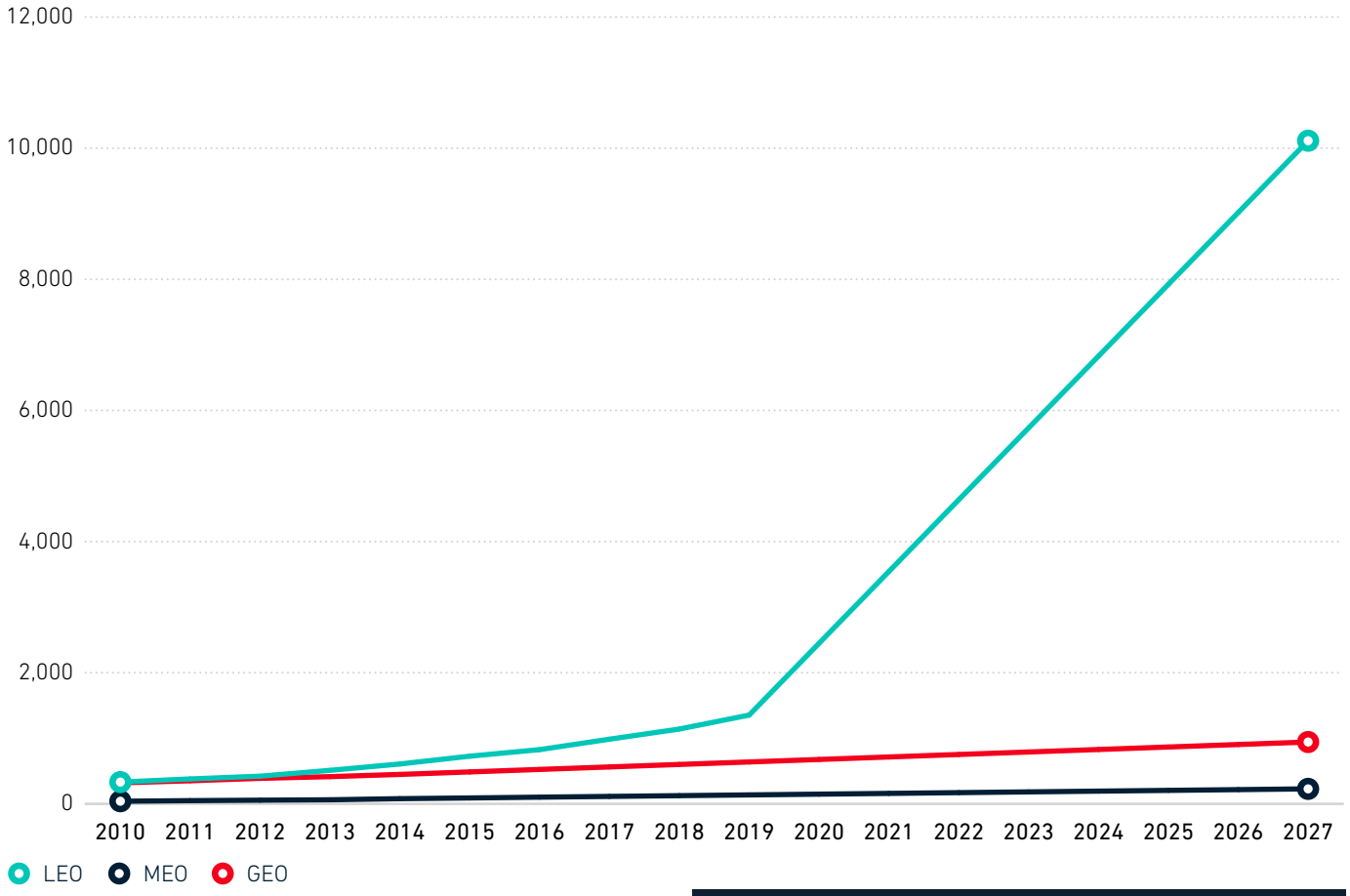
Space is becoming a crowded place

The LEO revolution is in full force

- In the 1990s and 2000s, satellite was a fairly traditional industry. Companies like Iridium and Intelsat sold connectivity to industries such as automotive and defence, and (to a certain extent) households in remote areas at a high premium, with relatively little technology innovation.
- This changed once SpaceX entered the sector around 2016 with plans for a low Earth orbit (LEO) constellation that, on its own, would almost rival the number of satellites in space overall.
- A range of other companies then deployed LEO networks, including OneWeb, Telesat and Amazon (Project Kuiper), operating with a lower cost model that offered operators the chance to reach new customers, which would otherwise not be possible or would be prohibitively expensive by simply extending land base stations.

Growth in satellites in orbit: once flat, now 'hockey-stick' shaped

Number of satellites in orbit (cumulative)



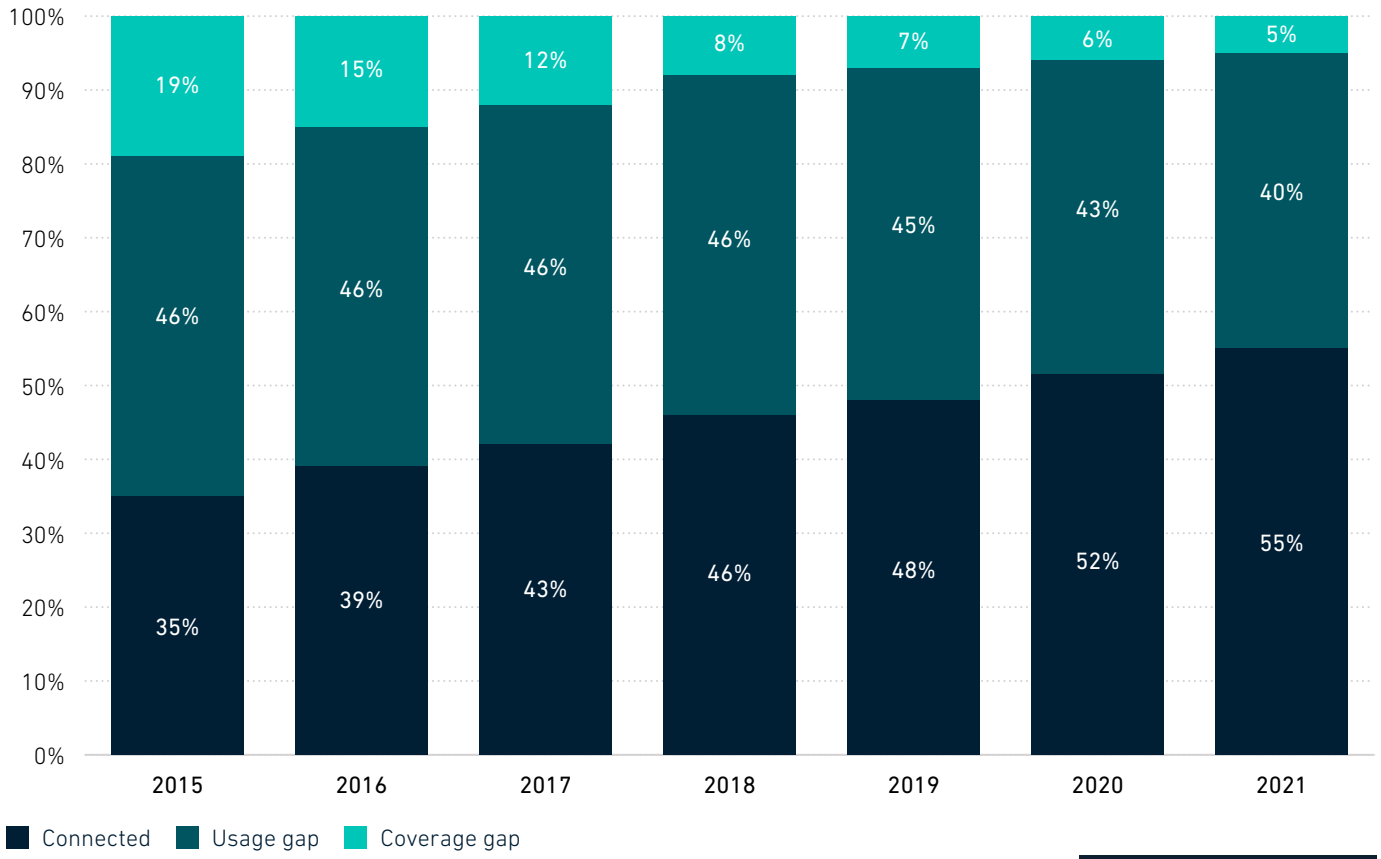
Source GSMA Intelligence and Union of Concerned Scientists

Closing the coverage gap
How to connect 400 million people?

- Despite achievements in expanding coverage, 400 million people still live in an area not covered by a mobile broadband (3G/4G/5G) network, and progress has slowed since 2018.
- 200 million people live in areas with no pre-existing infrastructure (even 2G) and so face significant deployment costs.
- Almost 1 in 5 people in least developed countries (in Africa and the Pacific Islands in particular) have no broadband coverage due to low incomes, large remote populations and challenging terrain.
- Meanwhile, millions of individuals live in areas with a mobile broadband signal but suffer from poor network quality and patchy coverage.

Mobile operators' extensive network investments have helped to close the mobile broadband coverage gap

Percentage of population



Source GSMA Intelligence

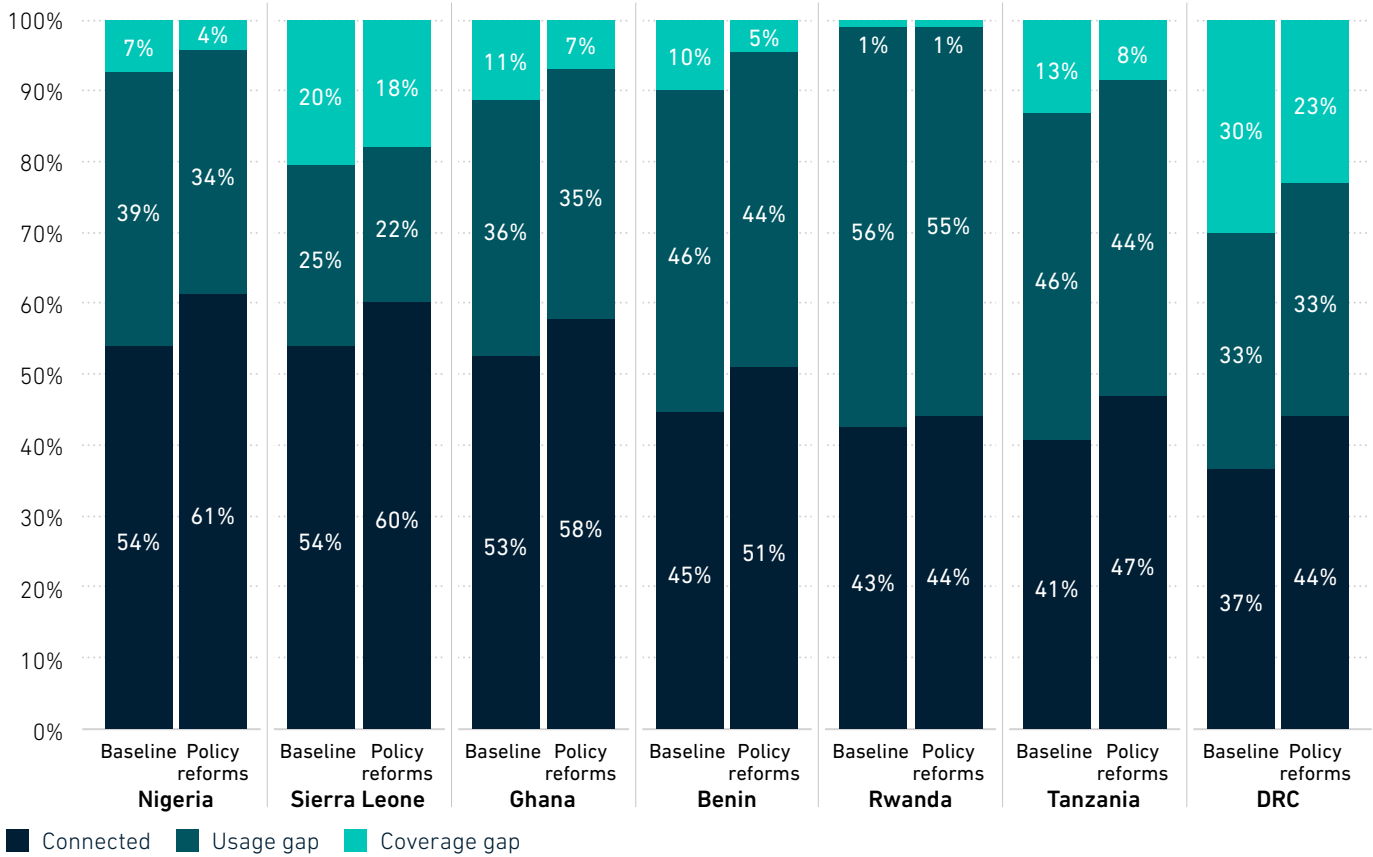
Terrestrial can't do it alone

100% coverage is not economically viable

- A GSMA study of seven African countries showed that site innovations combined with enabling policy reforms around spectrum, taxation and infrastructure sharing will allow operators to expand coverage.
- However, even with the reforms in place, there will remain a significant coverage gap in most of the countries.
- Even subsidies for terrestrial networks will not be able to achieve universal coverage, due to the exponential costs of covering the final 1–5% of population. Alternative solutions are therefore needed.

Enabling policies can increase mobile broadband coverage by 2030 but won't be enough

Percentage of population



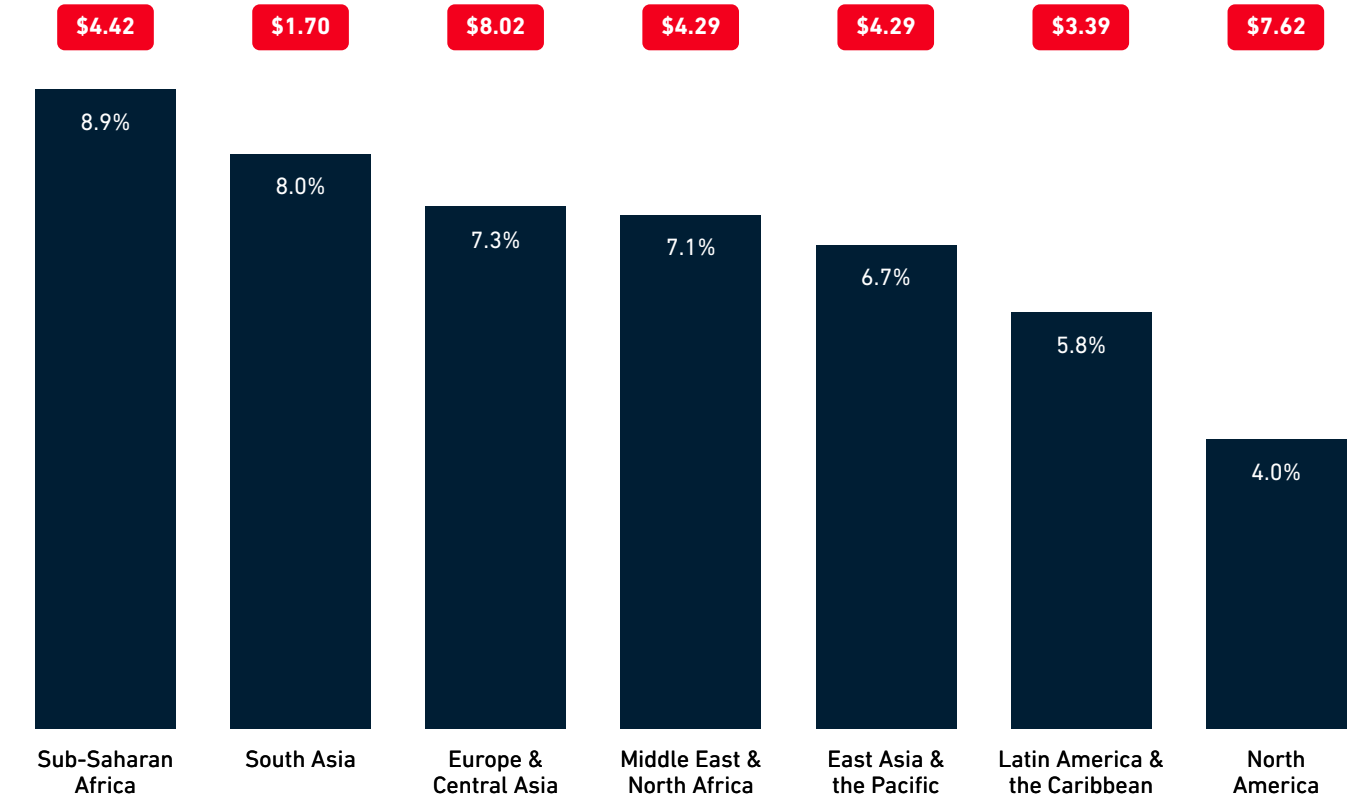
Source GSMA analysis of data sourced from mobile operators, GSMA Intelligence, Facebook Connectivity Lab and CIESIN, household survey data, and Group on Earth Observations

Africa and South Asia offer the clearest plays

But don't forget Europe

- The financial opportunity for mobile operators partnering with satellite companies tends to be correlated with the size of the coverage gap.
- This means that the opportunity for revenue uplift is greatest in Africa, South Asia and, to a certain extent, parts of Europe.
- The revenue uplift ranges from $4–8 per month, per customer for those connected via satellite (i.e. between what average 3G and 4G tariffs yield now).
- This scales to around $30 billion by 2035 – an uplift of 3% on existing telecoms sector revenues. This amount of money will not necessarily be realised, but something in that ballpark would be a meaningful uptick and one that would not be possible with terrestrial networks alone.

The consumer spend uplifts from connecting each incremental subscriber sit between 3G and 4G ARPU levels



Source GSMA Intelligence

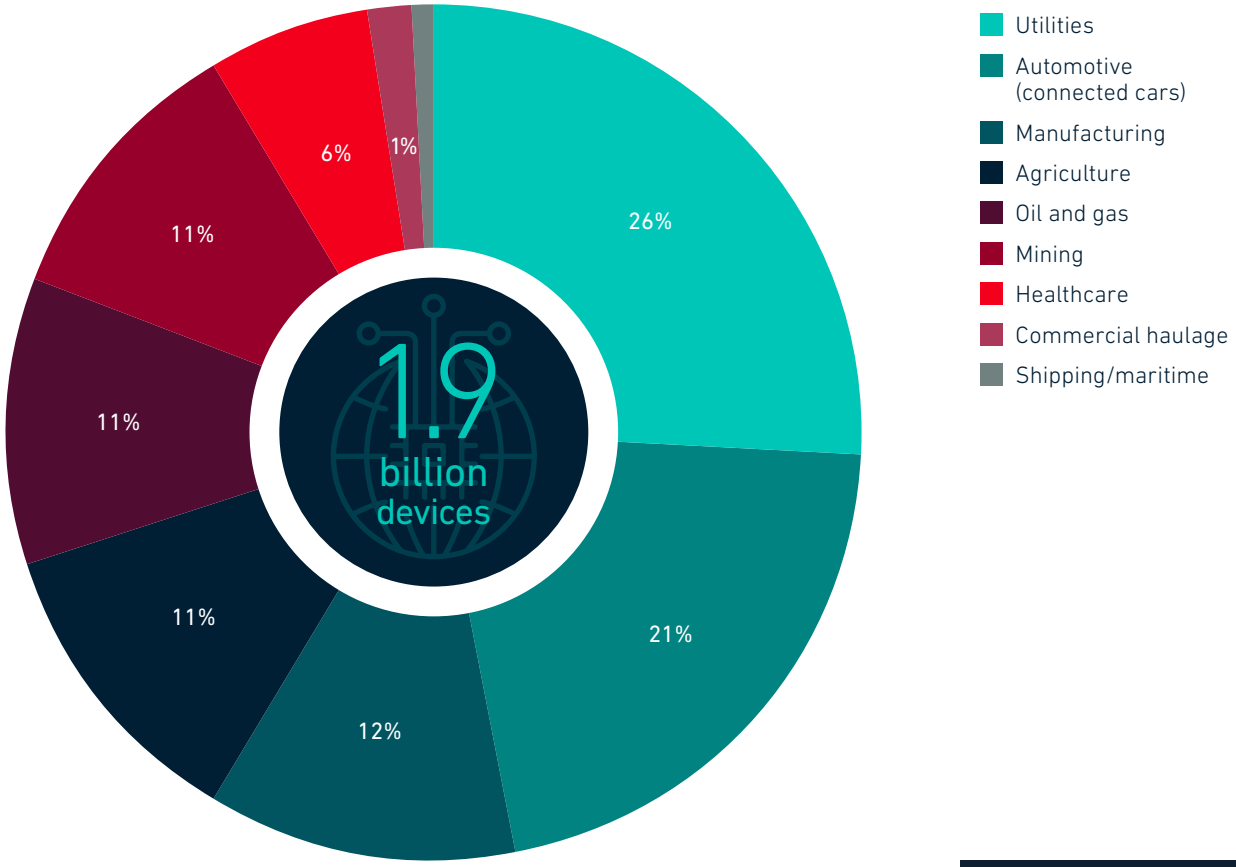
The B2B opportunity spans multiple sectors

8% of a big number is a big number

- There is a gap in the market for enterprises situated in areas of weak or no connectivity, or that require dynamic coverage. Dynamic coverage plays to companies that run moving assets, such as those in automotive, commercial logistics and shipping.
- Similarly, there is demand in sectors with remote installations, including agriculture, heavy industry (oil & gas, mining), rural manufacturing and healthcare.
- The revenue opportunity equates to 25% of existing IoT connectivity revenues for operators, which is a meaningful uplift, particularly in an environment of commoditised connectivity pricing.

Around 1.9 billion devices (8% of the IoT market) will be addressable for direct-to-device satellite by 2035

Sector share of total



Source GSMA Intelligence

Regional perspective

Africa

- Africa represents the largest source of unconnected people (130 million or 15% of the adult population) so is a natural opportunity.
- However, operators here are also among the most financially pressed and exposed to rising equipment prices through foreign exchange depreciation.
- Satellite partnerships will grow but may be slowed by the above factors.

Asia

- Asia is home to many interested operators, including those who have already deployed their own satellite constellations and may wish to move to a lower cost supplier.
- The B2B dimension is equally interesting given the rise in demand from manufacturing and energy companies, who grow in line with GDP growth. Several Asian countries are among the fastest here (e.g. Vietnam, Thailand and Indonesia).

US

- In the US, it's a case of when, not if.
- As interesting as the economics is which type of partnership model is most commercially successful, particularly in comparing D2D options (AT&T and AST versus T-Mobile and SpaceX).
- The Apple-Globalstar deal will offer messaging in emergency situations at first but could be expanded to other connectivity services in the future.

Considerations for the year ahead

Does D2D go mainstream?

- D2D offers the benefit of a lower cost for consumers/businesses (given there is no dish). All else being equal, this should accelerate take-up.
- The revenue upside is significant ($30 billion by 2035), though spectrum interference and rights remain a hurdle in some jurisdictions.

Is Apple's move a presage of others?

- What Apple does tends to garner attention. The partnership with Globalstar to offer emergency SMS is no different.
- However, this is not likely to prove a prelude to Apple launching wider communication services, but rather a spur for operators to extend coverage through this means.

Can satellite help operators with B2B?

- The enterprise market is often overlooked in the satellite discussion, but with 1.9 billion assets in play, it should not be.
- The short answer is 'yes' for industries requiring low-bandwidth, wide area connectivity (e.g. utilities, asset tracking). Servicing speed and latency-sensitive use cases in, for example, manufacturing is likely some way off considering that even '5G' satellite often only reaches speeds of 2–3 Mbps in reality.

GLOBAL MOBILE TRENDS

The enterprise verticals story

IoT 2.0, eSIM and the drive for scale

TOPIC OVERVIEW

The enterprise verticals story

Why it matters

The rise of digital industries
- Digital transformation more important than ever
- Enterprises find digital technologies compelling
- Dedicated resources and budgets are key

IoT enables digital transformation
- Link between IoT and digital transformation
- Enterprise sectors driving growth
- New revenues and cost saving equally important

5G adds impetus to cellular IoT
- Cellular IoT market doubling to 2030
- 5G brings new capabilities for IoT
- Testing new use cases

eSIM looking for scale
- Moving beyond connected cars
- Leveraging key benefits: security and scalability
- Supporting private networks and the green imperative

The B2B opportunity for the industry
- Seeking incremental revenue growth: B2B an opportunity for all
- Partnerships on the rise
- Cloud and security driving B2B revenue growth

Regional perspective

Considerations ahead

WHY THE ENTERPRISE VERTICALS STORY MATTERS IN 2023

Digital transformation of vertical sectors is the biggest catalyst for the B2B opportunity

The digitisation imperative

Industry 4.0 spreads: Digital technologies are increasingly important to competitiveness for a range of industries, well beyond manufacturing.

Sustainability moves up the agenda: More and more digital transformation projects and decisions will factor into sustainability targets.

The national agenda drive: Digital transformation is increasingly embedded in long-term government plans to boost productivity and competitiveness.

The B2B opportunity

New growth story: With consumer revenue stagnating, all players in the industry (e.g. vendors, operators, hyperscalers, tech companies) are targeting the digitisation of verticals to generate incremental revenue growth.

Doing it together: Partnerships are increasingly crucial to drive scale and optimise the use of resources and know-how.

Organisational changes: Fit-for-purpose business units and staff retraining/upskilling will be increasingly important to capture the B2B opportunity.

5G monetisation

Seeking 5G RoI: 5G SA deployments will gain momentum in 2023, adding pressure to monetise 5G networks through more scalable B2B services.

5G FWA on the rise: Operators will increasingly position 5G FWA as a valid alternative to traditional fixed broadband connectivity for SMEs.

Thinking beyond 5G: Now that early 5G technology has matured, operators are beginning to look at what comes next, including 5G-Advanced and 6G.

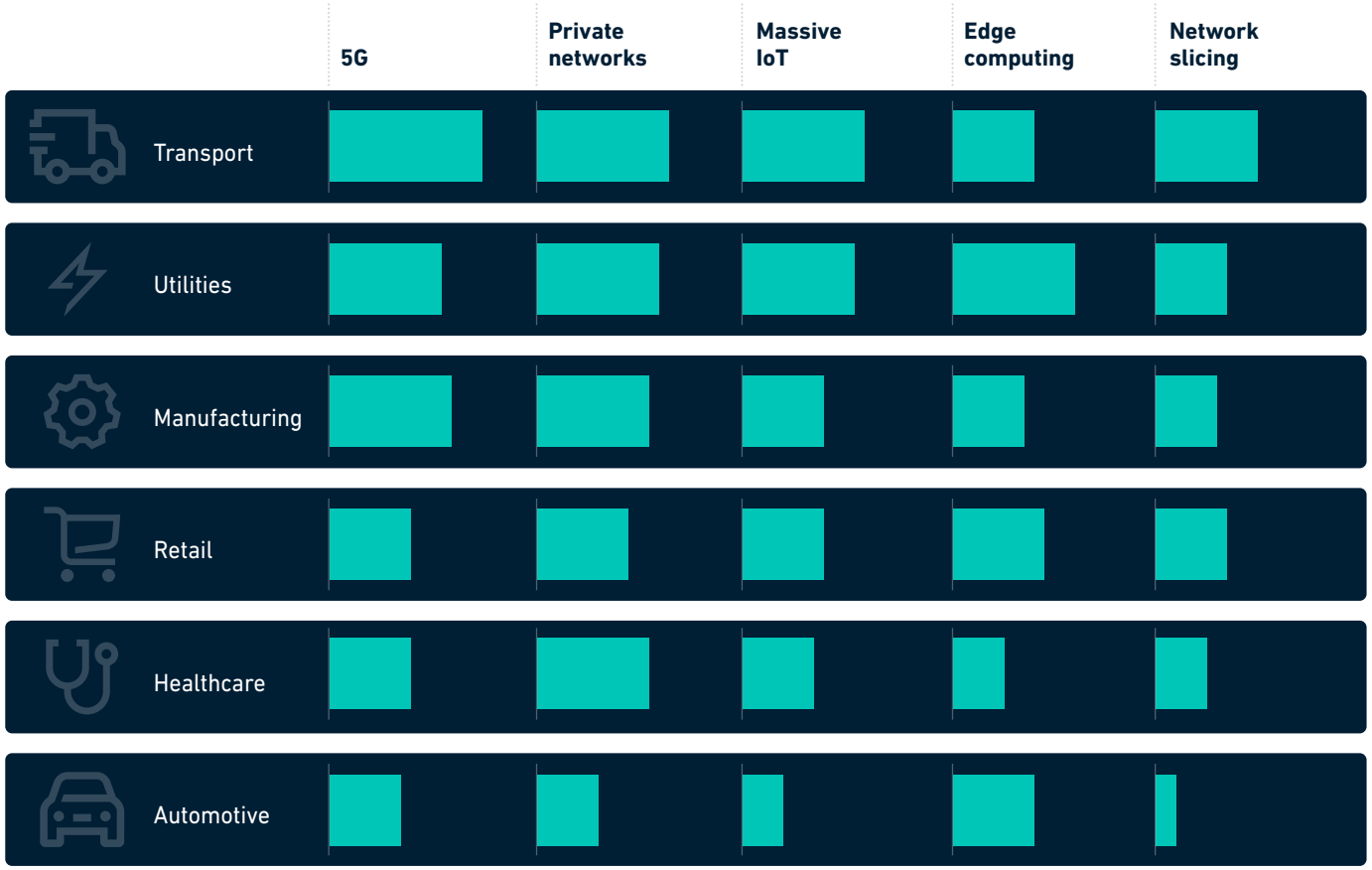
The rise of digital industries

Digital technologies help address enterprise challenges

- Even before Covid-19, the trend towards digitisation was clear, but the pandemic has accelerated the shift. Digital technology is also helping enterprises address new external pressures such as disruption to supply chains, rising energy costs, and compliance with sustainability targets.
- GSMA Intelligence research shows that enterprises in all verticals find new technologies such as 5G, private networks, massive IoT, edge and slicing compelling to advance their digital transformation. That is an important factor to build on. Turning enterprise interest into deployments will be a key focus in 2023.
- Realising the full vision of digital industries will take many years, but 2023 will likely see important advancements and larger-scale deployments. For enterprises, dedicated resources and budgets will be key.

New technologies important to achieving success in digital transformation

Representation of share of enterprises who rated the new technologies as very important or somewhat important



Source GSMA Intelligence Global Enterprise Survey

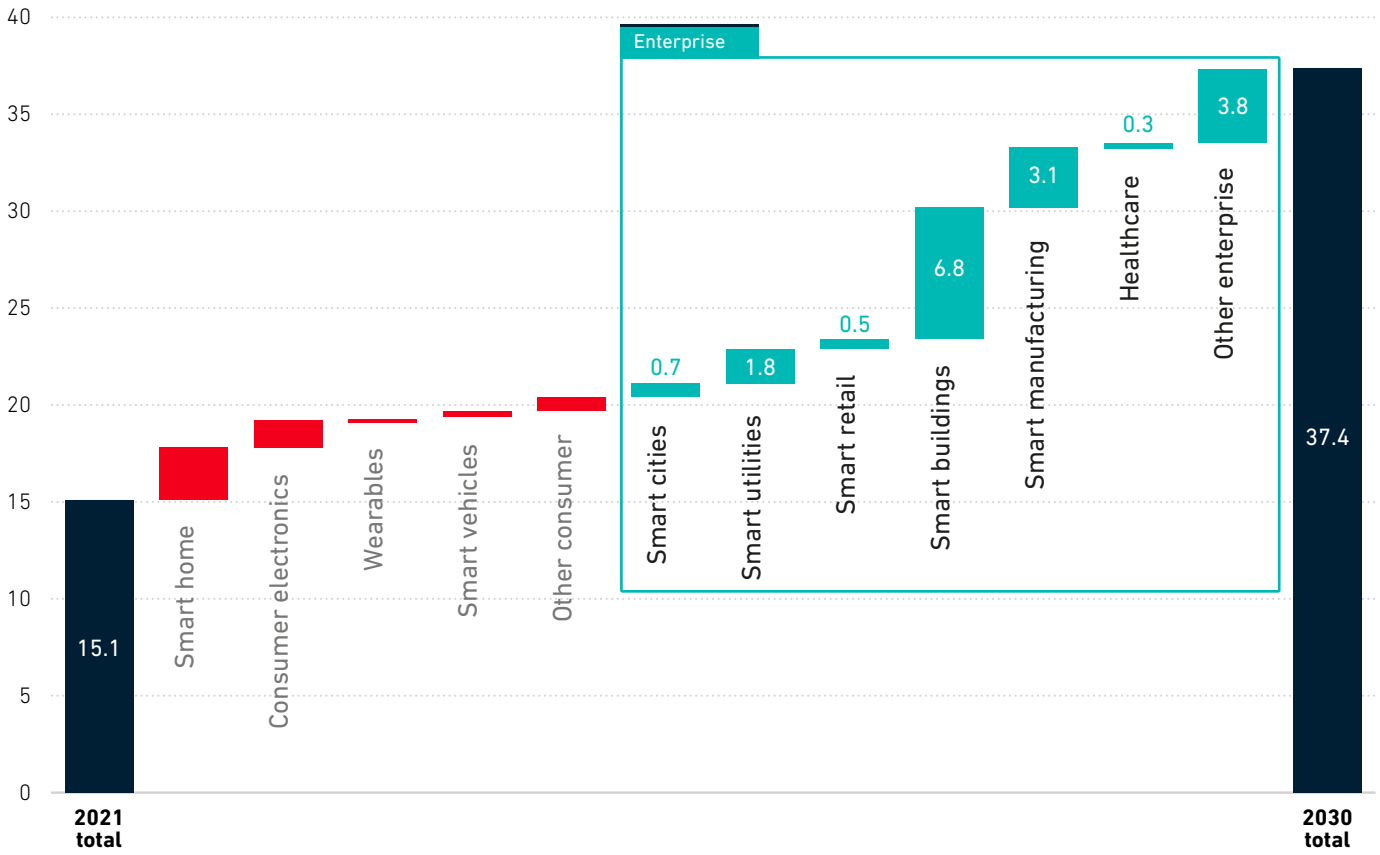
IoT enables digital transformation

Enterprise sectors are driving IoT growth

- The link between IoT and digital transformation is clear: IoT deployments are part of a wider digital transformation agenda for 63% of enterprises (standalone initiatives for 37% of enterprises).
- The impending growth for IoT underlines the economic value that enterprises place on 'smart' operations. Generating new revenues and saving costs are equally important objectives when deploying IoT.
- 2023 will see 2 billion new IoT connections globally (12% growth), with 1.4 billion (70%) from enterprise use cases. Indeed, enterprise will surpass consumer in terms of connections in 2024.
- IoT connections will reach 37.4 billion by 2030. Enterprise IoT will be the main driver of growth, with progress in almost all enterprise sectors.

IoT will reach 37 billion connections by 2030, with the enterprise sector driving growth

Global IoT connections (billion)



Note: Other enterprise includes agriculture, shipping, logistics, heavy industries (e.g. oil and gas) and a range of smaller segments. Other consumer includes a range of small-volume categories.

Source GSMA Intelligence

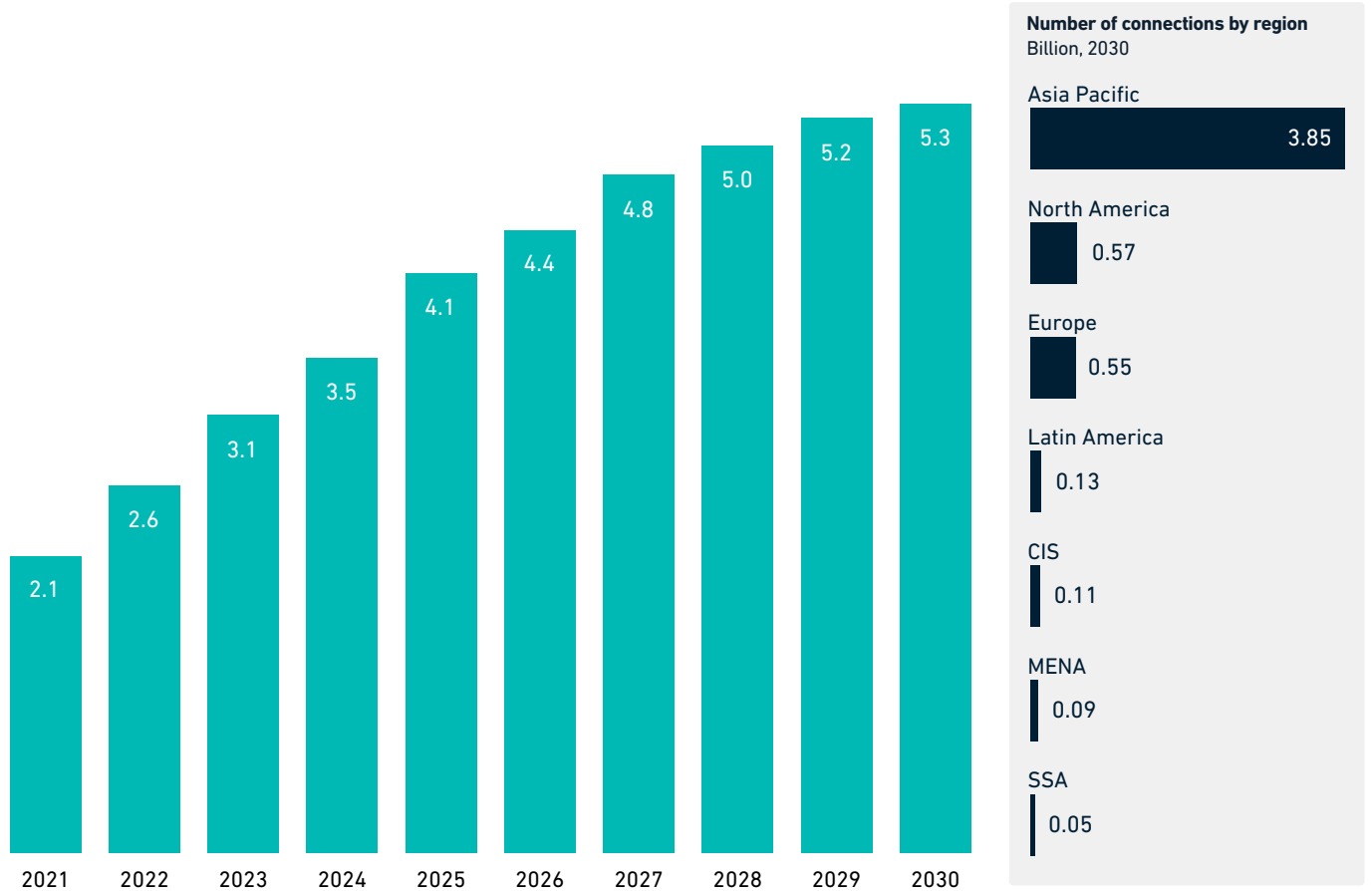
5G adds impetus to cellular IoT

New capabilities to scale the use of mobile technologies in IoT

- While cellular networks currently serve 15% of total IoT connections, the explosion of the IoT market provides significant room for growth in the cellular IoT space. The number of licensed cellular IoT connections will reach 5.3 billion globally by 2030, up from 2.6 billion in 2022 (10% CAGR), with China by far the largest market (3.5 billion).
- Within the cellular IoT space, cellular M2M will continue to support IoT devices that require mobility (with 5G enabling lower latencies and higher data transfer speeds for URLLC), while licensed LPWA will support devices previously served by legacy cellular networks (2G/3G).
- 5G will play a dual role in 2023: it will support IoT growth and will be used to test use cases (e.g. autonomous vehicles, drones, enterprise metaverse) that will then scale in the 5G-Advanced or even 6G eras.

The cellular IoT market will double between 2022 and 2030

Global licensed cellular IoT connections (consumer and enterprise, billion)



Source GSMA Intelligence

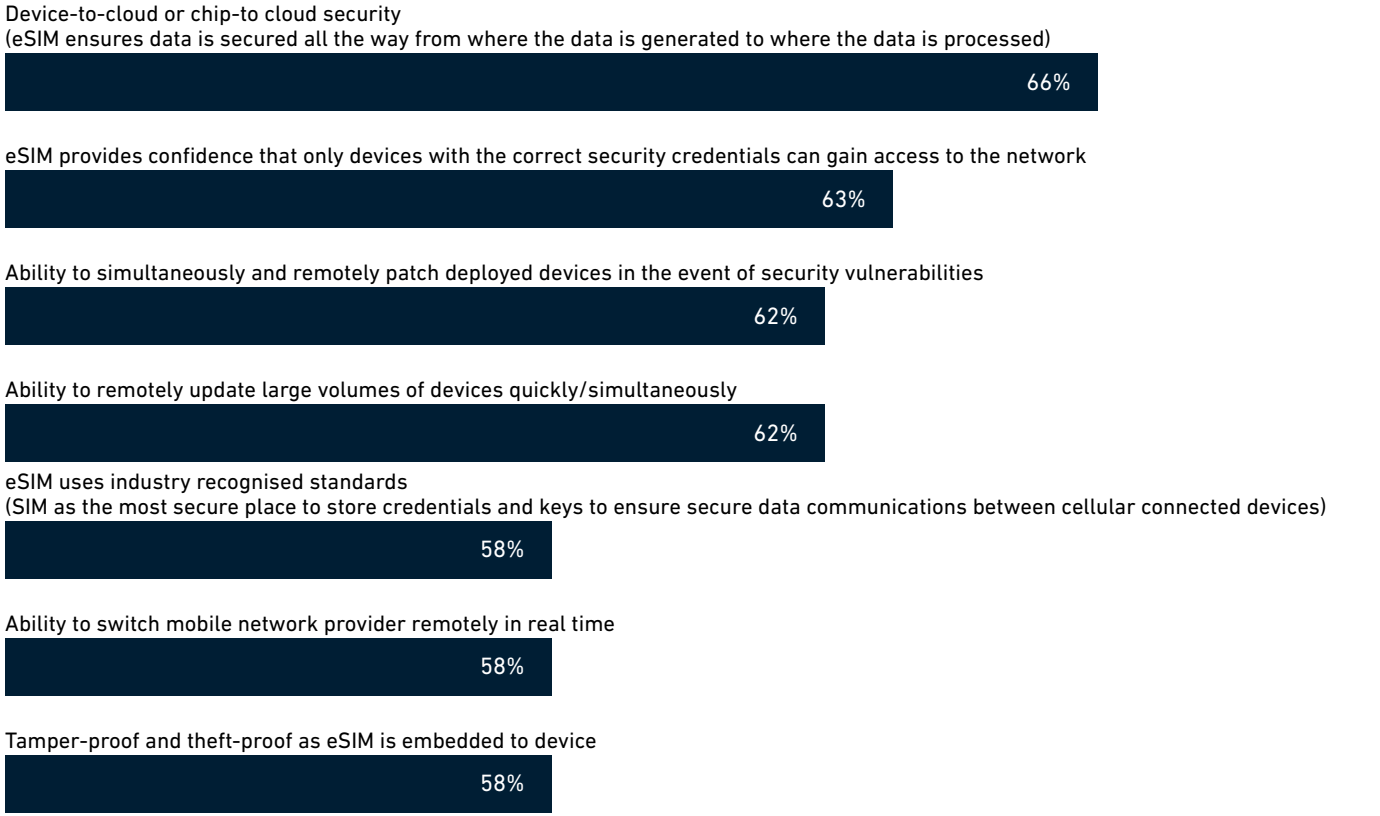
eSIM looking for scale

Turning availability into adoption

- eSIM technology has long been seen as a significant enabler of IoT deployments across vertical sectors. However, beyond automotive, eSIM adoption has yet to reach critical mass.
- The potential for growth is significant. GSMA Intelligence research shows that 83% of enterprises consider eSIM an important technology to achieving success in their IoT deployments, with best-in-class security and scalability the top eSIM benefits. There is an opportunity for operators and other providers of eSIM and IoT solutions to fulfil unmet enterprise demand.
- The focus in 2023 will be on advancing eSIM adoption beyond automotive (there is growing eSIM momentum in smart meters, smart grids, asset tracking, smart cities) and in private networks, while demonstrating how eSIM supports the green imperative.

Scalability and security top the benefits of eSIM for IoT deployments among enterprises

How important is each of the following eSIM benefits to the success of your IoT deployments? Percentage of respondents selecting very important.



Base: enterprises who consider eSIM important to achieve success in their IoT deployments (N=c2,400)

Source GSMA Intelligence Global Enterprise Survey

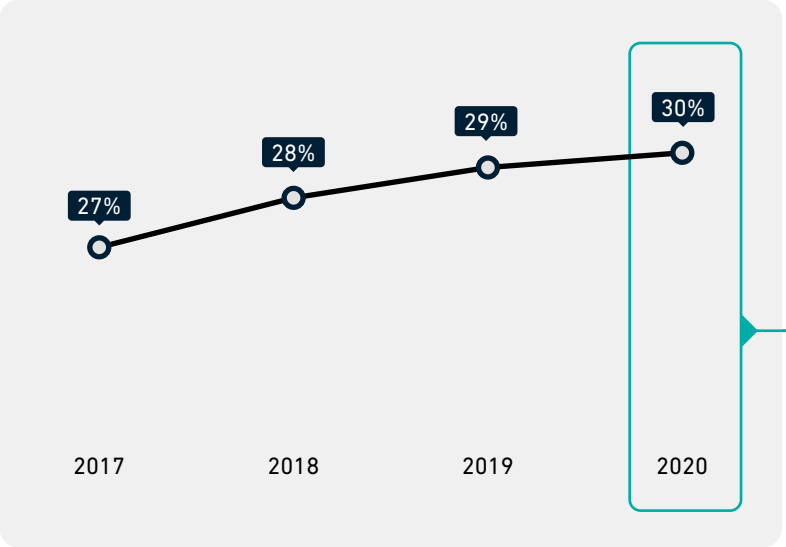
The B2B opportunity for the industry

Capturing incremental revenue growth

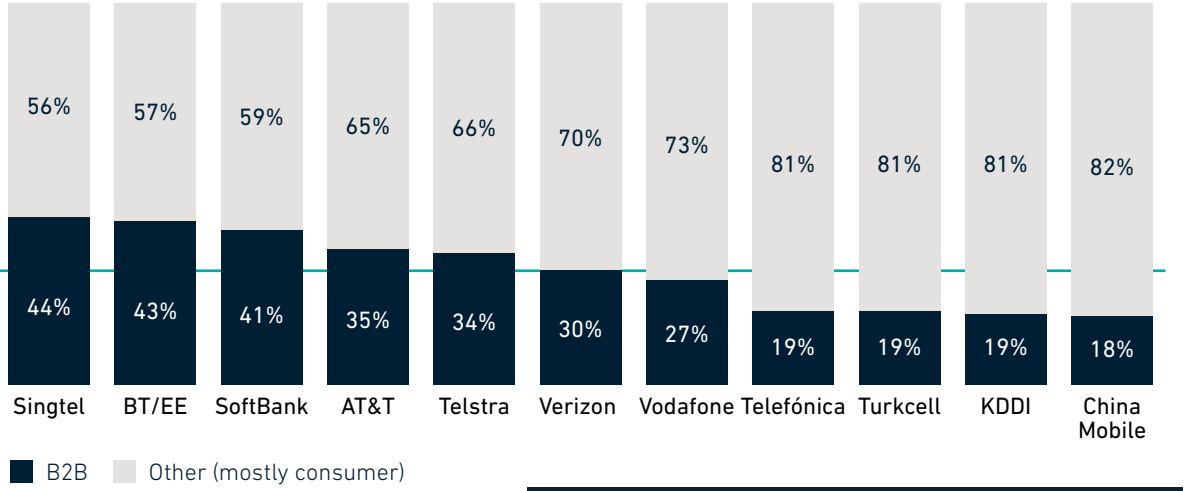
- Digital transformation of vertical sectors is the biggest catalyst for the B2B opportunity. Unsurprisingly, operators, network vendors, hyperscalers, tech specialists and a host of other companies in the B2B value chain are all seeking to monetise it through service innovation and partnerships. In 2022, we saw an unprecedented number of new partnerships; 2023 will take these even further, spanning all areas of B2B, including networks, cloud, edge, IoT and the metaverse.
- For operators, in turn, B2B is the main driver of revenue growth (30% contribution to total revenues in 2020, on average for major operators), with further potential going forward as IoT deployments and enterprise digitisation scale. Cloud and security will continue to drive B2B revenue growth in 2023.

B2B as a percentage of total revenues

11 operators in aggregate (simple average)



B2B as a percentage of total revenues (2020)*



*Service revenue for Vodafone. For Telstra, B2B excludes revenue from small businesses (reported within Consumer). Domestic figures for Turkcell (Türkiye accounts for 86% of Turkcell Group revenue).

Source company figures (at group level), GSMA Intelligence

thalesgroup.com

THALES

Building a future we can all trust

Thales for IoT: In the context of drastic growth of many diverse connected devices, Thales provides the IoT stakeholders with a complete solution to enable the best connectivity, relying on a scalable and sustainable infrastructure. Thales is leading the way towards GSMA eSIM standards for IoT and further facilitate IoT deployments with innovative value added services that remove IoT devices manufacturing constraints and help avoid cybersecurity breaches.

Thales eSIM solutions for the IoT:

Thales Adaptive Connect: making massive IoT available to all

Thales Adaptive Connect implements the GSMA eSIM standards, SGP.31 and 32, designed for massive IoT. With this solution, Global Connectivity Service Providers and Mobile Network Operators can offer global, resilient and cost-effective connectivity to IoT Service Providers, with no impact on device manufacturing and logistics operations. This innovative new solution, designed to deliver the flexibility required by the massive IoT segment extends commercial opportunities to MNOs and global network service providers of all sizes.

Read more

Thales IoT SAFE: improving IoT cyber security through eSIM-based scalable trust

While the emergence of billions more connected devices creates a wealth of new opportunities for stakeholders, it also presents profound security challenges. Every connection offers hackers a potential access to private and sensitive data. In response, Thales implemented the new GSMA IoT SAFE specifications. This set of globally recognized standards is designed to secure IoT devices and the connections to the cloud at scale.

The GSMA IoT SAFE initiative is built around the eSIM, which is field proven, hardware tamper proof and fully standardized. Because security is delivered through the eSIM, there is no impact on device design and production.

Thales IoT SAFE features a unique touchless provisioning service for cellular IoT devices.

This innovative plug & play approach provides security by design and removes all security constraints on device production and deployment.

Read more

Search: Thalesgroup

Regional perspective

Asia Pacific

- China leads (by far) on cellular IoT connections and plays a key role in driving IoT tech innovation (including ambient IoT – being tested by China Mobile and Huawei). 5G for B2B is backed by long-term government digital transformation agendas.
- 5G for B2B is on the rise in developed markets (e.g. Australia, Japan, South Korea, Singapore), supported by partnerships between operators, network vendors and cloud companies.
- Smart cities are a big focus in various countries (e.g. China, India, Singapore, Vietnam), driven by public-private partnerships.

North America

- North America is home to a vibrant (and growing) ecosystem of B2B tech suppliers of all sizes. Edge computing and private networks are driving B2B momentum. CBRS spectrum is commercially available for enterprise 5G deployments.
- Major US operators are focused on next-generation connectivity (5G and fibre rollouts) to support the digital transformation of vertical sectors. Media and entertainment is a big focus.
- The launch of eSIM-only smartphones may spur eSIM momentum in IoT too.

Europe

- Europe is lagging behind on 5G SA networks but there is extensive use of 4G for B2B services.
- Efforts continue to modernise policy and regulation in support of digital transformation.
- Operators are undergoing organisational changes to create fit-for-purpose B2B units (e.g. Telefonica Tech, BT).
- Germany is a country to watch for smart manufacturing progress and use of enterprise spectrum.

Considerations for the year ahead

Will M&A in IoT be a bigger trend?

- Ericsson's IoT Accelerator and Connected Vehicle Cloud businesses will be transferred to Aeris, while reports have suggested Vodafone may consider spinning off its IoT business unit. Although various factors play a role, there are signs that established IoT providers may be reassessing their IoT strategies and financials.
- To that end, GSMA Intelligence research shows that IoT will continue to be a strategic focus for operators but 36% stated they plan to re-evaluate/adjust their IoT strategies.

How will eSIM and iSIM play out?

- While the industry is currently focused on eSIM, iSIM technology is also being explored both as integrated eUICC and integrated UICC.
- eSIM versus iSIM is not an either/or scenario; there is overlap (e.g. integrated eUICC). Both are valid options that will coexist to meet the requirements of varied IoT use cases.

What does the metaverse mean for the vertical story?

- The metaverse is still in its early days, but the pace of announcements has accelerated in the last six months, with early developments in sectors such as digital entertainment and retail.
- GSMA Intelligence research shows that only 5% of operators have already defined an enterprise metaverse strategy, but many keep exploring opportunities. Operators should also look for synergies with their current enterprise solutions, such as private wireless networks that cater for on-site and remote operations or edge computing that reduces user-experienced latency – both relevant to metaverse's AR/VR applications.

GLOBAL MOBILE TRENDS

Private wireless networks

A flavour for all tastes

TOPIC OVERVIEW

Private wireless networks

Why it matters

Accelerating launches

- Where operators stand in offering private 4G and 5G
- The private 4G opportunity

The growing adoption base for private wireless networks

- Number of private wireless enterprise customers
- Early private 5G customer feedback

Vertical sector adoption

- Verticals that are a good fit for private wireless networks
- Considerations for private wireless network evolution

Who makes private wireless networks possible?

- New entrants in the market
- Who operators see as partners and competitors

IoT synergies

- The emerging synergy between private wireless networks and IoT
- What it means for the future of IoT

Regional perspective

Considerations ahead

WHY PRIVATE WIRELESS NETWORKS MATTER IN 2023

A significant opportunity with direct monetisation opportunities

Appealing to enterprises

Mobile networks as the backbone of digital transformation: Connectivity is an essential component in digitising operations and enabling smart products.

Private wireless networks fit with modern enterprise needs: Enterprises' connectivity needs have evolved, requiring better security, control and performance to support operations and digital transformation.

Tech enablers: 5G, IoT and spectrum

5G characteristics cater for enterprises: The cloud-native nature of 5G offers possibilities for enterprises to tap into networking resources.

IoT synergy: IoT is increasingly requested by users of private wireless networks, facilitating adoption of connected equipment and smart applications.

Enterprises tap into spectrum resources: Shared and private spectrum schemes make spectrum available to enterprises for their own use.

More players in the game

A highly contested space: Operators, vendors, hyperscalers and infrastructure companies are looking to tap into the private wireless network market.

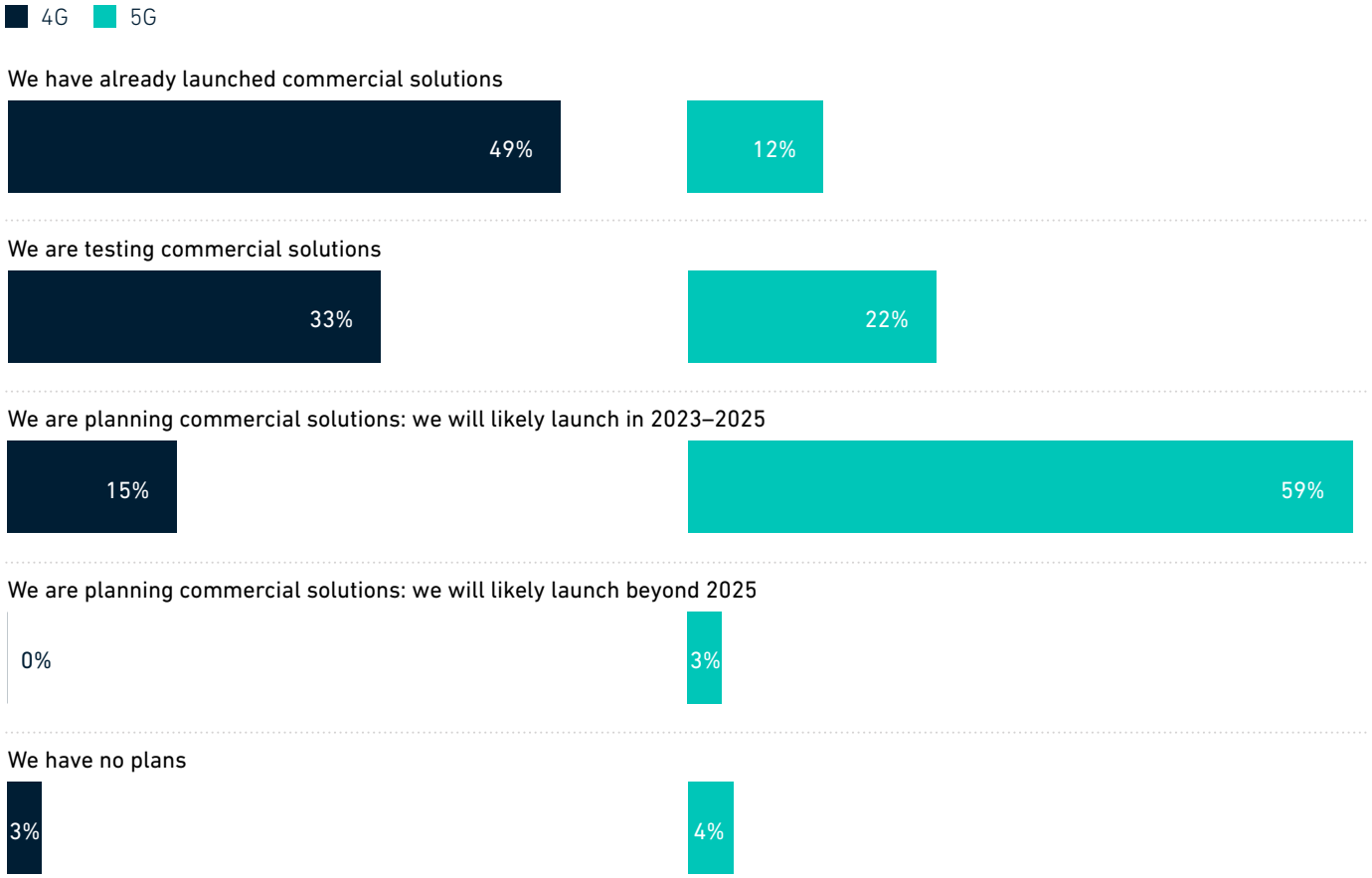
New entrants: Startups and specialist software providers are innovating and aspire to establish their presence in the private wireless space.

Accelerating launches
Don't overlook the private 4G opportunity

- Based on GSMA Intelligence survey data, around half of operators globally offer **private 4G** solutions. By 2025, it is anticipated that almost all operators will have brought such offerings to market.
- Successful deployments of private 4G solutions will increase enterprises' appetite to upgrade to private 5G, which will be easy once equipment and spectrum are available.
- A third of surveyed operators have launched or are testing **private 5G** wireless networks, while a majority are planning to launch in the next three years.

Private 5G set to move to mainstream

Where are you in the process of offering private wireless networks? Select one



Source GSMA Intelligence Operators in Focus: Enterprise Opportunity Survey 2022

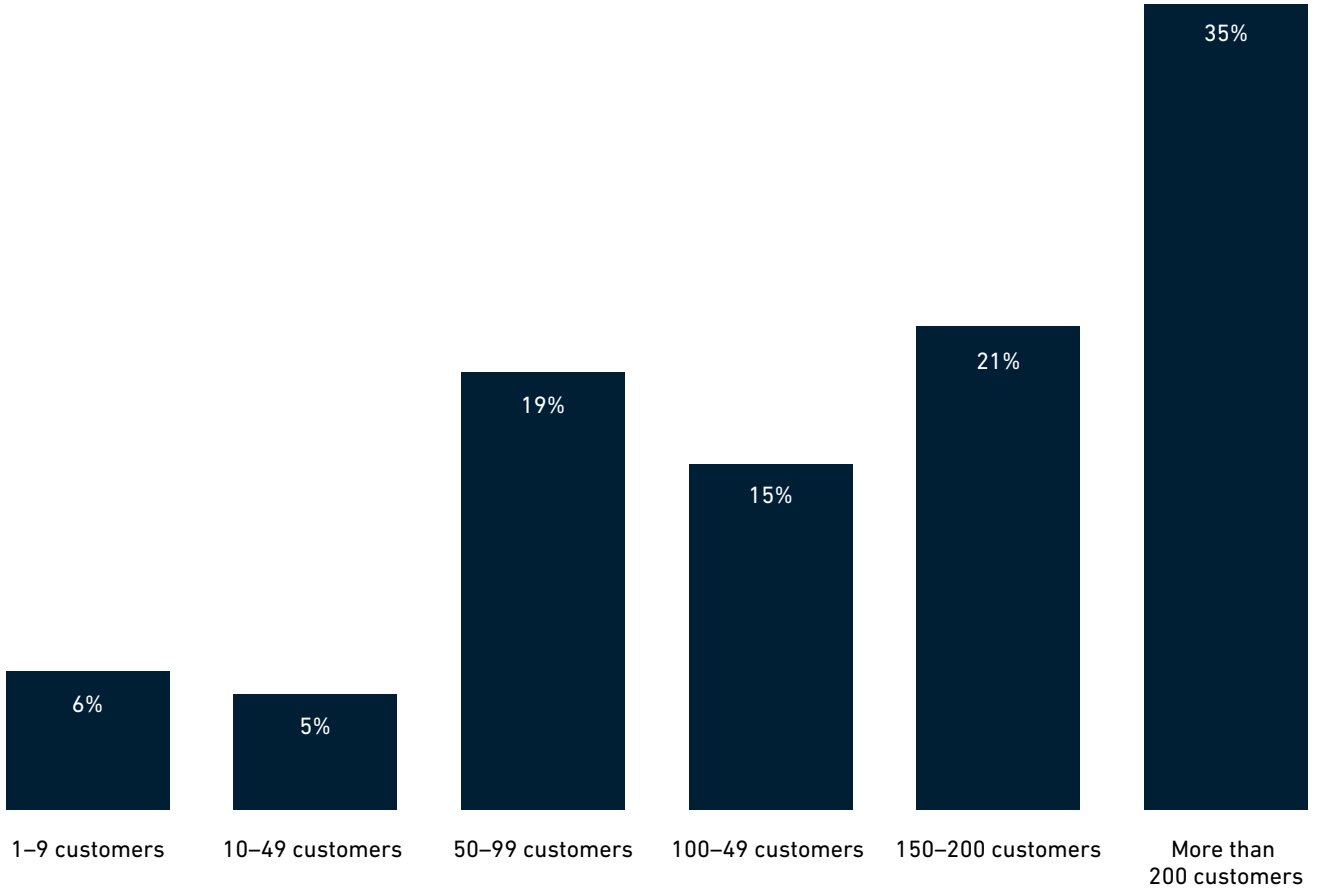
The growing adoption base for private networks

Anticipated high growth is justified

- Most operators (71%) claim more than 100 customers, while around one in three has more than 200 customers for private wireless networks. This is a significant increase compared to 2021, when the majority of operators had between 10 and 100 customers for private wireless networks.
- Questions remain around how to measure success. A quarter of operators say their enterprise customers have already achieved their desired 'return' on the private network investment. A higher share (40%) claim a benefit but have not yet validated a return.
- This leads to the USP question: what differentiates private 5G from edge cloud or Wi-Fi, for example? Consensus has coalesced around the attributes of connectivity assurance, reliability and the ability to drive low-latency applications that grow productivity (think robotics and drones).

Most operators claim more than 100 private network customers

Number of enterprise customers for operators' private wireless networks



Source GSMA Intelligence Operators in Focus: Enterprise Opportunity Survey 2022

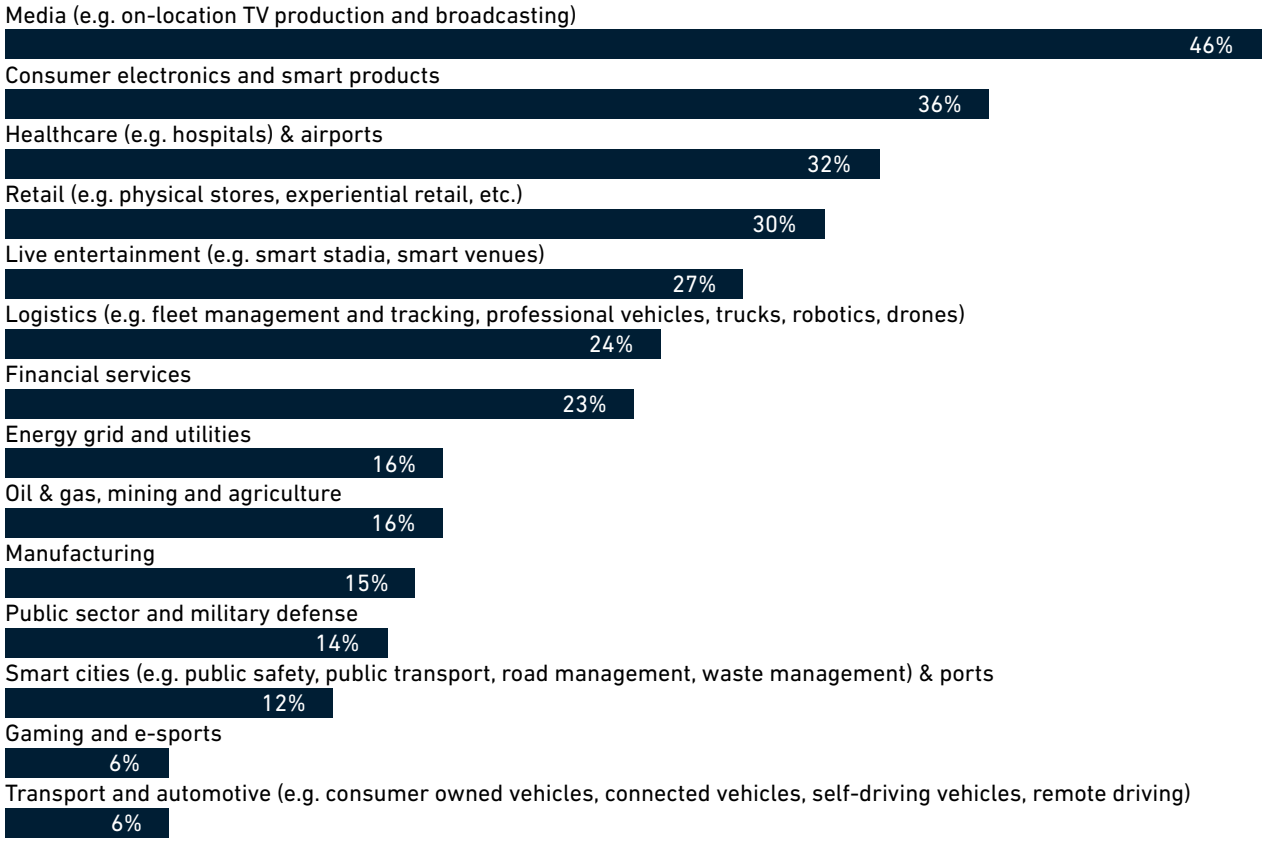
Vertical sector adoption

Operators' bets are in line with use-case requirements

- Private wireless networks are a good fit for certain verticals, providing benefits for specific use cases:
  - In the **media, retail and live entertainment** sectors, experiences leverage multimedia content in specially designed spaces such as venues, stadia and retail outlets.
  - **Hospitals and airports** are super intensive in terms of logistics, with a strong need for highly secure and reliable networking for people and assets.
  - **Oil & gas, mining and agriculture** are moving up the agenda. These verticals rely on heavy equipment and machinery; worker safety is critical; and operations often take place in remote areas and harsh conditions. The advantages of private wireless networks in terms of coverage, reliability and security are therefore appealing.

Demand for private wireless networks seen across a range of verticals

At present (2022), and thinking about the markets/countries where your company operates, what are the top three industry verticals where you see the highest demand for private wireless networks (4G/5G)? Select one answer for greatest demand, one answer for second largest, one answer for third largest. Aggregate.



Source GSMA Intelligence Operators in Focus: Enterprise Opportunity Survey 2022

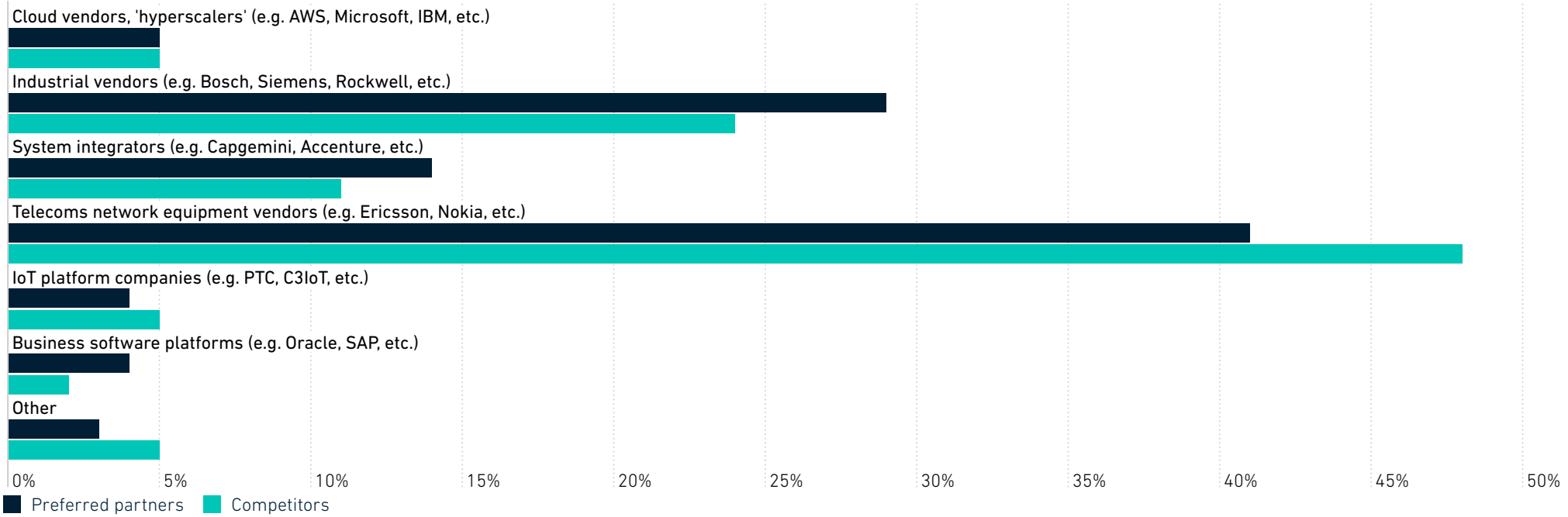
Who makes private wireless networks possible?

New and old players in the game

- As well as operators, established technology companies and startups are eyeing the private wireless network opportunity.
- Almost half of operators (41%) favour telecoms equipment vendors as partners in private wireless network solutions, while around a third view industrial vendors as partners.
- Hyperscalers are seen as less of a competitive threat – in large part because many operators work directly with them on enterprise technology implementations.

Operator view of competitors and preferred partners in private wireless networks

Who do you view as your most formidable competitor/partner, besides your telecoms peers in private wireless networks?



Source GSMA Intelligence Operators in Focus: Enterprise Opportunity Survey 2022

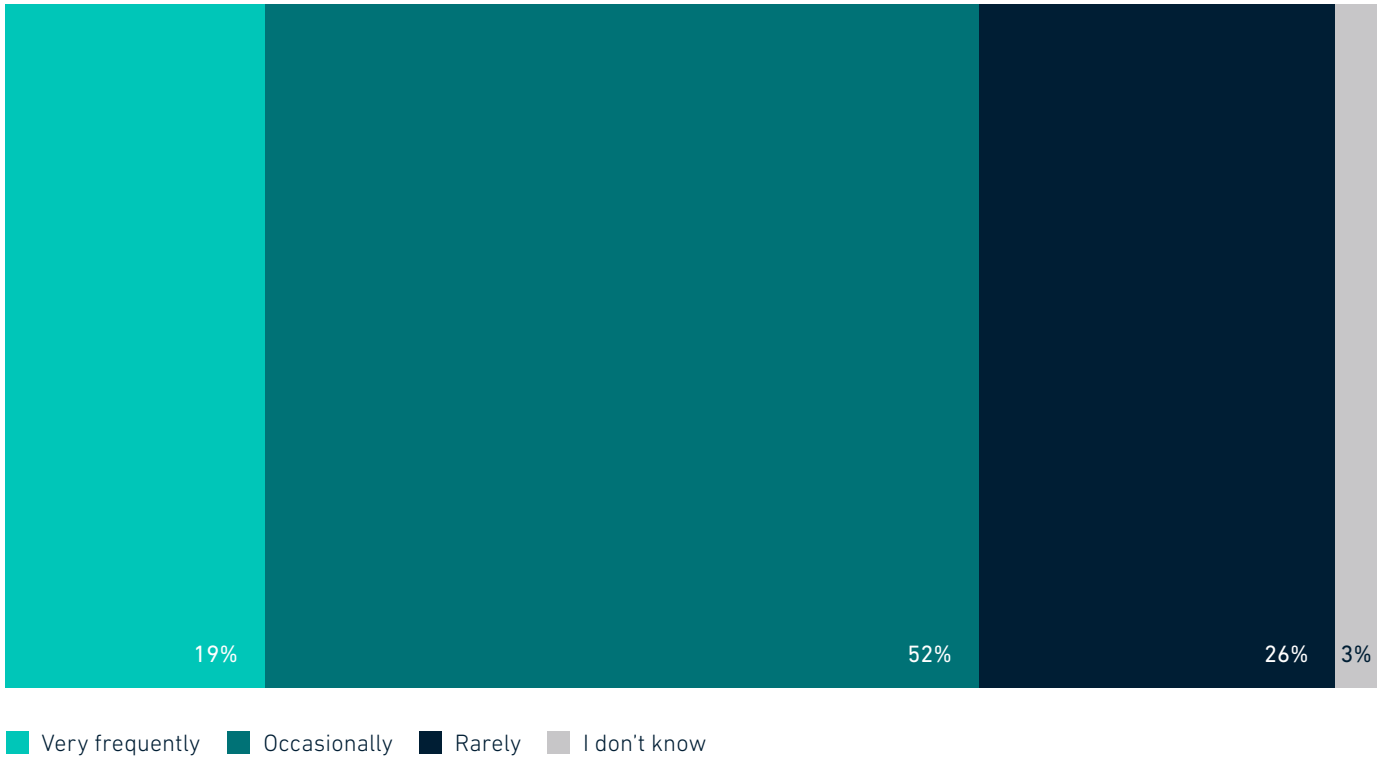
IoT synergies

Clear synergy between IoT and private wireless networks

- Enterprises that want private wireless networks also want IoT. Around 70% of operators claim that enterprise customers who buy private wireless (4G/5G) also request IoT services occasionally or very frequently, indicating an important synergy between the two services.
- IoT fits well with private wireless networks:
  - IoT aimed at use cases such as asset tracking and equipment monitoring is typically deployed in the enterprise setting – in factories, construction sites or offices, for example.
  - In many use cases for private wireless networks, the end-user will have to use connected devices such as laptops, tablets, smartphones, cameras and glasses.
- It is therefore likely that growth in private wireless networks will drive renewed interest and further growth in enterprise IoT.

Strong demand for IoT services among private wireless network enterprise customers

Thinking of your private wireless network (4G/5G) enterprise customers, how frequently do they request IoT services when buying private wireless networks? Select one



Source GSMA Intelligence Operators in Focus: Enterprise Opportunity Survey 2022

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Regional perspective

Europe

- Operators based in Europe report higher adoption rates than Asia Pacific in terms of numbers of private wireless enterprise customers, despite the fact that operators in Europe are planning to launch private 5G later than those in Asia Pacific. Shared spectrum schemes in Germany and the UK have been attracting enterprises in private wireless networks.

North America

- Operators in North America appear to have made more progress in private wireless networks than counterparts in Asia Pacific and Europe, considering the number of enterprise customers. This could reflect the success of the CBRS spectrum sharing scheme in the US, which is driving interest in private wireless networks.

Asia

- Operators in Asia Pacific can boast the most advanced private wireless launches and testing activity. Most activity is in China, Japan and South Korea.

Considerations for the year ahead

Do private wireless networks establish a position within enterprise digital transformation?

- Cloud, AI, analytics and IoT have become associated with digital transformation among enterprises. Private wireless networks are a new proposition for digital enterprises; if they are to live up to growth expectations, they would have to be widely recognised as a distinct digital transformation enabler, leading enterprises to hire talent and build relevant capabilities.

Can operators effectively scale their private network offerings?

- Private wireless networks are part of operators' enterprise business, which, on average, accounts for 30% of total revenues. The majority of operators expect private wireless networks to account for up to 20% of their total enterprise revenues, which could mean up to 6% of total revenues. Achieving this will require significant technical and commercial effort.

Could private wireless networks drive a new wave of growth for enterprise IoT?

- If there is actual synergy between IoT and private wireless networks, then growth in the latter could drive a renewed wave of growth for enterprise IoT.

GLOBAL MOBILE TRENDS

The three Ss

Sustainability, security and spectrum

TOPIC OVERVIEW

The three Ss

Why it matters

The new priorities in a mobile network	• Operator priorities for network transformation • What has changed? • Implications for vendors
Cloud and the open movement: implications for energy	• The implications of 5G workloads in the cloud (processing power, energy) • Open RAN and the broader open movement
Benchmarking progress on energy efficiency	• The value of measurement • Benchmark results: 2022 versus 2021 • Nuance, geographic variance and implications
Security in an insecure world	• A changing landscape • Security offence (new revenue) • Security defence (securing networks)
5G spectrum	• A multi-pronged approach • Mid-band: come one and all • mmWave: cementing its place

Regional perspective

Considerations ahead

WHY THE THREE Ss MATTER IN 2023

Energy efficiency and security are top priorities for 5G networks

5G efficiencies versus lower energy overall

Networks as the 'low hanging fruit': The network accounts for around 90% of electricity use for an average operator (the rest being fleets, property and travel). Equipment upgrades continue to target the RAN (such as AI-driven sleep), core and data centres (such as liquid cooling), with positive effects.

A holistic challenge: Lowering energy use overall is the challenge. That depends on retiring 2G/3G networks, behavioural change and moving to renewables.

Future innovation as things go ever more virtual

5G workloads increasingly moving to the cloud: As more 5G network loads are handled in the cloud, the imperative is to measure the energy impact, and coordinate with AWS, Microsoft, Google and others on efficiency measures.

Measuring the energy impact of open RAN: A key question around open RAN is the impact on energy consumption. While open RAN will likely be adopted in phases over several years, more data is needed to determine the effect (if any).

Security: offence and defence

Offence: Security is increasingly seen as a sellable service for operators (67% rate it as such in selling to enterprise clients). However, it remains to be seen whether that means selling security as a service (implying revenue growth), or if it is a de facto requirement in general for 5G (a cost of doing business).

Defence: Efforts to upgrade cyber-defences are using ever-advanced techniques, including quantum computing.

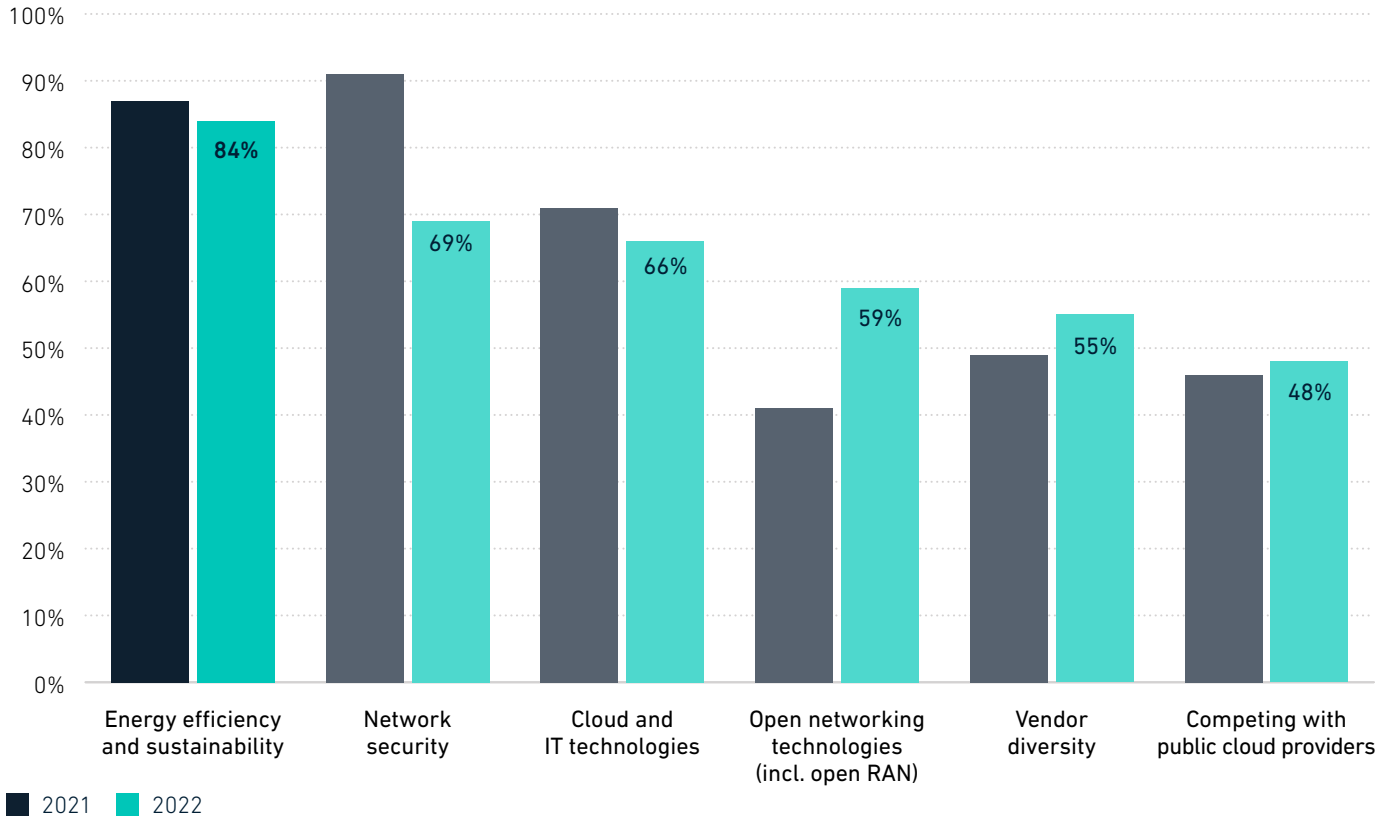
The new priorities in a mobile network

Energy efficiency tops the bill

- A clear change in telecoms network buyers' priorities is the growing imperative to build sustainability into the technology roadmap.
- Energy and the climate used to be confined to the realms of CSR, but survey evidence over the last three years suggests these factors have steadily risen up the agenda. This has culminated in energy efficiency being the top priority, with more than 80% rating it important or extremely important to their planned upgrades.
- This speaks primarily to a cost savings and environmental story for operators. For equipment vendors, it underlines the fact that power-efficient kit is now a competitive selling point – just as much as security.

Energy and sustainability mattered most to telecoms network buyers in 2022

How important are the following priorities as part of your current network transformation strategy? Extremely important + very important.



Source GSMA Intelligence Operators in Focus: Network Transformation Survey

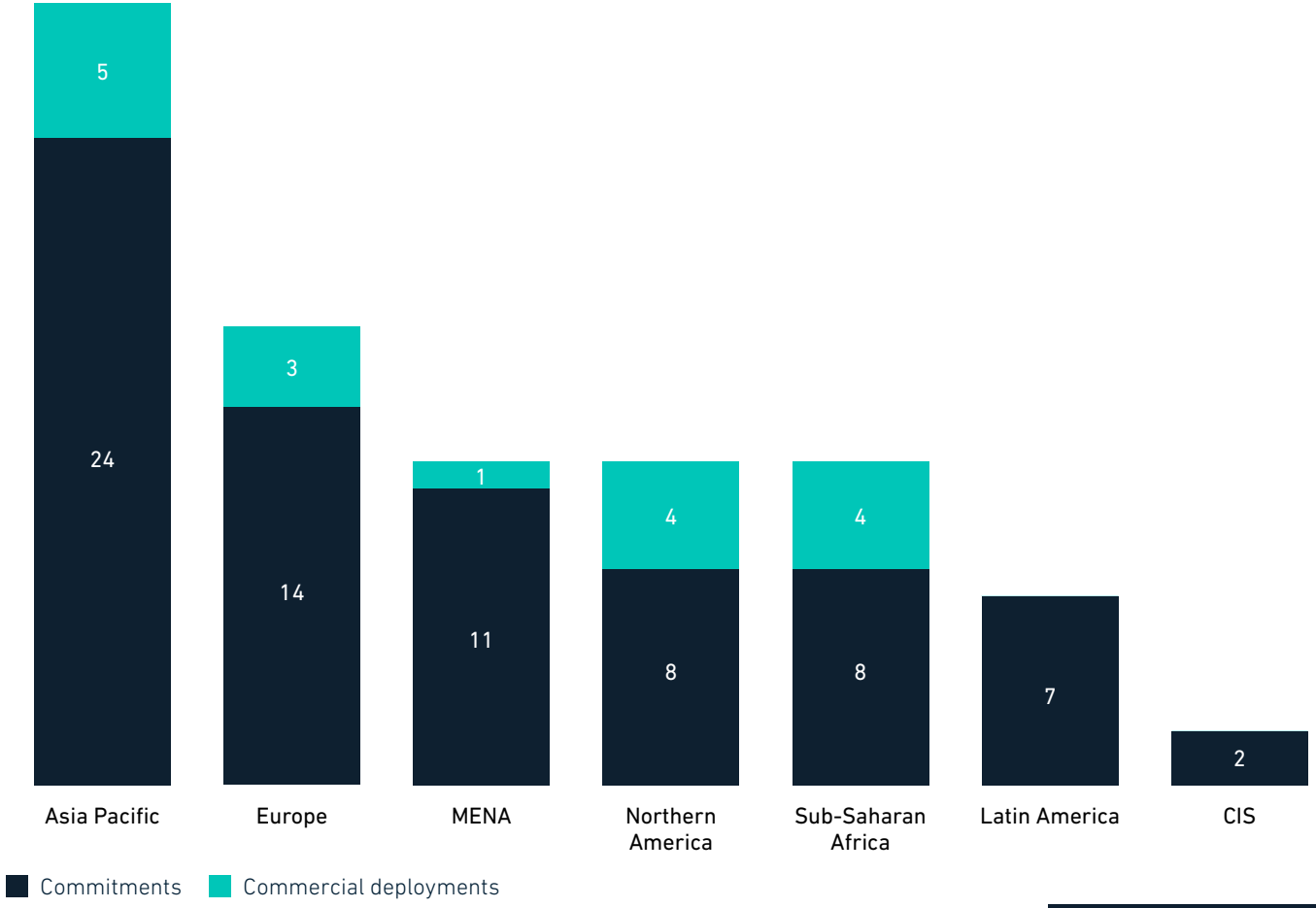
Cloud and open: implications for energy

Can open networks drive further gains?

- The rise of open architecture networks, including open RAN, has garnered much attention, even if its adoption has varied around the world.
- Besides reducing the market power of traditional vendors and lowering capex and opex costs for operators, energy implications are also in play.
- It is too early to make firm conclusions on the overall energy efficiency of open RAN compared to traditional mobile network architectures. More proof points are needed.
- The overall energy burden cannot be viewed in isolation of one company or technology. Open RAN is software driven and therefore linked to the datacentre world, whether controlled by operators directly or leased from Amazon, Microsoft and others.
- To help gain a holistic view, more detail on scope 3 emissions will be needed – a key challenge.

Open RAN is becoming a global phenomenon

Number of open RAN commitments and commercial deployments by region (as of August 2022)



Source GSMA Intelligence

Benchmarking progress on energy efficiency

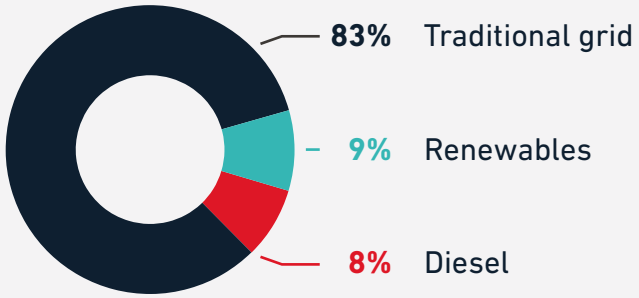
Translating energy efficiencies into actual reductions

- 5G is often said to be the most energy-efficient mobile technology ever. This is true given that it is 50% (or more) spectrally efficient than 4G. However, with inexorably rising data traffic forecast, the bigger question is how operators can lower their energy consumption overall.
- The network accounts for 90% of direct energy usage for an average operator so is the lowest hanging fruit.
- GSMA Intelligence tracks industry-level progress through the Energy Efficiency Benchmarking study. Overall efficiency is improving; in 2022, it was 0.17 kWh per GB, compared to 0.24 in 2021.
- European groups continue to lead. Africa and Asia are playing catch up, reflecting lower availability and use of renewables (see next section), continued use of 3G (which is less efficient) and capex challenges for network upgrades.

The energy make-up and performance of mobile networks

		2020/21	2021/22
Core network energy yield	kWh per GB data transferred (mobile networks)	0.24	0.17
Electricity distribution	RAN	73%	87%
	Core	13%	12%
	Datacentres and edge	9%	
	Other (e.g. fleet)	5%	1%

Fuel split in 2022



Note: data based on GSMA Intelligence Energy Efficiency Benchmarking studies in 2021 (31 networks) and 2022 (43 networks)

Source GSMA Intelligence

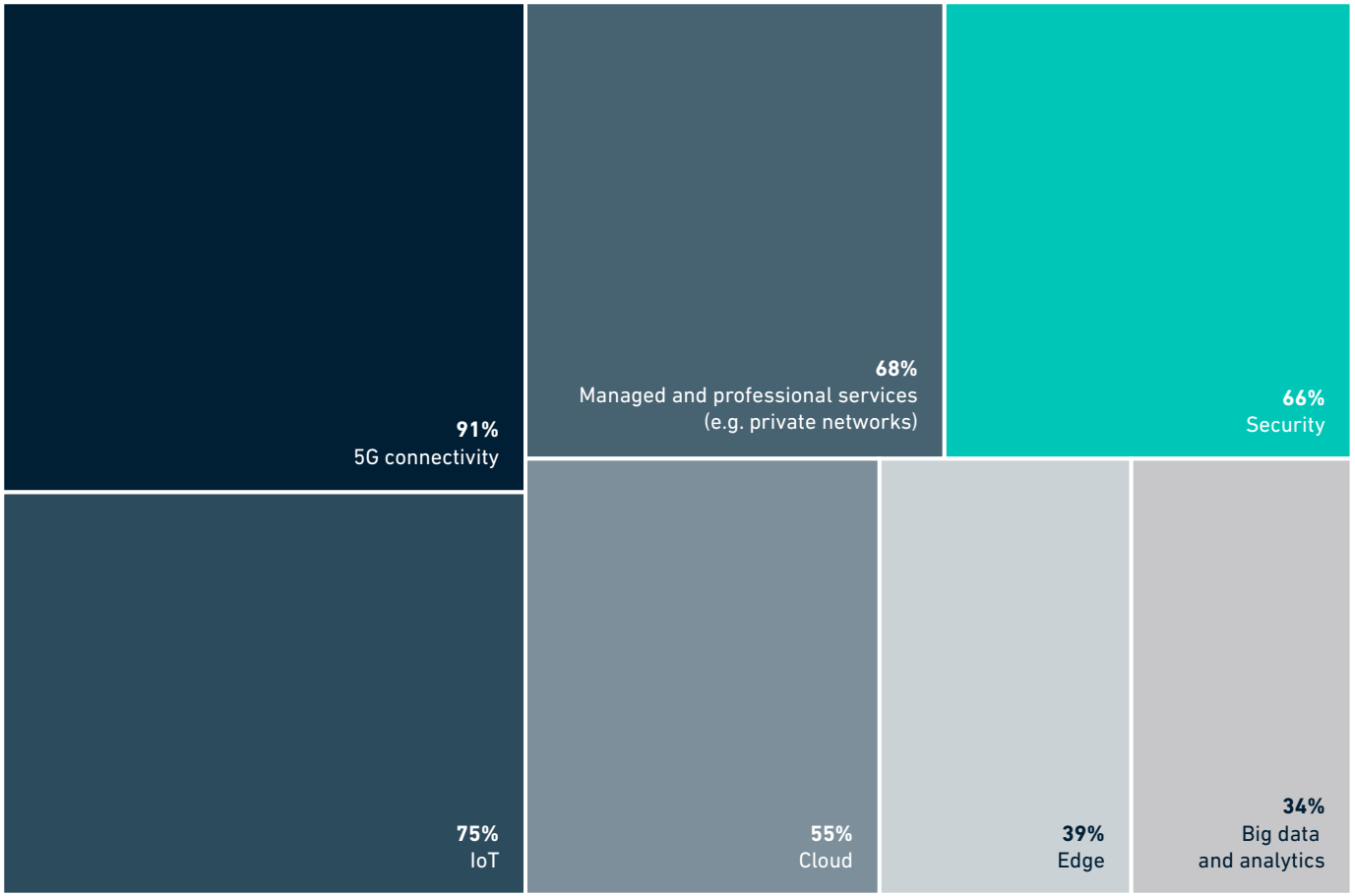
Security in an insecure world

Offence and defence

- Security has always been something of a hidden gem, under-monetised by operators.
- This is not for want of recognition; while more than 90% of operators rate 5G as key to boosting sales with enterprise, 66% say the same about security.
- The question is how to play offensively for an inherently defensive capability. This is likely where new quantum and cryptography upgrades will come into play in 2023.
- While these may not be sellable 'products' like McAfee or Norton antivirus software, they stand to increase the value of overall managed services packages that operators sell to enterprise customers, bundling connectivity, cloud and potentially edge compute support.

Operators see the value of security in their enterprise sales strategies

Percentage of operators rating service as important or very important to their enterprise sales strategy



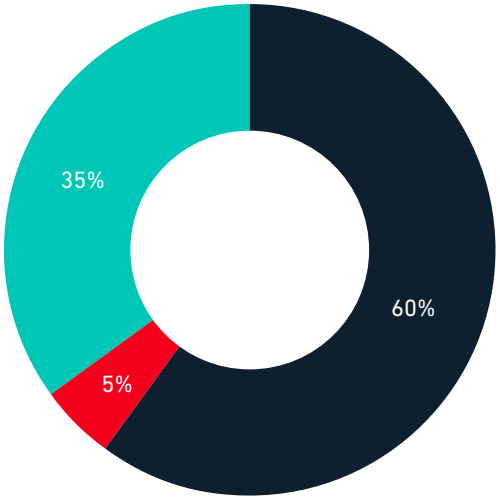
Source GSMA Intelligence

5G spectrum
Horses for courses

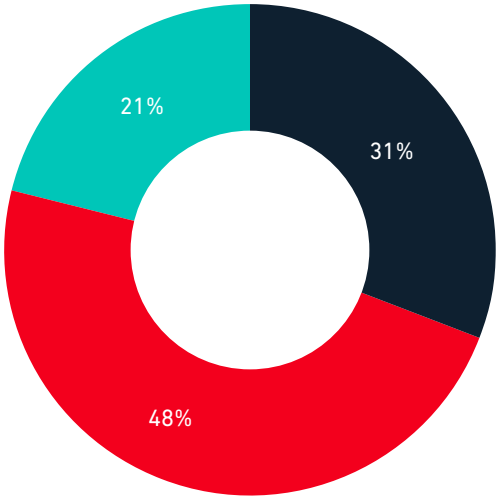
- 5G spectrum use continues to be a tri-band strategy, using high frequencies (mmWave), mid-band and low band below 1 GHz.
- Most of the initial 5G networks launched on low band, but the picture is shifting as mid-band frequency allocations (1–7 GHz) start to feed through.
- Over the period to 2030, we expect that the majority of GDP value from 5G will be underpinned by mid-band.

Spectrum distribution for 5G networks so far

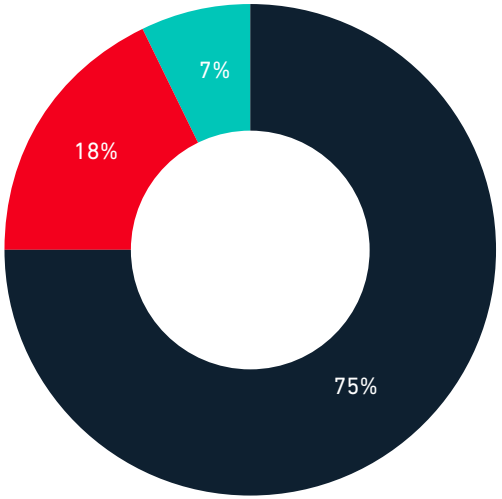
Trials*

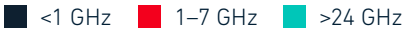


Assignments



Launches**





*Frequency information available for 54% of trials

**Frequency information available for 70% of launches

Note: figures refer to trials, assignments and launches, not individual operators. A number of operators have trialled or launched their 5G networks on more than one frequency.
Data correct to 30 September 2022.

Source GSMA Intelligence

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Regional perspective

Europe

- European operators are more exposed to the energy crisis. This may foreshadow a level of frugality in how energy is apportioned across the network compared to other operations. This is balanced against the positive that renewables are a majority energy source for the largest groups in Europe (80–90% for Telefonica, Vodafone, Orange and BT).

North America

- North America is a clear leader in mmWave 5G products. US operators (particularly Verizon) have taken advantage of the higher speeds with marketing-friendly language such as ‘ultra wide band’. The question is whether this can be extended to services beyond the smartphone such as FWA broadband.

Asia

- It remains to be seen whether the open RAN movement extends from its roots in Japan (the whole sector) and India (primarily Jio) to other Asian countries. Countries with impending 5G rollouts such as Thailand and Indonesia are an interesting test-bed for open RAN vendors trying to sell into countries outside of Europe and the US. GSMA Intelligence survey sentiment suggests intentions are positive, but proof points will come from actual deployments, particularly where operators who have taken the plunge can report cost efficiencies.

Considerations for the year ahead

Do mobile networks become more or less energy efficient as 5G subscribers and traffic increase?

- Initial indications are positive; energy efficiency is improving, with a core reading of 0.17 kWh in 2022 per GB versus 0.24 in 2021.
- According to GSMA Intelligence research, 75% of operators believe 5G is more energy efficient over the long term.

Can open RAN help operators (and suppliers) lower energy consumption?

- This will depend on the extent to which datacentres use renewables and improve power efficiency, given that open RAN is a software technology at heart.

Does mmWave spectrum move beyond its (primary) home in the US?

- mmWave spectrum is being used by some groups in Europe and the GCC states, particularly for FWA broadband, reflecting its advantages in terms of total cost of ownership. However, mid-band spectrum is likely to carry the majority of 5G traffic.

GLOBAL MOBILE TRENDS

ESG and the drive to net zero

From CSR to strategic priority

TOPIC OVERVIEW

ESG and the drive to net zero

Why it matters

The road to net zero	• Operator commitments to net zero • Timelines and pathways • Impact on operator strategy
Transition pathways to renewables	• The changing profile of energy usage (benchmarks) • Renewable grid access • PPAs and other means of access
The enablement effect on vertical industries	• 5G and IoT impact on decarbonisation of key industries • The link with digital transformation • Revenue versus environmental impact
The circular economy	• Reuse of network equipment and devices • Holistic process: design to end of life • Revenue versus environmental impact
The broader ESG picture	• How to think about ESG in telecoms • How it should be measured • Consensus versus inevitable variation

Regional perspective

Considerations ahead

WHY ENVIRONMENTAL, SOCIAL AND GOVERNANCE (ESG) MATTERS IN 2023

The green agenda is now an environmental and business imperative

Environmental

1.5°C in jeopardy: The central goal of the Paris Accord in 2015, which has continued to guide subsequent COP objectives, will not be met under current national net-zero timelines. Some industries – including telecoms – are stepping up, in some cases to fill a void in policymaking.

Operator systemic role: The contribution from operators to net zero is to become zero-carbon businesses themselves but also to help other industries reduce their carbon footprint, which has a bigger impact overall.

Financial

Stubborn costs: Energy costs still account for 20–40% of network opex. This puts further pressure on cashflow in an already low revenue growth environment.

Wholesale shocks and volatility: Volatility in the wholesale energy markets in the wake of the war in Ukraine has underlined the importance of long-term supply.

B2B revenue: Decarbonisation is a hidden selling point in how operators sell 5G to enterprises.

Reputational

Changing consumer value sets: Consumers are increasingly prioritising green credentials and commitments in purchasing decisions. Retail and marketing strategies need to focus on sustainability as a selling point, beyond traditional competition in quality, price and coverage.

Investor pressures drive change: Many investors now include hard and fast ESG requirements as part of their asset allocation decisions.

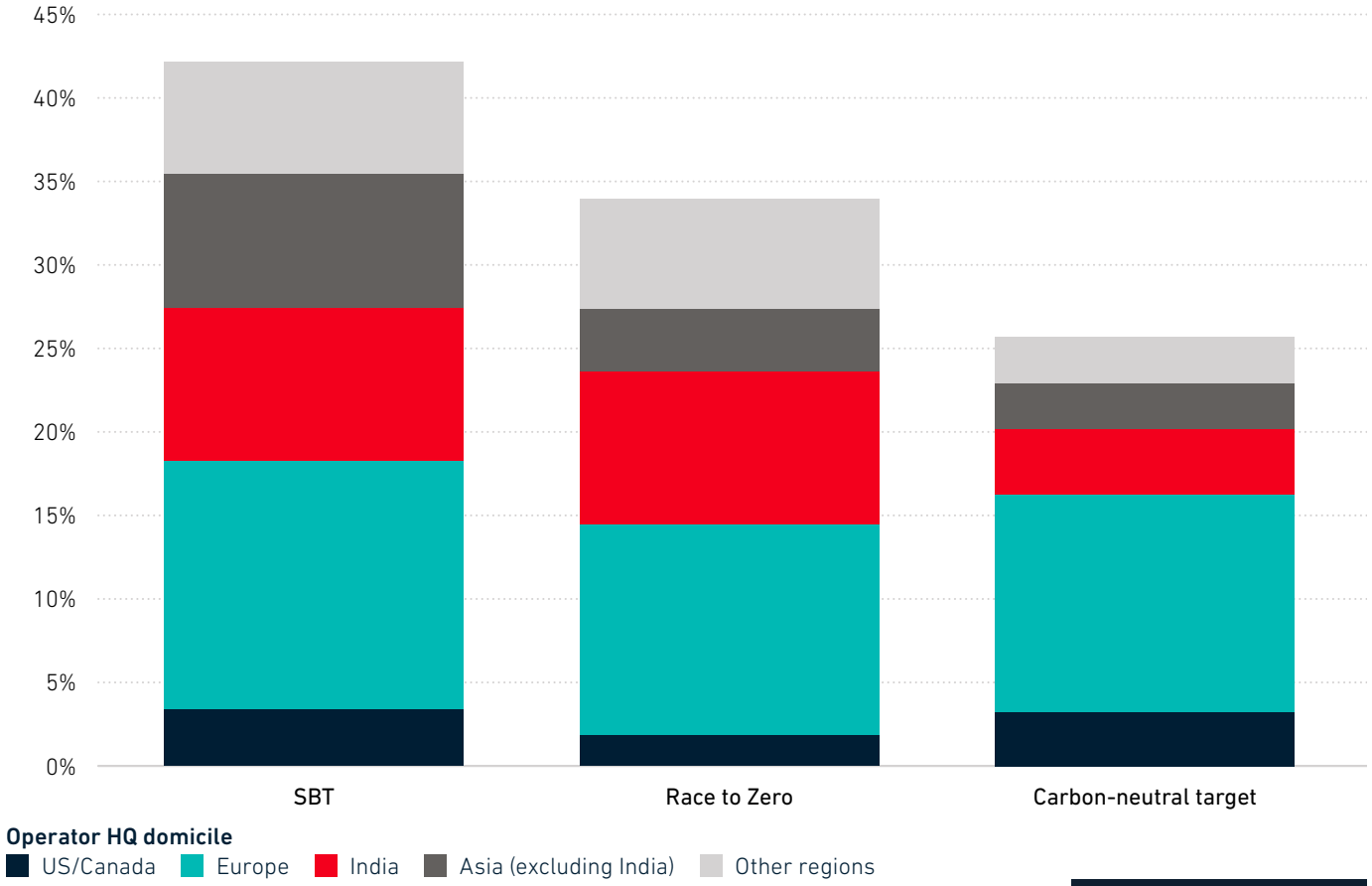
The road to net zero

Putting your money where your mouth is

- Operators accounting for around 65% of market share (by revenue) have committed to the Science Based Targets initiative (SBTi) carbon reporting framework. Just under 50% have committed to the UN Race to Zero pledge. The numbers are slightly lower in terms of share by subscribers (see chart) as some of the largest groups are in India – a high-volume, lower-ARPU country. However, telecoms is among the leading industries in terms of climate commitments.
- Global averages mask significant regional variation. Operators in Europe remain at the vanguard. Those in the US are also at the forefront, alongside some in Asia (with India less appreciated in particular). Africa, Latin America and parts of Southeast Asia are further behind.

Europe sets the pace as operators globally commit to major climate measures

Global market share of committed operators (subscribers)



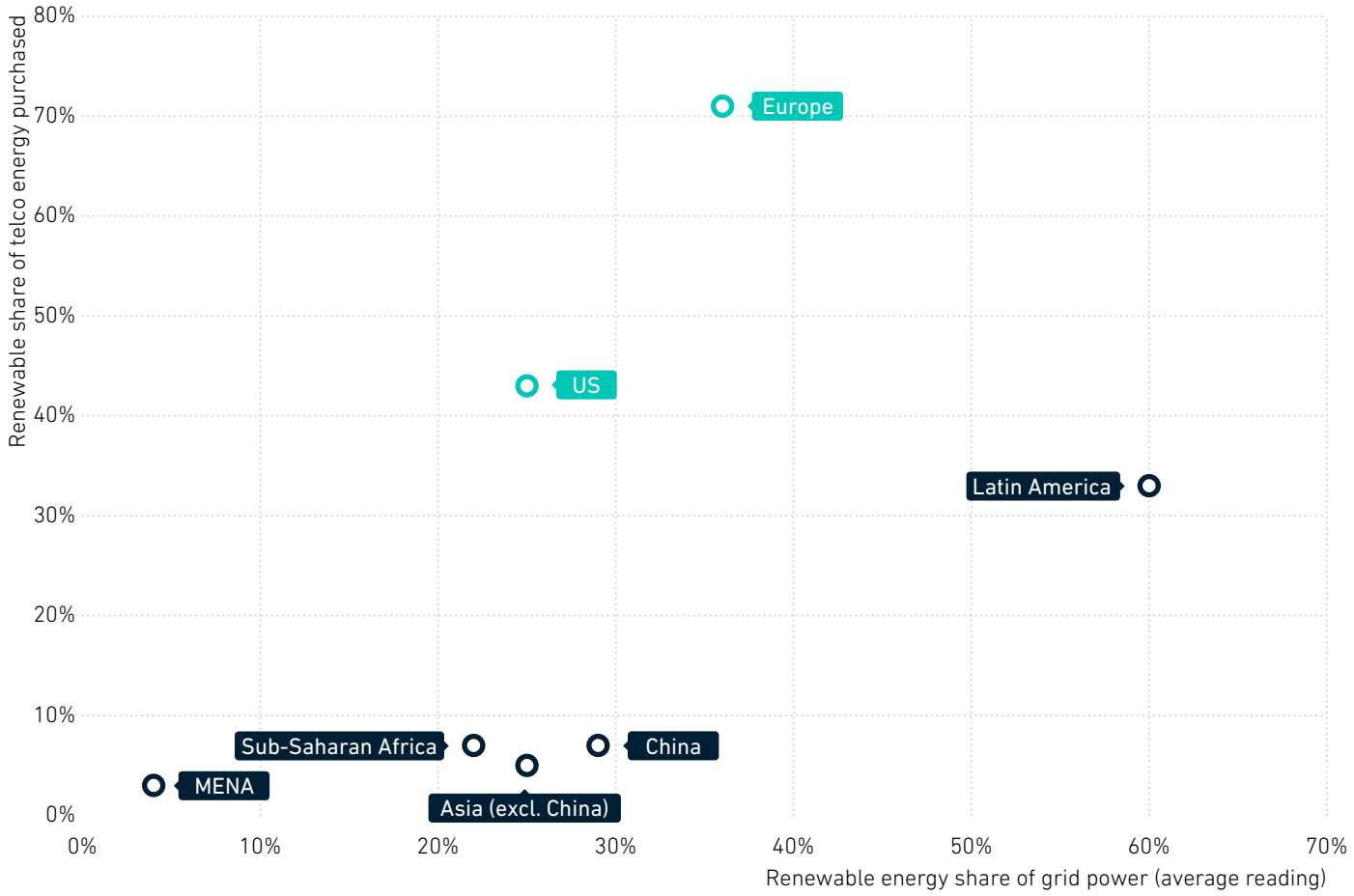
Source GSMA Intelligence

Transition pathways to renewables

Progress in many regions, but work to do elsewhere

- The substitution of fossil fuels for renewable sources of power is key to any journey to a zero-carbon business.
- Various data points allow us to triangulate an estimate of how far the telecoms sector has come. Findings from a GSMA Intelligence energy benchmarking study suggest renewables now account for 9% of energy consumption among operators.
- There is considerable variation by region. European operators use renewables for the majority (70%) of their energy, with the US the next highest at around 40%. African and Asian groups (including China) are at less than 10% – well below the prevailing grid availability for renewable power.
- Power purchase agreements (PPAs) have helped European and US operators with energy access. These are needed in much higher numbers in other regions to bridge the gap and complement grid supply.

Europe and US lead on renewables, with others playing catch-up



Note: data based on survey responses from mobile operators in October 2022 representing approximately 50% of global market share (by subscribers)

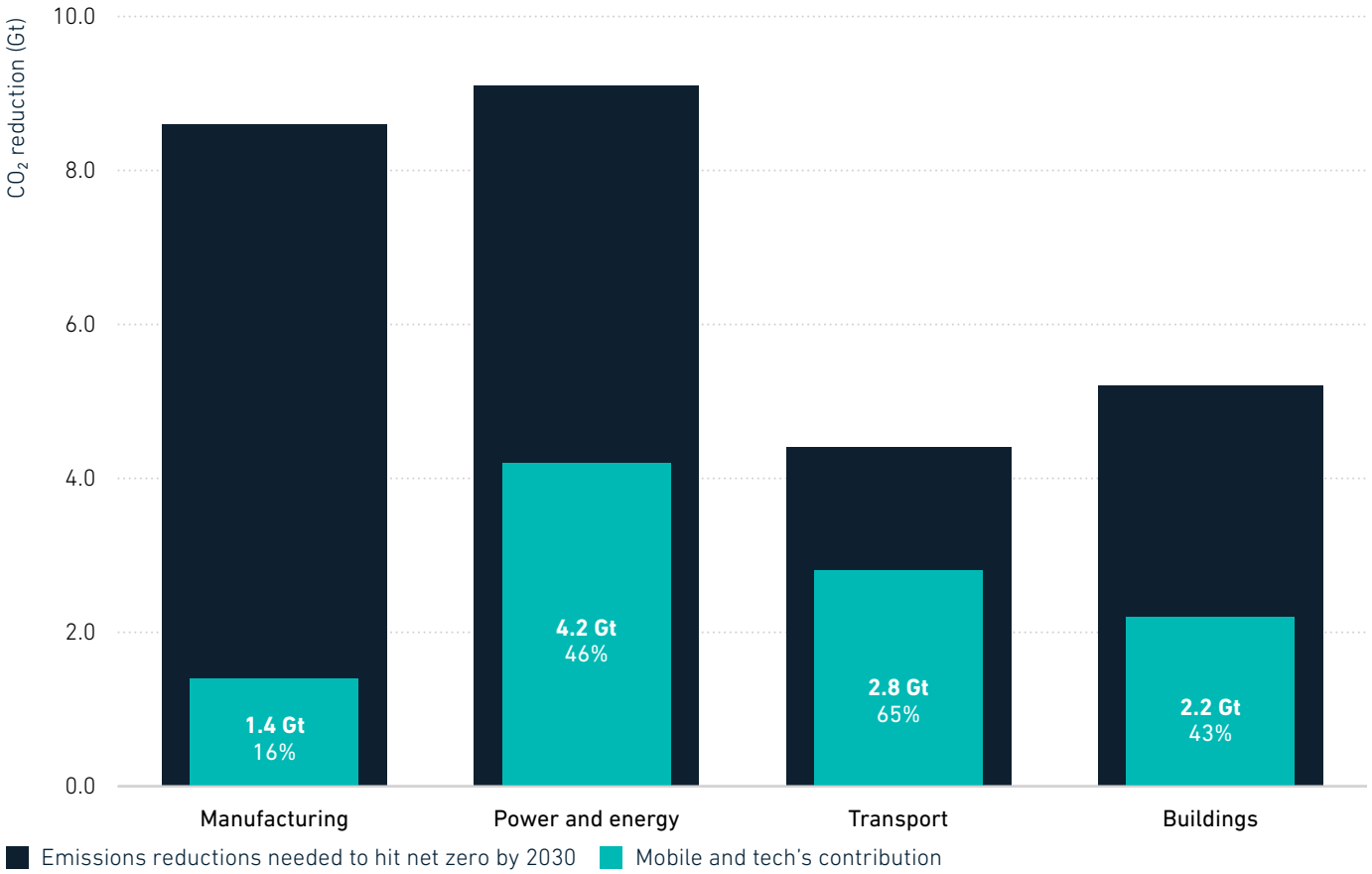
Source GSMA

The enablement effect on vertical industries

Green tech is good business too

- As well as reducing energy use and carbon emissions from their direct operations, operators can help partners cut their emissions through technology.
- In telecoms, this is referred to as the 'enablement effect'. The carbon savings enabled by 5G, IoT and other digital technologies for enterprise clients of mobile operators can run to multiples of an average operator's carbon footprint.
- On average, around 40% of the required CO_2 savings from the four largest carbon industries (accounting for 80% of global emissions) can be enabled by mobile services and digital technology over the period to 2030.

Mobile and digital technologies can drive around 40% of the CO_2 reductions required for the largest industries to stay on track for net zero



Source GSMA Intelligence, Carbon Trust and Exponential Roadmap

The circular economy

Back to the three Rs of reduce, reuse and recycle

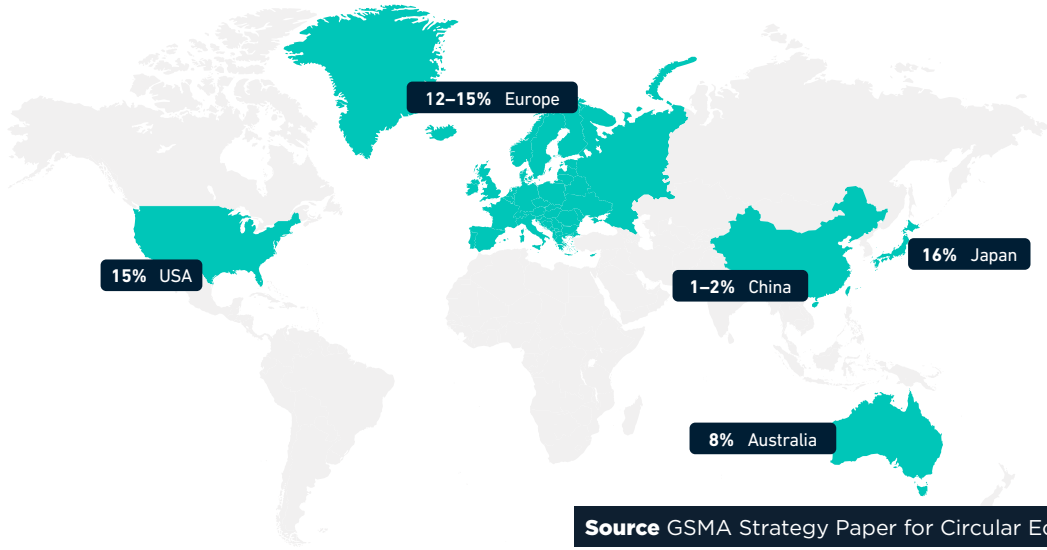
- The circular economy is a growing offshoot of the sustainability movement.
- In its broadest sense, a circular economy is built from the ground up to recycle and repurpose manufactured goods, saving waste and associated emissions.
- Applicability to telecoms is most obvious in smartphones and other devices. Unfortunately, recycling rates are very low; even the most advanced markets record only 10–15% of total volumes as recycled or repurposed.
- To improve those rates, a number of drivers are required, involving manufacturing standards, a vibrant secondary market for metal recycling, and incentives for consumers to trade in devices (e.g. discounts on upgrades).

End-of-life scenarios for a mobile

Source GSMA Strategy Paper for Circular Economy

Even in advanced economies, only 10–15% of handsets are recycled or repurposed

Estimated mobile recycling rates



Source GSMA Strategy Paper for Circular Economy

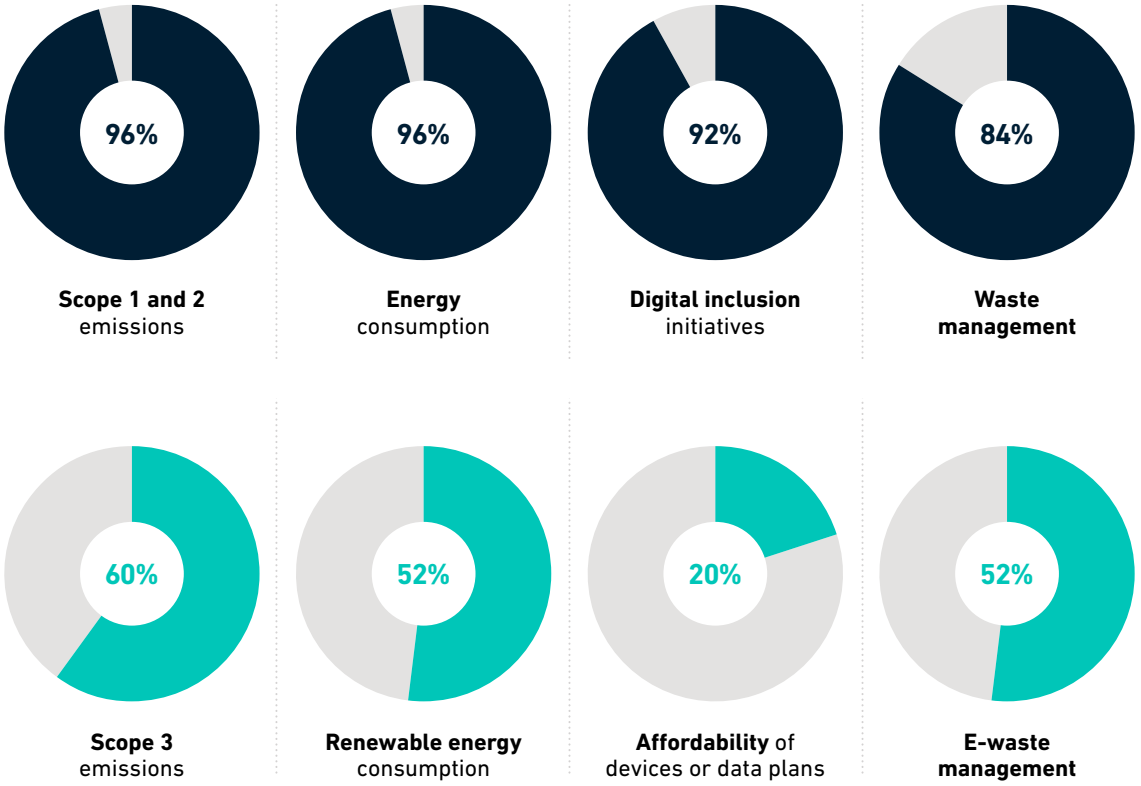
The broader ESG picture

Measurement and reputational value

- While climate and energy issues have garnered significant attention, the ESG movement is broader, incorporating social and governance reforms in terms of how companies operate.
- In the telecoms sector, this could, for example, include requirements for suppliers to have sustainable procurement practices, or a certain threshold for gender composition at the executive/board level.
- Reporting is key as it drives transparency. Climate disclosure is now commonplace across the industry. Of the largest operators worldwide (covering 68% of market share), more than 95% report on CO_2 emissions, with 84% reporting on waste management.
- There is less uniformity on reporting how affordable data plans are, and policies related to e-waste. Increasing these reporting rates will depend on investor pressures to do so, consumer attitudes, and reaching a consensus on accepted KPIs.

Status check: operator reporting on ESG metrics

Percentage of mobile operators reporting on topic



Note: data includes operators accounting for 68% of global market share

Source ESG Metrics for Mobile, GSMA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Regional perspective

Europe

- Europe is the regional leader in terms of the extent to which operators are committed to climate goals and reporting on those through recognised international frameworks. This has been helped by a high level of political buy-in, good supply of renewables, and the prioritisation of energy efficiency in 5G network builds.

Africa

- African operators face a challenge as the supply of renewables is heavily constrained in most countries – partly because of poor grid supply and partly due to a lack of power purchase agreements (PPAs). The reliance on diesel puts pressure on costs. However, there is strong buy-in among mobile operators to improving energy efficiency in Africa by leveraging innovations in the RAN and core to reduce power consumption.

Asia

- Asia is a mixed region in terms of energy performance. For example, India has made serious commitments on renewable energy at a national level, which is seemingly being emulated by major operators in terms of net-zero commitments. China remains the largest market to hold out on a 2050 net-zero timeline. Given the blurred line between industry and state, this may constrain operators in being more ambitious than they otherwise would be – a potential drag on the pace at which the overall telecoms sector's CO_2 footprint reduces.

Considerations for the year ahead

Do net-zero commitments spread south and east?

- Attention is gradually turning towards emerging markets for climate commitments.
- Acceleration will depend on access to renewable energy supplies more than any technology efficiencies. As average renewable supplies account for less than 10% of total energy on the grid in Africa, Asia and China, this is a 5–10 rather than 1–2 year story.

Can operators effectively 'sell' energy benefits as part of 5G?

- This represents a key competitive differentiator, but one that is currently undersold.
- Manufacturing, transport, power and buildings account for 80% of global CO2 emissions. These industries are prime candidates for the 5G opportunity. Energy savings could be used as a USP against cloud groups, vendors and others vying for a slice of spend on digitisation.

Does ESG become a valuation driver?

- Whether ESG criteria are formally incorporated into valuation models like discounted cash flow remains to be seen. Regardless, investor pressures have clearly shifted to invoking ESG as a means of influencing company behaviour. Expect more to come on the circular economy and net-zero commitments for companies yet to do so.

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