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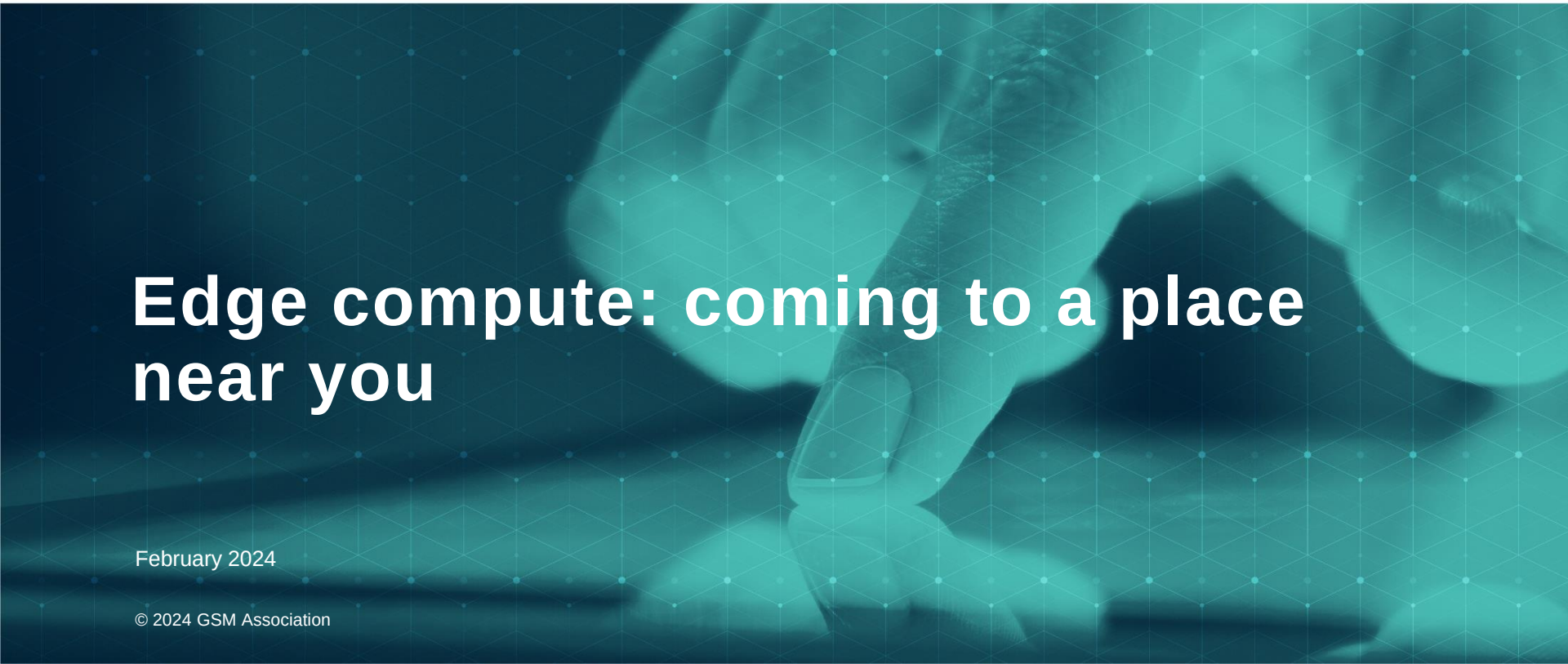
AUTOMOTIVE EDGE COMPUTING CONSORTIUM



Edge compute: coming to a place near you

February 2024

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.

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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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This report was authored by GSMA Intelligence with support from AECC.

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Shape of the market

1 **Edge computing network deployment is gathering momentum.** Edge computing is not new, but its value and demand profile are growing, playing to the link with 5G, IoT, AI and the cloud. Enterprises undergoing digital transformation are driving demand for edge computing, which is now expanding beyond the automotive industry and into a range of verticals. Overall, investment sentiment is positive, with 73% of companies across five groups in the GSMA Intelligence edge ecosystem survey planning to increase the value of edge investments over the next 12 months compared to the prior period.

2 **New verticals mean new business models.** The automotive industry has historically been a major driver for edge investments, and there remains positive sentiment for edge in product areas involving security and data storage, for example. However, other industries are now also entering the frame. Consumer electronics is viewed as having the highest sales potential (32% rate it No.1 of all sectors), followed by media and TV (17%) and retail (10%). This speaks to use cases in these industries requiring compute power closer to the end user as well as new (or changed) monetisation models anchored in data analytics. This could include VR broadcasting of sports matches, on-site training of oil & gas engineers, or car manufacturers monetising their data assets with insurance companies and fleet managers.

3 **Technology integration with existing IT enterprise networks is the primary obstacle**. Integration of edge computing into existing IT enterprise networks is the primary obstacle to edge computing deployment. To some extent, this reflects an age-old hindrance in trying to integrate new tech with a legacy stack. However, enterprises should view edge computing as a component of their broader enterprise digital strategy which also includes technologies such as AI/ML, cloud computing, private networks and slicing. Completing the transformation may take three to five years, but suppliers can mitigate the integration barrier by breaking things into stages.

4 **Should telecoms operators shoulder the investment burden?** Demand indicators aside, there remains an investment cost. Telecoms operators continue to be seen as the group bearing primary responsibility for investments in edge infrastructure by around 50% of companies in the GSMA Intelligence survey. IoT providers and systems integrators are next (43%), followed by equipment vendors (31%). This reflects the RAN and localised datacentre outlays inherent with edge. Two thirds of operators share this view of them having primary responsibility. However, this will not always hold (vendors may be the lead contractor), while the structure of edge investments is changing to incorporate cost or revenue sharing between parties – something that would help, given the investment pressures operators already face from expanding 5G and fibre.

5 **Cross-industry collaboration is required.** Edge can only really work with collaboration between different infrastructure providers (principally operators, hyperscalers and network vendors). New co-investment models are likely to support deployment between these groups. In 2024, the ecosystem is also likely to draw in specialist software providers as large language models (LLMs) become a point of competitive differentiation.

Research purpose and approach

Establish definitions	• Edge computing and infrastructure • Edge ecosystem and value chain
Assess edge opportunities	• The economic opportunities edge computing generates through infrastructure and connected devices • Sector demand: who's interested? Why? • Partnership opportunities and direct competition
Assess edge investment plans	• Investment sentiment and expectations • Sources (who pays) • Investment models
Assess risks to edge infrastructure deployment	• The risks affecting edge computing infrastructure deployment • Degrees of risk and how risk can be mitigated

Methodology

In 2023, GSMA Intelligence surveyed key players in the edge computing ecosystem, including:

- mobile operators (n=100)
- network equipment vendors (n=100)
- cloud service providers (n=50)
- IoT service providers and systems integrators (n=50)
- car manufacturers (n=100).

GSMA Intelligence also complemented the survey with analysis of its proprietary data and interviews with a selection of companies.

Numbers to note

73%

Share of respondents who will increase year-on-year investment in edge computing

This reflects growing enterprise demand across a number of industries, and the long lead times that infrastructure requires to generate a return (often years). Most of the companies forecasting a capital spend increase will increase budgets on edge by 10–15% in 2024 versus 2023, although 12% plan to go even further, with a rise of 20% or more.

43%

Share of respondents indicating mobile operators as the main group responsible for edge-computing network deployment investments

Two thirds of operators themselves agree with this, though more co-investment models and cost sharing will be needed to relieve pressures on operator capex budgets.

49%

Share of respondents indicating that integration of technology with existing IT enterprise networks is the No.1 barrier

Some 89% of these see the integration challenge as having a very significant or significant impact on their edge computing network deployment roadmap.

32%

Share of respondents indicating consumer electronics as the main enterprise vertical driving edge demand

The increased popularity of the metaverse, e-gaming and remote collaboration and operation are driving demand for smartphones, XR/VR devices, laptops and drones.

44%

Share of respondents who plan to launch artificial intelligence (AI) or machine learning (ML) as part of edge products

As edge computing deployment advances, AI/ML will play a key role in enhancing its functionality. Edge AI/ML applications will continue to run even if the network is disrupted, helping to bolster resilience.

41%

Share of respondents who believe increasing proof-of-concept development and testing is the most important thing needed to scale edge investments

Use cases always play a role in showing people the power of what technology can do, but proof points are crucial in validating these ideas, particularly in challenging macro-economic environments.

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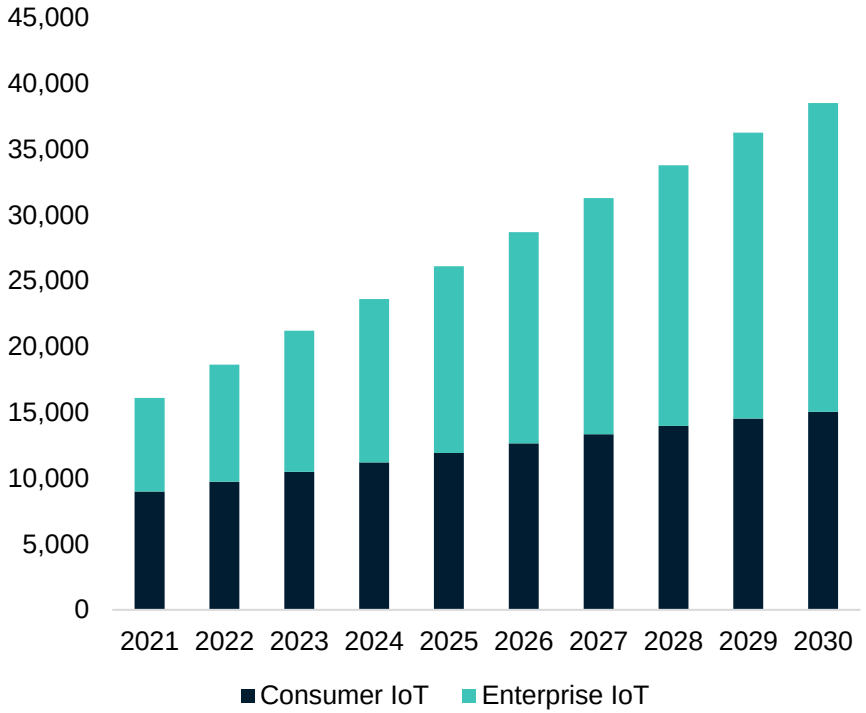
The expansion of IoT underpins edge demand

- Growing demand for IoT devices is among the drivers of demand for edge computing, particularly where it involves lower latencies and the need to service applications on-premises.
- By 2030, there will be over 38 billion IoT connections, of which about two thirds will be enterprise IoT connections.
- Although edge computing has been important in the automotive sector, interest is coming from a range of other industries, including manufacturing, media and healthcare. The common denominator is the need to support digital transformation.

Global consumer and enterprise IoT connections
Million

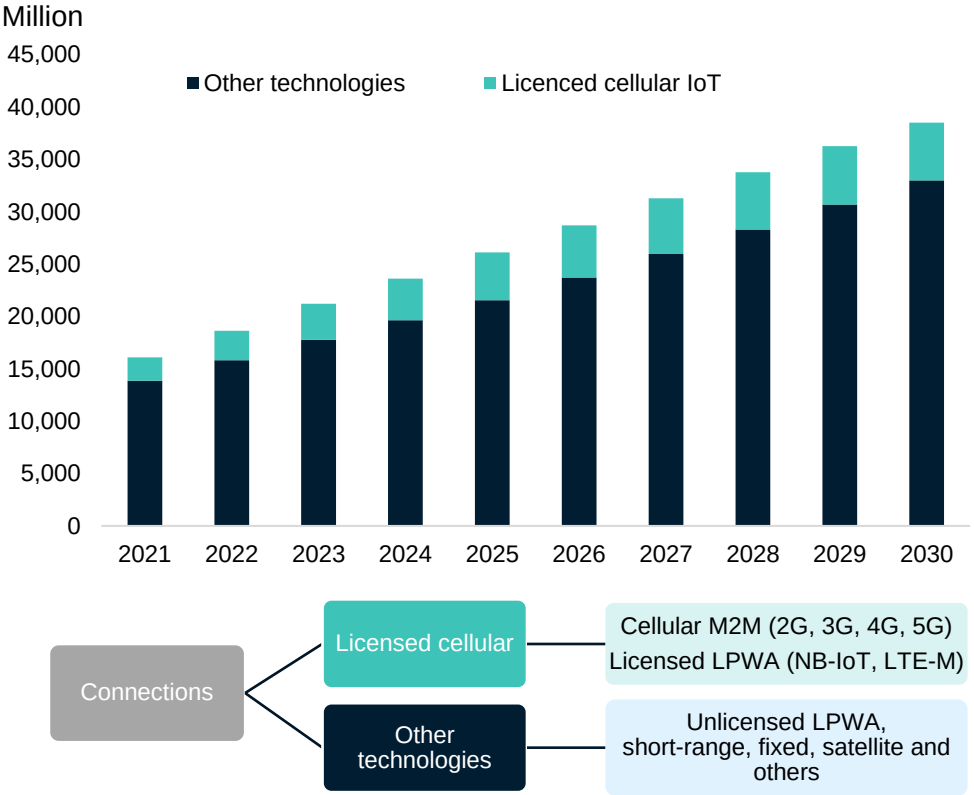


Source: GSMA Intelligence

Drilling down into the IoT story

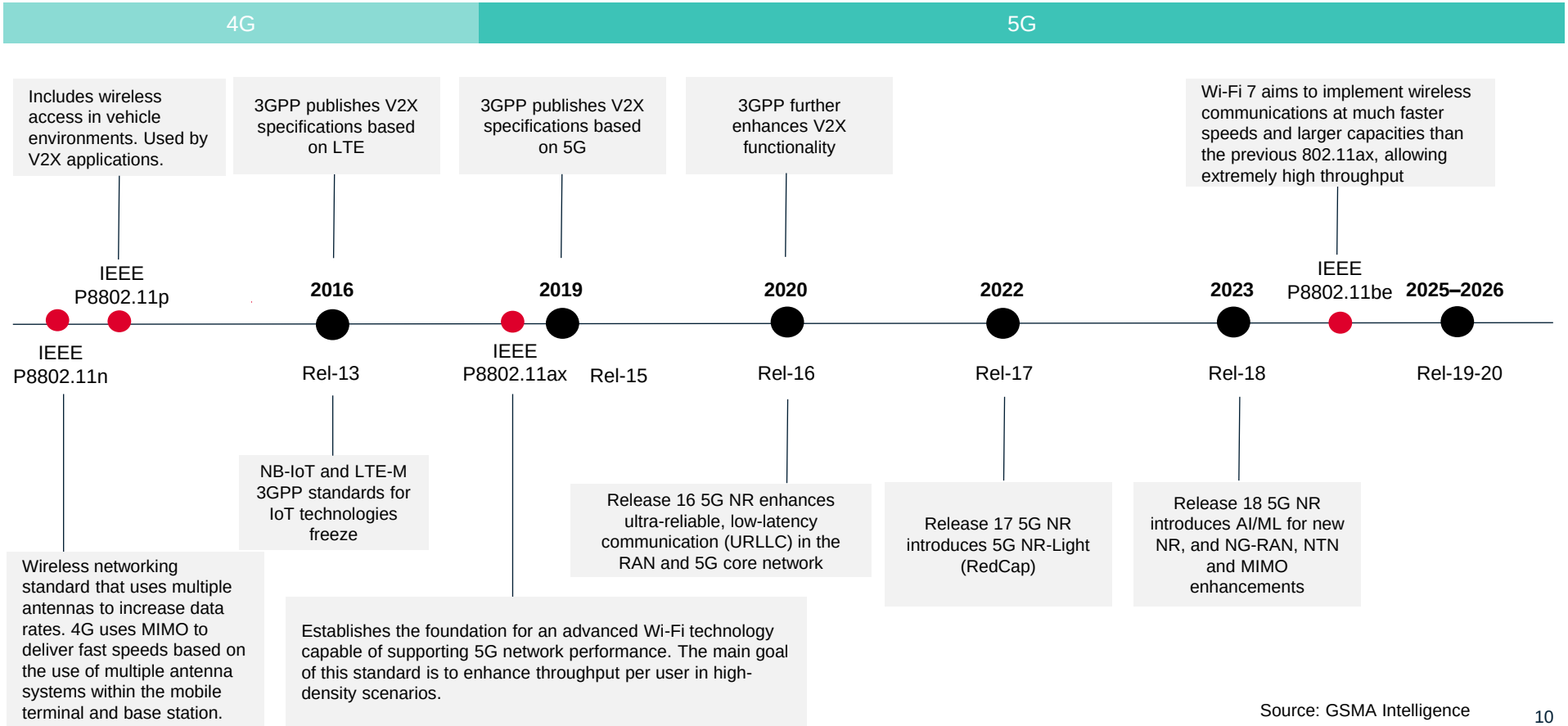
- The edge computing concept has been around for a while and has evolved within the 3GPP and IEEE standards. However, edge is still in its infancy phase. Together with Wi-Fi 7, 5G and 5G-Advanced networks, it is set to become increasingly important for IoT deployments.
- By 2030, there will be around 5.5 billion licensed cellular IoT connections. The remaining will comprise other IoT connectivity technologies (such as Wi-Fi, Bluetooth and satellite).
- On the enterprise side, fixed cabling (such as Ethernet and Wi-Fi) will continue its hold. But cellular connectivity is key for IoT use cases with assets in motion (e.g. for trucks, cars and trains).
- The growth of IoT has been driven by the digital transformation of enterprises. It is supported by the evolution of mobile broadband IoT technologies (NB-IoT and LTE-M), 5G slicing (eMBB, URLLC, mMTC) and MIMO (SU-MIMO, MU-MIMO).
- RedCap and Massive MIMO will further enable next-generation networks, enhancing data rates, user tracking and energy and spectrum efficiencies, as well as reducing latency.

Global IoT connections forecast



Source: GSMA Intelligence

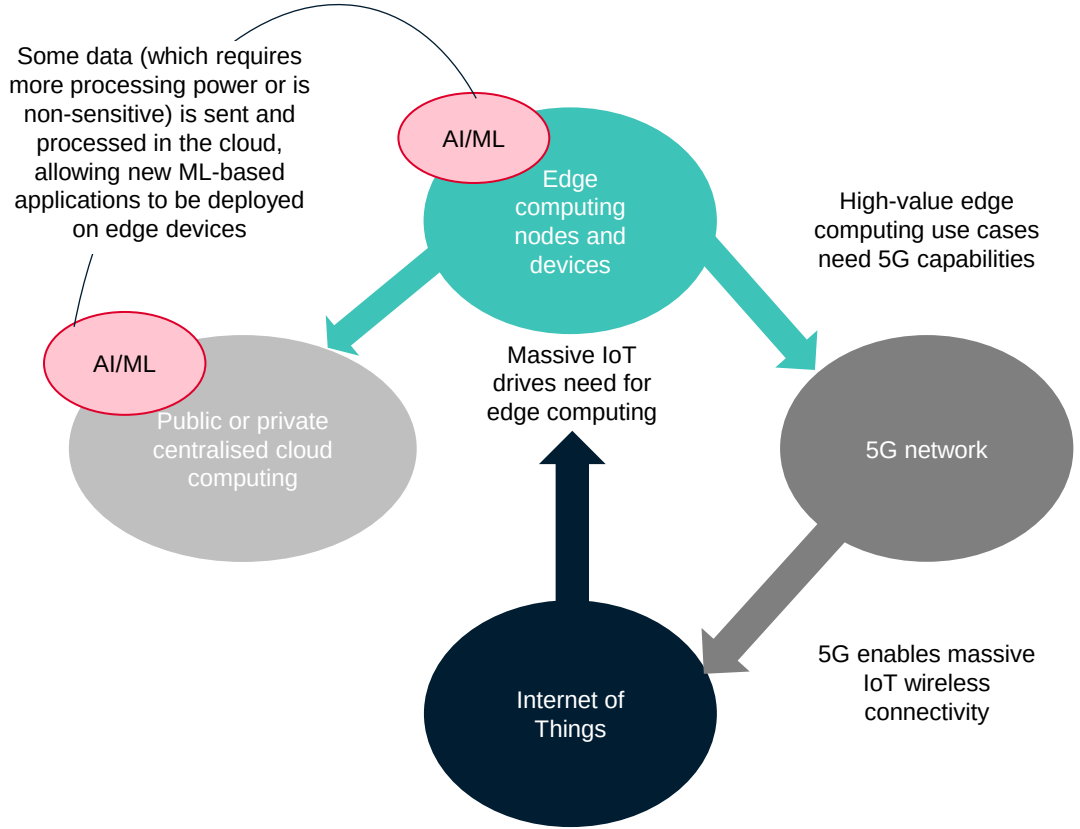
Level set: standards evolution



Source: GSMA Intelligence

How edge draws from (or enhances) other technologies

- Edge computing is becoming increasingly intertwined with 5G and IoT, which reinforces demand for edge solutions.
- Some data is processed at the edge (through AI/ML) and some is sent from the edge to the private/public centralised cloud to be processed, stored and analysed.
- Sending data to the cloud allows for the development of AI/ML-based applications that are then deployed on edge nodes or devices, enhancing their level of autonomy.



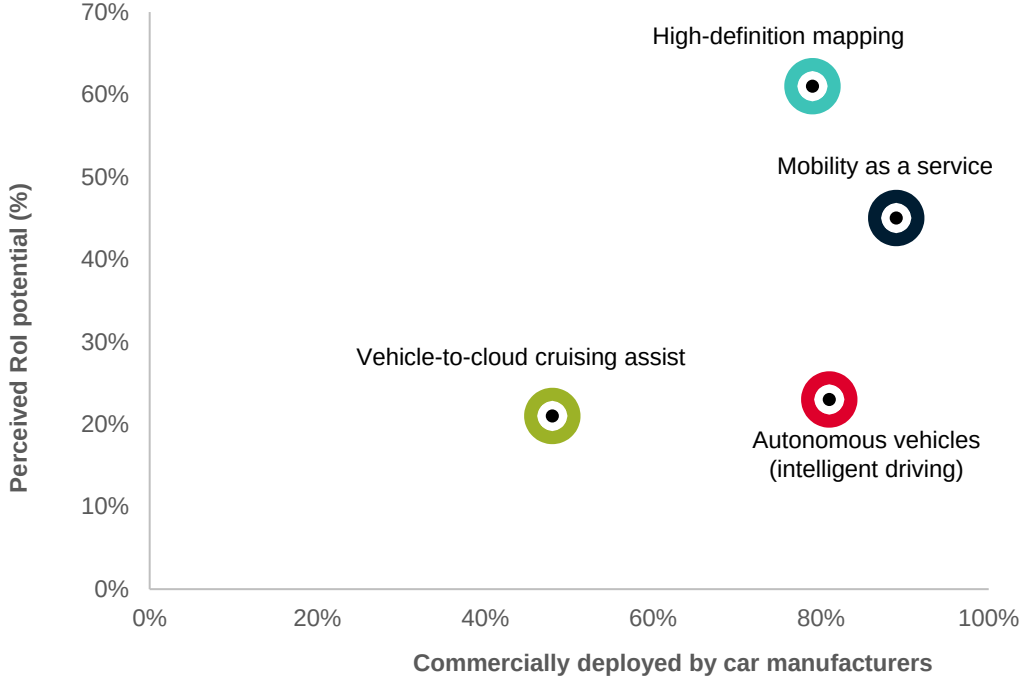
Source: GSMA Intelligence

Car manufacturers at the vanguard

- The automotive sector has long been at the vanguard of edge compute to service applications such as as mapping and driver assist.
- Growing demand for **HD mapping** and **mobility as a service** (MaaS) is boosting return on investment (RoI) potential for connected vehicle services among car manufacturers, with these services widely deployed.
- **Vehicle-to-cloud cruising assist** has not yet graduated into the same desired RoI quadrant but is slowing advancing. Some 44% of respondents from the car manufacturers group are at the trial stage, while 8% have plans to deploy it but are not yet at trials.
- Safety concerns, the regulatory framework, different national regulations, and liability in the advent of an accident are some of the challenges associated with **autonomous vehicles**, potentially affecting returns.

Connected vehicle services: RoI potential

Thinking about connected vehicle services, which of the following services has the highest return on investment potential? (Car manufacturer respondents)

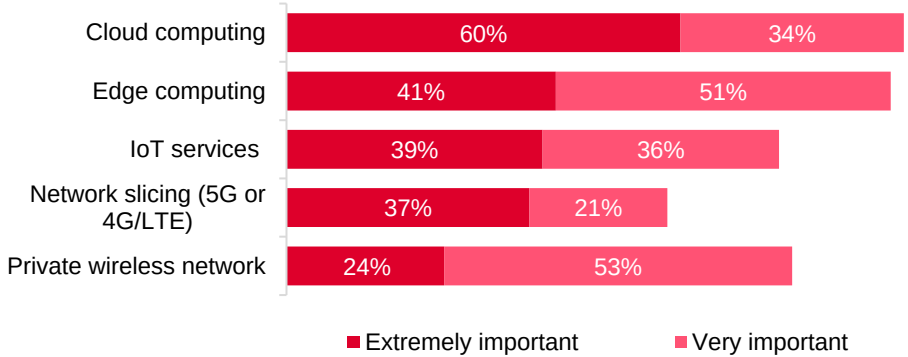


Note: commercial deployment includes deployment in one or more countries.
RoI score calculated as (Ranked 1st*1)+(Ranked 2nd*0.5)
Source: GSMA Intelligence

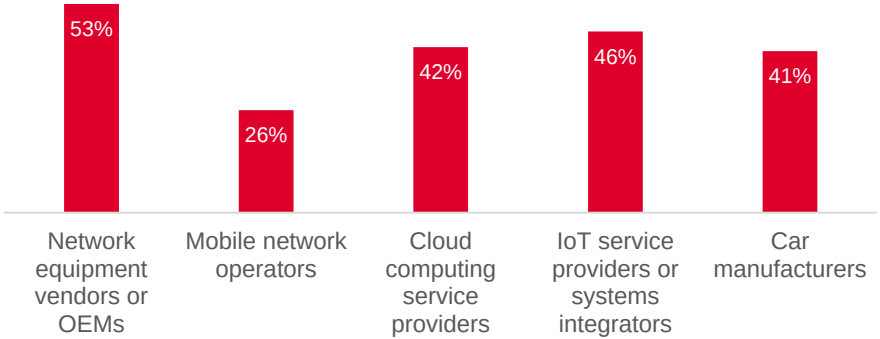
Edge grows in importance in B2B sales

- Edge computing is becoming increasingly important to enterprises' success with B2B sales. As edge use cases mature, edge players see this as an opportunity to capture more value in the B2B segment. According to the GSMA Intelligence survey, 64% of companies across all sectors have deployed edge in one country, with a further 28% having done so across multiple countries.
- These deployments will vary in size. Some will have standard edge servers on-premises, and some will link with other technologies. For example, integrating private wireless networks with edge computing enables businesses to support applications that require low latency and high bandwidth (e.g. autonomous guided vehicles in a car factory).
- Slicing is an important tool for separating network resources to support edge computing cases with different latency requirements. Integration with the edge can be achieved through a cloud-native microservices architecture that leverages software-defined networking (SDN).

How important are each of the following product areas for your B2B sales success? (All sectors surveyed)



Edge computing as extremely important: breakdown by group



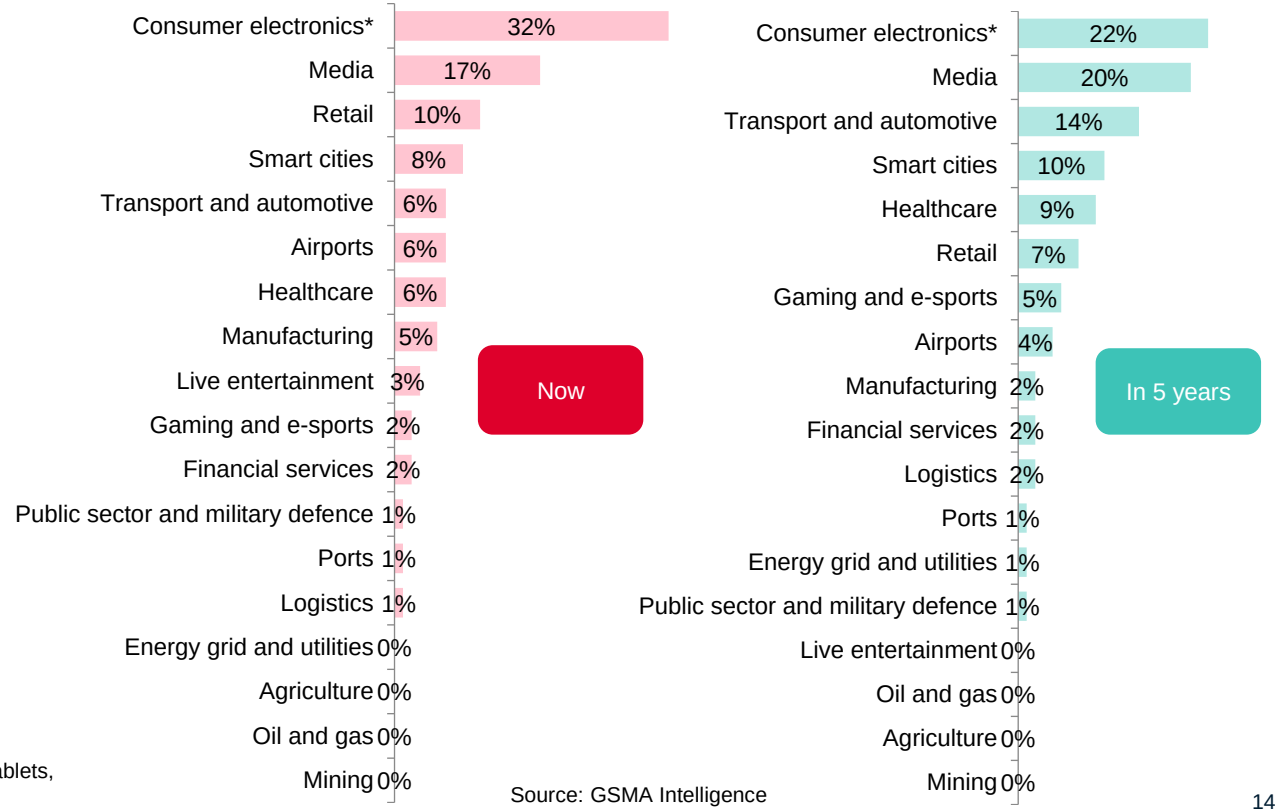
Source: GSMA Intelligence

It’s not just cars; many industries have an interest in edge

- Use of edge computing solutions is becoming more widespread in industries such as consumer electronics, media and smart cities.
- The adoption of edge computing in consumer electronics is being driven by the increasing popularity of the metaverse, remote operations and collaboration, e-sports and gaming.
- In the transport and automotive sector, edge computing is expected to grow due to rising demand for connected vehicle services such as intelligent driving, MaaS and V2X. Furthermore, growing concerns around data privacy and security will help drive the adoption of edge computing.
- Enterprise verticals play a crucial role in providing specialist industry knowledge to other edge players, making them not only a significant source of demand but also an essential component of the edge ecosystem.

What do you see as the top industry verticals that will drive the highest demand for edge computing? (All sectors surveyed)

Share of respondents that rated a given sector No.1 for highest expected demand for edge compute



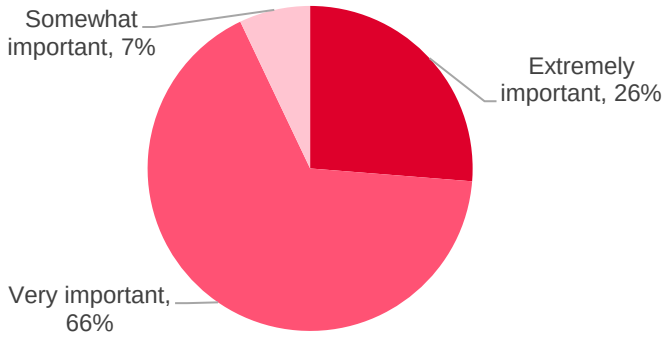
*Consumer electronics includes products such as laptops, tablets, PCs, XR/VR devices, wearables, drones

Source: GSMA Intelligence

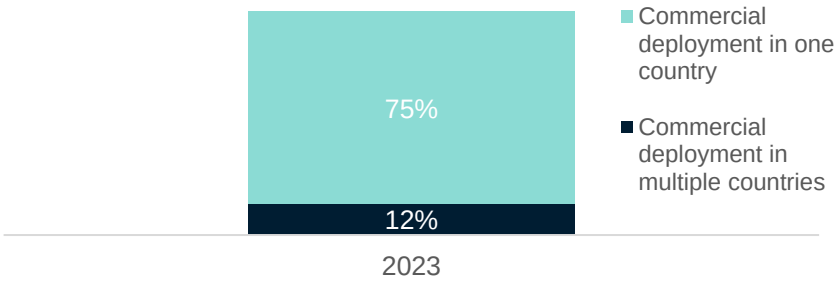
For operators, edge extends 5G

- Edge is increasingly relevant to the 5G monetisation story. More than 90% of operators rate it as very or extremely important in their drive to sell more into enterprise segments.
- Operators have put their money where their mouth is. Some 87% of operator respondents have commercially deployed edge computing.
- The main obstacle is integration with existing IT. 49% of mobile operators claim integration of technology with the existing IT network has a very significant effect on the edge computing infrastructure deployment roadmap. While this may not rule out further edge investments for these companies, it underscores the need to streamline integration.
- Updating existing network infrastructure with virtualised machines, using software-defined networking (SDN) and virtualised network function (VNF), can improve reliability and manageability and create the foundations for edge integration.

Importance of edge computing for B2B sales success (operator respondents)



Edge computing: state of deployment among operators

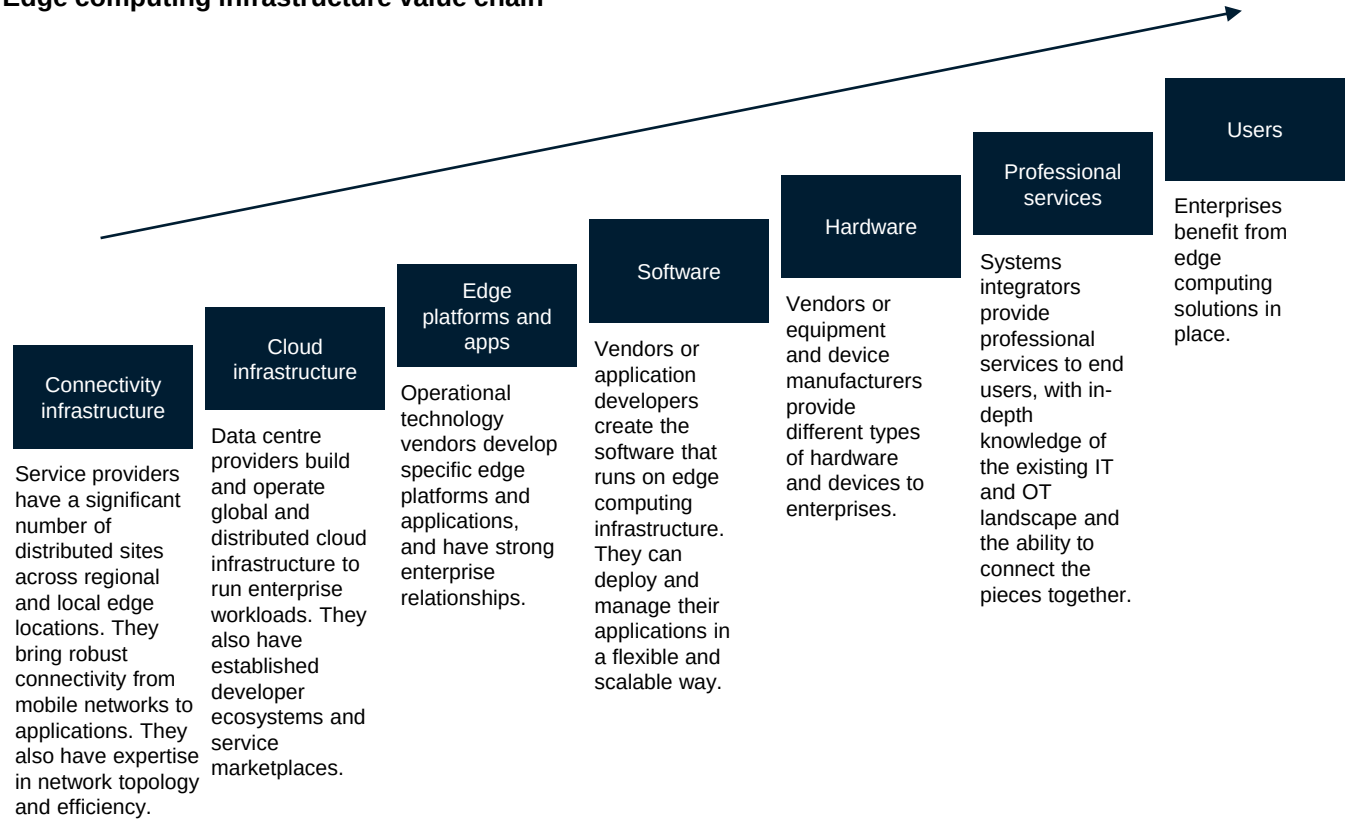


Source: GSMA Intelligence

The edge computing value chain is fragmented

- The edge value chain is highly fragmented, with no single type of player or company expected to deliver full edge computing network infrastructure and capabilities to enterprises.
- Chip makers, operational technology vendors, developers, cloud service providers and end users are all important parts of the edge stack.
- Each player needs to leverage their unique strengths, but partnerships are important too. Understanding the edge computing stack is critical to determine who to partner with.

Edge computing infrastructure value chain

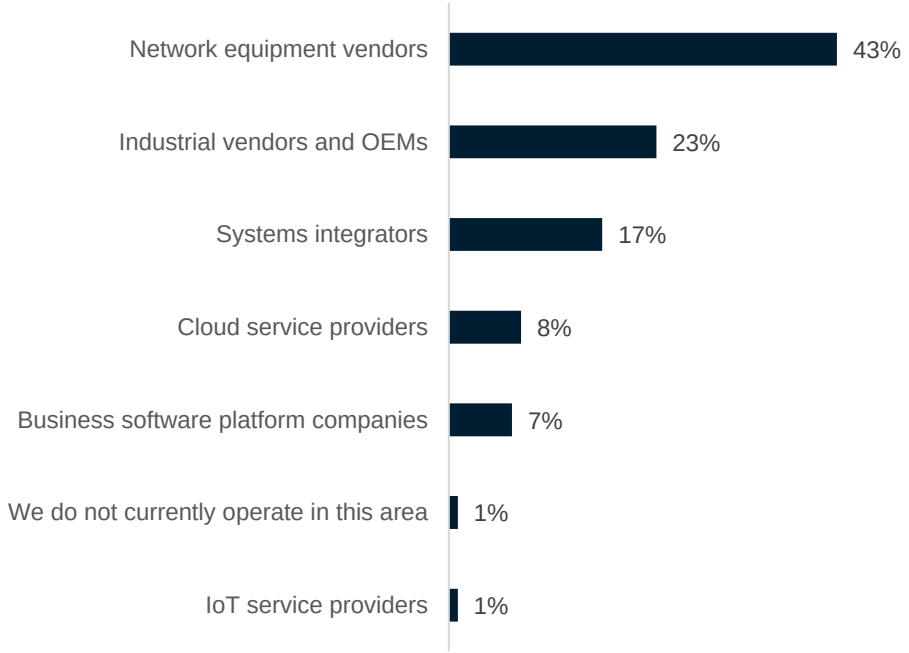


Source: GSMA Intelligence

A sense of co-opetition

- Edge computing opportunities in enterprise verticals are driving the need for partnerships.
- Edge networking is an area where operators see opportunities for partnerships with more types of player, such as cloud service providers, systems integrators and network equipment vendors (e.g. Huawei, Ericsson, Nokia and Cisco).
- The number of telco-cloud partnerships is increasing among larger operators on account of expanding network capabilities closer to the edge of the network. The enterprise opportunity is the main driver.
- Network equipment vendors and OEMs remain the most common partners for operators, extending their existing supplier relationships.

Preferred partners among operators
Which type of player do you prefer to partner with when selling joint solutions in edge networking? (Percentage of operator respondents)



Source: GSMA Intelligence Operators in Focus: Enterprise Opportunity Survey 2022

Hyperscalers to the fore?

- Edge computing plays to the strengths of cloud service providers, which continue to dominate by pushing computational resources towards the edge of the network.
- A host of partnerships have come about with operators to this end, including:
  - Telefonica expanding its partnership with AWS to offer customers edge computing solutions that run on AWS Outposts
  - Verizon partnering with AWS Wavelength to provide edge cloud and compute service at the edge of Verizon's 5G network
  - Google Cloud, Ericsson and TIM partnering to pilot 5G cloud solutions for telco edge enterprise use cases in automotive, transport and other sectors
  - Microsoft partnering with BT in the UK to develop new private 5G and edge technology, designed to unlock sustainability, safety and productivity in a range of verticals

Example players in the edge computing market

Cloud service providers	• Amazon Web Services • Google Cloud • Microsoft Azure
Mobile operators	• Telstra • Verizon • Telefónica • T-Mobile • Orange • Vodafone • AT&T • KDDI • TIM • SK Telecom • Telenor
Network equipment vendors and OEMs	• Dell • Nokia • Ericsson • Cisco • JMA Wireless
Systems integrators and IoT service providers	• Accenture • Tata • Infosys • Wipro • Capgemini
Car manufacturers	• Tesla • Waymo • BMW • Mercedes • Toyota

Source: GSMA Intelligence

Partnerships versus direct competition: both have a role

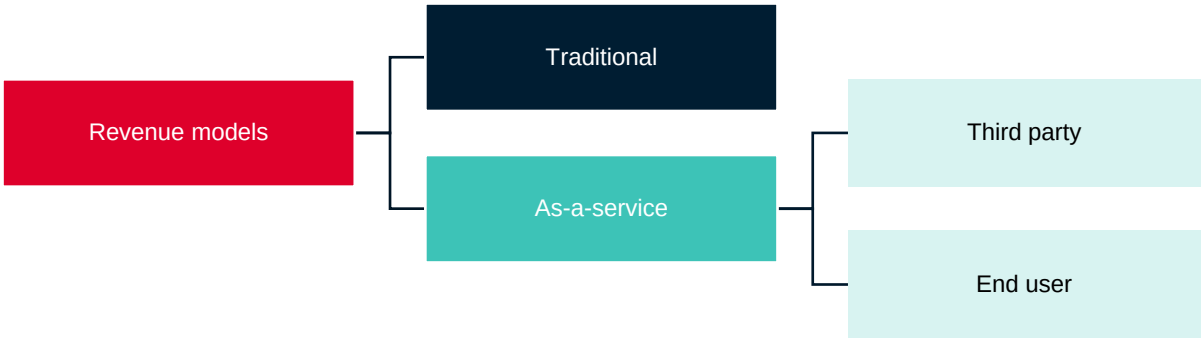
- Edge computing networking is where players see opportunities for partnerships but also direct competition.
- Network equipment vendors are seen as the main preferred partners as well as competitors by operators. The increasingly diversified market of enterprises is encouraging network vendors to go to enterprises directly or partner with datacentre providers.
- While telco-cloud partnerships have been growing, the reality is that cloud service providers could potentially threaten the relevance and reach of operators to enterprises utilising edge networking resources, creating competitive tension.
- IoT device and service providers (e.g. Cisco-Jasper, Wipro) and systems integrators (e.g. Accenture, IBM) are also in the mix and will remain as the 'glue' that holds everything together.

Examples of partnerships involving operators in edge computing

Mobile operators	Cloud providers	Systems integrators and IoT service providers	Network equipment vendors and OEMs	Data centre providers	Car manufacturers
Verizon		Wipro			
Verizon	AWS				
NTT		Cisco	Intel, Ericsson		Toyota
Telecom Italia	Google		Ericsson		
AT&T	Microsoft				
SK Telecom	Microsoft				
T-Mobile	Google				
Liberty Global SoftBank	Hitachi			Arrcus	
Vodafone	AWS	Accenture			
SoftBank				F5	
Vodafone	Microsoft				
Telstra	Microsoft				

Options for monetising

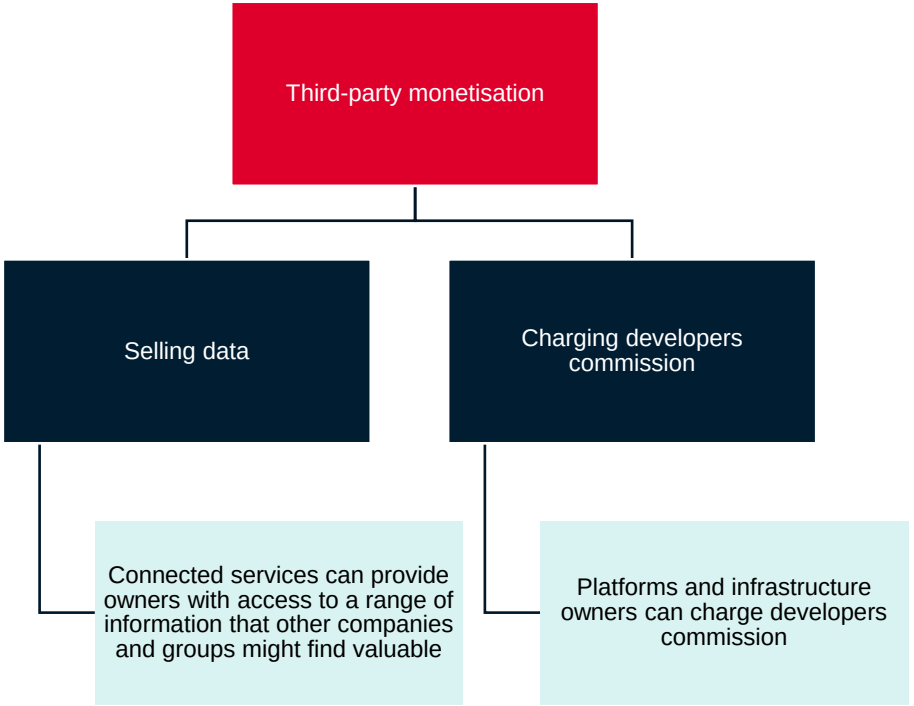
- The highly fragmented edge computing infrastructure value chain offers new revenue models, partnerships and direct competition opportunities.
- There are two main ways GSMA Intelligence thinks about monetising computing network infrastructure:
    - Traditional monetisation includes consulting and systems integration services, infrastructure components, enabling internet connectivity, and the rental of facilities.
    - The as-a-service model (i.e. platforms, software, network) is where end-users pay for what they consume (on-demand). In this business model, developers can create applications through exposure to APIs by tapping into the network edge. Telecoms APIs, for example, leverage telecoms network infrastructure and services (messaging, voice) that can be integrated with other APIs.



Source: GSMA Intelligence

Third-party developers: build it and they will come?

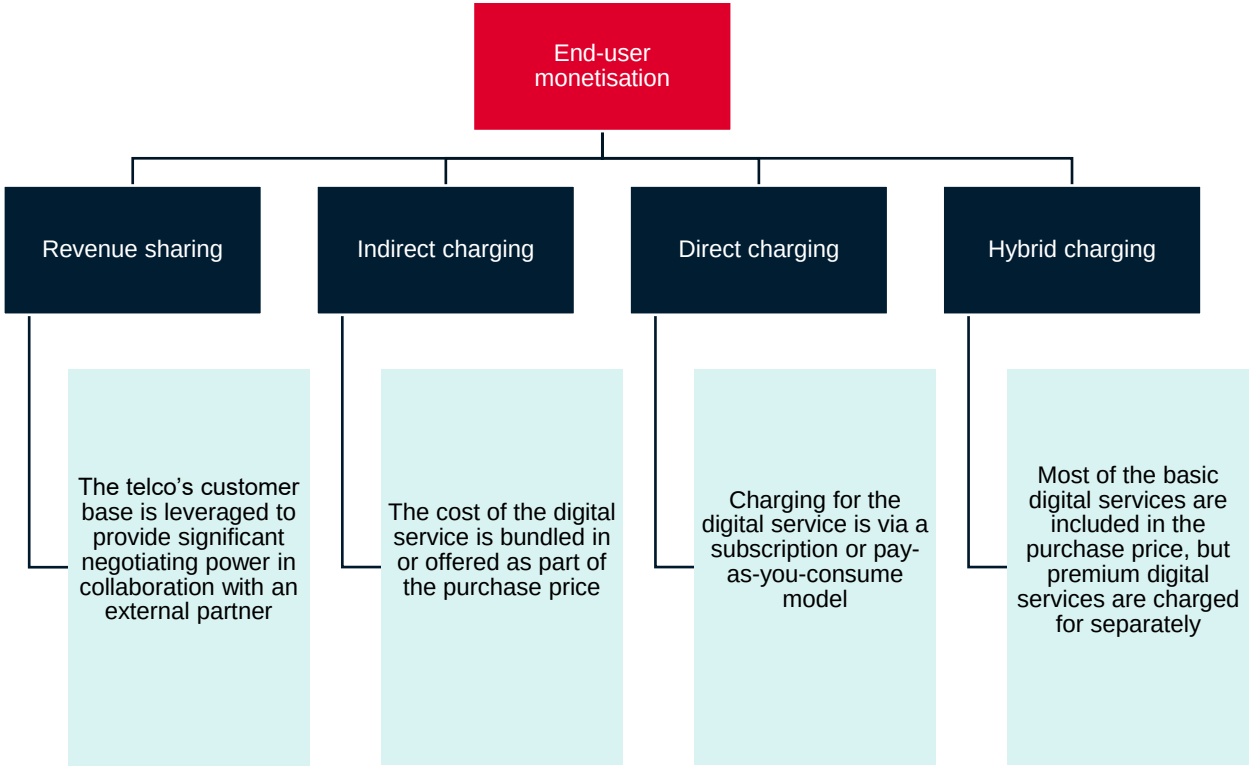
- Enterprises can gain a competitive advantage by leveraging edge computing infrastructure to extract timely and relevant information from various sources. This includes data from every edge node and device that generates information, not just within the organisation but also from partners, suppliers and other third-party sources.
- Edge computing network APIs enable third-party developers to access a network's capabilities, which creates indirect revenue streams for operators and cloud service providers. Developers can create customised applications and on-demand features for their use cases by using network APIs, bringing value to customers.
- The prospect of these APIs being available for general/open use is a pre-condition for scale. While this has not always been met in the past, the Open Gateway initiative involving the CAMARA library has global telco support, which should (among other market factors) help attract developer interest for services that leverage edge compute.



Source: GSMA Intelligence

The end-user route

- Monetising edge computing infrastructure is possible with end-user services through the adoption of different revenue models.
- In telco-cloud partnerships, the business model can be based on pure revenue sharing, with operators bringing their customer base.
- Car manufacturers might prefer a hybrid model, where most of the basic digital services are already included in the vehicle price, but with separate charges for extra services.



Source: GSMA Intelligence

Innovations in the pipeline

5G as an enabler

- **5G standalone (5G SA):** While not critical for edge services, 5G SA enables more flexible network slicing than is possible with 5G non-standalone (NSA). By creating slices tailored to different use cases, network slicing can support different edge use cases such as massive IoT, robotics and XR.

AI/ML as a game-changer

- **Expanding edge functionality**: AI and ML implemented at the edge represent a further evolution of the edge as it expands its functionalities.
- **Operational resilience**: Edge device processors (GPUs, NPUs) allow AI/ML to run locally on edge devices without relying on the cloud and connectivity to provide an output. This reduces reliance on the cloud and allows organisations to undertake more processing on-premises, either for mission-critical use cases or those that demand very low latencies.

APIs

- **APIs matter:** Tech innovation has set the stage for edge computing use cases and users who want them. APIs allows disparate IT systems to be integrated and end-user applications to be deployed. To the extent APIs can be opened and standardised (such as with Open Gateway), the logic and draw increases for developers to plug into 5G and edge infrastructure to release their own services.

5G enablement (ultra-low latency)

- With 5G SA, a portion of the network can be allocated based on the specific needs of the application, use case or end user.
- eMBB is dedicated to use cases requiring high throughput and low latency.
- eMTC is dedicated to use cases optimised for small data transmission, extreme power-saving mechanisms, stationary devices, low throughput and high geographic density.
- A URLLC slice enables mission-critical applications for use cases that require a highly reliable control plane, high-performance user plane, very low latency, high mobility and low throughput. URLLC can enable V2X applications.

Automotive and URLLC

Enterprise use cases enabled by 5G and key benefits

- Ultra-low latency and high bandwidth can support platooning, which improves fuel efficiency and reduces the number of drivers required.
- Ultra-low latency and high bandwidth can support remote driving and remote support.

New business models enabled

- Data-based business models become available to car manufacturers; they can monetise data assets (such as traffic information and driving patterns) with stakeholders such as insurance companies and fleet managers.

Key requirements from mobile operators

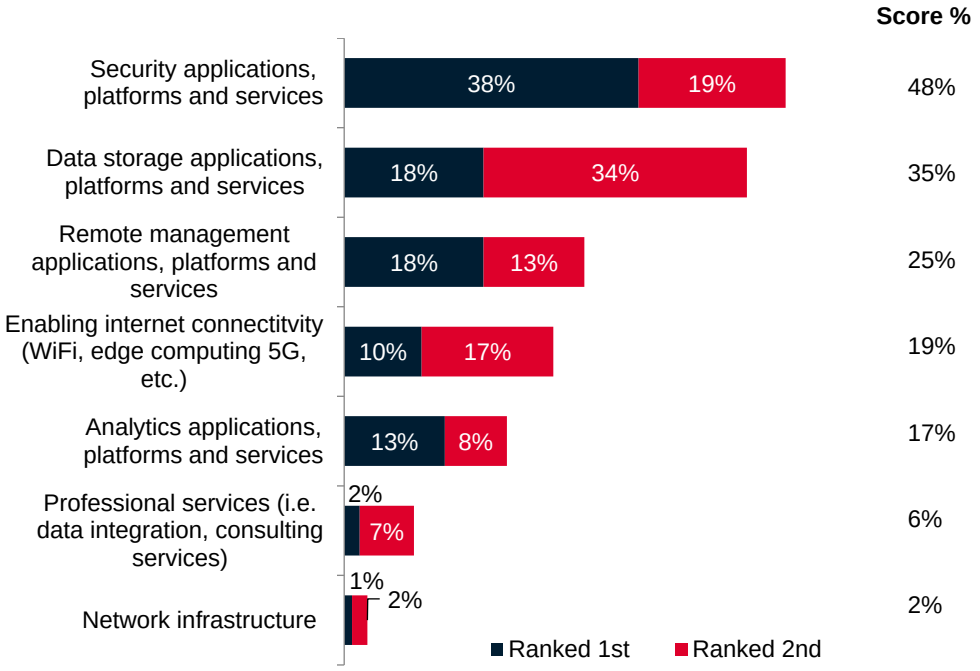
- Operators will need to provide clear service-level agreements (SLAs) for network slices.
- Closer relationships between operators and car manufacturers are needed.

Opportunities for car manufacturers

- Some 38% of car manufacturers surveyed claim security applications are the top revenue-generating connected vehicle service. Connected features in vehicles can open the door to vulnerabilities, so protecting end users and ensuring the safety and security of the vehicle itself is crucial.
- As valuable data generated from connected vehicle services increases, so does demand for storage at the edge of the network.
- Connected vehicle services are expected to unlock substantial revenue opportunities for car manufacturers. Revenue gains realised from deploying edge computing in connected vehicles are forecast to rise considerably in three years' times, with 15% of car manufacturers expecting to generate an uplift of 16–20%.

Highest revenue-generating connected vehicle services

Rank the top two highest revenue-generating services from connected vehicle services

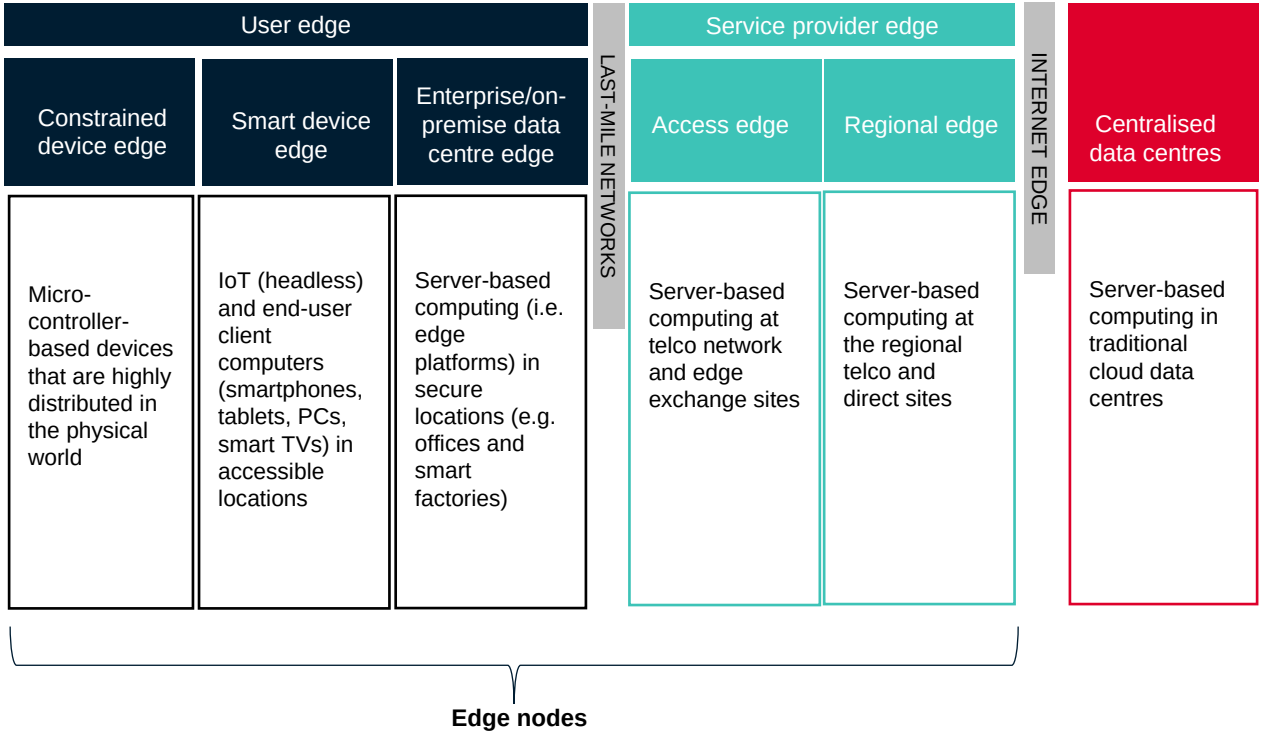


Score calculated as (Ranked 1st*1)+ (Ranked 2nd*0.5)

Source: GSMA Intelligence

Data centres and nodes

- GSMA Intelligence defines an edge node as the point of presence in an edge computing architecture that hosts computing, storage and networking resources used for customer applications and data.
- Edge computing network architecture is changing the data centre market, driving the emergence of different edge nodes.
- Strong growth globally in public cloud infrastructure and the emergence of edge computing have shifted the third-party data centre market. Traditional data centres are not equipped to handle the next-level requirements that will need support from the edge.



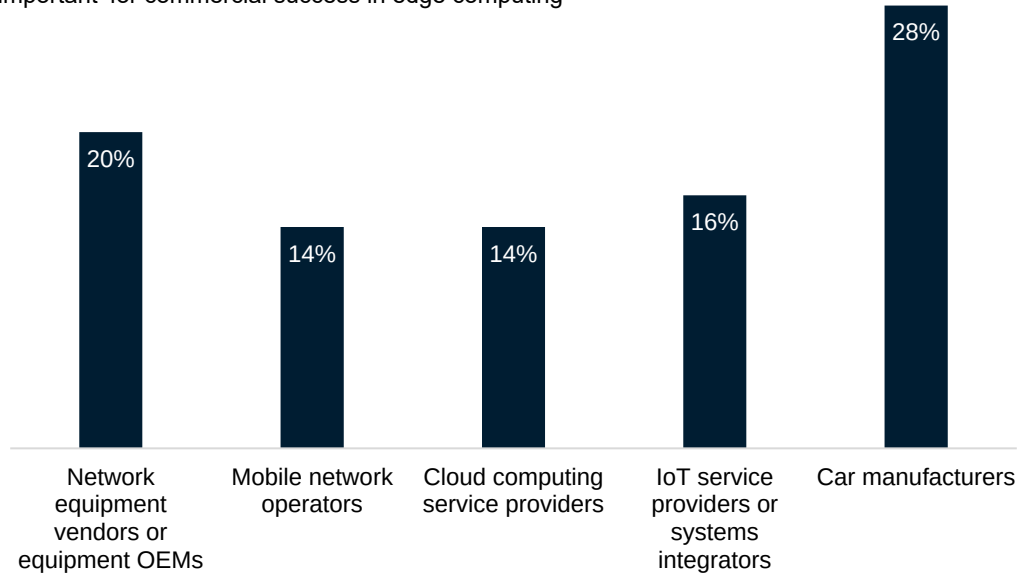
Source: GSMA Intelligence

AI and ML for analytics: part of the future fabric

- With 5G innovation from 5G-Advanced and RedCap, edge device processors will enable the capability to integrate and run AI/ML models without relying on the cloud.
- EdgeML applications continue to run even if access to the network is disrupted. This is important in intelligent driverless vehicles and medical equipment, for example.
- AI/ML edge applications are more powerful and flexible than conventional applications that can respond only to inputs that the programmer has anticipated. An AI neural network is trained to answer a particular type of question, even if the question is new (using automated ML processes).
- Some 44% of survey respondents plan to launch AI/ML (and around 30% of car manufacturers deem it extremely important to their sales success). As edge computing develops, AI/ML will acquire increasing strategic importance for enterprise offerings.

A fifth of companies see AI and ML as extremely important to future edge success

Percentage of respondents in each industry that rate AI and ML as 'extremely important' for commercial success in edge computing

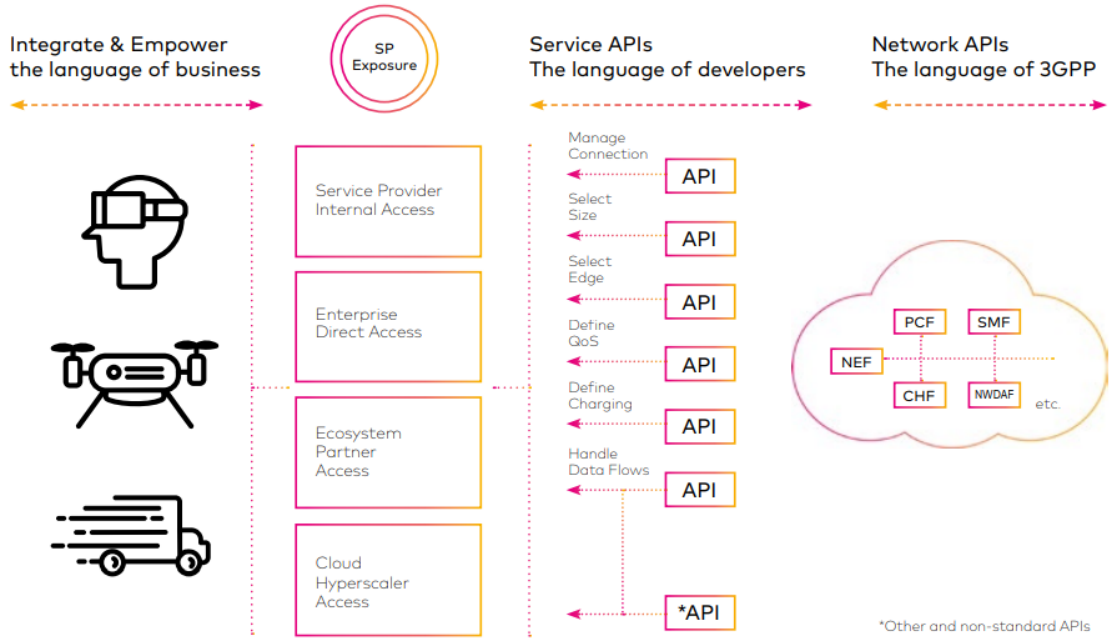


Source: GSMA Intelligence

Growing the availability of (open) APIs

- Edge is not a standalone technology but a topology that integrates centralised and decentralised architectures, AI/ML and digital twins.
- APIs play a pivotal role in enabling seamless interaction between edge devices and the networks they run on.
- The promise of a more open set of APIs is that enterprises (as well as operators and vendors) can expose these to the developer community, which can directly tap into network capabilities. Billing systems are a common example, as shown in the chart from Amdocs.
- For edge compute, this could include new healthcare offerings, traffic monitoring in cities, or operating heavy machinery at a mining site, for example.

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

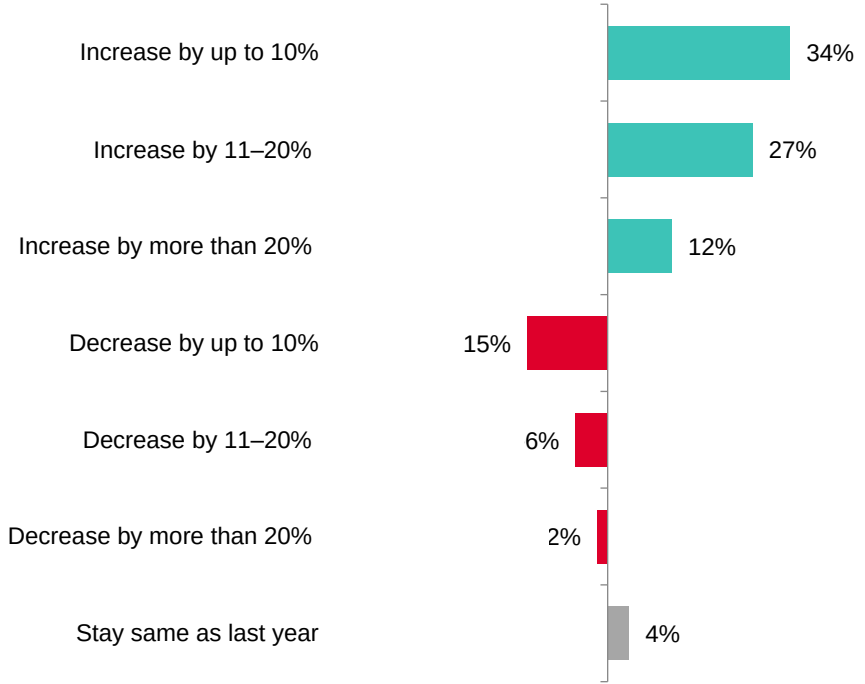


Source: Amdocs Network Exposure Function (NEF) Data Sheet, published in GSMA Intelligence Global Mobile Trends 2023

Edge investment sentiment is positive

- Some 73% of survey respondents claim they will increase their year-on-year spend on edge computing network investments, driven by increasing edge demand, expanding use cases and high potential returns. 23% plan to reduce while 4% plan to keep spend flat.
- It is important not to read too much into these numbers, as growth may be from a small investment number in the prior year for companies still at the start of their investment plans.
- Positive expectations are consistent across different parts of the ecosystem (see next slide), suggesting a genuine rise in demand for edge-enabled services and that Covid-induced headwinds to capital budgets are reducing.

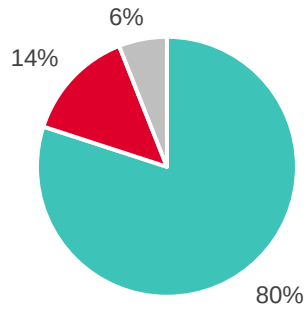
Change in investment in edge computing infrastructure
Compared to last year, how do you think year-on-year expenditure of your edge computing network investment will change?



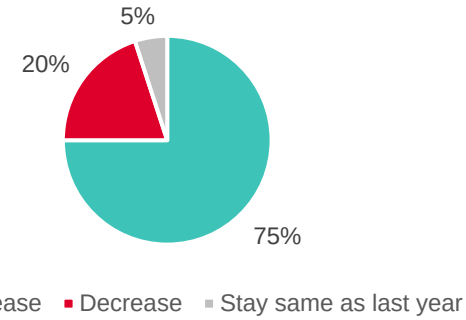
Source: GSMA Intelligence

The positive sentiment holds across the value chain

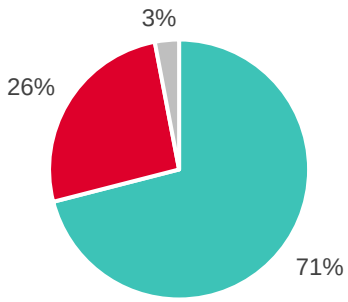
IoT providers or systems integrators



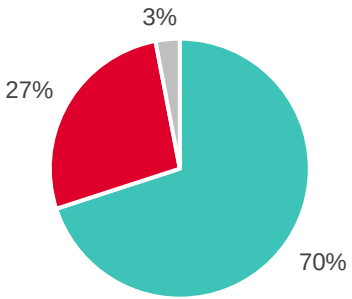
Mobile operators



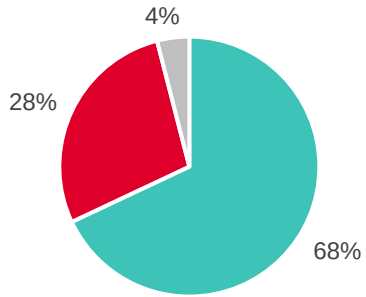
Network vendors or OEMs



Car manufacturers



Cloud computing service providers

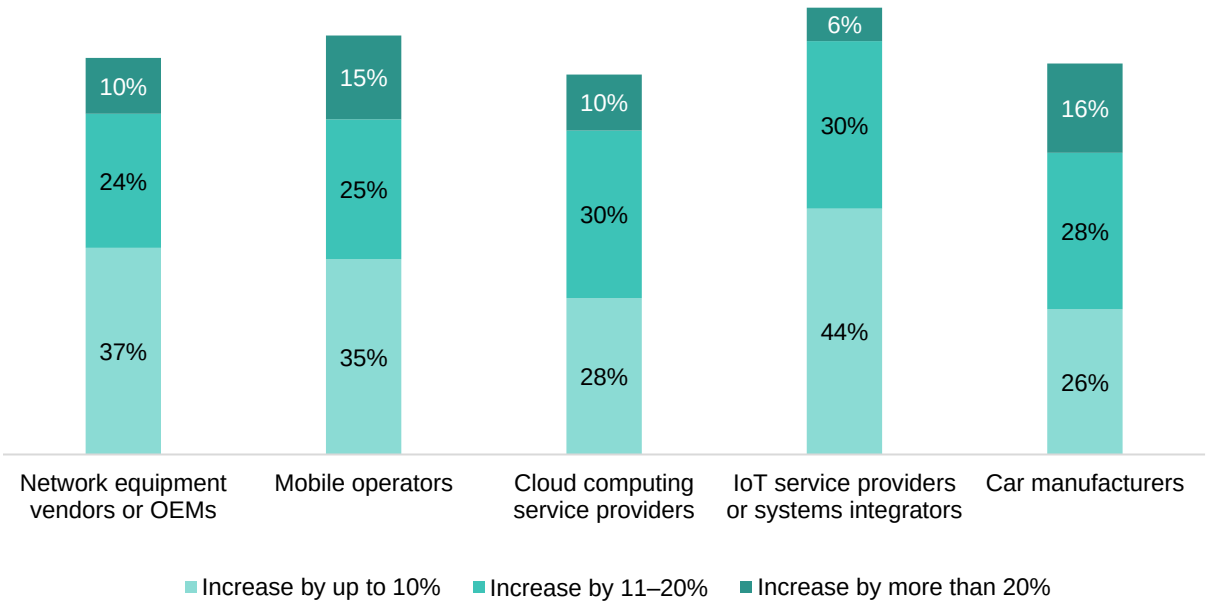


Source: GSMA Intelligence

A median investment rise of 10–15%

- Mobile operators, IoT service providers and systems integrators are expected to increase their spend on edge computing infrastructure the most year-on-year.
- Expectations are for a median increase across the ecosystem of around 10–15% compared to the previous 12 months.
- Survey responses need to be treated with caution, but the consistency across sectors supports the veracity of the expected investment rise.

Investment increase (2024) in edge infrastructure and services: breakdown by group



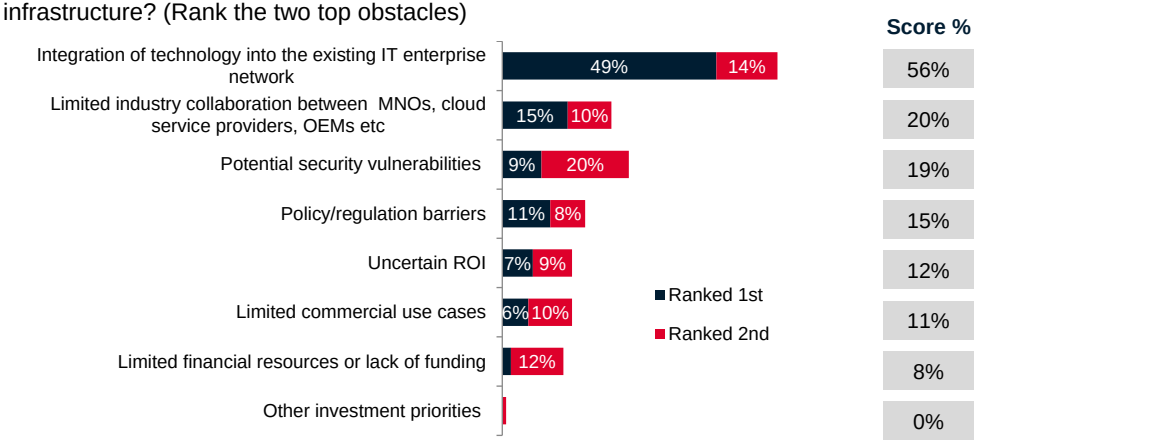
Source: GSMA Intelligence

Integration with legacy IT is the No.1 barrier

- Integration of edge computing with existing IT enterprise networks is a common painpoint. To make the most of the edge, enterprises need to integrate it with other technologies.
- APIs can support the integration of disparate IT systems and edge computing. However, work remains in terms of API development and standardisation. Key enabling technologies for an integrated network include SDN and NFV.
- Limited industry collaboration between key players in the ecosystem was ranked as the second biggest obstacle.
- GSMA CAMARA is an open-source project with a Linux foundation that facilitates network integration through API harmonisation.
- The GSMA Open Gateway framework of common APIs is designed to provide universal access to operator networks for developers and cloud providers.

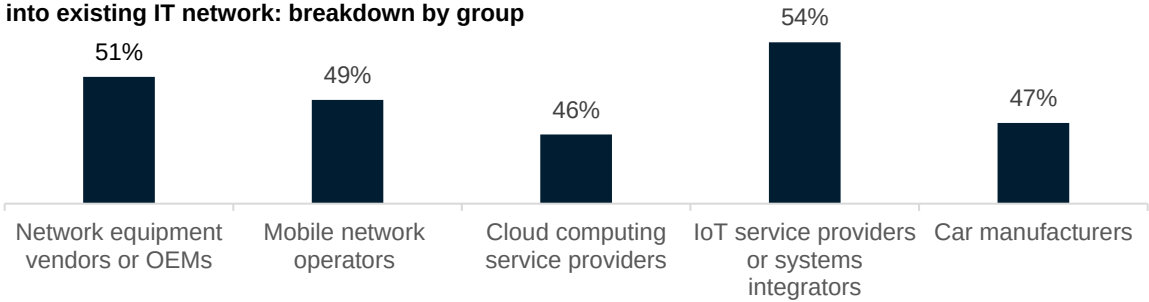
Primary obstacles to the deployment of edge computing infrastructure

What are the primary obstacles, at this moment in time, to the deployment of edge computing infrastructure? (Rank the two top obstacles)



Score calculated as (Ranked 1st*1) + (Ranked 2nd*0.5)

Ranking 1st of integration of technology into existing IT network: breakdown by group

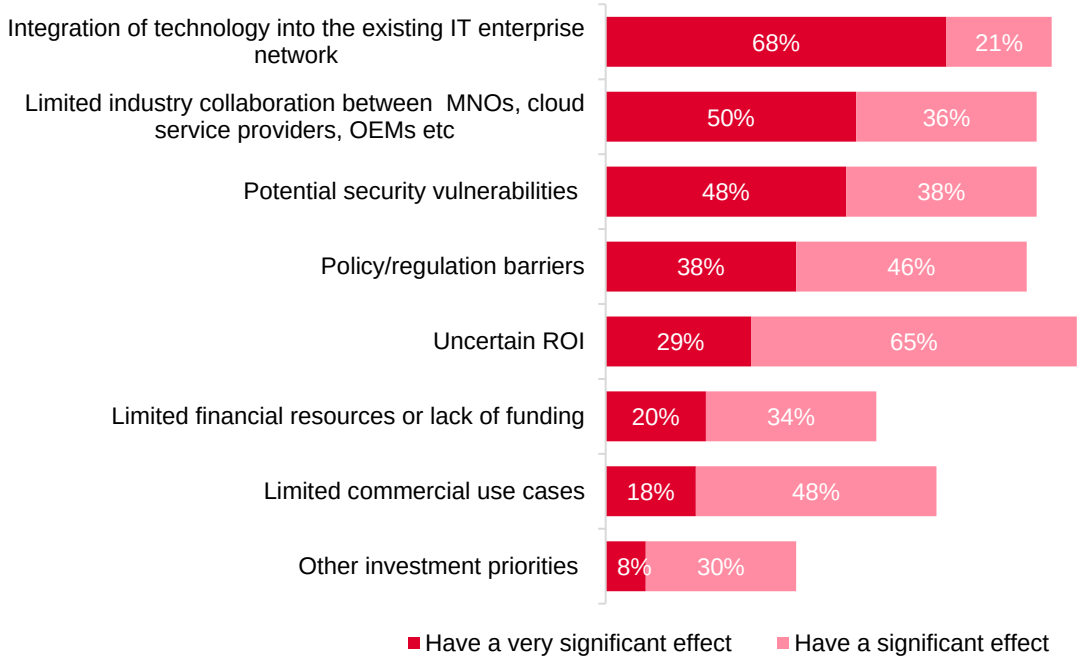


Source: GSMA Intelligence

Uncertain RoI, security and regulation are also factors

- Some 68% of respondents claim technology integration with existing IT networks can have a very significant effect on the edge computing infrastructure deployment roadmap.
- To scale edge networking while still complying with enterprise demand, security will need to be factored in.
- The exponential growth of data processed at the network edge will make adhering to data privacy policy measures essential.
- Data centres and edge devices consume massive amounts of energy. If players are to meet their sustainability goals, it is imperative to factor in the sustainability impact of data centres, edge nodes and devices.
- Risk and opportunity assessments, clear monetisation strategies and an effective business model are critical to deploying edge networking.

Impact of obstacles on the roadmap for edge computing infrastructure deployment
How do you expect each of the following obstacles to affect your company's edge computing infrastructure deployment roadmap?



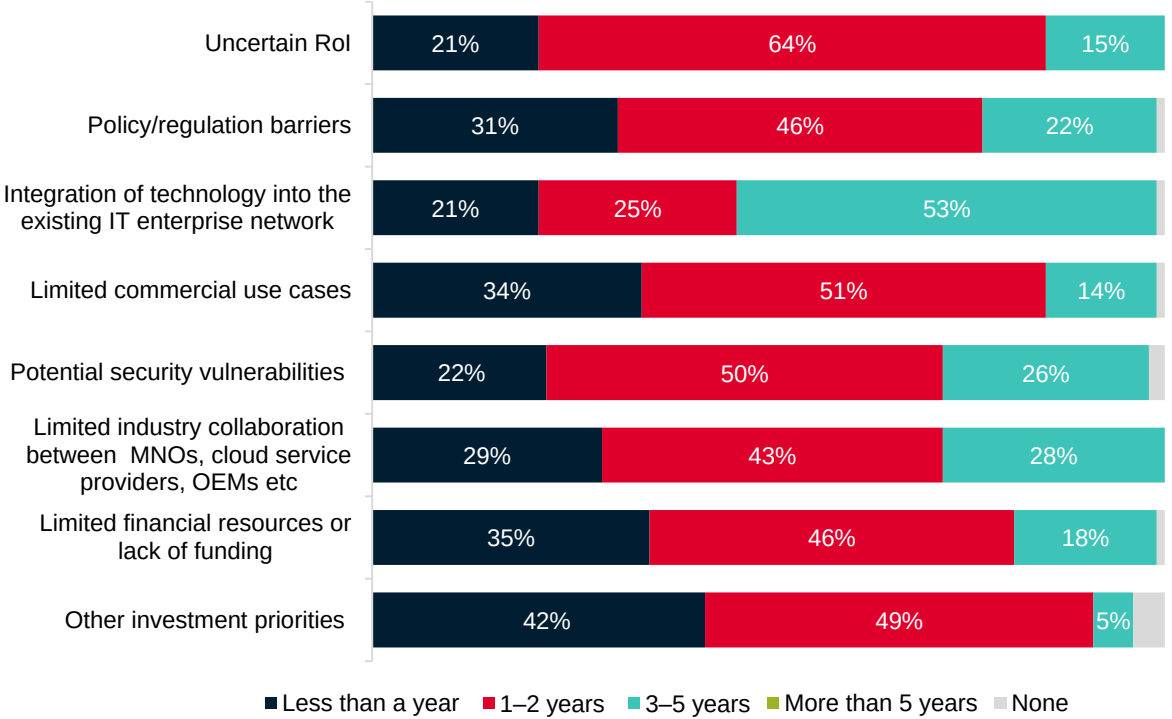
Source: GSMA Intelligence

IT integration requires planning and takes time

- Most of the obstacles to edge computing infrastructure deployment can be chipped away at, or potentially solved, over a two-year period.
- Commercial use cases, capital allocation and even some regulatory issues fall into this category.
- However, integration of technology with the existing IT network is a slow-burn obstacle, with 53% saying this is often a three- to five-year story.
- The integration challenge speaks to the need for cross-industry collaboration so that systems speak to each other and common standards are in place wherever possible.

Timeline for resolving obstacles

Thinking about edge computing infrastructure deployment, please select the timeline you believe is needed to resolve each of the following obstacles.



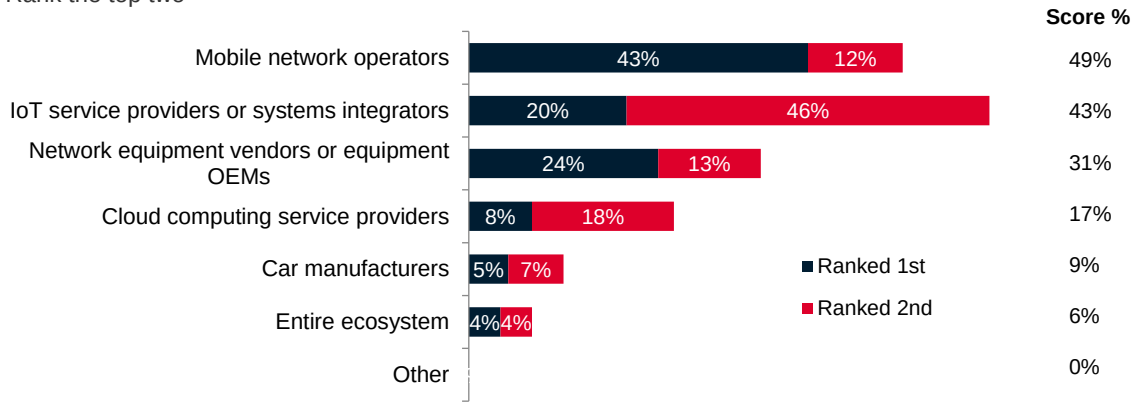
Source: GSMA Intelligence

Sharing the investment burden

- While edge computing infrastructure can be monetised by companies at different levels of the value chain (from IoT device makers to hyperscalers), telecoms operators continue to be seen as the group that should bear primary responsibility for investment. More than 40% of companies rate operators as the group most responsible.
- That 68% of operators rate themselves as having the most responsibility perhaps reflects the fact that most edge costs are infrastructure in nature, including active and passive equipment.
- The problem with this situation is that it is not sustainable. Operator revenue growth is still mostly in the low single digits, and the cost of capital is above net income margins, all of which are headwinds to investment. Co-investment models – either between operators and other suppliers or with actual enterprise clients – would help mitigate this pressure.

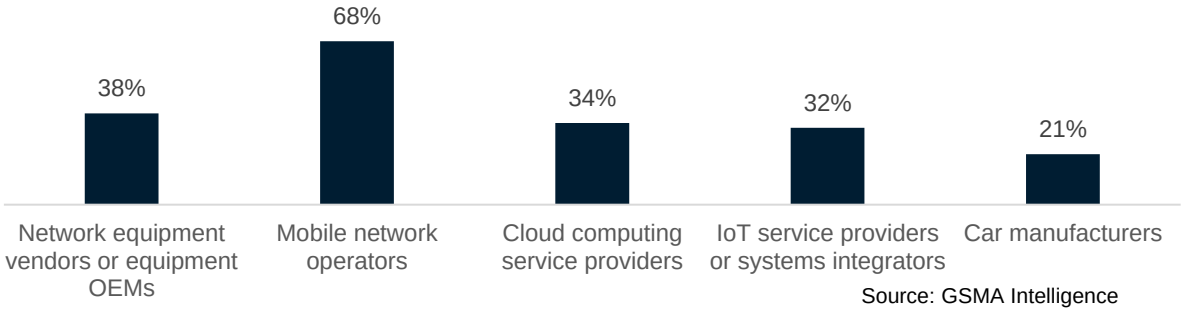
Responsibility of edge network infrastructure deployment costs

Thinking about edge computing, who should bear the costs of network infrastructure deployment? Rank the top two



Score calculated as (Ranked 1st *1) + (Ranked 2nd*0.5)

Share of respondents that ranked their own sector first: breakdown by group



Source: GSMA Intelligence

Bridging the gaps: partnerships

- Given the considerable edge computing deployment costs and highly fragmented value chain, it can be more rational for edge key players to form partnerships instead of competing directly. Two examples are given here.

Example partnerships	
Edge category: vehicle control Use case: V2X collision warning Vertical: transportation, Partners: Telefónica, DT, Continental, MobiledgeX Region: Europe (Germany)	Edge category: network Use case: multi-operator platform interconnect Vertical: telecoms Partners: Telefónica, Telstra, KT, China Unicom, Capgemini Regions: Europe, Asia
Problem: Continental Smart Mobility solutions require reliable and predictable low latency to ensure safe and efficient operations on MEC infrastructure. Continental explored how to build a future-proof set-up to support low-latency requirements for smart mobility services. **Solution**: DT and Telefónica enabled end-to-end latency across distributed telco edge cloud computing resources interconnected through operators' networks optimised with quality of service (QoS). MobiledgeX provided the independent operator platform to interconnect DT and Telefónica MEC QoS for a seamless Continental developer experience.	**Problem:** MEC roaming allows mobile users travelling abroad to leverage nearby MEC infrastructure for an optimal MEC experience beyond their home networks. Without this mechanism, mobile users abroad have to resort to MEC infrastructure located back in their home country, significantly undermining the low-latency feature and user experience. **Solution**: Telefónica, KT and China Unicom partnered to verify 5G edge computing technology for global roaming infrastructure and federation among different edge platforms. This scenario was successfully tested between KT and Telefónica. It lays the groundwork for enterprises and private developers to be able to make inroads into domestic and global markets with a single service development that meets common standards.

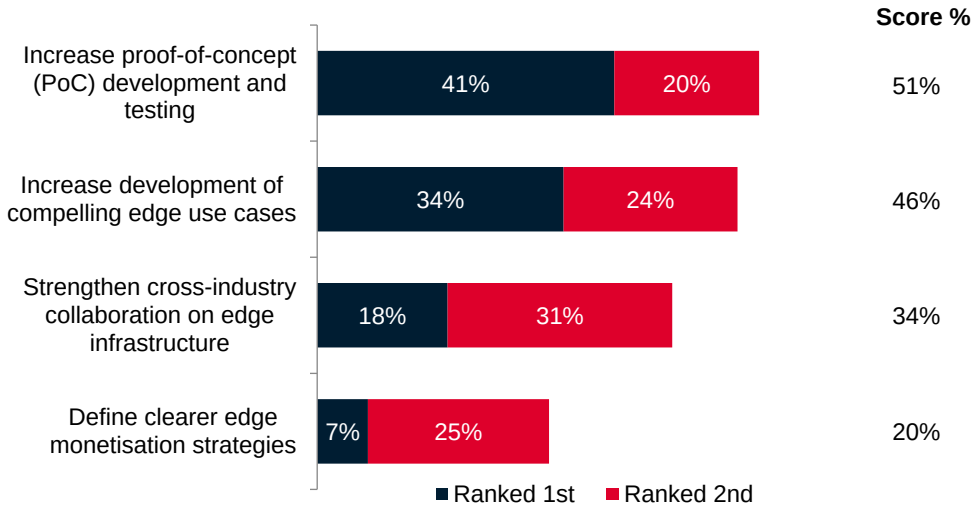
Source: Telco Edge Cloud Value & Achievement, GSMA, 2023

Bridging the gaps: use cases are one thing; proof points are another

- Survey data indicates that to scale edge computing, an increase in proof-of-concept development and testing is needed, while continued development of compelling edge use cases is also important.
- Enterprises deciding to use edge computing have to create their own customised software system, which is complex and expensive.
- Proof-of-concept (PoC) development and testing is key to creating standardised software that can be deployed, meeting enterprise demand across verticals. It is also important to validate RoI projections (i.e. can companies make money, save costs or both?)

How to scale edge computing

Thinking about edge computing, which of the following needs to be achieved to scale it?



Score calculated as (Ranked 1st *1) + (Ranked 2nd*0.5)

Source: GSMA Intelligence

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