Kaleido Intelligence

Enterprise Cellular IoT Demands & Opportunities

A Kaleido Intelligence Survey Report

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Introduction to the Survey

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Introduction

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Over the past decade or more, considerable interest has risen around the concept of IoT and what it might mean for businesses and end-users impacted by the digitisation strategies applied using IoT technologies. In turn, a plethora of IoT survey reports have been published that typically cover a broad range of topics. In 2022, Kaleido Intelligence recognised the need for a more focused understanding of specific areas of IoT implementation and, as a result, undertook one of the largest survey fieldwork efforts of its kind, examining enterprise perceptions around cellular IoT connectivity in detail.

Despite the fact that much of the revenue and user experience is impacted by the applications and services that are applied in the context of IoT, connectivity remains the bedrock for any deployment. Therefore, it is imperative that the ecosystem serving IoT customers understands where challenges exist, where improvements could be made, and how customers perceive the IoT ecosystem in the context of connectivity. As we shall see later in this report, cellular technology is well-understood as an important enabler of IoT connectivity, albeit with several challenges associated with it.

The end of 2022 saw some 2.5 billion cellular connections deployed globally for IoT programmes, with connections having increased by 26% over 2021. In contrast, the end of 2020 saw only a 12% increased in connection volume, and as a result, it is evident that the overall ecosystem for cellular IoT connectivity is on the path to recovery following the pandemic. Nevertheless, this strong growth highlights that meeting the challenge of 'scaling up': supporting higher volumes of connections from a technical, service and commercial standpoint is ever more critical for service providers if the ecosystem is to be sustainable. Meanwhile, the introduction of new radio technologies, such as 5G, support for converged cellular-satellite communications systems and private cellular networks, in addition to a vast ecosystem of connectivity service providers, hardware vendors and differentiated regulatory and commercial requirements has meant that cellular IoT is more complex than ever for enterprises to navigate.

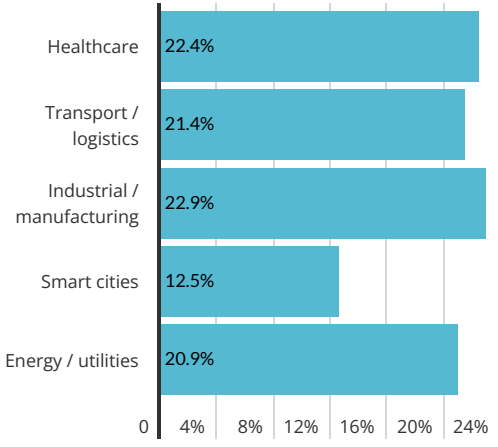
This year's survey has set out to take a deep-dive into where the key pain points in the context of cellular IoT connectivity lie and represents an expansion of the 2022 survey effort. Some 800 enterprises were surveyed during February-April 2023, representing activities in five key IoT industry verticals:

- Transportation & Logistics
- Industrial & Manufacturing
- Healthcare
- Energy & Utilities
- Smart Cities

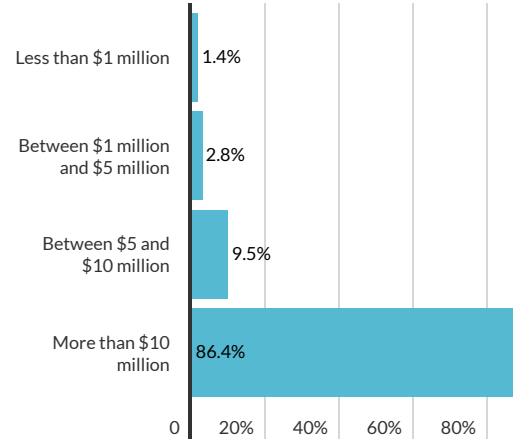
All respondents were all decision-makers at managerial level or higher within their organisation, in addition to having a good knowledge of the cellular IoT ecosystem. In order to understand a broad picture of perceptions, respondents included companies that had adopted cellular connectivity for IoT, in addition to those that had not. The differences, as well as the and consensuses in perceptions among these groups and industry verticals, are among the key goals of the study in terms of understanding where the industry can improve and where opportunities to accelerate

the adoption of cellular technology for IoT lie.

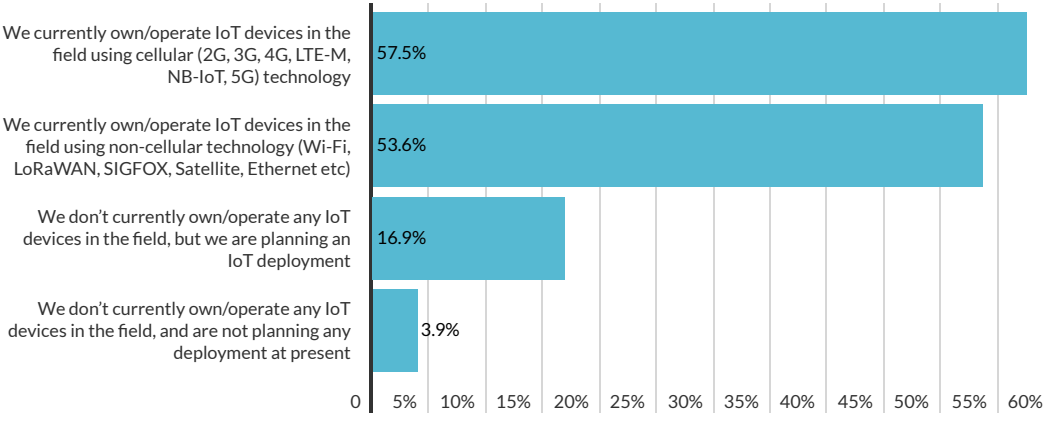
In what market segment does your business unit primarily operate?



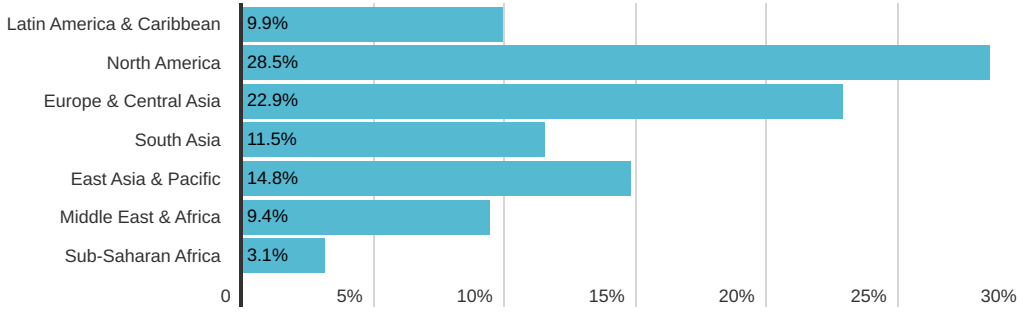
What was your organisation's turnover in 2022?



What is your organisation's current status in regard to IoT?



Where is your business unit based?



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Survey Themes

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The survey analysis allows us to identify several themes among the respondent base, which will be examined in the following sections.

Complexity

Costs, time-to-market, commercial and regulatory barriers, in addition to enterprise understanding of IoT requirements and goals all play a role in the success of IoT projects. Service providers must position themselves as both problem solvers as well as experts in the field here in order to help enterprise customers launch and maintain successful IoT deployments.

Sophistication

Enterprises are becoming increasingly aware of IoT risks, while simultaneously becoming more demanding in what they expect from connectivity providers. This means that service providers must become more sophisticated in how they approach the market.

Roaming

IoT devices provisioned with cellular connectivity often operate across several countries worldwide. Inevitably, this means that roaming, the technical and commercial arrangement that allows cellular devices to access networks in visited countries, is required. Coverage, costs, performance and support are of fundamental concern to enterprises here.

eSIM

eSIM enables a paradigm shift in how cellular connectivity can be provisioned and managed. Its reprogrammability over-the-air makes it a highly flexible solution to achieve various goals, and is increasingly considered a must-have for cellular IoT connectivity.

Private LTE/5G

Private cellular networks offer enterprises significant enhancements over traditional communications solutions, and suffer from few technical compromises. The ecosystem is complex, however, and a significant level of expertise is required to aid in choosing an appropriate deployment.

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IoT Connectivity Challenges & Opportunities:

All IoT Verticals

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Complexity - All Verticals

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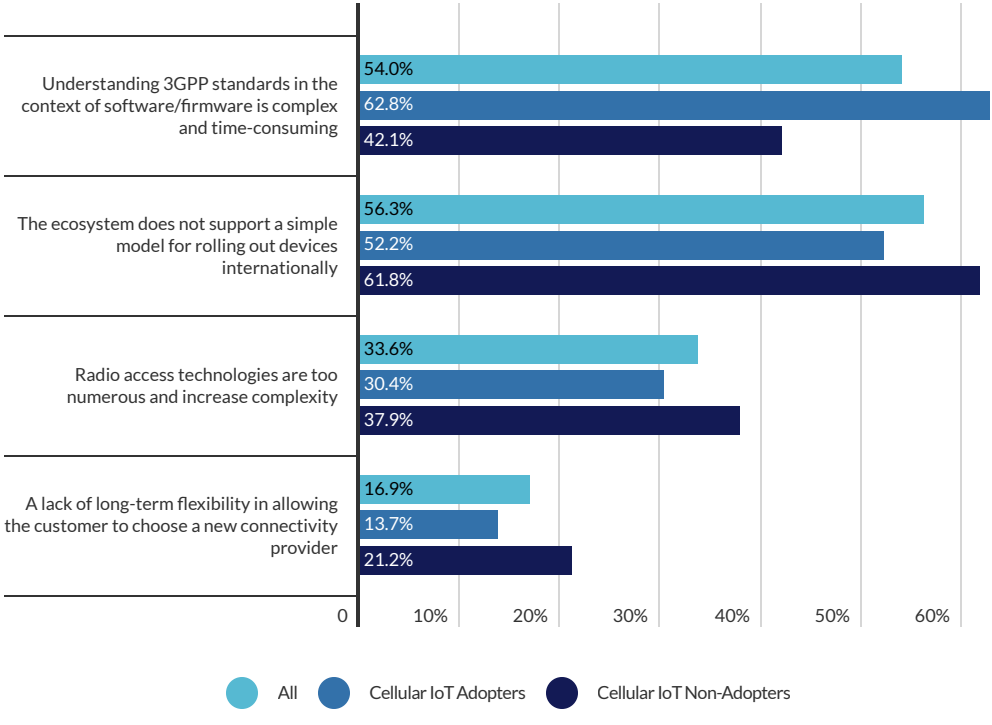
Deploying cellular technology to support IoT programmes requires a considerable level of expertise in order to be successful. Regulations in countries are varied, which might mean that different approaches to data processing and storage will need to be considered, while a lack of harmonisation in regard to spectrum allocation around the world means that a device produced and certified for one particular country may not operate or be certified for use in another. Meanwhile, cellular technology has now reached its fifth generation of mobile radio standards, and includes subsets of generations, such as NB-IoT and LTE-M, as a result of different use case objectives. For enterprises, this means that choosing cellular connectivity for their devices is not simply a matter of spending allocated funds on the latest 5G technology: indeed, 5G coverage is not universally supported, while Radio Access Technology (RAT) choice is ultimately a question of pricing, coverage and suitability for the use case in question.

Overall, the majority of survey respondents agreed that there are two critical challenges for enterprises wishing to adopt cellular technology for their deployments: 54% of all respondents cited the difficulty in unpicking 3GPP standards for software and firmware development, while 56% reported that a lack of a simplified model for rolling devices out internationally was a major barrier.

What do you perceive as the main challenges for organisations wishing to leverage cellular technology for IoT connectivity for the first time? (All Respondents)



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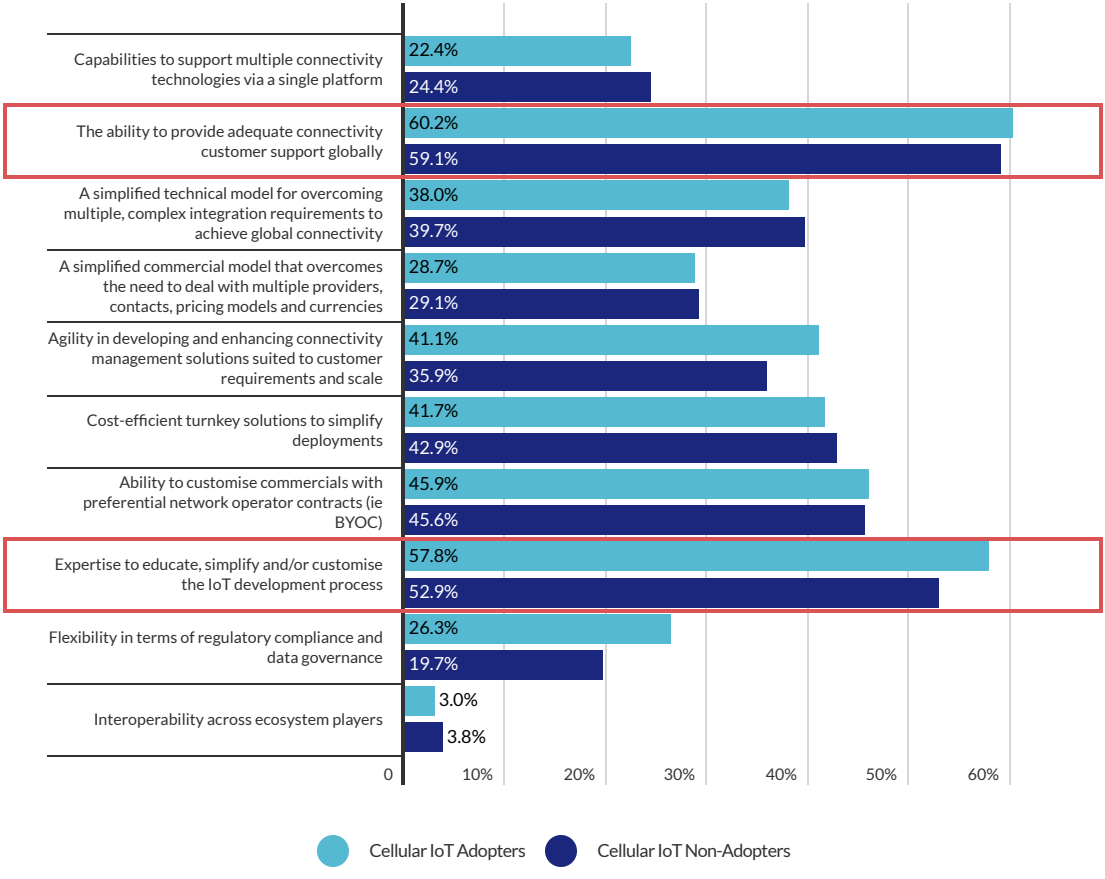
There are interesting differences when analysing response rates between those that have adopted cellular IoT, and those who have not. Here, **63% of cellular IoT adopters stated that 3GPP standards presented the most significant challenge, compared with 42% of non-adopters**. Evidently, the complexity of developing software and firmware solutions for devices is under-appreciated by those that have not yet adopted the technology and indicates a strong need for development expertise and professional services or solutions to smooth the path to project realisation. Meanwhile, **62% of cellular IoT non-adopters believe that rolling out devices internationally represents the greatest challenge for those stepping into the world of cellular IoT; here, adopters are in agreement, albeit to a lesser degree, with 52% of respondents reporting the same**.

The challenges of stepping into the cellular IoT world are further evident when survey participants were asked to select in which areas of the ecosystem they felt were lacking. It is notable that here, the top-ranked items, in addition to the proportional strength of the items selected, show a remarkable level of agreement between those who have adopted cellular IoT and those who have not.

What do you perceive as lacking in the present IoT connectivity ecosystem? (All Respondents)

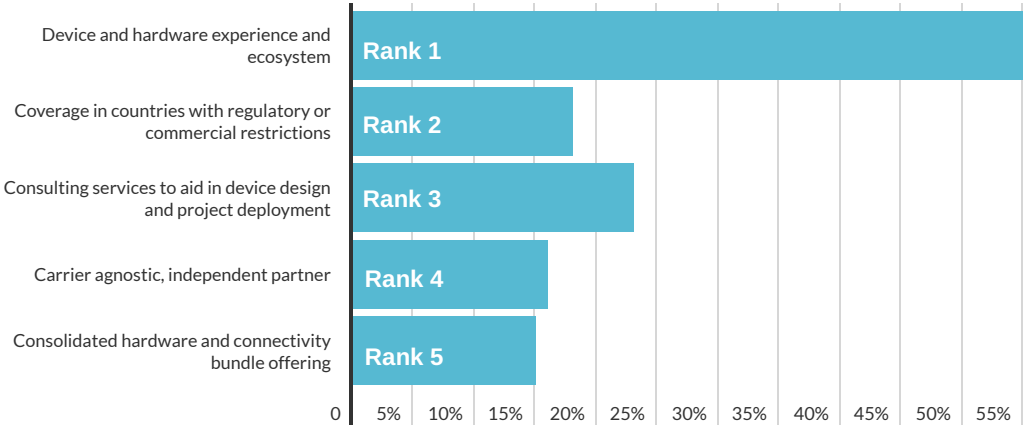


Here, one can observe that within the top four elements, a lack of professional services to simplify the IoT development process is perceived as missing from the ecosystem, in addition to a lack of turnkey solutions for deployments. The ability to deliver end-to-end turnkey solutions is undoubtedly something that is extremely difficult in IoT: the majority of projects are bespoke, with different outcome requirements, varied backend systems etc. While it is evident that this pain point is unlikely to be resolved in the near future, it is perhaps a telling statistic behind rationalising the absence of the 'hockey stick' projections for IoT growth made a decade ago.

More pertinent is the perceived inability of service providers to offer tools and professional services to help simplify customers' IoT journeys. While it is true that many Connectivity Service Providers (CSPs) simply focus on delivering connectivity services, several MNOs, as well as MVNOs, have made advancements over the years to offer expertise in the realm of hardware testing, software solutions to simplify cellular IoT connectivity optimisation, provisioning and authentication with external services in addition to offering professional services to guide enterprise customers from project conception to deployment. Nevertheless, as the ecosystem remains relatively fragmented, this expertise is likely only to benefit a limited proportion of the total enterprise customer base.

Looking deeper into where CSPs may well be able to pivot towards improved ecosystem expertise, we can turn to survey results examining what kind of capabilities enterprises look for in a CSP. The consensus here is overwhelming: **55% of the total respondent base ranked device and hardware experience as the number one capability that they would like to see from CSPs.**

What are the top 5 factors that you look for in an IoT connectivity partner's product? (All respondents; percentages indicate strength of response within a given rank)



Hardware remains a perennial challenge for cellular IoT customers, and, indeed, was ranked as a top challenge by cellular IoT non-adopters in 2022's survey results: earlier, we observed how standards complexity has impacted the ability to deliver software solutions for devices while enterprises must additionally grapple with varied chipset certifications, regulatory requirements and nuances in performance, price and optimisation between the many RATs within the cellular IoT ecosystem.

These factors, combined with a desire for more turnkey solutions to connectivity, help explain why respondents reported that a consolidated hardware and connectivity bundle is in their top 5 criteria for a CSP's capabilities. Meanwhile, **the ability to offer consulting services for device design and project deployment was ranked as a top 3 item by cellular IoT adopters, and as a top 2 priority among cellular IoT non-adopters**. This further underlines the need to offer expertise in the realm of hardware in addition to other areas of the ecosystem, and indicates a need for CSPs, if they are not able to offer such expertise directly, to form close partnerships with ecosystem actors that can offer potential customers a route to deployment simplification.

Sophistication - All Verticals

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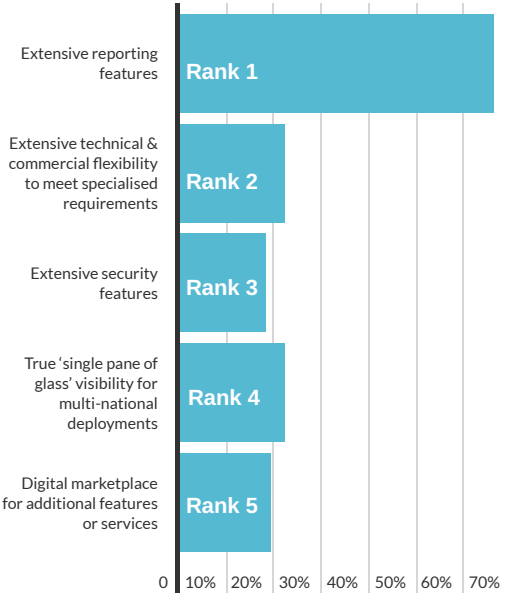
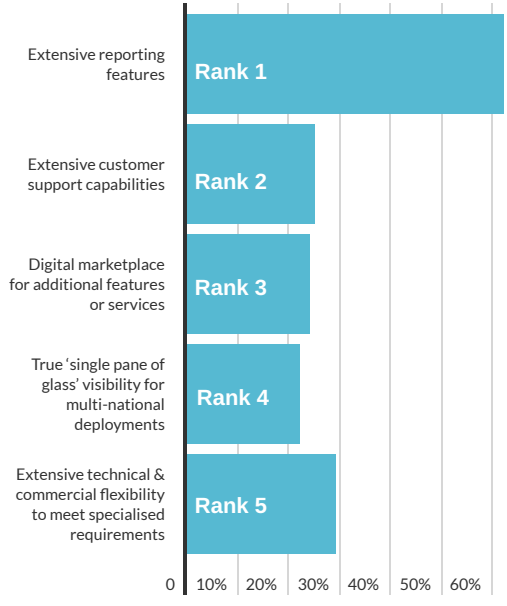
Despite the fact that the evidence points to the fact that many enterprises are in need of expert assistance when they wish to scale projects up or even enter the ecosystem, it is notable that from a broader perspective, enterprises are becoming increasingly sophisticated. Such sophistication can be found in results that in particular highlight a good understanding of the potential pitfalls involved with cellular IoT connectivity, in addition to a more concrete formulation of what the customer expects from its cellular IoT CSP.

In the latter case, it is evident that survey respondents believe that the connectivity solution must offer broad capabilities to allow the customer to extract detailed information regarding fleet activity. In the first instance, this can be observed by the fact that **66% of cellular IoT adopters and 62% of cellular IoT non-adopters ranked extensive reporting capabilities as their number one priority where CSPs' products are concerned**. Typically, Connectivity Management Platforms (CMPs) offer relatively limited information regarding fleet activity, offering stock reports concerning usage, inventory, provisioned/deactivated devices in addition to summary reports of top data-consuming devices or similar. Evidently, this information is no longer sufficient for customers: they wish to obtain visibility over devices' location, their roaming activity, greater depth in any OTA campaign activity as well as more detailed information allowing them to diagnose potential issues with SIM cards. While some cellular IoT CSPs have made good strides in this area, this level of detail is by no means pervasive in the industry.

What are the top 5 factors that you look for/would look for in an IoT connectivity partner's product? (Cellular IoT Adopters - left ; Cellular IoT Non-Adopters - right)





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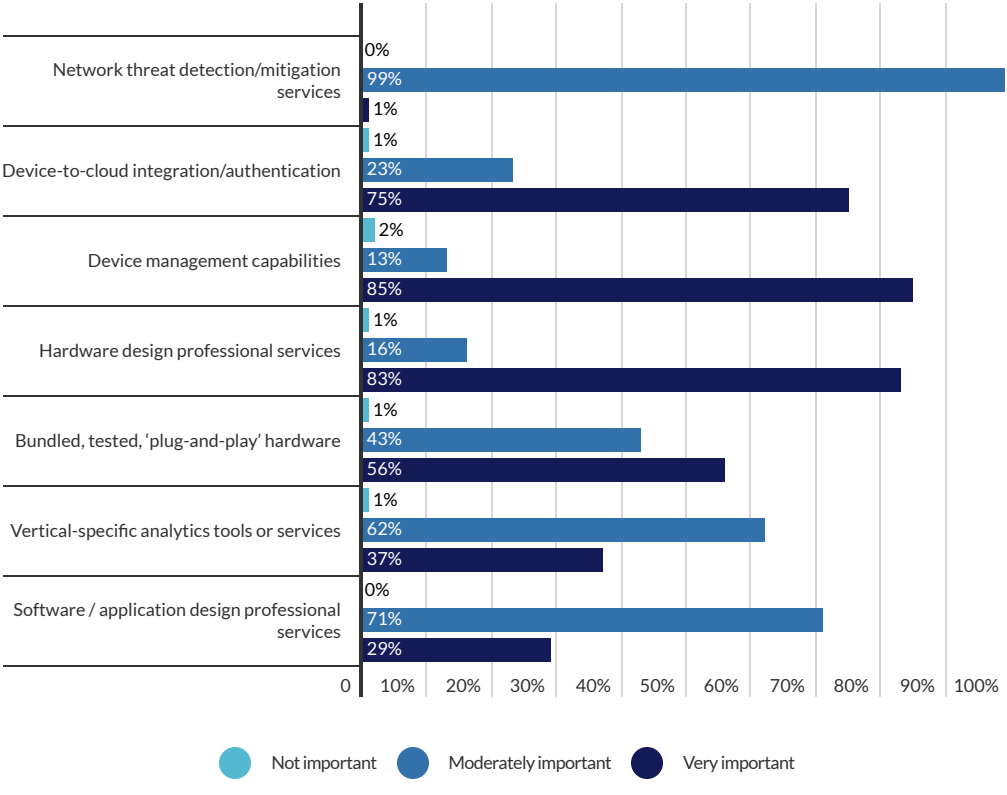
Ranking second highest in terms of CSP priorities among cellular IoT adopters is the ability to deliver a product with technical and commercial flexibility in order to meet specialised customer requirements. It is well-known that IoT projects are highly diverse and typically involve some form of international connectivity requirement. Both of these factors mean that rigid, legacy platforms are often viewed as no longer fit-for-purpose.

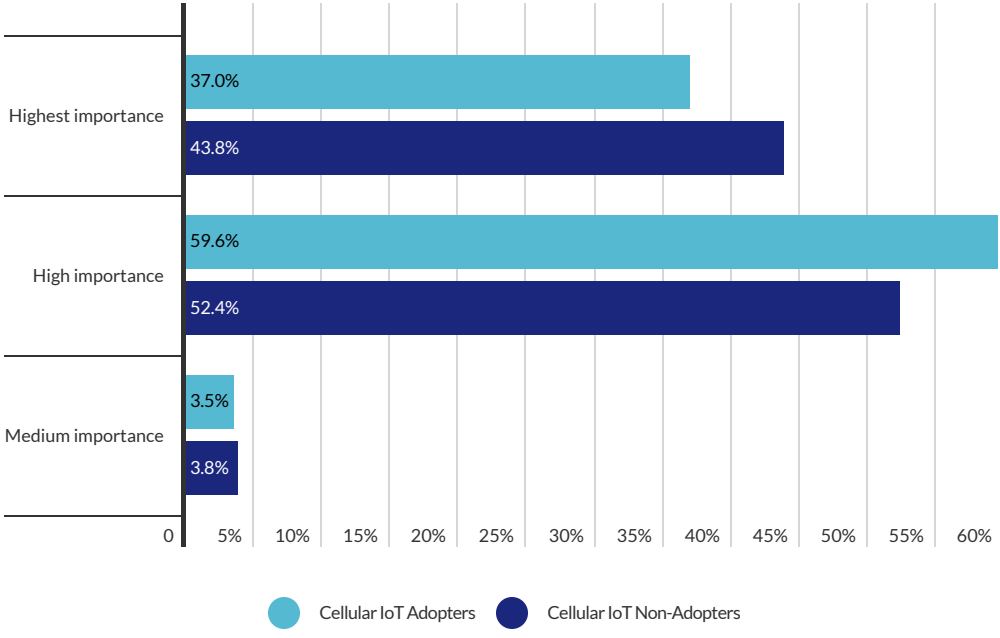
New requirements mean that back-end integrations with third-party services are often expected out-of-the-box in addition to other Value-Added Services (VAS), while CSPs are now expected to be able to overcome regulatory challenges in certain verticals and markets without handing much of the complexity to the end-customer. These elements can be observed through results that highlight a strong desire for device-to-cloud integration and authentication capabilities (75% of cellular IoT adopters rated this as very important), device management capabilities (85% of cellular IoT adopters rated this as very important) in addition to requirements such as security threat detection and mitigation capabilities (99% of cellular IoT adopters rated this as moderately important); with the latter proposition being rated as a top three product feature in terms of cellular IoT adopters' requirements from their CSP.

Beyond connectivity, what are the most important value-added services you expect your cellular IoT connectivity service provider to offer? (Cellular IoT Adopters)



Meanwhile, it is apparent that enterprise customers are becoming increasingly aware of and demanding CSPs' sustainable approaches to business. **Among cellular IoT adopters and non-adopters alike, the requirement that their CSP adheres to Environmental, Social and Governance (ESG) frameworks was reported as high importance by 60% and 52% of adopters and non-adopters, respectively.** Thus, it is evident that the choice of CSP among enterprises no longer simply focuses on capabilities and commercial factors but also the overall business practices employed by the service provider. That said, adherence to ESG frameworks does not take overall priority over service provider choice: here, capabilities and product proposition take priority. Therefore, it is important to understand that CSPs must be both capable as well as progressive in terms of the overall business proposition.

How important is that your connectivity partner actively adheres to sustainable (Environmental, Social and Governance) frameworks? (All Respondents)



Roaming - All Verticals

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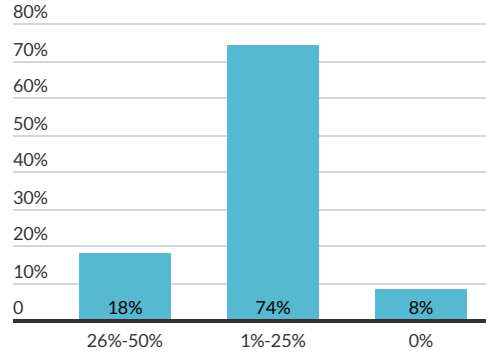
In a similar fashion to last year's survey, roaming and international connectivity needs form a key theme in terms of pain points and needs among enterprises. Cellular IoT roaming is markedly different to traditional handset travel-based roaming in terms of both the behaviour of devices roaming, in addition to the length of time spent outside of the home network. Indeed, many IoT devices begin and end operations using network connectivity in roaming scenarios, and often spend years in the visited network. This practice, described by the industry as permanent roaming, has become a major topic of contention in some countries over the years, both among regulators as well as incumbent MNOs. The onset of the COVID-19 pandemic provided further fuel in terms of igniting the debate: as leisure and business travel ground to a halt during widespread lockdowns, many operators were surprised to find that a substantial number of International Mobile Subscriber Identities (IMSIs) were still active on an inbound roaming basis, effectively uncovering the scale of cellular IoT roaming globally. **In 2022, Kaleido estimates that nearly 360 million cellular IoT connections were roaming globally: this number is expected to increase to over 1 billion by 2028, highlighting that any contentious issues that exist today are only likely to increase in future.**

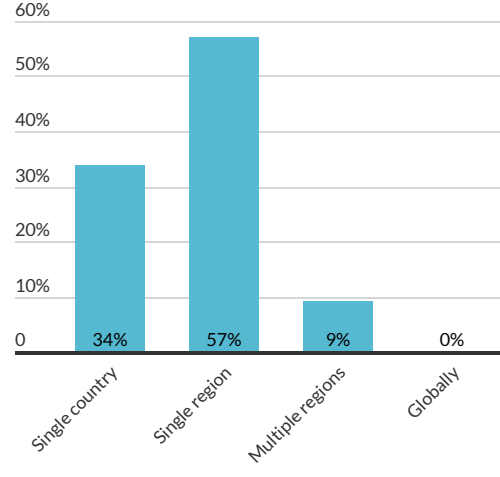
The survey further underlines the prevalence of international connectivity, and roaming requirements. **Less that 8% of cellular IoT adopters reported that they have no requirements for international connectivity support, with 74% of respondents stating that up to a quarter of their connected devices require international connectivity.**

What proportion of your organisation's cellular IoT device fleet requires international or multi-regional connectivity? (Cellular IoT Adopters)



Cellular IoT non-adopters were posed a similar question regarding their intentions for forthcoming cellular IoT deployments. Here, **66% of the respondent base anticipates that their devices' connectivity will span networks across more than one country.**

How do you expect your organisation's forthcoming IoT devices to be distributed? (Cellular IoT Non-Adopters)



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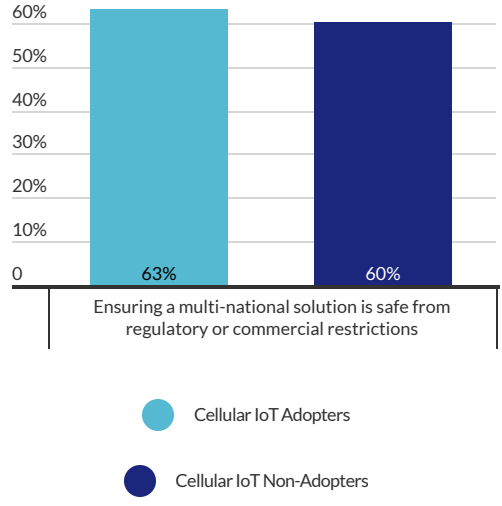
Several countries have now developed IoT regulatory frameworks, which sometimes explicitly or indirectly forbid the practice of permanent roaming. In such instances, regulations will effectively mandate some form of local connectivity, such as local SIM, an eSIM profile or IMSI provided by a local operator and, depending on the specifics of the regulation, potentially require that the CSP has a local presence in the country of operation. Meanwhile, some countries, such as China, have implemented rules concerning cross-border data flows. In most cases, this effectively means that a local operator must provide connectivity services unless an international player is able to establish a presence as well as data infrastructure in the country in question.

Hostility towards permanent roaming is not limited to regulatory authorities. In several countries across the world, incumbent operators are increasingly enforcing limits on the number of connections that are allowed to roam inbound, or disallowing the practice altogether.

The result of this changing environment means that long-term IoT connectivity projects may be viewed as risky, given that over a 10-15 year period, regulations or incumbent operator attitudes to permanent roaming may become less favourable, thus requiring expensive remediating action. Enterprises surveyed have certainly recognised this risk: **63% of cellular IoT adopters and 60% of cellular IoT non-adopters reported that ensuring that their international deployments are safe from commercial or regulatory risk is their top most important concern where connectivity is concerned.** This underlines the need for a flexible approach from CSPs: SIMs must, in the majority of cases, have the capability of being updated over-the-air (OTA) in order to allow for more appropriate operator profiles or IMSIs to be used, if they are going to be roaming on a permanent basis. Meanwhile, the onus is on CSPs to ensure that, where regulatory constraints are not present, commercial agreements have been made with incumbent operators to ensure that long-term viability for connections is assured.

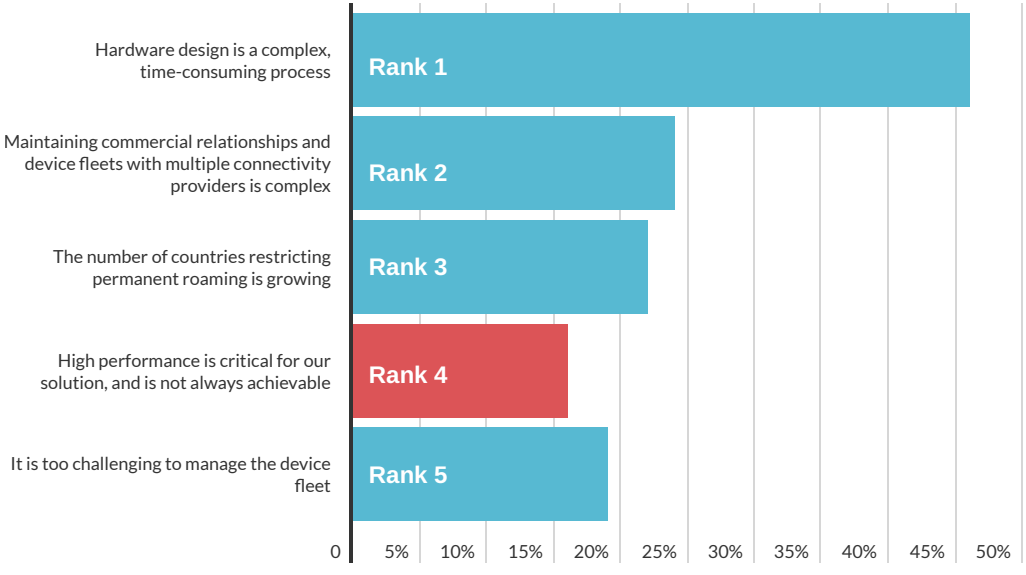
What are your top 5 factors that are most important where IoT connectivity is concerned? - Rank 1



Challenges with roaming are not limited to issues associated with permanent roaming. As observed earlier, enterprises are becoming more sophisticated and demanding in terms of IoT connectivity requirements. In an international context, this means that new performance requirements are emerging which is not capable of being addressed via traditional roaming architecture. For instance, low latency use cases, high bandwidth devices etc, cannot efficiently be addressed by traditional roaming architecture, which routes traffic from the visited operator back to the home operator and then back to the end-device in a process called 'tromboning'.

Tromboning increases both latency as well as the cost of data traffic transport, which is undesirable in specialised IoT scenarios. Here, it is preferable that the CSP is able to avoid this by establishing local or regional breakout services, which allows latency to be reduced as well as reducing transport costs. CSPs themselves may run into issues here, depending on if they have ownership of their own distributed core network infrastructure; the lack of which will remove the direct ability of the CSP to monitor wholesale billing metrics in addition to visibility and management of the roaming session of the end-device. Thus, ownership of several PGW or UPF instances on a regional or global basis is a key differentiator in today's market, where more demanding IoT use cases are emerging. Evidently, many enterprises wish to leverage new approaches to international connectivity: in a separate 2022 survey conducted with Deutsche Telekom Global Carrier, Kaleido found that 93% of CSPs reported that they have had customers with low latency requirements for international IoT connectivity. In this survey, it is apparent that many enterprises continue to perceive the ability to meet these capabilities is lacking: **both adopters and non-adopters stated that high performance is not always achievable, and ranked this as a top four issue behind challenges in scaling IoT up.**

What do you perceive to be the top 5 challenges where scaling up cellular IoT connectivity deployments is concerned? (All Respondents)



eSIM - All Verticals

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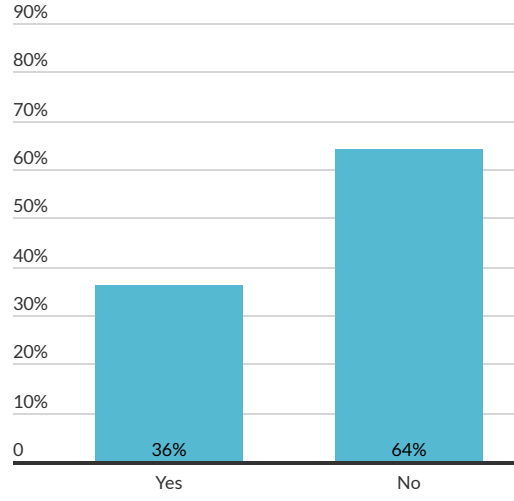
Although a standardised specification for eSIM has been in existence for close to a decade, the technology has been relatively slow to gain traction in the IoT world. In part, this is due to the complexity associated with the specification originally designed for IoT devices, dubbed SGP.02, or the 'M2M' specification. While the vision behind eSIM has played on the potential to switch operator profiles OTA, technical, commercial and legal barriers have largely prevented this practice from taking place. In essence, the majority of eSIM-enabled cellular IoT devices have remained in 'insurance mode' where leveraging the Remote SIM Provisioning (RSP) infrastructure necessary to execute profile swaps is only anticipated to be used in instances where regulations or considerable commercial restrictions make it necessary. Therefore, eSIM deployments have largely been considered a mechanism to avoid the long-term risk associated with IoT connectivity. Meanwhile, the additional expense associated with eSIM hardware and digital profiles has meant that, in an industry vertical context, automotive was the main customer for eSIM.

Over the past few years, the situation has begun changing. Industries beyond automotive have begun realising the long-term value of eSIM, while the mobile industry has carried out work on developing a new specification (SGP.32 – dubbed the 'IoT' specification) that is more aligned with the relatively simple RSP architecture in use for consumer smartphones and other mobile-enabled devices.

In the context of the survey, some **36% of cellular IoT adopters reported that they use eSIM as part of their IoT connectivity deployment**, which highlights that the technology has yet to become pervasive across the IoT ecosystem.

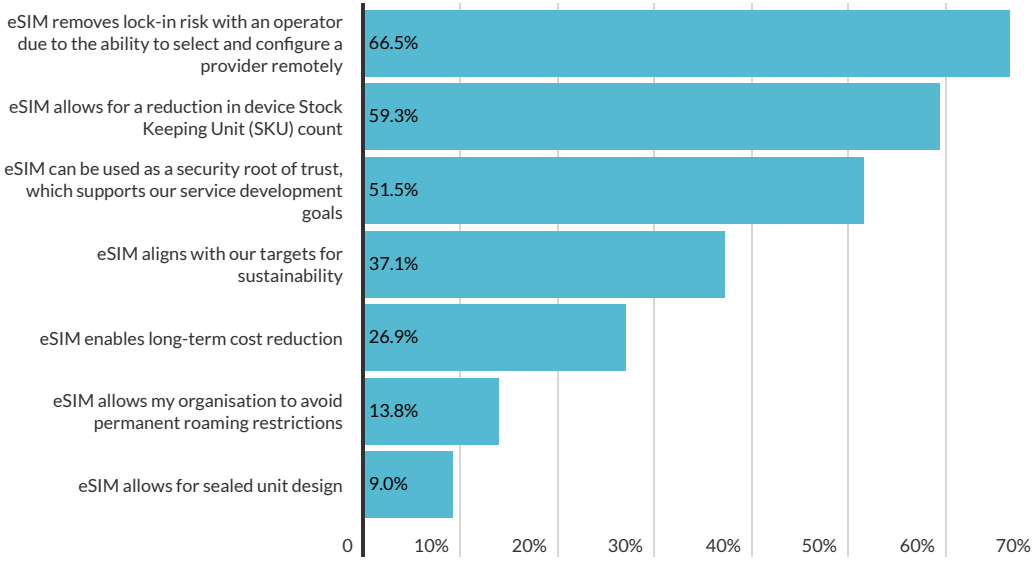
Have you decided to use eSIM (eUICC) as part of your IoT deployment? (Cellular IoT Adopters)



The primary reason behind choosing eSIM is, not unexpectedly, the ability to mitigate risks associated with being locked in with a single operator, and was cited by 66% of those who have adopted eSIM. Importantly, it is apparent that this is not the only reason for choosing eSIM, with 57% of respondents claiming their decision was based on the ability to reduce the number of device Stock-Keeping Units (SKUs) on the production line. Here, it is pertinent to note that without the capability to optimise device connectivity OTA, different device configurations with different SIM cards targeting varied countries or regions are often produced at the point of manufacture.

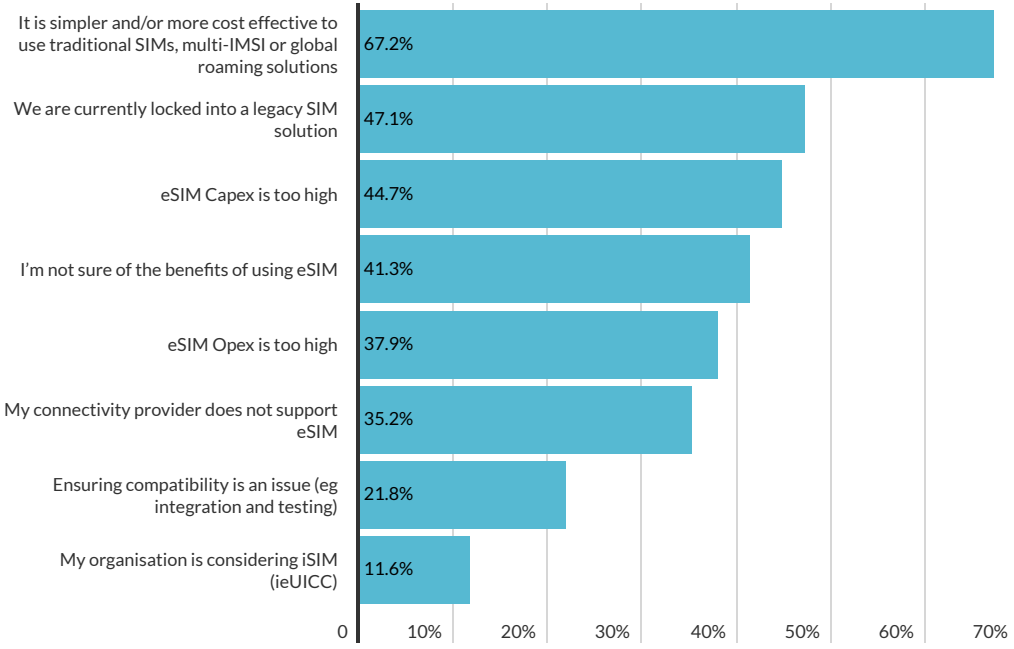
Naturally, this increases complexity and costs; despite the additional costs involved with an initial eSIM deployment, avoiding this complexity at the production line can be highly beneficial to IoT customers. Meanwhile **51% reported that eSIM can be leveraged as a root of trust**, which is important in a security context. By leveraging industry frameworks such as IoT SAFE, eSIMs can be used to guarantee device identity, as well as ensure that data integrity between the device and connected third-party services has not been compromised.

What factors made you choose eSIM (eUICC)? (Cellular IoT Adopters)



The 64% of cellular IoT adopters who stated they had not used eSIM for connectivity were questioned on their reasons for not adopting the technology. Given the imminent emergence of the IoT specification during summer 2023, the results provide an interesting juxtaposition, given that this development is almost certainly not broadly understood by the majority of enterprises. 67% of respondents reported that they felt it is simpler or more cost-effective to use solutions such as traditional roaming SIMs, multi-IMSI SIMs or global roaming solutions. While this might be the case where the use of the M2M specification is concerned (if one ignores the high costs involved with remediating and regulatory or commercial issues encountered with international connectivity), the new IoT specification has been developed with reduced complexity in mind, and will thus make OTA profile switching a less painful process for customers.

Why have you chosen not to use eSIM (eUICC)? (Cellular IoT Adopters)



Nevertheless, challenges related to eSIM costs, whether Capex-related (45% of respondents) or Opex-related (38% of respondents), remain significant points of concern. The physical cost of eSIM will always be higher than legacy UICC cards (removable or embedded non-eSIM cards) due to the additional memory utilised for storing more than one operator profile on the card itself. The prevalence of iSIM (a SOC-integrated form factor of eSIM) will certainly reduce this cost, although iSIM is not anticipated to gather industry traction until around 2025. Meanwhile, other costs associated with eSIM, such as digital operator profiles, set-up fees and fees associated with OTA operations are dependent on both economies of scale being reached from a service provider perspective in addition to widespread recognition of the benefits of eSIM and associated action taken to encourage its use among the broader MNO community which, in many cases, will only play a role at the wholesale level where providing profiles is concerned.

WALBING

Walbing's next-generation platform integrates trade finance services for seamlessly embedding financial services into marketplaces, e-commerce businesses and SaaS providers

The Problem

Many businesses still rely on manual and error-prone processes for payments, like letters of credit, paper invoices, and checks. The lack of visibility into the status of shipments and payments can make it hard to plan production and financial capacities. Long payment terms can lead to cash flow problems for small businesses and accessing liquidity and working capital can be a challenge for small and medium-sized businesses.

Uncertainty of payment and delivery can also create difficulties for businesses, as they may not be able to accurately plan for future expenses or production needs. International trade traditionally relies on letters of credit, a financial instrument that guarantees payment to the seller and delivery of goods to the buyer. While they provide payment security, dependence on their guarantees and bank conditions can add additional complexity and risk to the payment process, further highlighting the need for automation and digitization.

To address these challenges and help businesses streamline their payments, Hamburg-based FinTech Walbing has released a brand-new solution: Track & Pay – a digital alternative to the letter of credit driven by IoT technology.

Walbing's Track & Pay

Walbing offers B2B companies innovative integrated FinTech and InsurTech solutions, including Track & Pay (TnP) – a fully digital and automated payment solution that replaces the letter of credit and raises the security bar in trade payments. The service is aimed at simplifying the payment process and increasing transparency between suppliers and buyers.

With TnP, the purchase contract parties can set up and agree upon custom payment conditions (a TnP agreement) in accordance with shipping parameters such as geolocation, temperature, humidity, and shock. Customers transfer the purchase grand total to a secure escrow account and, once the TnP agreement conditions are fulfilled and the shipment is delivered in good order, the supplier receives an automatic payout.

With real-time updates on the shipment status, TnP helps improve transaction transparency and automate and accelerate payouts to the supplier. Overall, Track & Pay is a game-changer that streamlines payment processes and helps businesses focus on growth.

How does the Smart Label help?

To measure the shipment data in real time, Walbing employs tracking devices that can satisfy a complex set of supply chain requirements. These include the use across multiple modes of transportation and the availability of sensors for measuring an array of physical parameters.

The Smart Label, a joint offering from SODAQ, Lufthansa Industry Solutions, and Pod Group – a Giesecke+Devrient Company, ticks all these boxes. Boasting an innovative printed battery for minimal weight, the Smart Label also includes a location tracker, temperature sensors, and accelerometer. The paper-thin label developed by SODAQ can be applied to any surface, even items as small as an envelope, making it an ideal device for TnP.

The LEAP platform from Lufthansa Industry Solutions receives data transmitted by the sensor in the label, so the established payment conditions can be easily checked. The data transmission by the Smart Label provides increased visibility and control over the shipment process.

Pod Group equips the Smart Label with connectivity using a eSIM that connects to LTE-M, a low-power 5G technology. This low power usage prolongs the label's battery life to up to 6 months and ensures maximum uptime along the supply chain. The real-time tracking helps set a new standard for secure and reliable international trade in the TnP framework.

The Result

Thanks to the combined capabilities of the Smart Label and TnP, businesses can increase transparency with their suppliers, experience an enhanced level of security when it comes to payments, and improve their bottom line.

"We believe in Track & Pay's ability to revolutionize the global finance supply chain, offering a much more secure and fraud-proof solution than the common letter of credit," says Joerg Hoerster, founder and CEO of Walbing. "The Smart Label's slick size, active tracking capacity, and reusability make it a competitive candidate for the selection of trackers we'll offer to our TnP clients."

"Pod takes pride in its pivotal role in promoting precise supply chain tracking for critical applications, while also eliminating the need for laborious manual processes," says Sam Colley, CEO of Pod Group. "This demonstrates how Pod can simplify the deployment of essential IoT applications, by delivering dependable, affordable and forward-looking connectivity."

pod group
A Giesecke+Devrient Company

Giesecke+Devrient
Creating Confidence

Private LTE/5G - All Verticals

Kaleido Intelligence

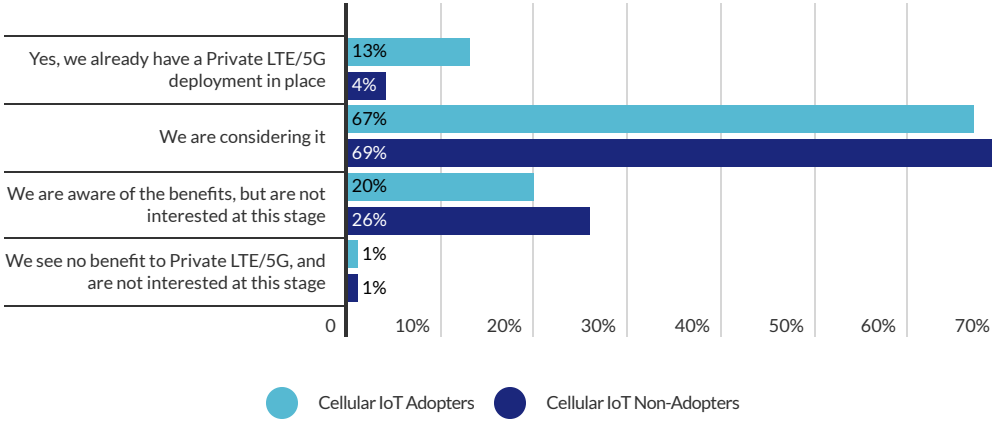
Private cellular networks represent a significant opportunity for service providers and enterprises alike, owing to the increased flexibility and reliability afforded by cellular technology over alternatives such as Wi-Fi and wired connectivity. As of the end of 2022, Kaleido has found that over 2,500 private cellular networks are in operation globally, with this number expected to increase to nearly 29,000 by 2028. Several factors have contributed to the increase in interest and demand for private cellular networks, including the availability of dedicated spectrum for enterprise use cases in several countries, the absence of 5G network slicing services available to potential enterprise customers, in addition to increased digital transformation initiatives across several industry verticals that require features such as higher bandwidth, better reliability or support for large numbers of devices, or features not enabled through non-cellular technologies, such as the ability to maintain connectivity both inside as well as outside the private network coverage area.

Nevertheless, the deployment of private cellular networks remains a complex process. Regulatory frameworks for spectrum access in countries that have made dedicated enterprise spectrum available are inconsistent, while pricing varies considerably. In many countries, the only route to spectrum access is through MNO channels, which in itself is broadly inconsistent in terms of how incumbent MNOs are approaching the market, and how they price leased access to spectrum. Meanwhile, the range of devices suited to private LTE or 5G is dependent on support for specific spectrum frequency ranges, which means that hardware choice can pose a challenge to customers.

Finally, enterprises must navigate a complicated ecosystem of actors to build a complete solution, and must heavily rely on third-party expertise. It is certainly the case that while interest in private cellular networks is high, education and understanding of the journey still have some way to go in terms of improvement: in extreme cases, Kaleido has heard of instances where enterprises were unaware that SIM cards are required in order to connect to the private network.

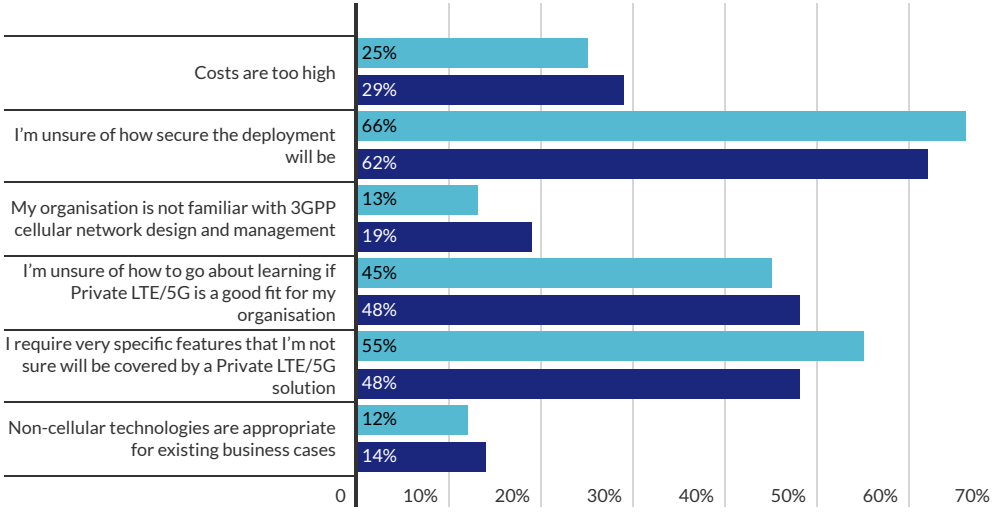
Private LTE or 5G adoption among survey respondents remains relatively low: **13% of cellular IoT adopters reported they have a solution in place, with 4% of cellular IoT non-adopters reporting the same** (it should be understood here that private cellular does not always focus on IoT; thus it is possible for IoT non-adopters to have a deployment). Nonetheless, **interest is considerable: 67% of cellular IoT adopters stated that they are considering a future deployment, compared to 69% of cellular IoT non-adopters.**

Does your business unit have an interest in Private LTE/5G to enhance business operations? (All Respondents)



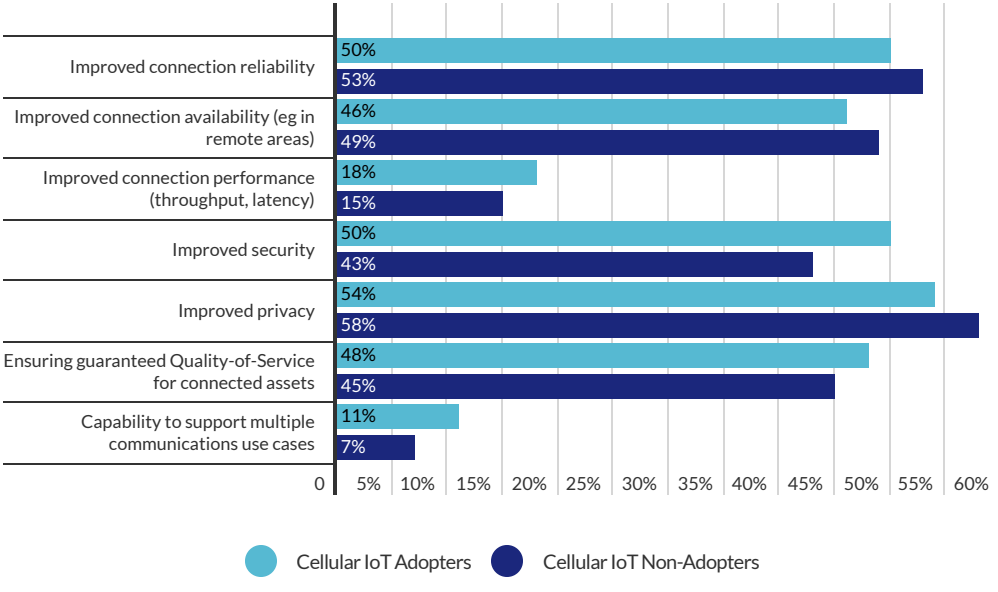
In similar fashion to results produced in 2022's survey, concerns over private LTE or 5G security remain top-of-mind among both cellular IoT adopters as well as cellular IoT non-adopters. From a superficial level, this might seem a bizarre statement to make, considering the fact that private networks are, by design, typically more secure than public networks. On the one hand, this may well speak to a lack of education or understanding in terms of how corporate security policies can be applied to private LTE or 5G networks, while on the other, one can infer that respondents have concerns over the potential security of emerging private network architectures, where the core network is located off-site, or where devices 'roam in' and 'roam out' of private network coverage zones. Nonetheless, the hypothesis over the lack of enterprise understanding and education of private LTE and 5G is confirmed when examining other results: **45% and 55% of cellular IoT adopters stated that they are missing knowledge where deployment suitability as well as features are concerned, respectively.**

What are your main concerns over a potential Private LTE/5G deployment? (All Respondents)



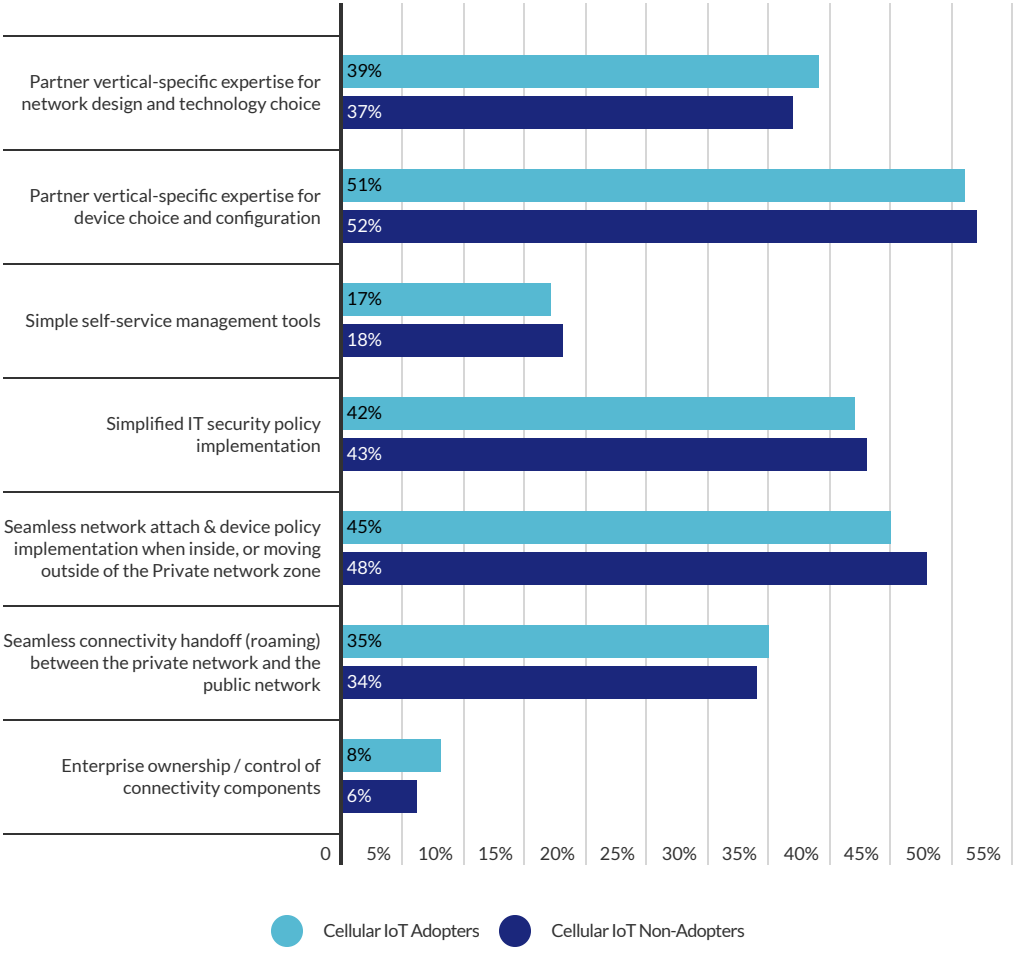
Delving deeper into the data helps build a clearer picture of enterprises' understanding of private networks: **improved security and privacy were cited as key benefits by 50% and 54% of cellular IoT adopters, respectively, and 43% and 58% of cellular IoT non-adopters, respectively.** This serves to support the hypothesis that enterprises are concerned over the security of emerging private network architectures, as described earlier.

What do you perceive to be the main benefits of a Private LTE/5G solution? (All Respondents)



Clear pain points are revealed when asking respondents what the main points for consideration are where private LTE or 5G are concerned. Here, **51% of cellular IoT adopters and 52% of cellular IoT non-adopters reported a need for expertise covering device choice and configuration, which brings back the issue of hardware complexity described earlier in the report.** Notably, a significant proportion of respondents have concerns over network attach capabilities and device policy implementation inside and outside of the private network coverage zone: maintaining both a seamless experience as well as a consistent security policy is evidently top-of-mind where private LTE or 5G deployments are concerned. Both of these factors represent challenges for the industry at large, given the lack of 3GPP standardisation where private and public network attach policies are concerned (some devices must be manually moved between networks, which is not suited to machine-type use cases), while security policy implementation presents a different set of challenges.

What are the most important factors for consideration where Private LTE/5G is concerned? (All Respondents)



Kaleido Intelligence

IoT Connectivity Challenges & Opportunities:

Transport and Logistics

bics Kigen pelion pod group
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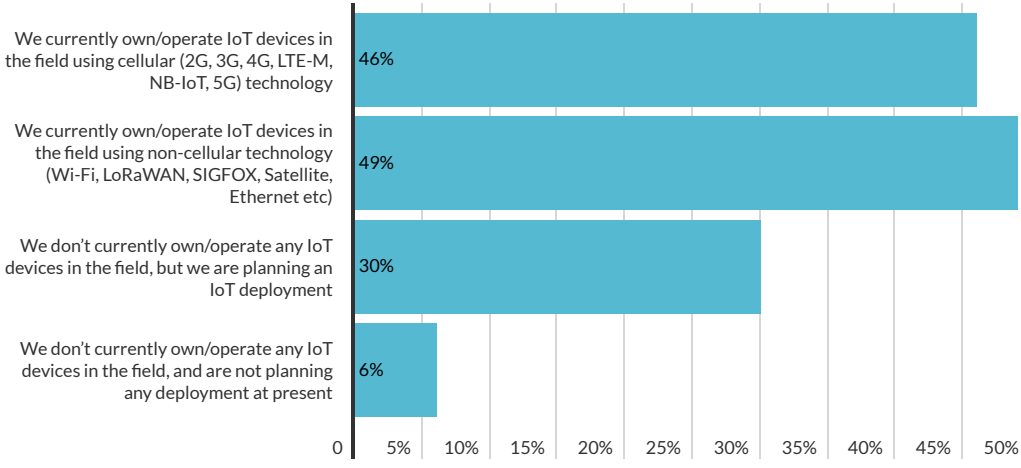
State of IoT - Transport/Logistics

Kaleido Intelligence

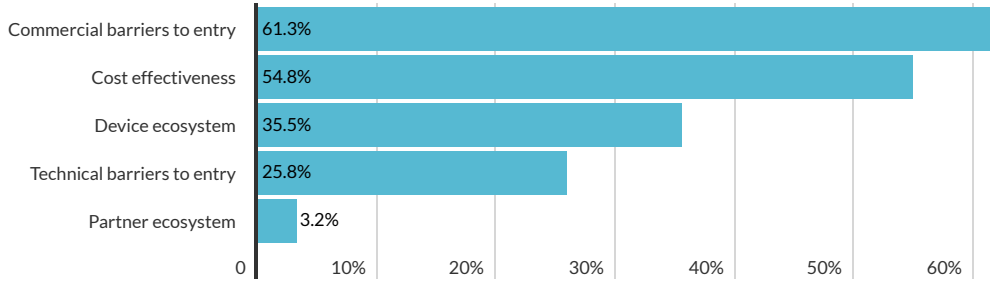
The transport industry has huge potential as a market for cellular IoT, with highly mobile assets that need a ubiquitous infrastructure. However, the vertical shows the least amount of cellular IoT adoption among those surveyed – **46% of transport respondents report they currently operate a cellular IoT deployment, slightly less than report owning and operating non-cellular IoT device**s. Both technologies are likely to grow together in this industry, as similar proportions consider at least one form of unlicensed wide-area connectivity suitable for their needs.

Does your business unit currently have an IoT deployment or proof-of-concept underway that uses 3GPP cellular radio technology (2G/3G/LTE/5G)? (All Respondents)



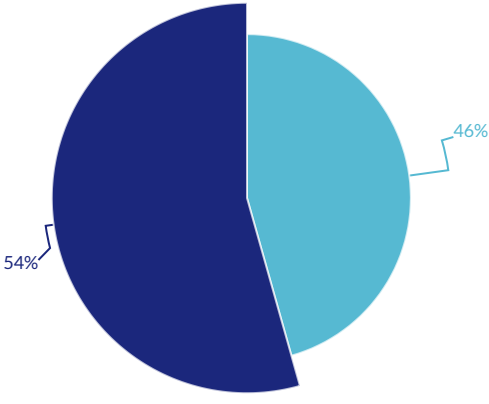
The technologies will also coexist, as **41% of current cellular IoT adopters indicate that they use at least one form of unlicensed LPWAN, and 45% indicate they also use fixed-line communications**. Meanwhile, **55% of future adopters report that they consider both cellular and unlicensed technologies suitable for their IoT deployments.** Service providers need to be able to offer multiple forms of connectivity if they are to cover all of a client's potential use cases, particularly in the low-power arena. However, **the biggest challenge for cellular connectivity may be commercial rather than technical. 61% of those who consider cellular technology unsuitable for IoT deployments consider commercial barriers a reason, while only 26% think the same of technical barriers.** It is, therefore, clear that there are some business model issues discouraging usage by this sector rather than the technical difficulties of implementation.

Why do you perceive cellular connectivity as unsuitable for IoT deployments? (Cellular IoT Non-Adopters)



In terms of service providers, **MVNOs are the most common type of service provider among current users by a slim margin (56% of adopters in the transport industry). However, while only 14% of respondents planning a cellular IoT deployment have not approached MVNOs for their connectivity, 23% have already chosen an MNO as their provider, while none have firmed up relationships with MVNOs in the same way. MNO service providers are primed to make a comeback in the IoT space in the coming years.**

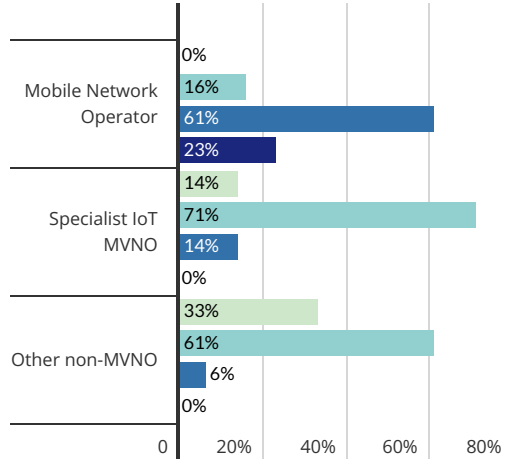
What type of connectivity service provider have you chosen to engage with for your cellular IoT deployment? (Cellular IoT Adopters)



A mobile network operator(s)

A mobile virtual network operator(s)

What types of organisations are you considering approaching or have you approached for your IoT connectivity needs? (Cellular IoT Non-Adopters)



Have not considered approaching/Not approached

Considered approaching

Have approached

Have selected as connectivity provider

bics

Kigen

pelion

pod group
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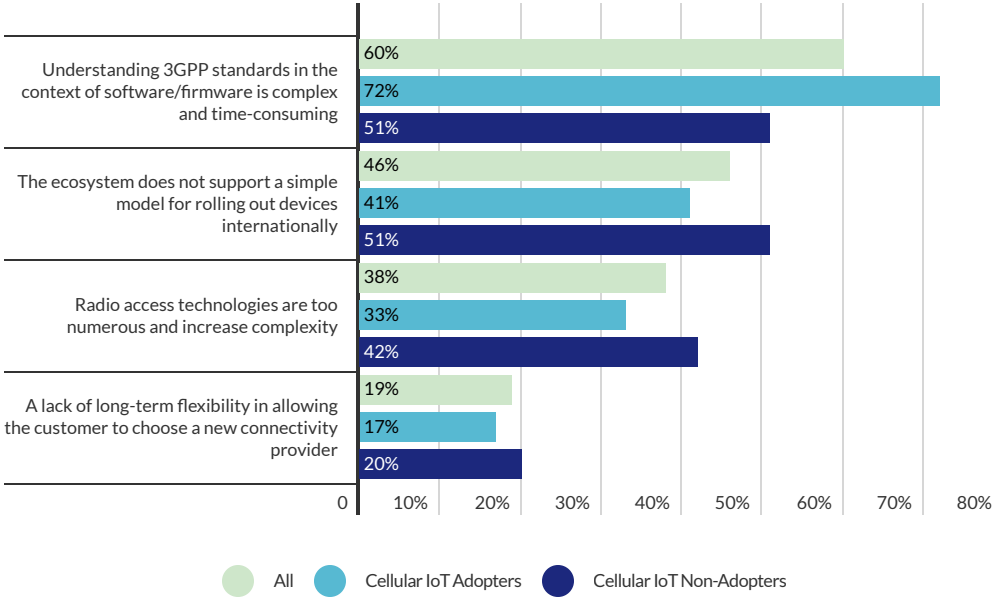
Complexity - Transport/Logistics

Kaleido Intelligence

Different forms of radio technology are only one part of the complexity of the IoT for transport and logistics companies and not the biggest concern. Only 38% of respondents perceived the number of RATs available for cellular deployments to be one of the main challenges to using the technology in the first instance. Instead, they reported that 3GPP standards implementations through software as the biggest challenge.

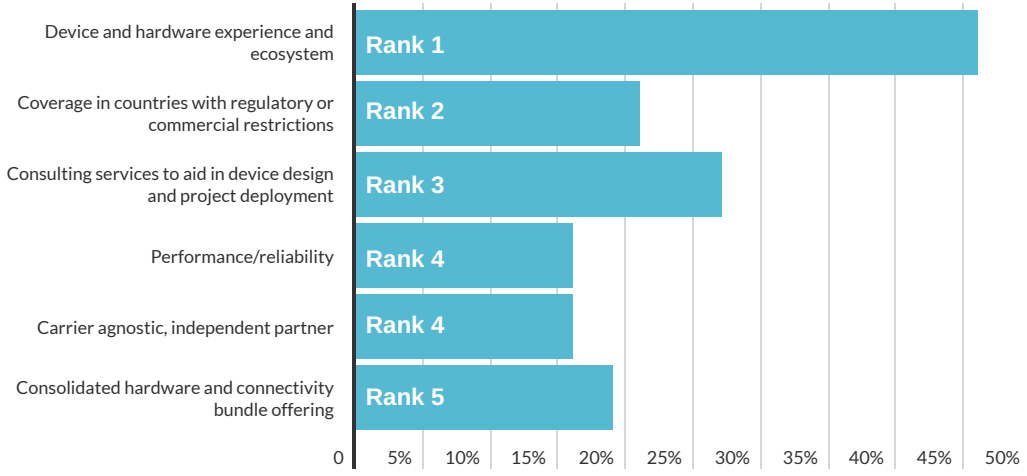
What do you perceive as the main challenges for organisations wishing to leverage cellular technology for IoT connectivity for the first time? (All Respondents)



This is mirrored in the hardware space, with **the challenge of hardware design being the biggest in the cellular IoT space for manufacturers, although felt more acutely in his space, with 60% of respondents naming it the number 1 scaling challenge.**

As a result, logistics providers want hardware assistance in their deployments after the basic connectivity needs are met. Consultative device design and capabilities rank number 3 in what respondents look for in a connectivity partner's capabilities, and hardware and software bundling features in the top 5 capabilities that 50% of respondents look for, although it only ranks highest at number 5. **This indicates the desire for a more customised solution rather than off-the-shelf products, a fact reinforced by 54% of current users and 47% of future users noting that vertical-specific solutions are one of the main non-technical influences in selecting a connectivity provider.**

What are the top 5 factors that you look for/would look for in an IoT connectivity partner's capabilities? (All Respondents)



Cellular IoT Adopters: Ability to provide vertical-specific solutions importance in choosing a connectivity provider

54%

This industry also wants general ongoing support to deal with the complexity; customer support ranks second in product features transport and logistics professionals look for in a connectivity product, while **62% believe that adequate expertise to simplify the IoT development process is lacking.** This is closely followed by an absence of global connectivity customer support, and a simplified technical model for global integrations.

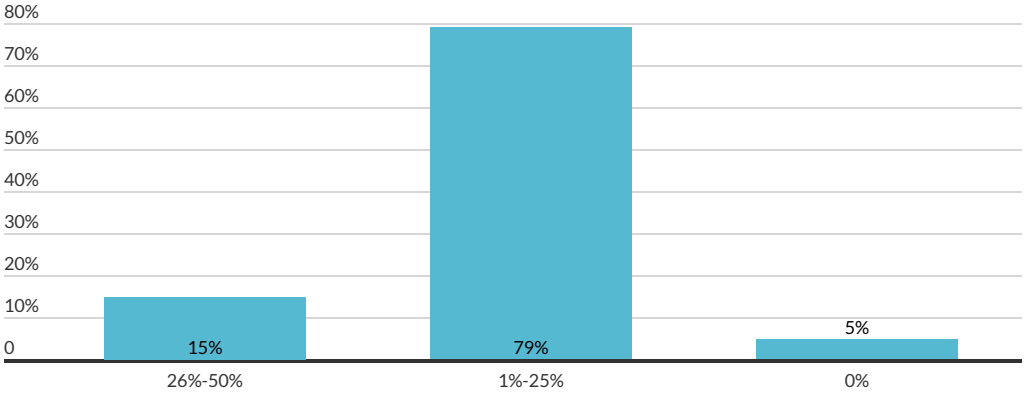
Several respondents may be resolving this complexity themselves; maintaining relationships with multiple connectivity providers is ranked the 2nd biggest challenge for scaling cellular IoT, but only 5th by adopters.

Cellular IoT Non-Adopters: Ability to provide vertical-specific solutions importance in choosing a connectivity provider

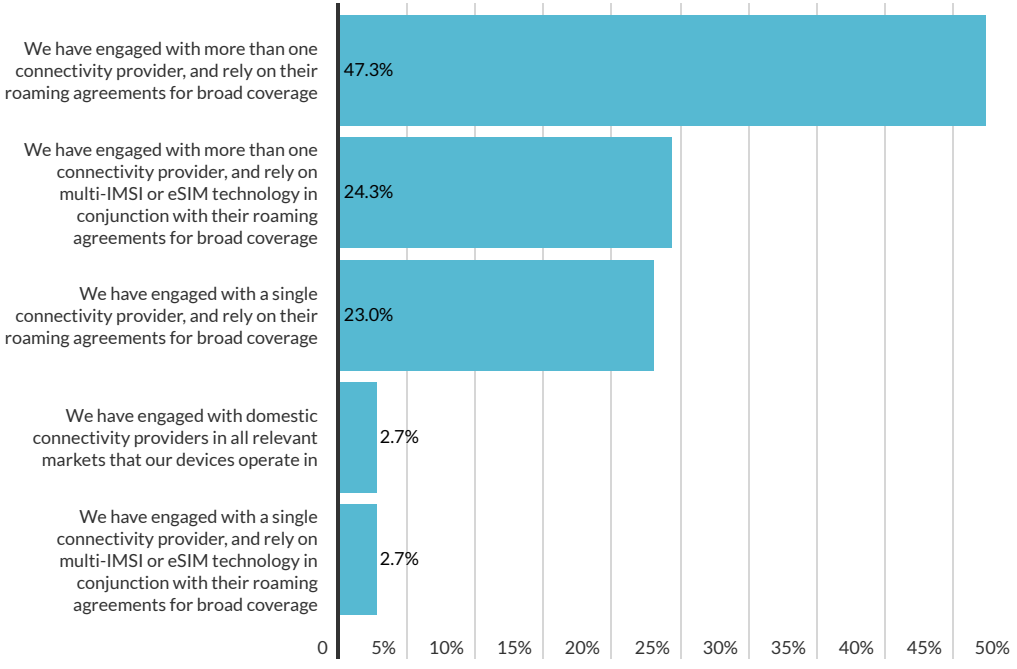
47%

This is because companies with a larger proportion of their device fleet operating internationally are actually less likely to engage multiple providers, with 42% of respondents with more than a quarter of their devices operating internationally reporting that they only engage a single provider, while only 22% of those with a smaller multinational commitment say the same. However, these smaller-scale multinational commitments are far more common, with **72% of all respondents using more than one connectivity provider in some way to cover their international connectivity requirements.**

What proportion of your organisation's cellular IoT device fleet requires international or multi-regional connectivity (Cellular IoT Adopters)



How has your organisation addressed this international cellular IoT connectivity requirement? (Cellular IoT Adopters)

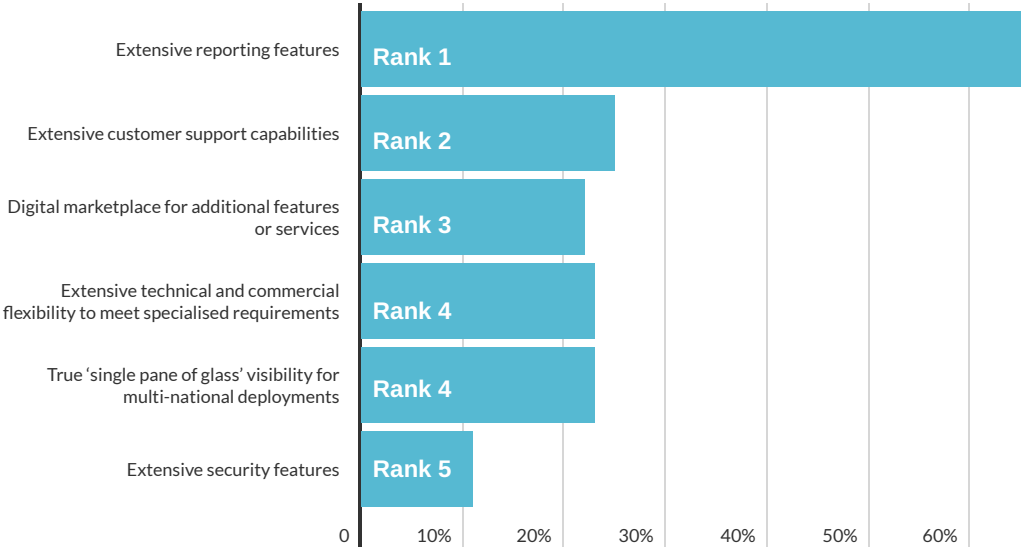


Sophistication - Transport/Logistics

Kaleido Intelligence

The level of desire for customer support and custom solutions noted in the previous section means that connectivity providers need to offer increasingly sophisticated services, with the need for ongoing support increasingly important. This customisation need is also reflected in the desire for a range of services, with **22% of respondents ranking a digital marketplace at number 3 in factors they look for in a connectivity partner's product** and 39% listing it in their top 5 important factors overall. However, it should be noted that only 35% of cellular IoT adopters who put a digital marketplace in their top 5 features actually expect their connectivity VAS portfolio delivered in that manner. The important thing here is clearly that there are multiple options available to deal with complex needs, not the marketplace in itself.

What are the top 5 factors that you look for/would look for in an IoT connectivity partner's product? (All Respondents)



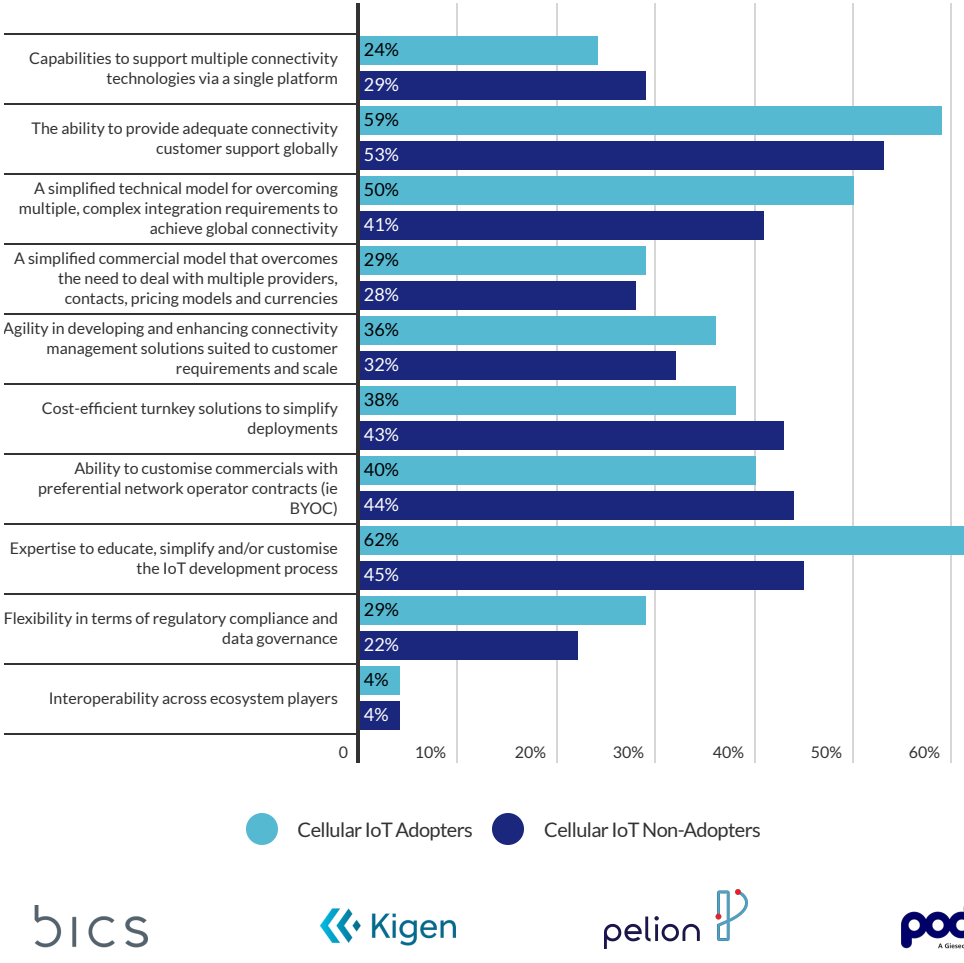
What respondents actually want in a product is detail and the ability to ask more questions if required – extensive reporting capabilities are the clear first choice, being one of only 2 factors to score more than 10% for rank one in what factors respondents consider most important. The other top scorer, extensive self-service, is only in the top 5 factors for under half of respondents, and so while these are strongly desired by a particular subset of respondents and there is a potential market for this, it is not the majority of transport and logistics professionals that feel this way.

By contrast, technical and commercial flexibility is somewhat important to most respondents, with 87% placing it in their top 5 product features overall, although it only comes top at rank 4.

Tied with it in that position is single-pane-of-glass visibility, reiterating that tools available to the end user are some of the most important aspects of the product overall. Single pane of glass will, however, be difficult to achieve given the landscape – cellular to non-cellular in the first instance, as **65% of respondents use both cellular and non-cellular modes of connectivity.** These integrations will be relatively simple compared to the cellular integrations that will be necessary for single-pane visibility. With 74% of respondents engaging more than one connectivity provider, achieving single-pane visibility will require many back-end integrations between connectivity providers to ensure a smooth service.

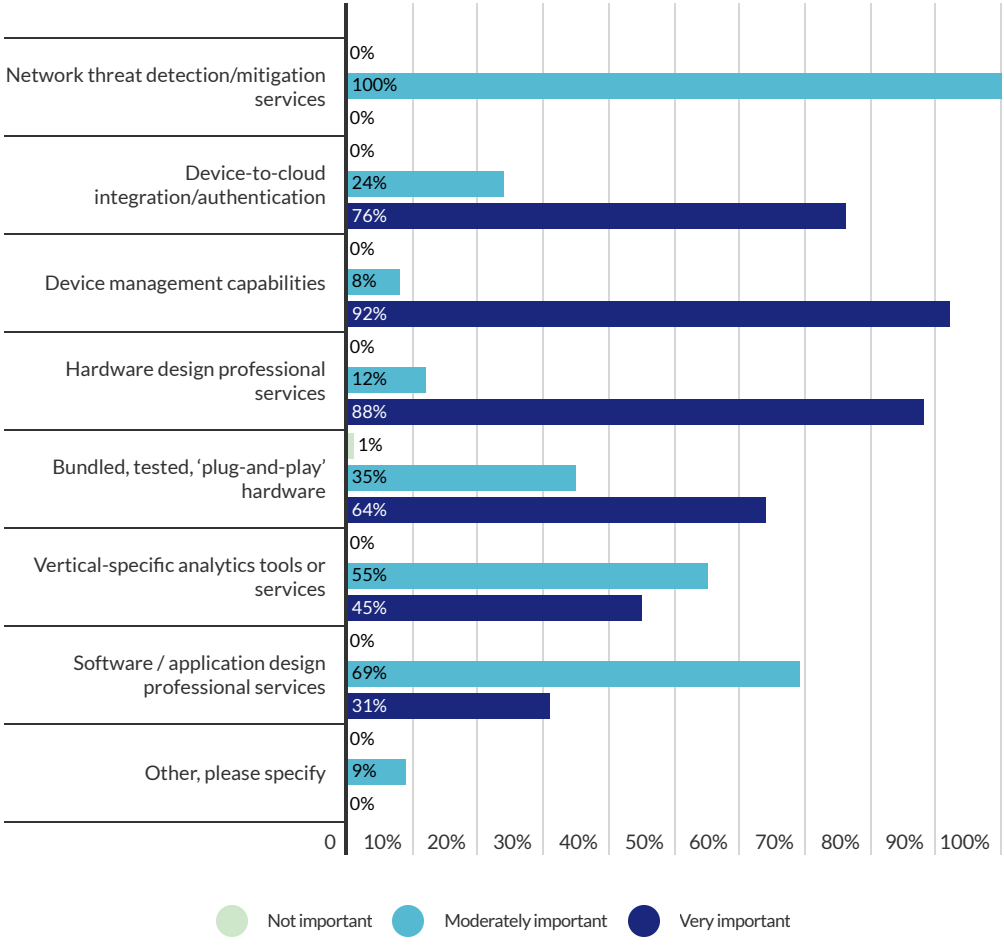
This may be contributing to the perception of complexity in the ecosystem, as 60% of respondents note software complexity as the main challenge for first-time cellular IoT users. It will also be a strong differentiator for those who can produce a reliable integration service, with 45% reporting that simple ways to overcome the integration requirements are currently lacking within the IoT ecosystem overall. It is also worth noting that the thing most seen as missing is consistent international connectivity customer service, also noted as the second highest thing that respondents look for in an IoT product. Having a responsive and competent customer support team is an asset that will be appreciated by the logistics industry.

How has your organisation addressed this international cellular IoT connectivity requirement? (All Respondents)



Building any simplified integration would require CSPs to integrate with other providers, as well as potentially non-cellular connectivity. Transport professionals already acknowledge this, as 42% noted an extensive set of ecosystem partners as the top capability they look for in a connectivity partner. 46% said the same for having device and ecosystem experience in general; however, with hardware continuing to be a strong focus overall. It is one of the most important things for service providers; as already noted, it is a key challenge for the logistics industry, and when it comes to VAS, the 3 top-scoring services are all device-related. Most particularly, 92% of current cellular IoT users consider device management capabilities very important, and only slightly fewer respondents say the same about hardware design. Interestingly, vertical-specific features are less relevant than device management, with only 45% of adopters reporting these as very important.

Beyond connectivity, what are the most important value-added services you expect your cellular IoT connectivity service provider to offer? (Cellular IoT Adopters)

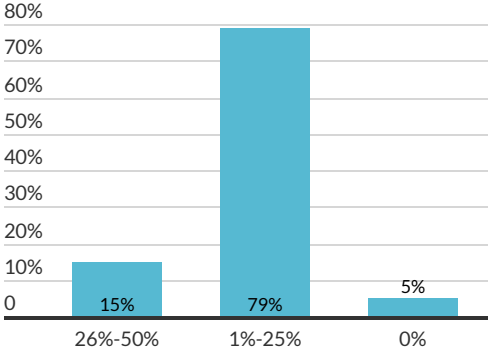


Roaming - Transport/Logistics

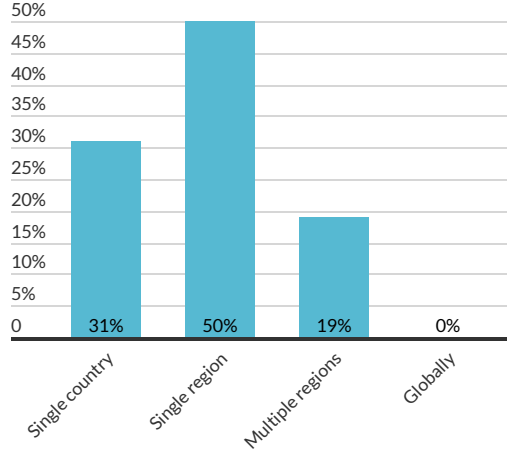
Kaleido Intelligence

Roaming is a key part of the connectivity ecosystem for transport and logistics, thanks to the mobile nature of many of the industry's assets; international connectivity is required by 95% of respondents, and 69% of future users will need it. Additionally, 56% of respondents put robust international coverage as one of their top 5 most important factors, although it is not scored highly. Roaming agreements are the most common way of dealing with international connectivity requirements, with 70% relying purely on roaming agreements for their international connectivity. Future respondents will be similarly focused, if not more so; 84% of those report they will rely on multiple connectivity providers and leverage their roaming agreements to do so. However, this also needs to be paired with some domestic connectivity, with no respondents reporting that over 50% of their devices would need international connectivity and most only requiring it for 25% or less. This will need to be rectified in conventional ways, typically; while 45% of cellular IoT users report using eSIMs (see in the next section), only 11% report using them to alleviate roaming concerns. In addition, switching profiles may complicate matters, particularly as 42% of respondents wish for simpler BYOC frameworks, which eSIM profiles will make more complex to deploy.

What proportion of your organisation's cellular IoT device fleet requires international or multi-regional connectivity? (Cellular IoT Adopters)



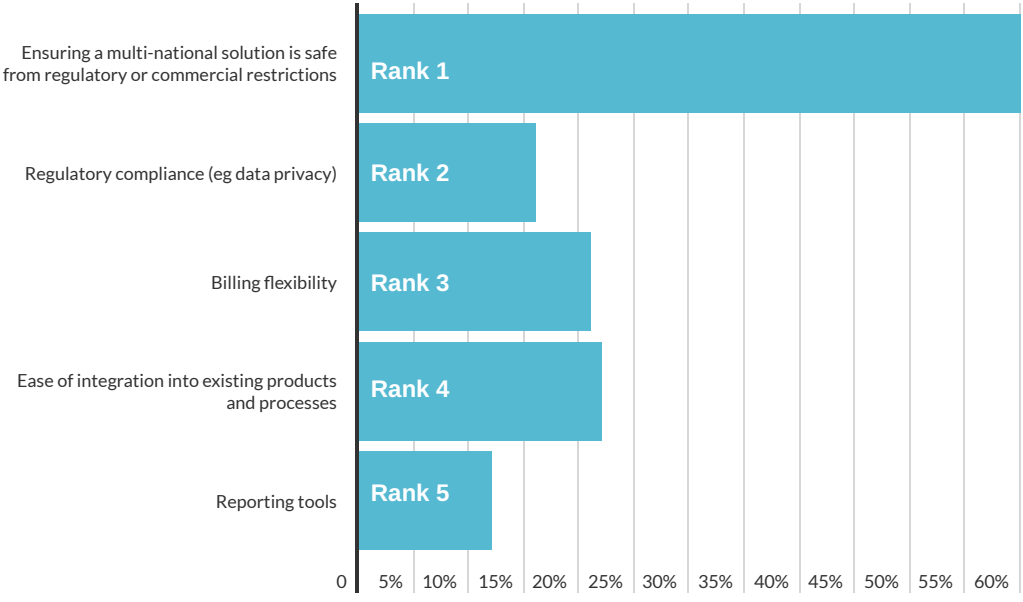
How do you expect your organisation's forthcoming IoT devices to be distributed? (Cellular IoT Non-Adopters)



Concerns about roaming could be holding the space back, with 63% of respondents see growing roaming restrictions as one of their top 5 concerns in scaling IoT, with it coming in as the third-ranked concern overall. 60% of respondents also report that keeping a multinational solution safe from regulatory or commercial restrictions is their top most important factor for IoT connectivity, while ensuring coverage in countries with roaming restrictions is ranked second overall in a connectivity partner's desired capabilities. However, robust international coverage is a logical corollary of this, and that factor did not make it into the

top 5 most important factors. This suggests that logistics companies simply expect robust international connectivity, rather than it being fully top-of-mind until it comes under regulatory threat.

What are your top 5 factors that are most important where IoT connectivity is concerned? (All Respondents)



That said, there is still a long way to go with its implementation; 45% of respondents think that a simplified technical model for integrations is lacking in the current ecosystem, and 42% say the same about the use of preferential operator contracts and BYOC arrangements. International connectivity itself may not be the primary concern in some circumstances, but the ability to simplify roaming and accommodate alternative connectivity is something that a sizeable minority of respondents want. There is also a desire for connectivity partners to be seen as independent, with a carrier-agnostic partner being ranked as a top 4 capability that respondents look for and selected by 47% of respondents to be in their top 5 capabilities. This is, however, moderately less important for those who would consider using or do use an MNO directly for their connectivity requirement, possibly because they rely on that MNO's existing roaming agreements. Above all else, respondents want high-quality connectivity, noted as the top technical feature adopters reported influenced their choice of connectivity provider. This, coupled with the requirements for carrier-agnostic partners, would potentially require a degree of sophistication in roaming steering based on use case-dependent criteria, such as low latency or signal strength, in order to minimise the required transmit power. This makes it important for roaming providers to be able to gauge connectivity requirements not just on availability and agreements but use case-specific criteria. In the long run, this should put MVNx players at an advantage, as these providers are more likely to be able to negotiate more flexible terms with their roaming partners than MNOs, who will have more restrictive peer agreements in place.

Instant global connectivity for an asset management company

Asset management | USA

Context

Our client is an asset management company from the US that integrates wireless Bluetooth and Cellular technologies into assets – allowing automated operations and improved efficiencies through the logistics lifecycle. They are a full stack IoT Platform as a Service(PaaS) startup, offering turnkey solutions for serialization, continuous inventory, logistics, and anomaly traceability for industries such as pharmaceutical, healthcare, and retail.

They have developed a printable, ultra-thin GPS tracker, that has a battery life of approximately 5+ years at a fraction of the cost of traditional trackers. Their trials, some of which are with some of the world's leading automotive and logistics companies, are being powered by BICS.

Challenge

- **To centralize their domestic and global roaming providers**, to avoid managing multiple and complex agreements
- **NB-IoT and LTE-M capabilities**, to tackle the regular power issues on their devices, which are battery powered and need to send small amounts of data over long distances
- **An easy to deploy, manage, and troubleshoot solution** that enables them to operate and scale with agility across continents

Instant global connectivity for an asset management company

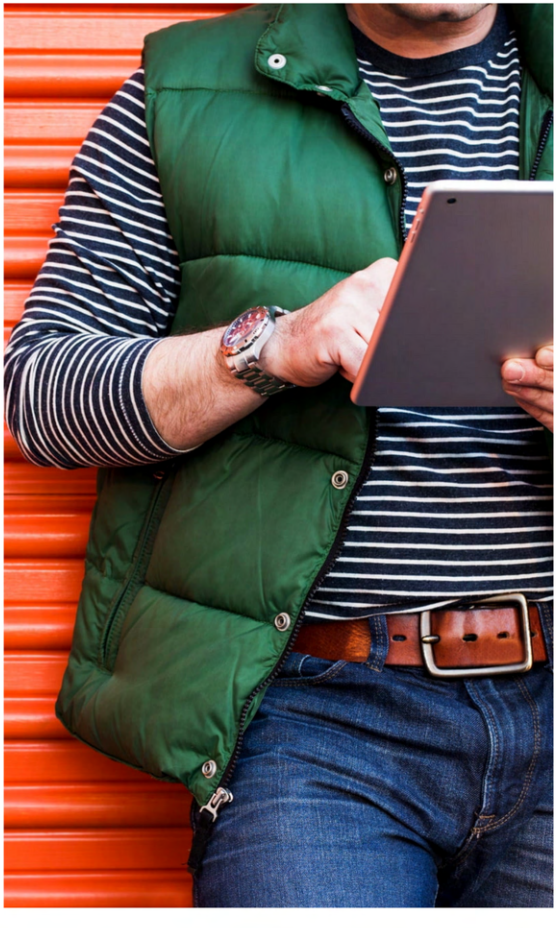
Asset management | USA

Solution

- **Better reliability with lower power consumption**: Through leveraging BICS' LTE-M and NB-IoT capabilities, which also improves their global coverage
- **A single global partner**: Thanks to BICS' relationship with operators around the globe, our client can deal with BICS only for their connectivity needs, optimizing resources and further saving on costs
- **Self management portal**: BICS simplified their operations by giving them full visibility and easy management of their connected assets on a global scale. The powerful diagnostic tools and testing abilities also mean both deployments and troubleshooting can take place seamlessly.

Instant global connectivity for an asset management company

Asset management | USA



Results

Higher flexibility: BICS offers them a customized solution and plan, to match their unique business needs, further increasing their business' agility thanks to the flexibility to evolve the partnership as priorities
change

One-in-all solution: BICS enables instant global connectivity, fully
compliant and highly secure; which can be managed from one place, and through a unique partnership

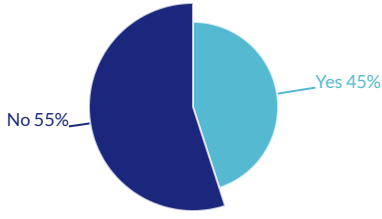
Improved compliance, security, and QoS: BICS provides outstanding QoS, and the highest security routes thanks to our fully owned global infrastructure - with no compliance challenges

eSIM - Transport/Logistics

Kaleido Intelligence

eSIMs are an increasingly common solution to many of the problems of international connectivity, and the logistics industry has enthusiastically adopted them. **45% of transport and logistics respondents with a current cellular IoT deployment reported they use eSIM**, the most highly adopted vertical of all the survey.

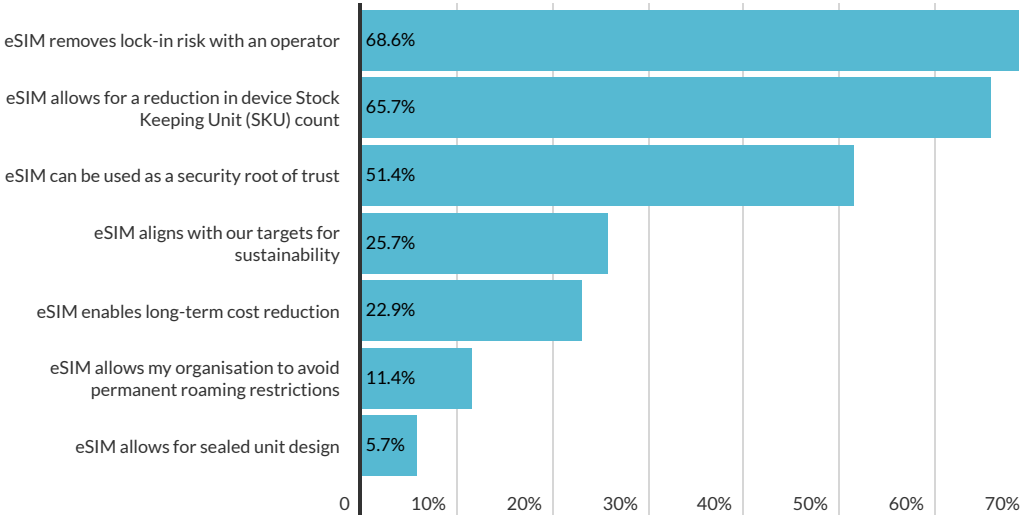
Have you decided to use eSIM (eUICC) as part of your IoT deployment? (Cellular IoT Adopters)



The main driving force for this is **to avoid operator lock-in, with 69% of users reporting this as the reason for their usage. A reduction in SKU count is close behind at 66%.** These measures are intended both as a security policy and as a way to simplify international deployments, which it seems to be doing; non-eSIM users are significantly more likely to rank the complexity of managing multiple providers higher than those who use eSIM.

However, this reduction in complexity is unlikely to be related directly to roaming, with **only 11% of users reporting they use it to avoid permanent roaming restrictions.** It is likely to be used to provide a handful of global connectivity providers that can then be switched to local profiles as required, rather than local profiles being a consistent use pattern wherever devices are located. In the context of logistics, this is also more cost-effective, as international mobile assets may need to change profiles several times if they are aiming for local usage, whereas a single international profile will require less switching, lowering both management time and profile costs.

What factors made you choose eSIM (eUICC)? (Cellular IoT Adopters)

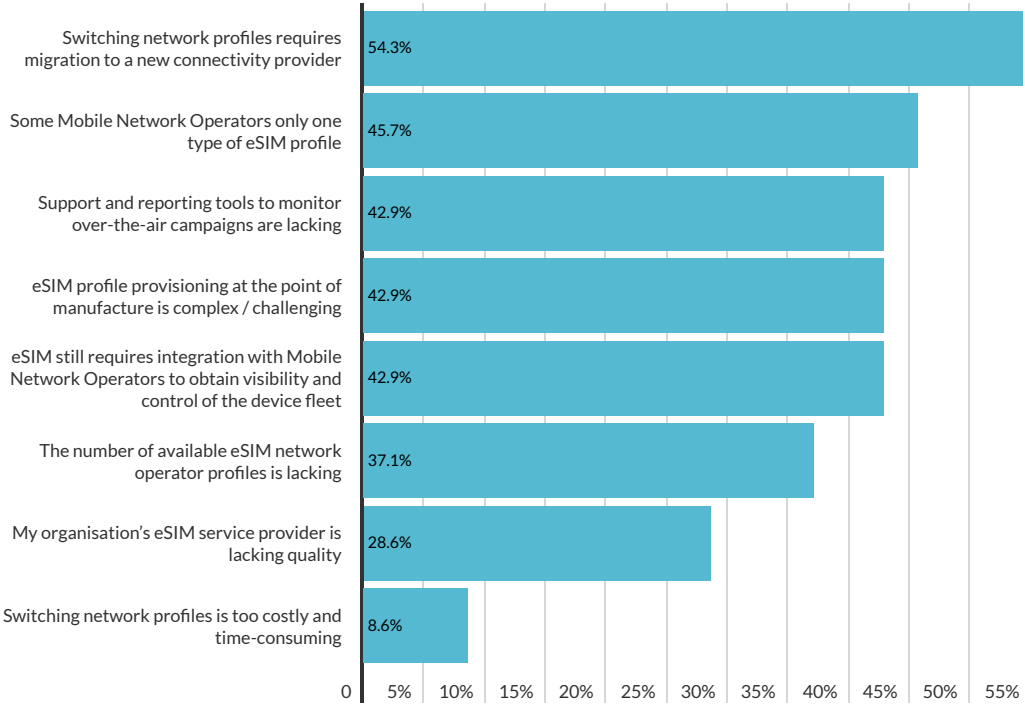


bics Kigen pelion pod group

Indeed, there is likely to be a pervasive hesitancy from end users around profile switching; **54% of eSIM users reported that changing profile meant changing provider, negating the biggest benefit to using the technology to a large extent.** More profile flexibility is needed in general as well, with **46% of eSIM users reporting that there is limited support for the whole range of eSIM profile types.** With logistics covering a wide variety of device types, eSIM providers need to make a broader range of profile types available to match the needs of their end users.

These profiles also may not be delivering what end users need, with 43% noting that they cannot get full visibility without more integrations with local MNOs. This also makes switching MNOs challenging, as there will be a reluctance to change MNOs without guarantees of that fuller integration. Making sure that the profiles offered are full-featured should be a priority for eSIM providers.

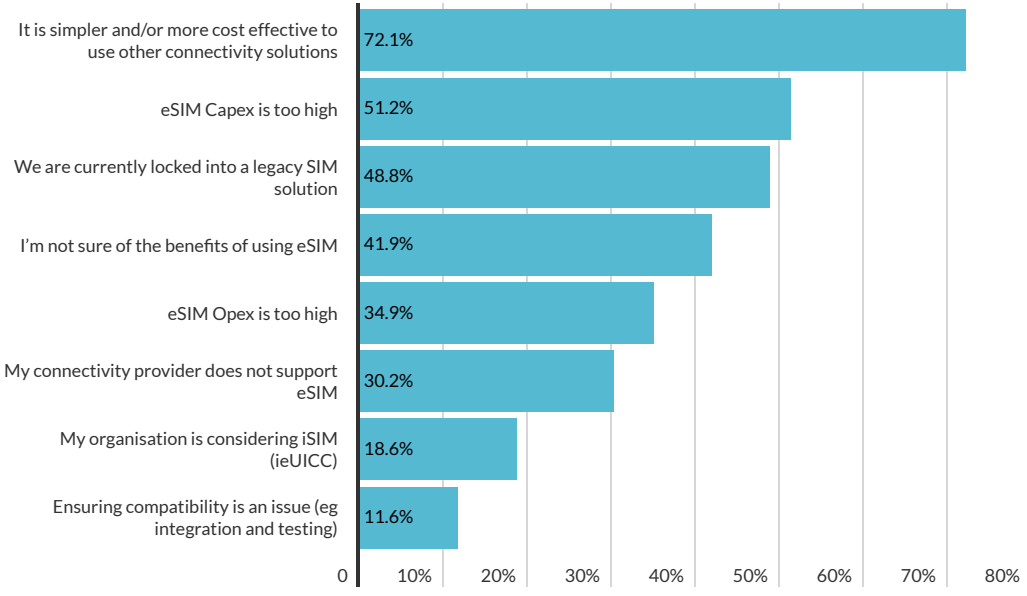
What are your main issues with your current eSIM (eUICC) solution? (Cellular IoT Adopters)



eSIMs' operational complexity is putting off potential users – **72% of non-users report that they believe other connectivity solutions are simpler.** However, even with the perception of complexity reduced it is unlikely to increase adoption by much. On average, non-users are reporting more than 3 reasons they do not want to use eSIM, and almost half are locked into a legacy SIM solution, and, therefore, unlikely to move unless the switch to eSIM happens as part of a broader hardware refresh.

iSIM can potentially help with some of these issues, although not all. Most particularly, the note that eSIM Capex is high can potentially be reduced by using iSIM over eSIM; with a reduced bill of materials, the expenditure on connectivity can potentially be reduced to more acceptable levels. More broadly, it should be emphasised that there is still a lot of uncertainty in the market about eSIMs, with 42% of non-users reporting that they are not sure of the benefits of using eSIM. Working with enterprises to clarify where it can be useful would be a good start towards increasing their adoption, particularly for those who are committed to legacy solutions – establishing a relationship before the need to replace devices would give connectivity providers time to make the benefits of eSIM clearer to potential users.

Why have you chosen not to use eSIM (eUICC)? (Cellular IoT Adopters)



eSIM and iSIM enabled vehicle tracking and retrieval

Rethinking what smart vehicles are

Smart e-bike fleets and logistics tracking with smart trucking solutions are redefining urban mobility by addressing transportation challenges in major cities. These innovative approaches tackle congestion, emissions, air quality and the lack of city transit options. Research shows the sustainability benefits clearly:

if the share for e-bike riding rises to 11%, we could see a 7% decrease in CO_2 emissions from the urban transport sector by 2030 – potentially accounting for over 50% of urban trips in the US and 70% in cities like London.

Behind the scenes, smart-vehicle solutions are complex. Interoperability is crucial as it facilitates collaboration among various stakeholders, including government and city councils, product manufacturers, and platform developers. Vehicle operators need a reliable, long-lasting solution to locate and retrieve lost devices or re-distribute them to places of greater usage.

Their success lies in the simplicity they present to users, who will only change their behaviors if the services offered are significantly more convenient and reliable. Those who sign up for e-bikes give away sensitive data, including billing information and other involuntary analytics, such as location and individual vehicle information.

Kigen

Challenge:

Our customer is a pioneer in developing tracking and analytic solutions for managing and servicing large fleets of smart-mobility urban transportation. Our customer requires a unified customer experience that adheres to the regulatory, security, and safeguarding standards of over fifty cities spanning multiple regions. To meet these requirements, it was necessary to simplify the manufacture of a low-power and compact cellular IoT-enabled device.

This has resulted in a device that can be customized to cater to specific local requirements and associated carrier profiles. Its capabilities include offering location and retrieval functionality, reporting of lost assets, and collecting utilization statistics to drive adoption.

Solution:

Kigen's integrated SIM (iSIM) and embedded SIM (eSIM OS) combined with our strong partnerships within the module and chipset ecosystem provided a route to simplifying secure manufacture and late-stage personalization eliminating the need for multiple product development routes and inventory management.

Kigen is proud to contribute to the industries' collaborations around eSIM specifications within GSMA working groups. We understand the requirements of businesses who need to embrace eSIM and iSIM today and those looking to deploy their devices to leverage the latest IoT-centric functions and features as detailed in the new IoT Remote SIM Provisioning (RSP) technical specification, SGP.32.

Kigen offers a flexible portfolio of eSIM operating system (OS) designs, which cover the full range of RSP specifications and can be employed to enable products to integrate with the matching RSP ecosystem. Furthermore, to meet the needs of citizen data security, it was essential that these edge devices were treated with robust security protocols - implementing chip-to-cloud security with GSMA's IoT SAFE security scheme. This approach offers additional assurances on ease of data cloud integration and interoperability.

Kigen

Result:

By simplifying the manufacture of cellular-connected smart-mobility vehicles to offer location tracking, pattern tracking and more usability features in a compact, low power and ready-to-connect out-of-the-box solution, vehicle companies now have a solution that can scale seamlessly. To ensure that the early benefits of greening our cities are realized, operators of fleets and city councils can take advantage of well-established security frameworks ensuring data of the city, it's consumers and all IoT that serves them is cost-effective, secure and tamper-proof.

Wider applicability:

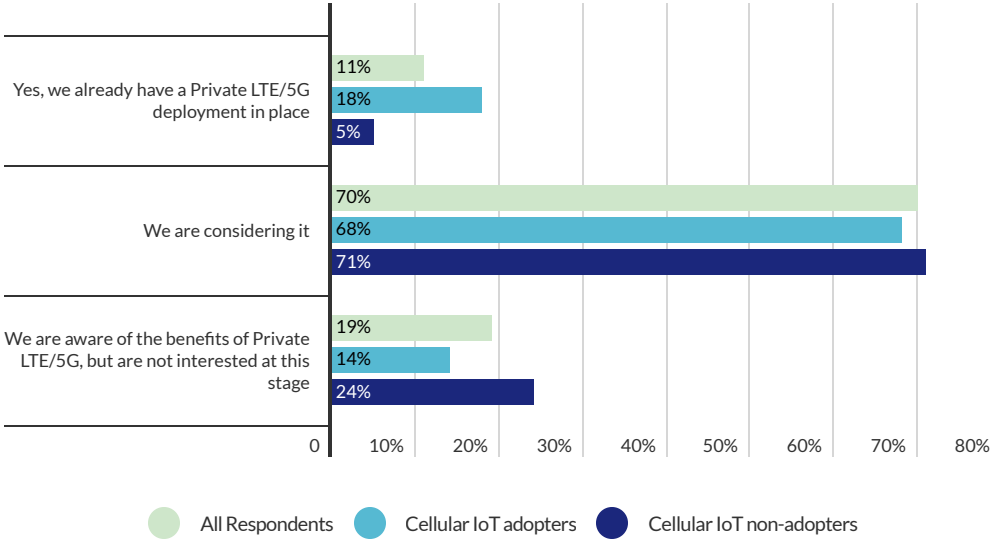
Kigen's iSIM OS and solutions are built with high-growth markets of Massive IoT, such that enterprises can leverage strong security even at the most constrained size, power, and cost envelopes. Through greater integration of components, longer battery life and tamper-proof protection can allow safeguarding IP and innovation for manufacturers. Kigen's iSIM OS enables edge devices in consumer lifestyle products, mobile medical healthcare and point-of-sale devices. This along with standards-based security schemes such as IoT SAFE is a perfect combination to support the market's growth and strengthen the social contract with users.

Private LTE/5G - Transport/Logistics

Kaleido Intelligence

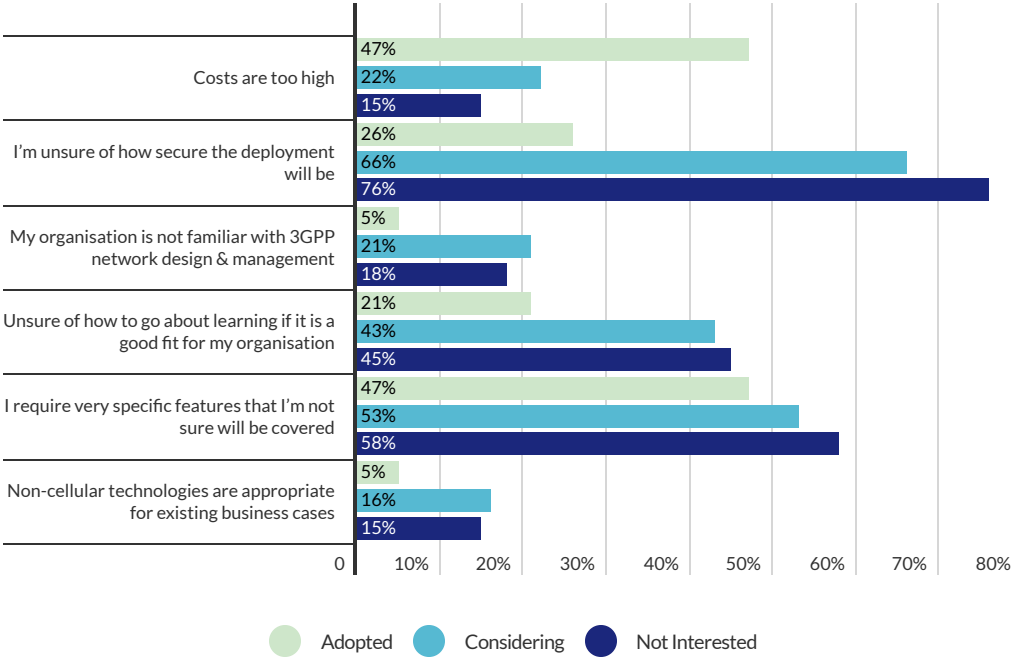
Private networks are one of the hottest topics in connectivity at present, and the logistics sector is no exception, with **11% of respondents reporting having already deployed a private network and a further 70% considering it as a possibility.** Of the verticals surveyed, only the energy and utilities sector have higher adoption and interest in the technology.

Does your business unit have an interest in Private LTE/5G to enhance business operations? (All Respondents)



However, current adopters in transport and logistics have had a different set of drivers compared to the broader set of those who are thinking about using the technology. Current users are more likely to highlight privacy as one of the core benefits than those considering, who instead focus on a broader range of possible benefits, including the reliability of connections and their potential to support a guaranteed QoS for connected assets. There is little difference between those considering and even those who are not interested in private networks, however, with the benefits mostly clear to all the industry at this point.

What are your main concerns over a potential Private LTE/5G deployment? (All Respondents)

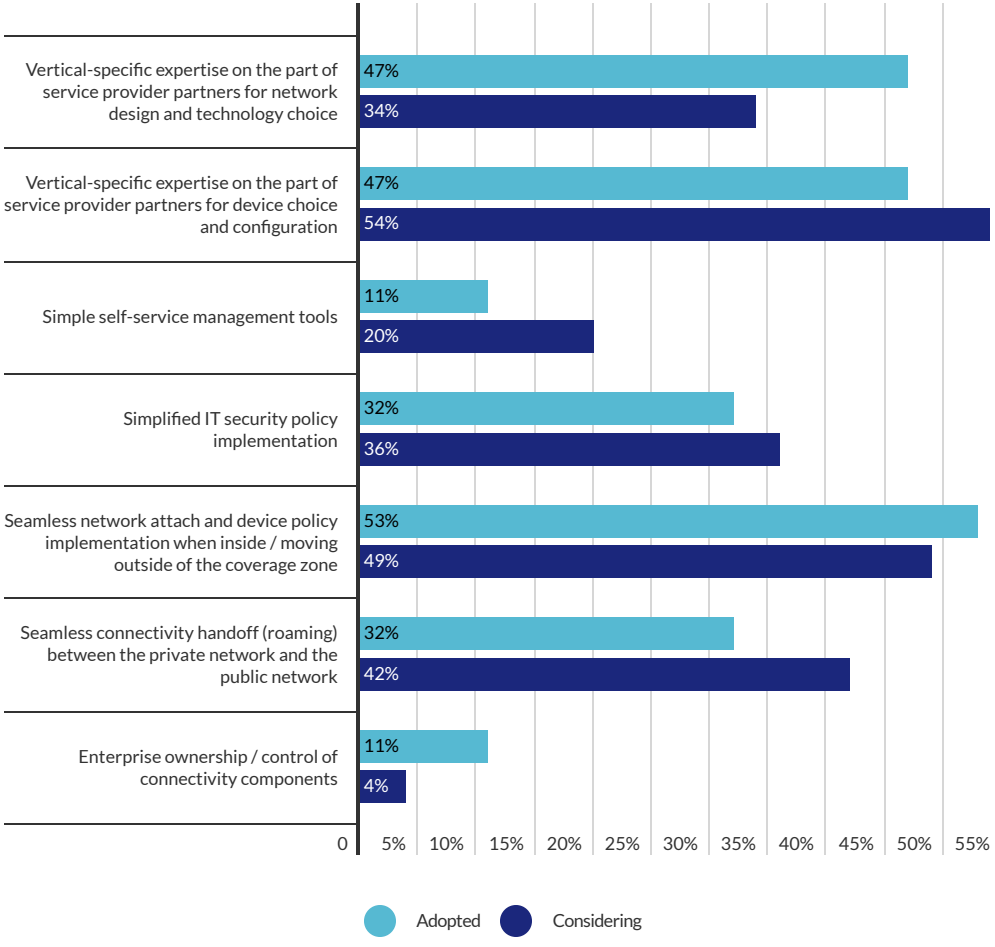


In terms of barriers to adoption, perceived security is the clear barrier, with **76% of those who are not interested saying they are unsure of the security of private networks.** This is even true of many respondents who consider security to be one of the benefits of private networks. There is clearly an awareness of how private networks can improve security but a level of mistrust around how that works in practice. This is emphasised by how many respondents are unsure whether private networks will meet their specific requirements; over 50% of both those not interested and those considering. There is an awareness that private networks are useful in general, but connectivity providers need to be able to show how that applies in specific circumstances and use cases to win over clients.

Part of this will be instruction on cellular network management, which 19% of respondents reported as a concern. Adopters are far more confident in their ability to manage cellular networks, as well as being less likely to consider non-cellular networks suitable for their business cases. Private network providers need to focus on the unique benefits of private cellular over non-cellular to make a case for them. This would also clear up the uncertainty of the **42% of those considering who do not know how to assess if private networks will be a good fit for them.** As with the rest of the cellular IoT, hardware plays a part in what respondents wish for; **51% consider vertical-specific expertise in device choice and configuration to be important for private networks, while 37% think similarly for vertical-specific network design**, although both private network adopters and those not interested show higher results here.

Similarly, 50% want seamless device policy implementation for movement between the private network and public networks, with elevated importance given to these by current adopters and those not interested. In fact, adopters and those not interested have a similar order of priorities for private networks. This indicates that many of those who have dismissed them may have done so prematurely, without full comprehension of what private networks can offer.

What are the most important factors for consideration where Private LTE/5G is concerned? (Solution Adopters & Considering Adopting)



Kaleido Intelligence

IoT Connectivity Challenges & Opportunities:

Energy and Utilities

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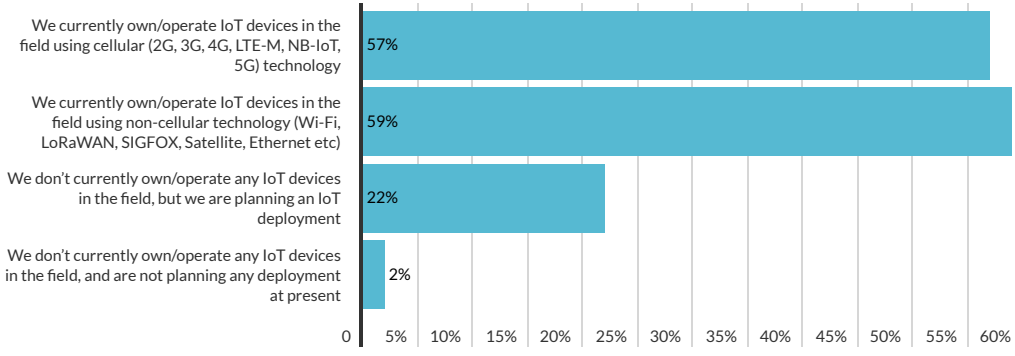
State of IoT - Energy/Utilities

Kaleido Intelligence

In last year's survey, some **48% of the survey respondent base reported that they had a cellular IoT deployment in the field; this proportion has now increased to 57% of respondents**. Naturally, this does not indicate an absolute percentage increase in adoption on account of the refreshed cohort, but it does serve to indicate that cellular technology is increasingly important in the energy and utilities segment.

Does your business unit currently have an IoT deployment or proof-of-concept underway that uses 3GPP cellular radio technology (2G/3G/LTE/5G)? (All Respondents)

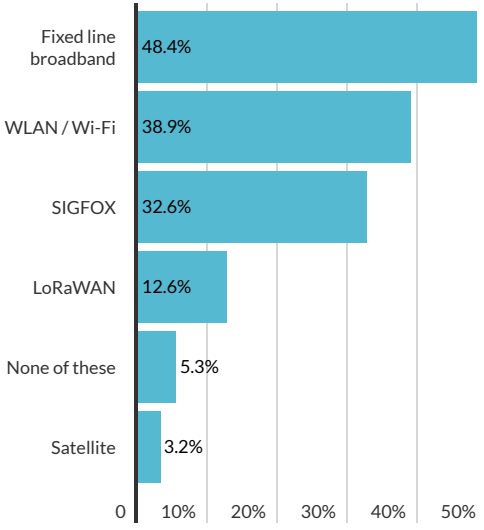


Does your organisation plan to adopt IoT over the next 12-24 months? (Cellular IoT Non-Adopters)

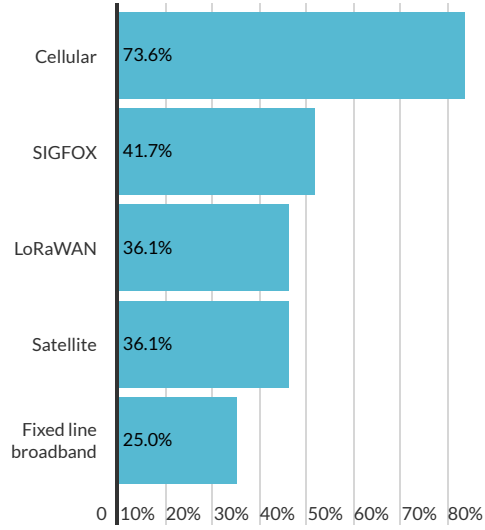
72%

It should be noted that 72% of cellular IoT non-adopters reported that they intend to deploy IoT connectivity over the next 2 years: cellular's importance is further underlined through cellular IoT non-adopters, with 74% of respondents stating that they view the technology as most viable for wide-area connectivity within their segment, although it should be noted that alternative LPWAN technologies such as LoRaWAN and SIGFOX combined to reach a proportion of 78% of respondents. Interestingly, satellite is viewed as a potential radio access technology by 36% of cellular IoT non-adopters, which reflects the current renewed interest in satellite communications following the development of the Non-Terrestrial Networks (NTN) support framework within the 3GPP's Release 17 for 5G. In contrast, only 3% of existing cellular IoT adopters reported that they have leveraged satellite communications.

Apart from cellular technology, are you deploying IoT using devices with other communications technologies? (Cellular IoT Adopters)



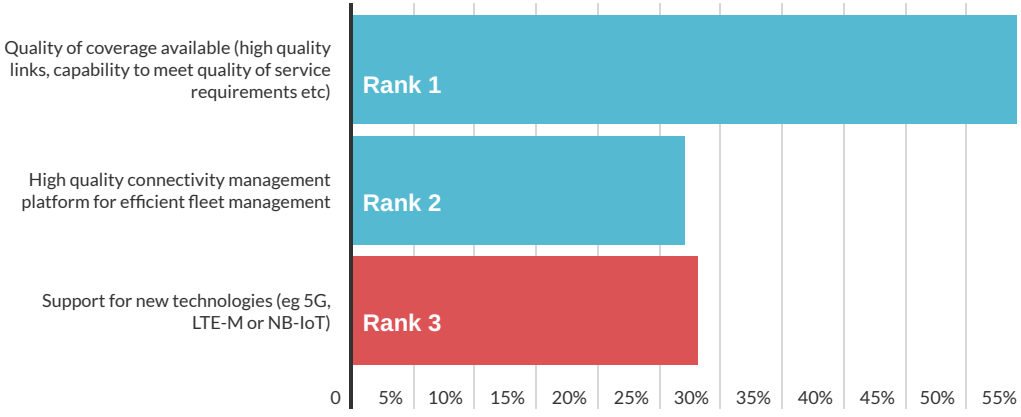
Which technology(ies) for wide-area connectivity do you view as most viable for IoT deployments? (Cellular IoT Non-Adopters)



This particular market vertical represents a diverse set of use cases ranging from smart metering, smart grid monitoring and automation, in addition to infrastructure monitoring and automation use cases, often in remote locations around the world. It is thus understandable to see a high proportion of respondents favour satellite for potential future applications, given the current state of NTN support in addition to in-orbit satellite capacity, while the lean towards LPWAN technologies, whether licenced or unlicensed, speak to many existing use cases, namely low-bandwidth monitoring and telemetry deployments.

Current industry support for LPWAN technologies such as LTE-M and NB-IoT remains in development, particularly from a wholesale and international perspective. The low throughput and battery-powered nature of these devices make them largely unsuited to eSIM OTA campaigns, where OTA downloading of a new operator profile can have a significant impact on battery life. Thus, roaming is a critical tool to support such devices. As such, it is not surprising to see that, among cellular IoT adopters, support for new radio technologies, including NB-IoT and LTE-M, was reported as a top three priority in terms of CSP choice for cellular connectivity.

What are the top 3 technical factors that influenced your organisation in choosing a cellular IoT connectivity provider? (Cellular IoT Adopters)

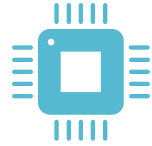


Complexity – Energy/Utilities

Kaleido Intelligence

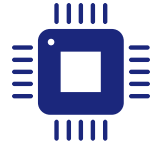
Vertical analysis reveals that challenges and complexity associated with hardware for cellular IoT represent a top pain point, and enterprises within the energy and utilities vertical are no exception. Here, 51% of cellular IoT adopters ranked this as their top challenge in the ability to scale operations up, compared to 60% of cellular IoT non-adopters. Linking this to earlier analysis regarding the types of RATs likely to be used for deployments, it is certainly understandable why this might be the case: international support in terms of coverage for technologies such as NB-IoT and LTE-M is inconsistent to say the least. In most cases, this requires acquiring hardware capable of supporting at least both radio types. Meanwhile, support for low power modes such as PSM (Power-Save Mode) and eDRX (Extended Discontinuous Reception) is not a given even when a network supports either LTE-M or NB-IoT, which creates new challenges at the application design level.

Top IoT scaling challenge: hardware complexity (Cellular IoT Adopters)



51%

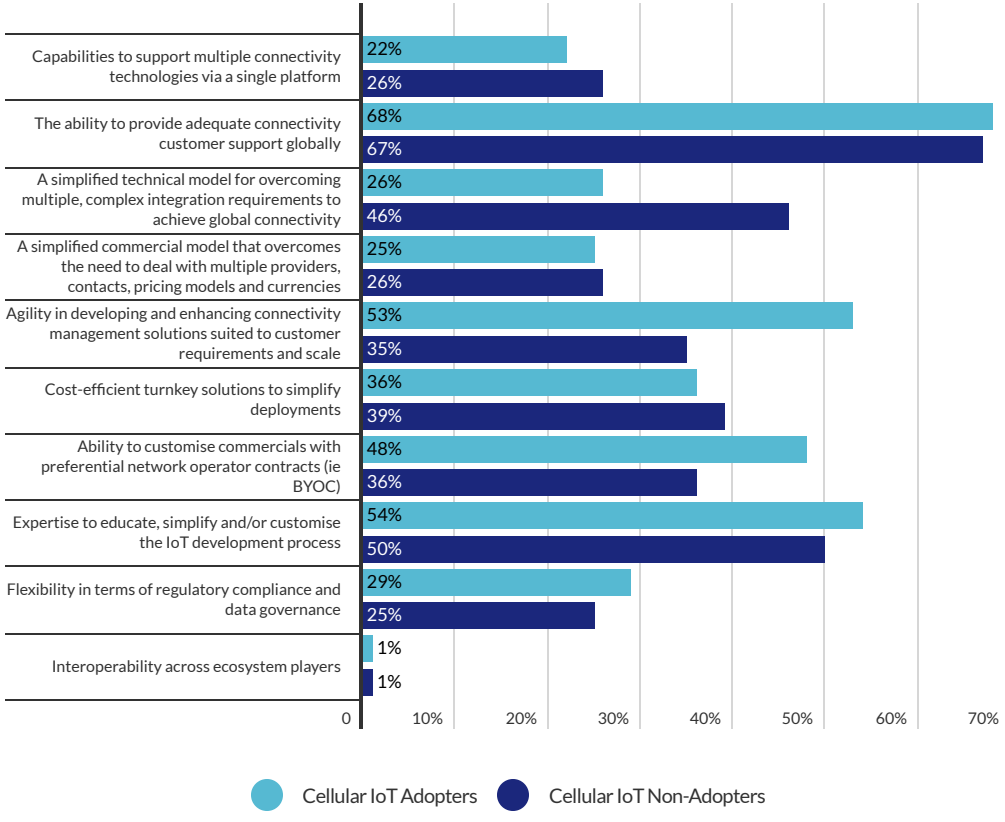
Top IoT scaling challenge: hardware complexity (Cellular IoT Non-Adopters)



60%

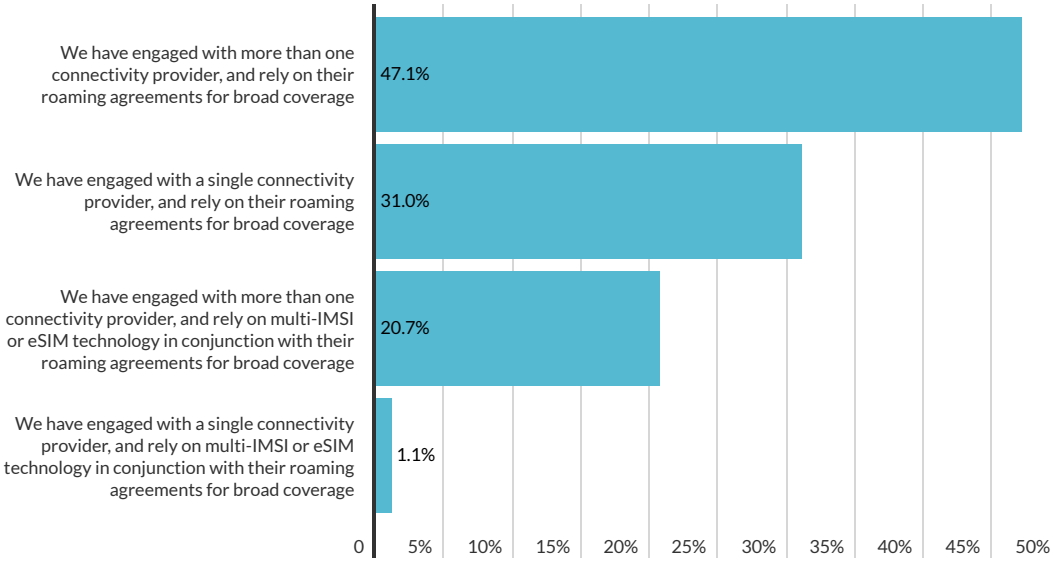
According to survey respondents, these challenges are compounded by a lack of ecosystem professional services and expertise to help them in design choices such as hardware and associated software. 54% of cellular IoT adopters and 50% of cellular IoT non-adopters perceive that expertise to educate, simplify or customise the IoT development process is lacking in the industry.

What do you perceive as lacking in the present IoT connectivity ecosystem? (All Respondents)



Further pain points continue with how customers approach the market to meet their coverage requirements. **68% of the cellular IoT adopter respondent base reported that they have contracted with more than one connectivity provider to meet international connectivity needs**, which underlines a key pain point that runs throughout the cellular industry today: global connectivity advertised by many CSPs is not truly global, owing to gaps in coverage footprints, ability to adhere to specific regulations within certain countries, or an inability to achieve competitive access rates in all markets that customers require.

How has your organisation addressed its international cellular IoT connectivity requirement? (Cellular IoT Adopters)



The ecosystem does not support a simple model for rolling out devices internationally (Cellular IoT Non-Adopters)

60%

This sentiment is reflected when examining perceptions from the cellular IoT non-adopter cohort: 60% of respondents believe that the lack of a simple model for rolling out devices internationally represents a major challenge in entering the cellular IoT connectivity ecosystem.

One possible avenue to overcoming the issue of engaging with multiple providers for connectivity can be found through an emerging concept, dubbed 'Bring Your Own Connectivity' (BYOC). In this scenario, enterprise customers can retain commercial connectivity contracts with favoured partners, and integrate them into a preferred CSP's CMP solution. This allows the enterprise customer to leverage both the connectivity relationships that the CSP is able to offer, in addition to existing contractual relationships formed by the enterprise. BYOC remains at a relatively nascent stage of development and is inherently challenging to execute: not only must connections be migrated from one CMP to another (a long and often arduous process), but all parties involved must also agree to the migration. The result is typically an expensive process.

Notably, respondents also stated a desire for simplification where connectivity and back-end systems are concerned. In this context, cellular IoT adopters and cellular IoT non-adopters ranked the ability to simplify the integration of solutions into existing products and processes as a top 3 and top 2 priority, respectively.

How important is ease of integration into existing products processes? (Cellular IoT Adopters)

How important is ease of integration into existing products processes? (Cellular IoT Non-Adopters)

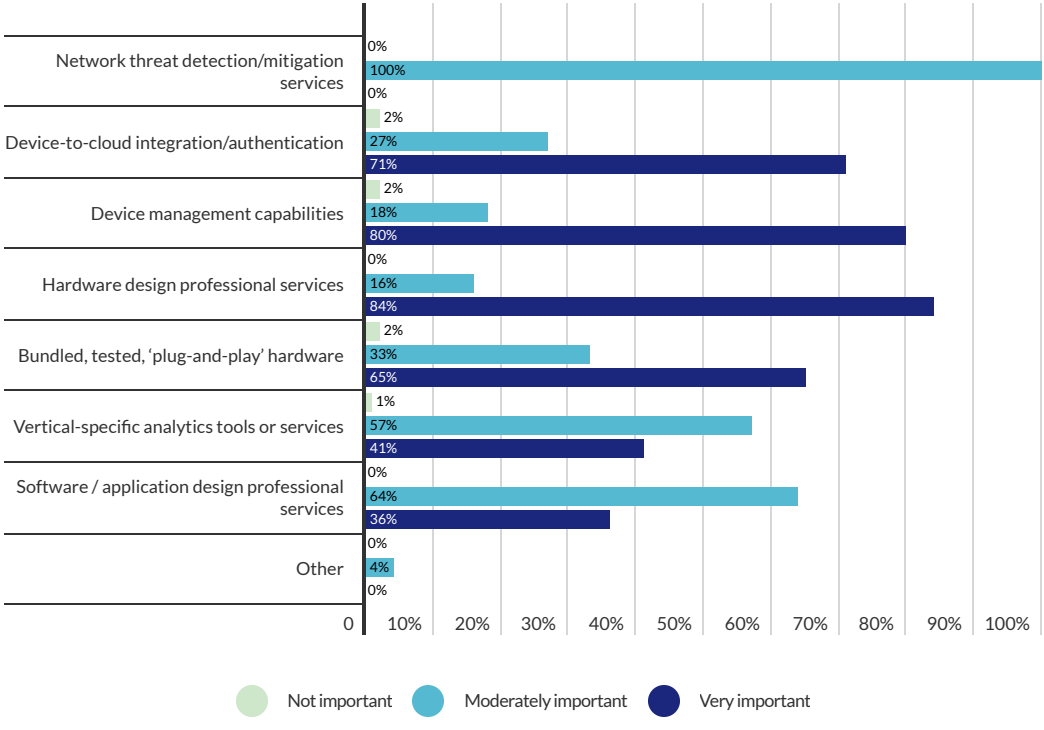
These results underline the need for CSPs to look beyond their role as simply a connectivity provider and focus on delivering more fleshed-out solutions. As we saw in the overall survey results, the ability to authenticate and provision devices with cloud services is viewed as highly important, and this type of offering goes some way in simplifying integrations processes. Meanwhile, the desire stated for professional services and expertise highlights that enterprise customers would like to see CSPs as more of a 'one-stop-shop' for many of their requirements, and this is likely related to the fact that conversations with CSPs typically now take place much earlier in the IoT development process than was the case some years ago. Indeed, the points raised in this section highlight how enterprises are now more demanding in terms of their expectations from service providers and their portfolios, which leads us to the following section.

Sophistication - Energy/Utilities

Kaleido Intelligence

VAS is evidently an important factor in theenergy and utilities enterprise customer selection process in the context of their CSP. While device-to-cloud authentication is viewed as very important by 71% of cellular IoT adopters, compared to a survey average of 75%, device management capabilities were also reported as very important by 80% of the respondents. In the present market, relatively few CSPs offer device management capabilities in conjunction with connectivity management services, with the majority of providers that do provide a combined offering falling into the MNO or module OEM and connectivity service provider segments.

Beyond connectivity, what are the most important value-added services you expect your cellular IoT connectivity service provider to offer? (Cellular IoT Adopters)



Similar results were observed in 2022's survey regarding device management capabilities, and these indicate an increasingly demanding enterprise customer base within this vertical. It is certainly the case that devices, particularly in smart metering use cases, can be in the field for 15 years or more, and thus must ensure that firmware can consistently be updated in order to mitigate security risks. The capability to provide security services as VAS was viewed as moderately important by the entire cellular IoT adopter respondent base, while the capability to offer extensive security features was ranked as a top 3 and top 2 priority by cellular IoT adopters and non-adopters, respectively, when asked which CSP product capabilities were top priorities.

How important are extensive security features as part of a CSP partner's product? (Cellular IoT Adopters)

Rank 3

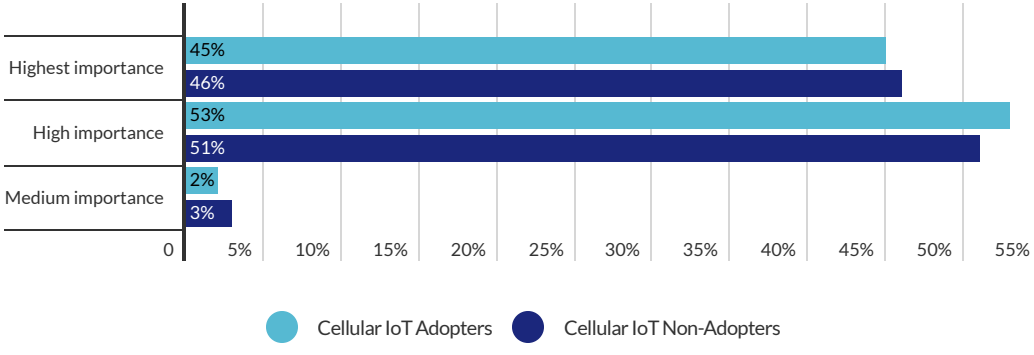
How important is ease of integration into existing products processes? (Cellular IoT Non-Adopters)

Rank 2

Security is notably important within this particular vertical, given the fact that critical infrastructure is often involved, such as in the supply of electricity and water. CSPs must evidently position themselves to enable customers to not only keep devices updated throughout their lifecycle in order to mitigate risks but also consider offering solutions beyond the typical private APN and VPN offering found across the ecosystem. In many instances, MNOs offer managed security services, although this does not provide the customer with visibility over devices' risk profile; as such, there is a potential avenue for MVNO players to develop offerings to help customers understand traffic flows, identify risky behaviour and perform root cause analysis and mitigation.

A further point of consideration is the fact that enterprise cellular IoT adopters evidently place a high emphasis on CSP business practices: 45% of respondents, higher than any other vertical, placed a very high importance on CSPs' adherence to ESG frameworks. This is not an unexpected result, given the growing trend for businesses to adopt environmentally sustainable approaches to business; even in the case of fossil fuel industries, considerable pressure has led some companies to become more environmentally sustainable and incorporate ESG frameworks into operations and reporting.

How important is that your connectivity partner actively adheres to sustainable (Environmental, Social and Governance) frameworks? (All Respondents)



Further evidence of growing enterprise sophistication is the demand for more flexible approaches to billing, which becomes important when one considers the types of connectivity technologies involved in deployments. Earlier, we observed a strong preference towards LPWAN-based technologies, which do not consume large volumes of data. Additionally, deployments for use cases such as smart meters normally involve several hundred thousand, if not millions of devices. In this case, the ability to offer pooled pricing plans, where a large pool of data is allocated to a group of devices, is critical in maximising efficiency for the customer. Meanwhile, Kaleido has observed over the past 2 years that some CSPs are beginning to move away from data-based billing and billing instead based on 'non-telecom' metrics, such as the number of messages transmitted per day, or the number of sensor readings made per day. Pure data-based billing is still highly prevalent in the industry, but the fact that cellular IoT adopters and non-adopters ranked billing flexibility as top 5 and top 4 in terms of IoT connectivity importance highlights a growing demand for new approaches to how the market is set up.

Roaming – Energy/Utilities

Kaleido Intelligence

International connectivity and roaming continue as a key theme in the energy and utilities segment. Although risks associated with permanent roaming were ranked as the top 4 and top 3 challenges in scaling up operations by cellular IoT adopters and non-adopters, respectively, the same respondents agreed that ensuring deployments are free from regulatory and commercial restrictions is the number one priority for IoT connectivity.

Permanent roaming causes scaling issues (Cellular IoT Adopters)

Rank 4

16%

Permanent roaming causes scaling issues (Cellular IoT Non-Adopters)

Rank 3

21%

CSPs must safeguard against commercial & regulatory restrictions (All Respondents)

Rank 1

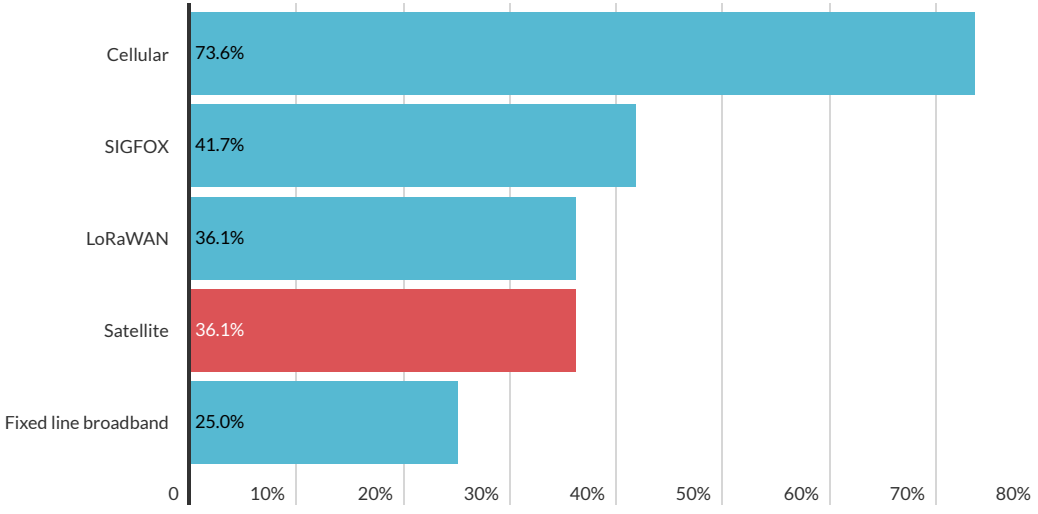
52%

Risks related to roaming are particularly evident in this vertical, given the fact that devices are often in the field for longer than a decade, and the need to replace SIM cards across what might be hundreds of thousands, or even millions of devices would be considered a catastrophe in terms of the viability of any IoT initiative. It is thus imperative that CSPs delivering connectivity solutions to customers within this vertical can offer long-term guarantees to customers in the context of ensuring that connectivity uptime can be maintained throughout the lifecycle of the devices in question. This is easier said than done, given the length of typical wholesale roaming agreements in place for IoT connectivity and likely means that technical solutions must be delivered to provide the relevant assurances. Indeed, these will be observed and examined in more detail as we analyse the use of eSIM in this vertical.

Notably, coverage is an important factor within this vertical, likely due to the fact that many deployments will involve devices either located in remote areas, such as is the case in mining or smart grid applications, or devices potentially located underground, as might be the case in smart metering scenarios. Here, 54% of cellular IoT adopters ranked quality of coverage as their top technical factor behind choosing a cellular IoT CSP, and indicates a need for CSPs to establish multiple connectivity partnerships to fill coverage gaps that might occur if reliance is placed on connectivity through a single MNO incumbent. Indeed, the idea of quality of coverage becomes even more important when considering the fact that LPWAN connectivity is often demanded in this segment: while operators may well claim to have coverage for LTE-M or NB-IoT within a specific country, this by no means indicates that blanket coverage is offered alongside traditional LTE. In some instances, LPWAN coverage is limited to a select number of cities, which in turn

does not match the requirements of enterprises that might require coverage in remote locations. It is here that one can infer that establishing satellite connectivity partnerships may well be beneficial for the industry as a means of bridging that connectivity gap: 36% of cellular IoT non-adopters reported that they would consider the technology as viable for any future IoT deployment

Which technology(ies) for wide-area connectivity do you view as most viable for IoT deployments? (Cellular IoT Non-Adopters)

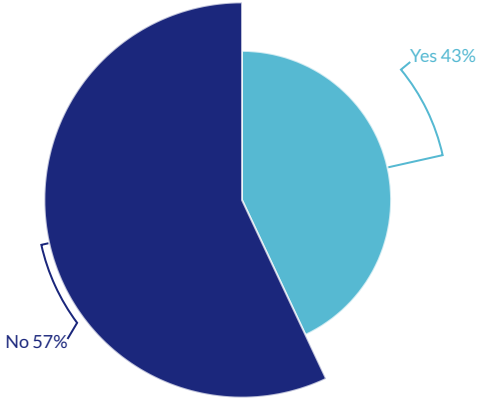


eSIM - Energy/Utilities

Kaleido Intelligence

The energy and utilities sector demonstrated the second highest adoption level of eSIM across the 5 verticals analysed here, second only to transportation and logistics. Here, 43% of cellular IoT adopters reported that they have included eSIM in their deployment, compared with a survey average of 36%.

Have you decided to use eSIM (eUICC) as part of your IoT deployment? (Cellular IoT Adopters)



As outlined earlier, many deployments in this vertical involve connectivity requirements that span a decade or more. This presents issues, not only from a security perspective but also from the perspective of long-term connectivity assurance.

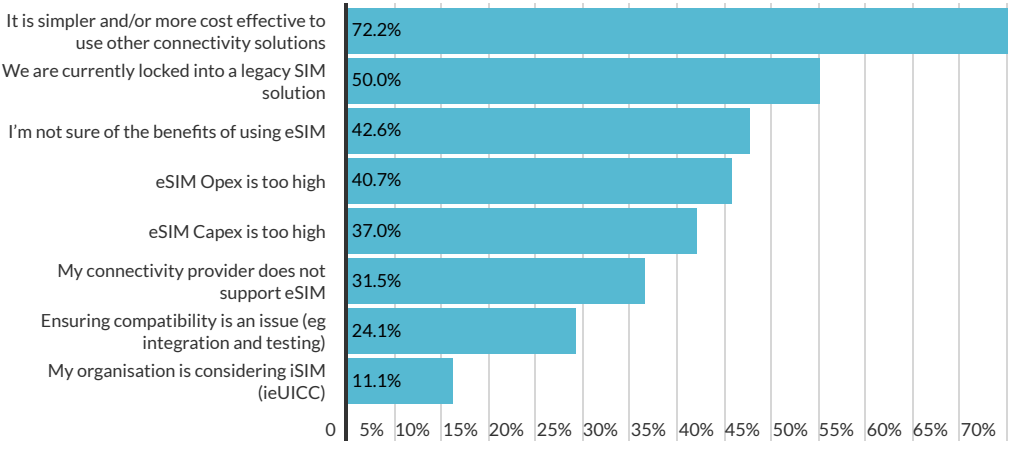
Leveraging the capabilities of eSIM within the energy and utilities vertical is presently problematic in cases where LPWAN connectivity is used. In the first instance, eSIM profiles typically consistent of several hundred kilobytes, which may present issues for LPWAN devices designed to utilise low bandwidth. Additionally, NB-IoT devices utilising the M2M eSIM specification typically cannot be reached by SMS (the mechanism with which an OTA campaign is initiated), requiring a custom solution. Meanwhile, devices may have inconsistent sleep times, depending if they make use of PSM or eDRX, which in turn means that they may be difficult to reach when an OTA campaign is executed. In this instance, careful monitoring of the campaign will be required to understand the success rate of any commands issued to change operator profile OTA. According to cellular IoT adopters, **39% of the respondent base reported that support and reporting tools to monitor such campaigns are lacking in the industry**: it is certainly the case that, due to the complexity of OTA operations, these are often conducted via the 'back office' of the CSP in order to minimise error rates and potentially costly mistakes in configuration. Nevertheless, it is evident that more transparency regarding campaign activity is desired.

Support and reporting tools to monitor over-the-air campaigns are lacking from eSIM Connectivity Solutions (Cellular IoT Adopters)

39%

Importantly, more pressing challenges are perceived in the form of profile availability for eSIMs, with **54% of respondents reporting a lack of available profiles.** This ties closely in with the concern over regulatory and commercial restrictions that may arise over time in roaming scenarios, given the lack of a suitable commercial arrangement will necessitate the use of a local profile, or even the full migration of connections onto an alternative provider. For the time being, the majority of local profiles available on the market are delivered as a result of regulatory restrictions in place, such as in Turkey, Brazil etc. Kaleido is aware of activity by operators, particularly in North America as well as the Middle East to maximise the wholesale potential of eSIM by initiating strategies to open up their profiles to MVNO players, although this development by no means indicates a free-for-all on the market. Nevertheless, profile availability is likely to increase over the coming years, particularly following the commercial launch of IoT specification RSP architecture.

Why have you chosen not to use eSIM (eUICC)? (Cellular IoT Adopters)



A large majority of those who have not adopted eSIM reported that this is due to the fact that **it is simpler or more cost-effective to use alternative SIM solutions, with 72% of the respondent base reporting as such.** This strong perception certainly highlights an ongoing belief that entry into the eSIM ecosystem results in complexity, and undoubtedly the existence of the M2M specification has had a hand in developing this perception among those who have a reasonable technical understanding of eSIM.

Nevertheless, it is potentially encouraging, from a service provider perspective at least, to see that **43% of those who have not adopted eSIM are not sure of the benefits** of eSIM technology. Studies have been produced that highlight the advantages of eSIM over 'legacy' SIM solutions, both from a practical perspective as well as from a cost standpoint, when physical SIM swaps are required into the long term. It is evident, however, that greater education is required, and greater emphasis is applied to the total cost of ownership for eSIM versus alternative solutions, particularly for deployments that involve many thousands of devices or devices in remote areas.

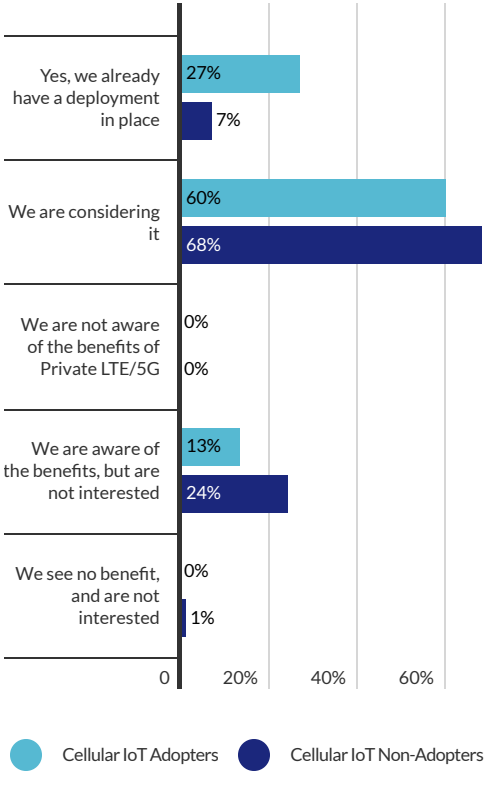
Private LTE/5G - Energy/Utilities

Kaleido Intelligence

Private cellular networks can be viewed as a particularly attractive solution for enterprises within this vertical, on account of the range of use cases requiring connectivity in remote locations, in addition to the high-security requirements for connected critical infrastructure. In the case of energy and utilities enterprises, private network solutions may often require connectivity across multiple sites across a given country, leading to a network architecture that makes use of public RAN infrastructure alongside private core network infrastructure. Naturally, private RAN infrastructure will be required for locations where no public RAN coverage is available, which may mean additional complexity for deployments.

Some **27% and 7% of cellular IoT adopters and non-adopters reported that they have a private LTE or 5G solution in place**, with adoption among the former cohort considerably higher than the survey average of 13%. Meanwhile, it is notable that a sizeable proportion of the respondent base, **60% of cellular IoT adopters and 67% of non-adopters, reported that they are considering a future private LTE or 5G deployment.**

Does your business unit have an interest in Private LTE/5G to enhance business operations? (All Respondents)

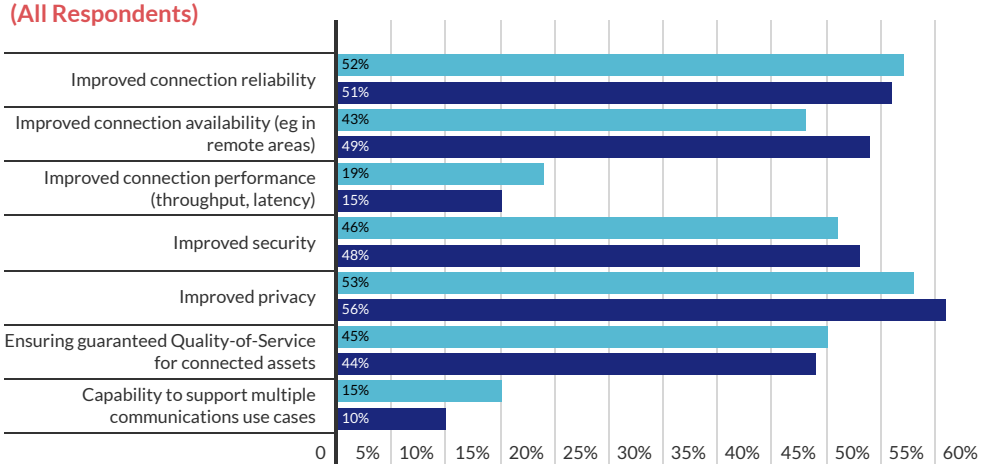


Improved privacy and connection reliability were cited as key factors behind the consideration of private cellular networks as an organisational benefit, according to 53% and 52% of cellular IoT adopters and non-adopters, respectively. As noted earlier, deployments often involve the communication of potentially sensitive data, while the nature of the industry means that assurance of connectivity uptime is critical to operations. Interestingly, **throughput and latency improvements resulting from private network deployments were not seen as a critical benefit, with only 19% of cellular IoT adopters and 15% of cellular IoT non-adopters citing this as key.**

Once again, this highlights the likely nature of devices involved in potential deployments, where sensing and intermittent status reporting are the most demanded use cases, as opposed to high throughput, real-time applications. Nevertheless, it is important to note that this capability may well be of interest to certain enterprises within this particular vertical: for example, mining operations may wish to deploy private LTE or 5G

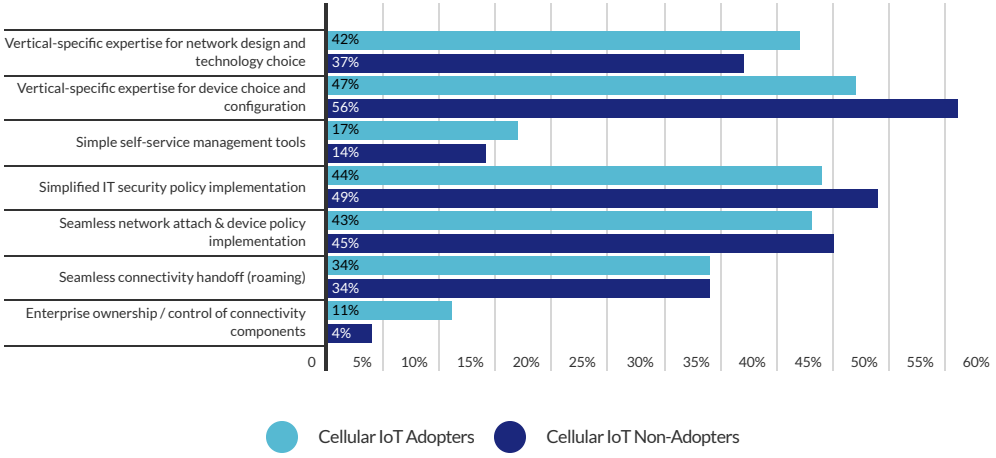
while leveraging the technology in conjunction with automated guided vehicles.

What do you perceive to be the main benefits of a Private LTE/5G solution? (All Respondents)



Several factors come to light as important where enterprises consider private LTE or 5G deployments. In line with broader survey results, **expertise in device design and configuration is a key requirement, according to 47% of cellular IoT adopters and 56% of non-adopters.** However, it is interesting to observe that **42% of cellular IoT adopters additionally reported a need for expertise in network design,** which likely speaks to the more distributed nature of private LTE or 5G requirements in this vertical – whereas in some other verticals, deployments will be restricted to campus-type deployments. Meanwhile, other factors, such as IT security policy implementation in addition to seamless network attach between private and public networks, indicate that a high level of service provider specialism will be required to cater to enterprise needs where private LTE and 5G is concerned.

What do you perceive to be the main benefits of a Private LTE/5G solution? (All Respondents)



Kaleido Intelligence

IoT Connectivity Challenges & Opportunities:

Manufacturing and Industrial

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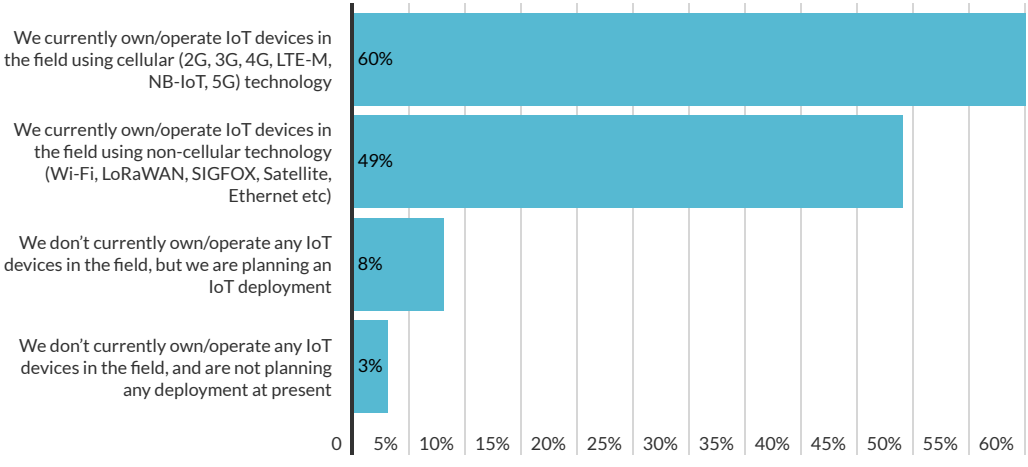
A Giesecke+Devrient Company

State of IoT - Industrial/Manufacturing

Kaleido Intelligence

Manufacturing is one of the biggest sectors for the future of cellular IoT, with the smart factory being a prevalent concept in the imagination of the IoT. There is strong current adoption as well; over 96% of respondents reported they either currently have or are planning to have an IoT deployment. However, not all of this is cellular – manufacturing has the highest incidence of non-cellular deployments reported, with 33% of manufacturing industry respondents reporting that they do not have any current cellular IoT deployments. Non-cellular connectivity has a clear role to play, with 49% of respondents reporting they have non-cellular devices in-field and 68% of future adopters considering some form of unlicensed spectrum potentially suitable for their IoT deployments.

What is your organisation's current status in regard to IoT? (All Respondents)



It should be noted, however, that there is a significant number of deployments where cellular and non-cellular connectivity coexist – **34% of cellular IoT users report using non-cellular connectivity as well**. Connectivity providers need to be ready to support multiple technologies within their management platforms in this industry, particularly as **72% of cellular non-adopters use non-cellular connectivity for their IoT needs**. Cellular gateways transporting data from non-cellular endpoints will be a core feature of these forms of networks in future. The bandwidth constraints inherent in most non-cellular technologies also mean that many of the features of new cellular technologies, particularly 5G-based networks, are not necessarily required by manufacturing customers, despite high levels of interest in the technology.

In addition, supporting smaller companies may also be a good way to grow the market, as relatively few of these

companies are currently deploying cellular IoT. While 65% of manufacturers with more than 500 employees report they have a current cellular IoT deployment, only 38% with under 500 employees do so. However, this is likely due to the inaccessibility of the IoT to small businesses in general, as non-cellular IoT adoption shows similar numbers.

Much of this opportunity will fall to MVNOs; they remain the most popular type of company to engage for cellular IoT, with **67% of current adopters using an MVNO, and 62% of future adopters having approached them.** However, MNOs appear to be positioning themselves as strong contenders as well, with **31% of future adopters reporting they have selected an MNO as an IoT connectivity provider**, while no future users noting confirmed MVNO selection. It should be noted that, even where an MNO is selected, being able to offer services on an independent basis is still valued; being an independent partner is a capability that manufacturers ranked number 4 in their assessment of connectivity provider capabilities, and so being able to offer not merely the operator's own connectivity but the best connectivity available is vital. MNOs need to become like MVNOs if they are to provide a strong product offering in the IoT market.

Penetration of Non-Cellular Technology use for IoT (Cellular IoT Adopters)

34%

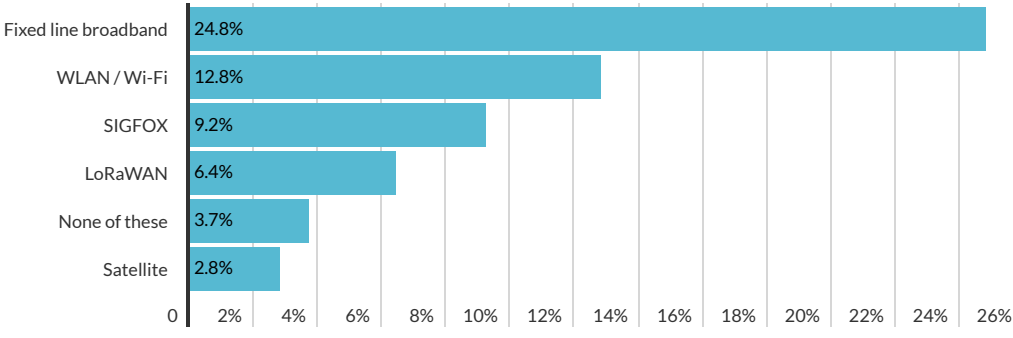
Non-cellular technology use for IoT (Cellular IoT Non-Adopters)

72%

How important is a carrier agnostic, independent partner? (All Respondents)

Rank 4

Apart from cellular technology, are you deploying IoT using devices with other communications technologies? (Cellular IoT Adopters)

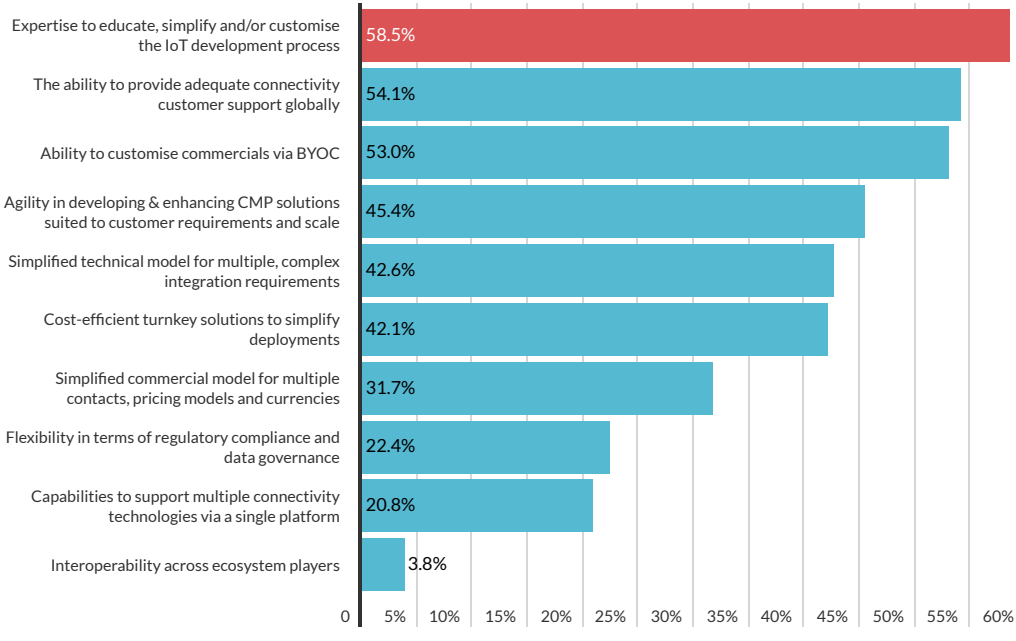


Complexity - Industrial/Manufacturing

Kaleido Intelligence

The complexity of the IoT is seen as one of the biggest barriers to both overall adoption and scaling up; the combinations of different radio technologies, protocols and systems can produce an array of potential problems for equipment designers and other manufacturers. With **59% of manufacturers putting support for new technologies in their top 3 factors that influence their choice of connectivity provider,** being able to offer a variety of connectivity options while keeping things simple is a key competence for connectivity providers. This is particularly important when it comes to hardware; hardware design is given as the number 1 obstacle to scaling up IoT deployments. **82% of respondents consider hardware design services a very important capability for a connectivity provider to have, and 61% of all respondents ranked device and hardware experience as the top factor they looked for in a connectivity partner's capabilities,** alongside consulting services for device design as the third highest concern. However, this may be difficult to convince end users of; **58% of respondents reported that they believed that expertise to simplify and customise the IoT development process was lacking in the current ecosystem.** Connectivity providers need to be able to provide hardware-related services to end users if they are to be of the greatest value to end-users, and put those services in easy-to-understand terms for end users to be satisfied.

What do you perceive as lacking in the present IoT connectivity ecosystem? (All Respondents)



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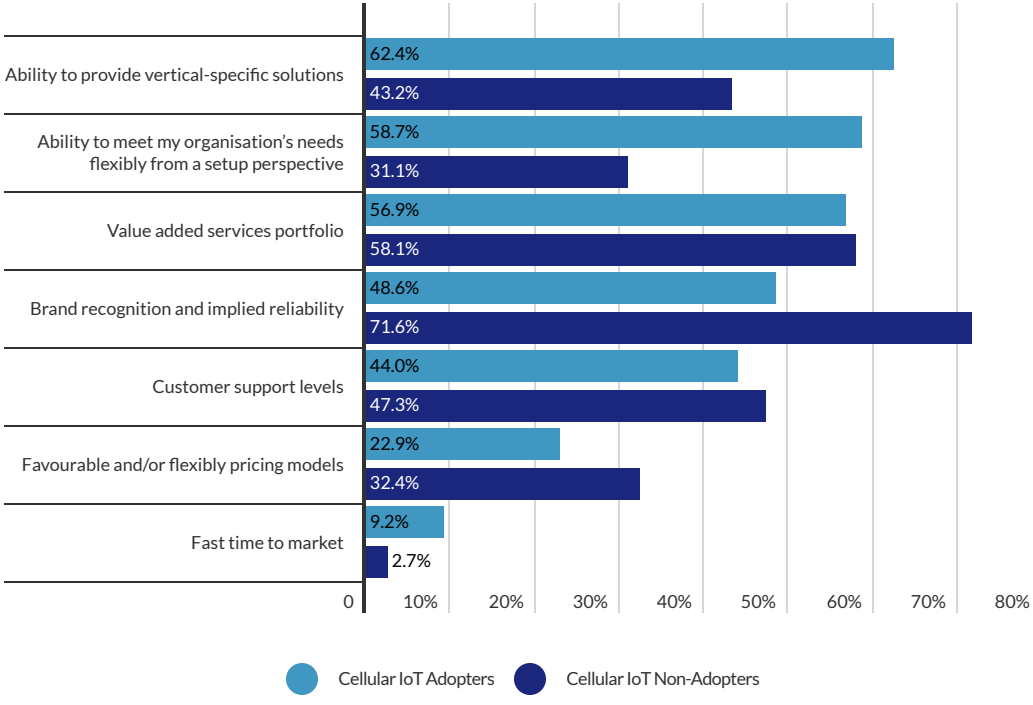
However, this cannot be generalised knowledge and offering generalised solutions. While **41% of manufacturers consider 'plug-and-play' hardware bundles to be very important,** few respondents reported fast time-to-market as an influence on their choice of connectivity provider. Instead, **being able to offer flexible and customised solutions is the key competence, rather than simplification, with 80% of respondents placing consulting services in their top 5 features they look for in a connectivity partner's capabilities.** This needs to sit alongside vertical-specific knowledge to be most helpful to customers; **62% of manufacturers currently using cellular IoT report vertical-specific solutions as a key non-technical influence on their choice of connectivity provider, and 43% of future adopters said the same.** In addition, only slightly fewer reported that flexibility of setup was important. These are ultimately two sides of the same coin, pointing to a need for customised and adjustable solutions at all stages of connectivity management.

This desire for flexible and tailored solutions may explain respondents' sales channel preferences. Only 12% of cellular IoT adopters expect VAS to be delivered through a digital marketplace, with the vast majority expecting direct sales channels. This mode allows dialogue about network performance and related concerns to be discussed more openly, tying into a demand for thorough customer service; **44% of cellular IoT users and 47% of non-users state that customer support levels are one of their main non-technical influences in choosing a connectivity provider, even if a fully globalised 'follow-the-sun' customer service is not a requirement for many.**

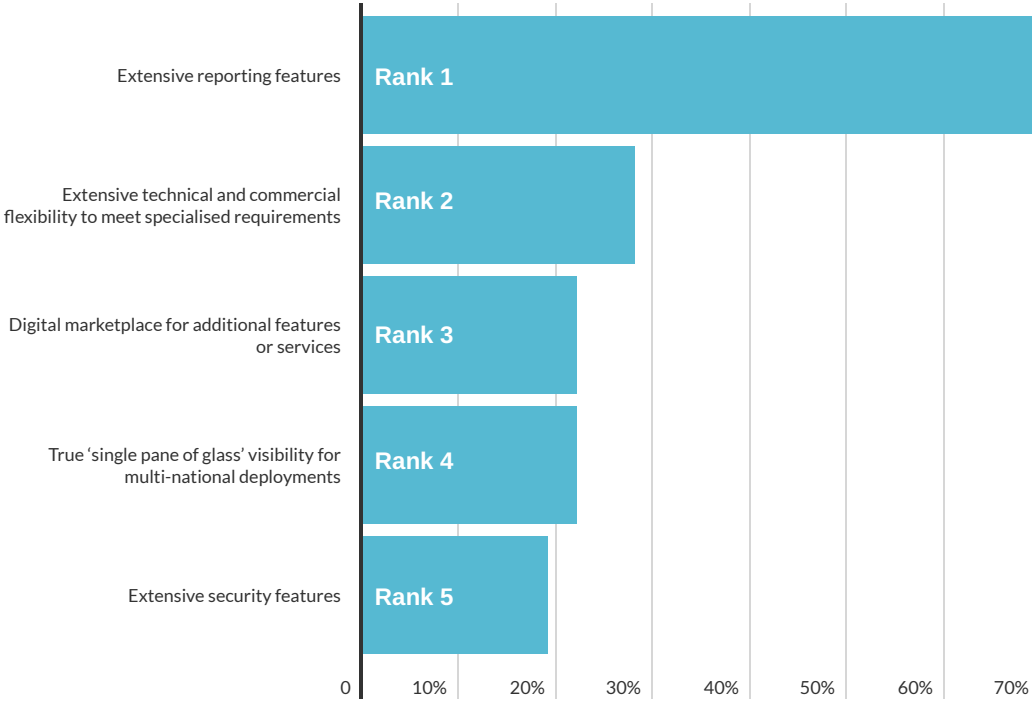
What are the main non-technical/commercial influences impacting your organisation's choice in choosing a cellular IoT connectivity provider? (All Respondents)



In addition, the need for international coverage often requires multiple providers, a particular pain point for the industry. Indeed, **64% of all respondents believe that the connectivity ecosystem not having a single model for international deployment to be the biggest challenge for first-time adopters. This lack of a consistent model has led 71% of current cellular IoT users to report using more than one connectivity provider.** As with results from last year's survey, dealing with multiple providers is seen as the biggest challenge to scaling IoT deployments. It is, however, one that is well understood by the manufacturing industry; those who actually engage multiple providers do not believe it is much more or less of a challenge than those who rely on a single connectivity provider, meaning that expectations are realistic in this respect.

The simplification that can be offered by connectivity providers is instead best offered through its platform once the devices are up and running. **Extensive reporting is the top product feature manufacturers look for in their IoT solutions, and 56% of respondents put 'single pane of glass' visibility in their top 5, with it being the highest-scoring rank 4 factor.**

What are the top 5 factors that you look for/would look for in an IoT connectivity partner's product?
(All Respondents)

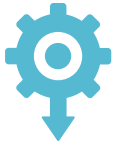


Sophistication - Industrial/Manufacturing

Kaleido Intelligence

With connectivity rapidly becoming a necessity in many ways, offering services in addition to connectivity is the main point of difference between providers in the current market. **More than half of both adopters and non-adopters consider VAS a major non-technical influence on their choice of connectivity provider. At the same time, only 2% of respondents consider an end-to-end solution one of the top 5 things they look for from a connectivity provider's product.** Striking a balance between full service and a narrowly-focused set of connectivity capabilities is key to appealing to customers while not overloading them with unnecessary features. Being able to step alongside existing processes is a vital capability here, with the ease of integration into existing processes being the second most important factor for IoT connectivity overall for respondents generally.

Importance of ease of integration into existing products & processes (Cellular IoT Adopters)



Rank 2

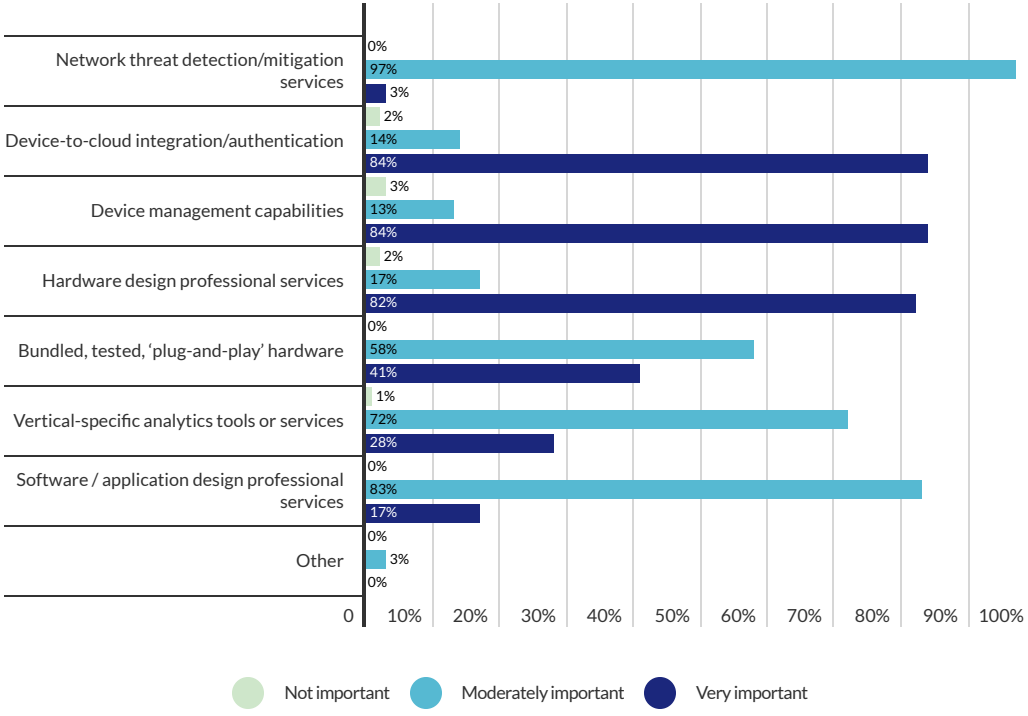
Importance of ease of integration into existing products & processes (Cellular IoT Non-Adopters)

Rank 4

The primary VAS desired by current users are all focused on devices, with over 80% of current cellular IoT users considering device-related VAS very important. This underscores the complexity that IoT hardware management brings, and the necessity of offering assistance with that. Even with the emphasis on vertical-specific customisations noted above, tailored analytics software takes a back seat to device services. However, these need to remain distinct and flexible – only 41% of current adopters consider plug-and-play hardware to be very important, and consolidated hardware bundles only reaches the rank 5 in a partner's desired capabilities, with only 44% of all respondents putting it in the top 5 things they look for in a partner's capabilities. It is clear that device services are necessary, but they should not appear standardised to any great degree if they are to appeal to most users.

A marketplace and extensive security features are other VAS that respondents find most useful. The ability to select features as necessary from a marketplace again underlines the notion that OEMs want choice in their connectivity packages, but do not necessarily want or need an all-encompassing single product. It is also worth noting that only 12% of respondents expect to be sold VAS through such an interface. Keeping direct sales channels open, as a way to provide a sought-after high level of customer service, is a must-have for connectivity providers, whether or not they can build compelling marketplace experiences.

Beyond connectivity, what are the most important value-added services you expect your cellular IoT connectivity service provider to offer? (Cellular IoT Adopters)



Product digital marketplace importance (All Respondents)

Rank 3

Product security features importance (All Respondents)

Rank 5

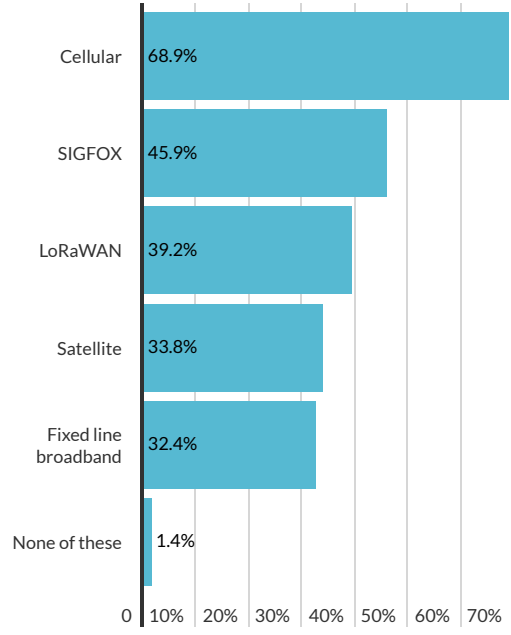
Comprehensive reporting is also required, as the #1 thing that manufacturers look for in a connectivity product, which will require granular details on connections' status, data usage, location and other features. However, it should be noted that single-pane-of-glass visibility is not the goal here, with only 9% of respondents reporting that as a top 5 factor they look for in a connectivity partner's capabilities. Having the information available is clearly important, but having everything in a single platform is not an expectation for manufacturers, potentially a symptom of expecting to work with many connectivity providers. Service providers also need to be ready to handle multiple RATs in their systems; all future cellular IoT adopters also see at least one form of non-cellular RAT as viable for their use cases, and so connectivity providers need to be willing and able to integrate non-cellular technologies into their CMPs so that these multi-RAT needs can be met. This is not particularly marketable, however, as very few respondents highlighted RAT interoperability in things they would look for in a

partner's product, so while there is little in the way of marketable benefits from such a move, it can be used to extend influence within a customer's operations to enable a smoother experience, which will enhance stickiness overall.

Connectivity providers would also benefit from making the range of cellular technologies they support more prominent, as well. There is a clear desire for a variety of different cellular technologies, with **59% of adopters ranking the support for technologies like 5G or cellular LPWAN in their top 3 technical factors influencing their decision of connectivity provider.** Such services would also give connectivity providers a wider range of ways in which to upsell clients and apply that tailored experience that is so valued in this industry.

The manufacturing sector also shows a strong preference for connectivity providers with sector-relevant expertise. As noted above, custom solutions tailored to customers' requirements are very much in demand, and although domain expertise does not make it onto manufacturers' radar for an overt capability, the preference for vertical-specific solutions heavily implies it. In addition, 58% of respondents believe that expertise to simplify and customise the IoT development process is lacking in the ecosystem. This could make for a strong differentiator from the competition if properly conveyed.

Which technology(ies) for wide-area connectivity do you view as most viable for IoT deployments?
(Cellular IoT Non-Adopters)



Gardner Denver has over 150 years' experience in developing industrial solutions for manufacturers, including the development of air and gas compressors for their international client base. The age of the smart factory, driven by Industry 4.0 means their customers were looking for a way of harvesting real-time data relating to their plant performance in a bid to eradicate downtime and maximize efficiency.

The Milwaukee-based industrial equipment provider responded to the market's appetite for data insights by creating the cloud-based iConn, an Intelligent Compressor Data Platform.

Internet of things (IoT)-enabled sensors integrated within the air compressor collect vibration and temperature data which is relayed via an eSIM over a 4G network to a browser-based visualization tool for remote monitoring and analytics. This data generates insights that can highlight machine parameters, and trends over time that may indicate a loss of efficiency or a complete failure that could result in an outage impacting the overall equipment effectiveness (OEE) of a facility. This data can also be passed to the manufacturer's proprietary dashboards thanks to APIs, which can assist in predictive preventative maintenance (PPM).

Gardner Denver

pelion

The Solution

Pelion's on-demand connectivity and global network coverage meant Gardner Denver could offer 'Connectivity as a service' (CaaS), meaning clients enjoy remote diagnostics that reduce the cost of physically sending engineers to site to troubleshoot plant failures and offer energy optimization tools to help reduce energy costs. Pelion's pre-negotiated tariffs with over 600 networks offer competitively priced coverage regardless of how many networks are used.
It's all very well offering a platform that delivers analytics, pattern recognition and algorithms that can compute and predict issues before they happen, but the platform is useless without a reliable means of relaying that data from around the globe in an efficient and secure manner. Gardner Denver's IoT & Analytics Director was tasked with their digital transformation and set about finding a connectivity partner that could support their fledgling platform.

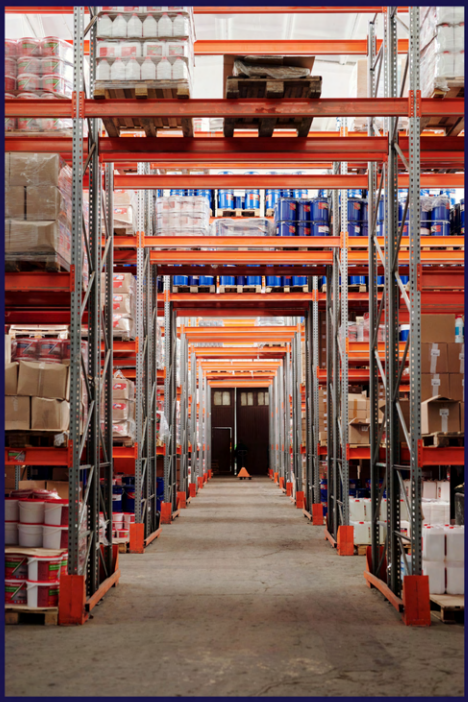
Their challenge involved extracting value from the data gathered via thousands of devices in remote locations whilst developing a retrofitted solution that could IoT-enable the thousands of compressors that were are already in the field. The Pelion partnership meant that Gardner Denver could focus on developing the open source iConn platform, rather than concerning themselves with maintaining connectivity in export markets. Appointing Pelion as Gardner Denver's connectivity partners meant the team could focus on improving his manufacturer's user experience, rather than managing multiple mobile network operators (MNO) contracts and invoices.

Gardner Denver

pelion

Additional revenue opportunities unlocked

"Our plan was to create new revenue streams by offering an intelligent solution that appeals to new clients, plus grow our share of wallet with existing customers by eradicating downtime from their existing compressors. Pelion makes this possible." **IoT and Analytics Director, Gardner Denver**



Pelion's cellular connectivity is embedded in Gardner Denver's current compressor range, whilst their retrofit kit is designed to give existing assets the means to connect to the platform. It's part of a two-pronged approach, which is key to Gardner Denver adopting an as-a-service (aaS) revenue model that compliments their plant machinery sales.

The aftermarket kit has seen early success thanks to its plug and play operability which can see a retrofitted compressor kit installed in under 20 minutes and, thanks to Pelion, start to relay data to the cloud-based iConn platform in just seconds.

This embedded connectivity, global coverage across many standards and access to multiple networks means that Gardner Denver can assign the best possible network post-deployment, then maintain the same SIM and connectivity with iConn, even if the manufacturer relocates their plant to alternative factories elsewhere in the world.

Gardner Denver

pelion

"Pelion not only facilitates our manufacturers' digital transformation, it expedites our ambitions to grow from delivering basic analytics and gaining predictive insights, to offering clients valuable cognitive data analysis that's processed at the edge." **IoT and Analytics Director, Gardner Denver**

Whilst a single eSIM for all territories dramatically reduced the need for multiple SKUs and SIMs to support each country, Gardner Denver cited the appointment of an agile partner that could scale with his ambitions as a key factor in choosing Pelion.

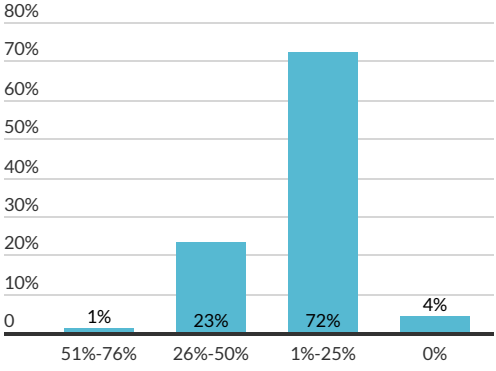
"The partnership transformed Gardner Denver into a service provider that could facilitate global deployments with just a small team, then add resources as the proof of concept showed a return on investment." **IoT and Analytics Director, Gardner Denver**

Roaming - Industrial/Manufacturing

Kaleido Intelligence

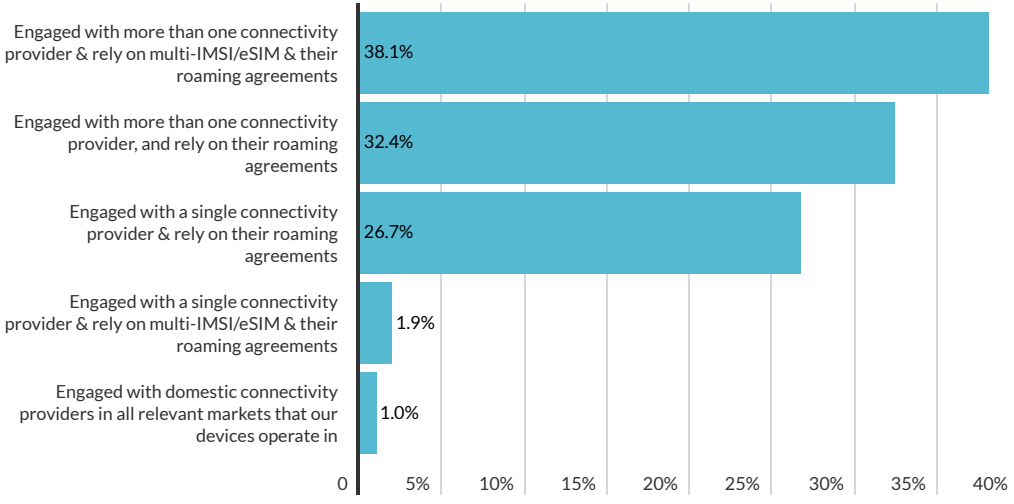
Roaming is a necessary part of the IoT ecosystem, and the manufacturing sector is no different; over 96% of respondents in this industry have an international connectivity requirement, and **59% of respondents rely purely on roaming agreements to cover this. This will not go away in future – 83% of future adopters report that they are planning an international distribution of their devices.**

What proportion of your organisation's cellular IoT device fleet requires international or multi-regional connectivity? (Cellular IoT Adopters)



As a result, roaming is high on respondents' priorities, with both present and future cellular IoT adopters considering it the #3 challenge to IoT scalability. This is of particular concern to future users; 72% of these respondents see the absence of a simple international deployment model as a challenge for first-time cellular IoT users, and more manufacturing respondents placed roaming restrictions in their top 3 challenges for IoT scalability than any other vertical surveyed. There is likely a commercial as well as operational concern here, with 98% of manufacturers reporting to be connected device OEMs, and an inability to secure stable roaming agreements for these devices will restrict the markets they can be sold in.

How will your organisation address its international connectivity requirement? (Cellular IoT Non-Adopters)



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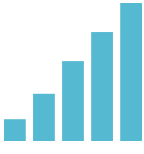
However, the ability to actually have full international coverage is less important to manufacturers; even while 66% claimed safety from roaming restrictions as the most important factor for connectivity overall, no manufacturing respondents placed robust international coverage overall in this spot, instead ranking it the third most important factor for IoT connectivity, with similar levels of concern from adopters and non-adopters. It is worth noting however that manufacturing respondents are more concerned about this than any other vertical, with 28% of respondents placing it at number 3. It is also a feature that will be looked for in a potential business partner, with 17% rating coverage in countries with regulatory or commercial restrictions as the joint second factor they would look for in a connectivity provider's capabilities, with 72% putting it in their top 5 factors overall.

Importance of assurance of protection against commercial & regulatory restrictions (All Respondents)

Rank 1

Robust international coverage as a key consideration for connectivity (All Respondents)



Rank 3

Manufacturers seem keen to solve this is conventional ways, through roaming agreements with 59% of respondents solving their international connectivity needs via these arrangements. Change is coming in the form of eSIMs and multi-IMSI options being used by 40% of current users, and **40% of users considering OTA network optimisation the number 2 technical factor that influenced them in choosing an IoT connectivity provider.** However, this is most likely to be in an effort to optimse connectivity to provide a high quality of service (the top factor) rather than necessarily to solve international roaming issues specifically. This means that those manufacturers looking for the best possible connectivity will engage in a degree of network switching, even within a single nation. These forms of advanced switching will also coexist with roaming agreements, with very few respondents seeking to manage relationships directly with domestic connectivity suppliers.

Roaming agreements do need to sit alongside other partners and arrangements, however, and be seen to be simple to integrate in this way. Over half of respondents report that they see an ability to incorporate preferential data rates and BYOC arrangements is lacking in the current cellular IoT ecosystem. There is also a perception that international deployments need a simpler model, with 64% of respondents saying this was lacking in the current ecosystem. There are high expectations for what should be possible with international connectivity and roaming, with respondents wanting BYOC options, simple deployments and increasing demands for technologies such as eSIM to simplify and optimise connectivity. This means that flexibility is needed at the connectivity profiles level, regardless of what SIM technologies are used, and the ability to provision roaming and local profiles to customer specifications will be a key competence in the coming years.

eSIM - Industrial/Manufacturing

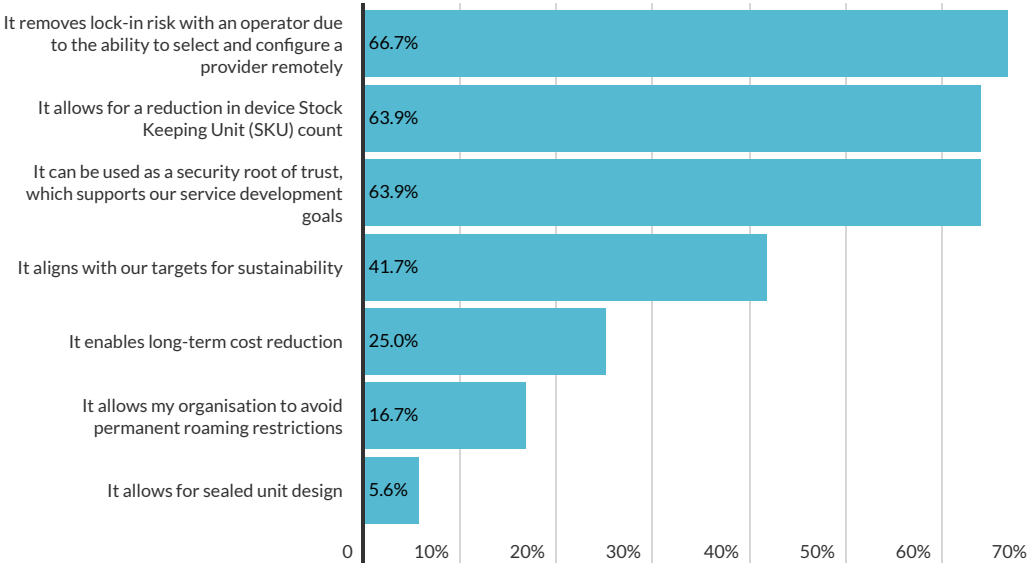
Kaleido Intelligence

33% of current cellular IoT users report that they use eUICC as part of their deployment. eSIMs appeal on multiple levels, with the average adopter reporting more than 2 reasons for using the technology. The most popular of these is that they remove operator-in risk (67%), reduce SKU count (64%), and the desire to use eSIM as a root of trust (64%). Interestingly, only 17% of eSIM users report that they are using the technology to mitigate permanent roaming restrictions, despite clear concerns about that being present (see the previous roaming section).

The reduction of lock-in risk shows through the usage patterns of the technology, where more than 95% of eSIM and multi-IMSI users engage more than one connectivity provider. Despite this, there is still an array of problems with eSIM deployment, with the average manufacturing respondent claiming more than three problems with the technology.

Chief among these remains the fact that OTA campaign tools are limited, although a similar number of respondents report that the number of available

What factors made you choose eSIM (eUICC)? (Cellular IoT Adopters)



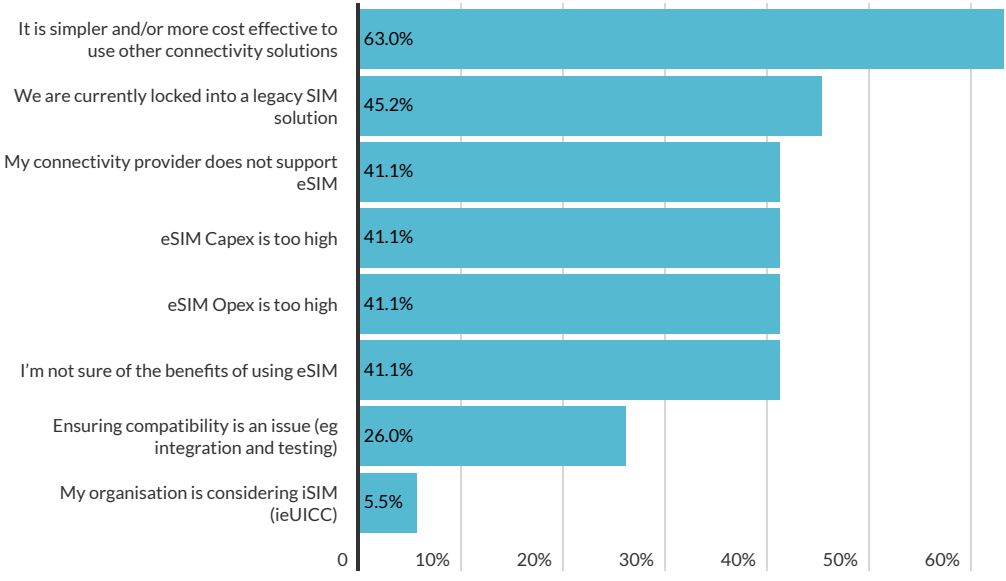
profiles is lacking. This latter problem should begin to be resolved with the forthcoming SGP.32 specification and the more flexible and changeable nature of profiles under the new specification. However, this will not begin to have an impact until Q4 2023 at the earliest, given the time required for devices to be made in line with the new specification.

The ability to offer eSIM will also make a connectivity provider more flexible and appealing, with 26% of current IoT adopters considering OTA network optimisation the number 2 technical feature they look for in an IoT connectivity provider, an area where eSIMs are very capable. As 41% of non-users claim a reason for their non-use to be that their providers do not offer

eSIM, there is a large potential market for eSIM capabilities, although existing multi-IMSI technologies and other network steering options may be desired as well.

Despite this, more work needs to be done to make eSIMs more appealing overall, particularly concerning their value proposition. 63% of non-users consider it to be simpler or more cost-effective to utilise other connectivity solutions, and 77% of non-users believe that either the Capex or Opex of eSIM is too high.

What are your main issues with your current eSIM (eUICC) solution? (Cellular IoT Adopters)

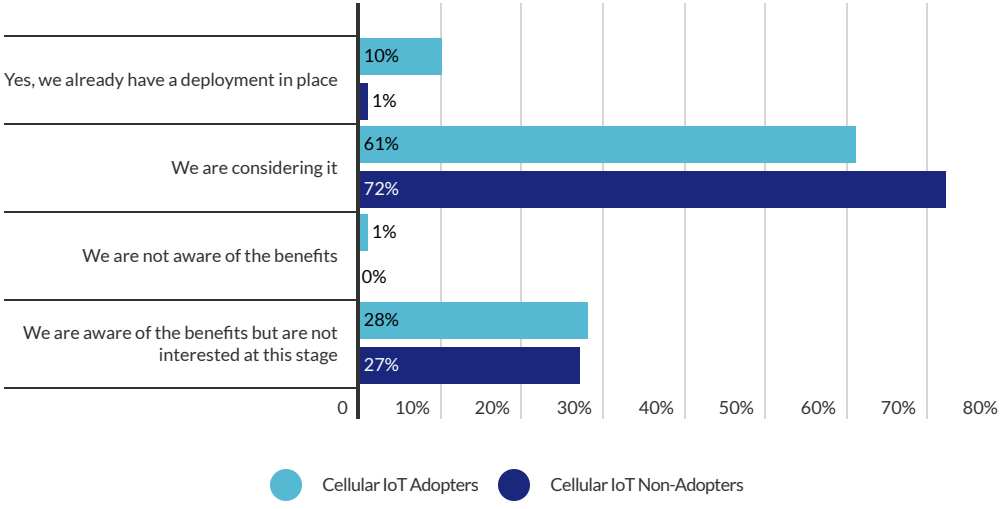


Private LTE/5G - Industrial/Manufacturing

Kaleido Intelligence

Private cellular networks are a hot topic at the moment, although there is limited deployment on the ground, with manufacturer network numbers worldwide numbering close to 1,000 rather than millions. Our survey bears this out, with 66% of all respondents considering private networks but only 7% reporting they have deployments in place.

Does your business unit have an interest in Private LTE/5G to enhance business operations? (All Respondents)

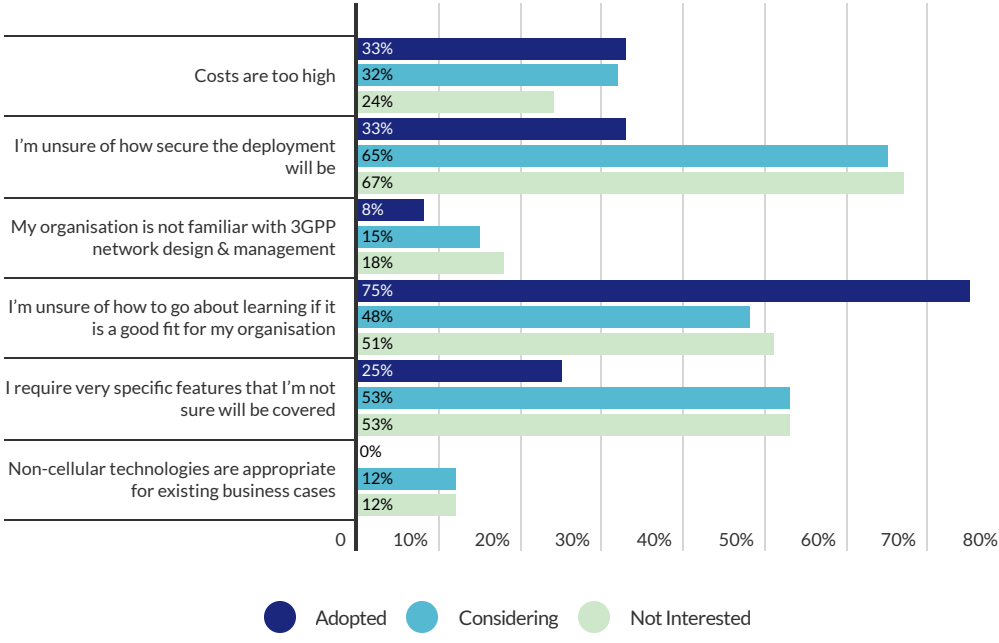


Awareness of the benefits of private networks is high, with the average respondent listing more than 2 benefits of the technology, even among those who have no interest in using private networks, and only 11% of users considering that non-cellular technologies are appropriate for them. However, the main stumbling block appears to be perceived security, with 65% of respondents considering private networks reported security as a concern. This is markedly lower among adopters, where 33% report it as a concern. Overcoming these obstacles may take some time, particularly as private network architectures increasingly tend towards cloud-based networks. With much network data often being competitively sensitive for manufacturers, work needs to be done by connectivity providers to illustrate how private networks enhance security, potentially by enforcing a strict boundary between the management and data planes in any architecture discussions and builds.

There also needs to be more work done to make private networks more obviously cost-effective. 30% of respondents reported that the cost of private networks was too high, including 33% of adopters. When paired with the fact that 75% of adopters in manufacturing are also unsure how to go about checking whether private networks are a good fit for their organisation, it

is clear that producing a quantified value proposition is key to both retaining customers and placating concerns of potential buyers.

What are your main concerns over a potential Private LTE/5G deployment? (All Respondents)



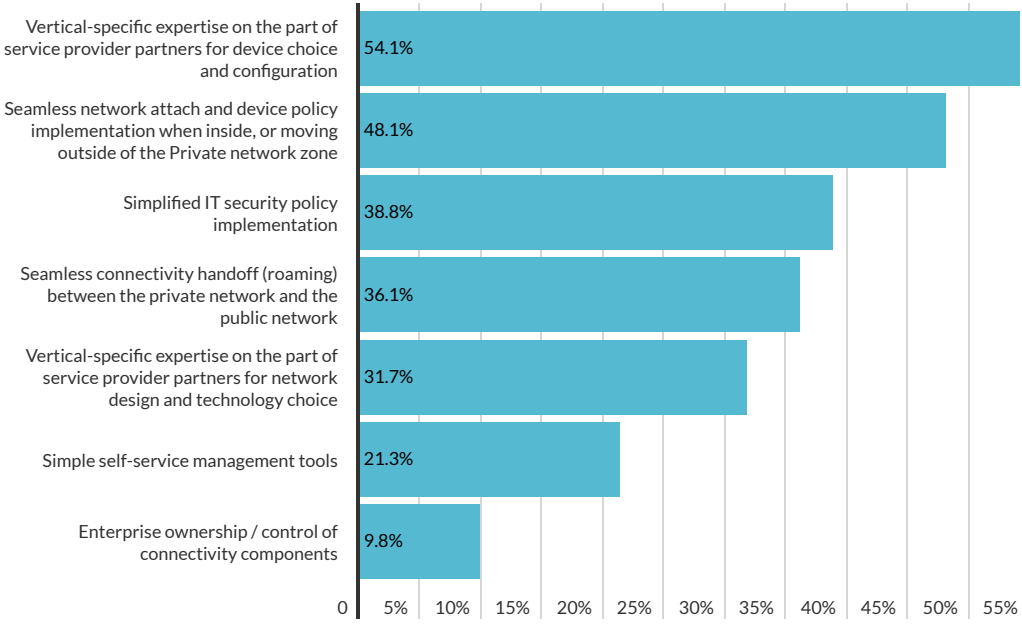
Note that this cannot be done by making the network security seem worth the cost; less than 5% of these respondents are concerned about both the security and cost of private networks. This means that it is not a case of "is it secure enough for the cost" but instead separate questions about private network security and their potential to achieve ROI.

The first steps towards this can be taken by providing manufacturing-focused designs and devices. Over half of respondents consider vertical-specific expertise in device choice and configuration to be an important factor for private networks. This is less vital for overall network design, with only 32% of respondents claiming this as important. However, these are of similar importance for current adopters, with 50% or overseeing both kinds of vertical-specific expertise as important.

Seamless network attach is also a key area for many, particularly those considering private networks, where 50% of respondents consider it important. While we have not seen much demand for private-public network roaming to date, emerging use cases may support use cases for seamless network attach, particularly as multi-campus network deployments become more common.

There is a clear indication that managed services are preferred for manufacturing private networks – self-service tools and enterprise ownership of connectivity components are the two lowest-scoring factors for private networks, indicating that manufacturers are happy to have MSPs play a large role in private network management. In line with results from last year's survey, this is even more pronounced among current adopters, none of whom consider enterprise ownership important, and only 8% want self-service tools.

What are the most important factors for consideration where Private LTE/5G is concerned? (All Respondents)



Kaleido Intelligence

IoT Connectivity Challenges & Opportunities:

Smart Cities

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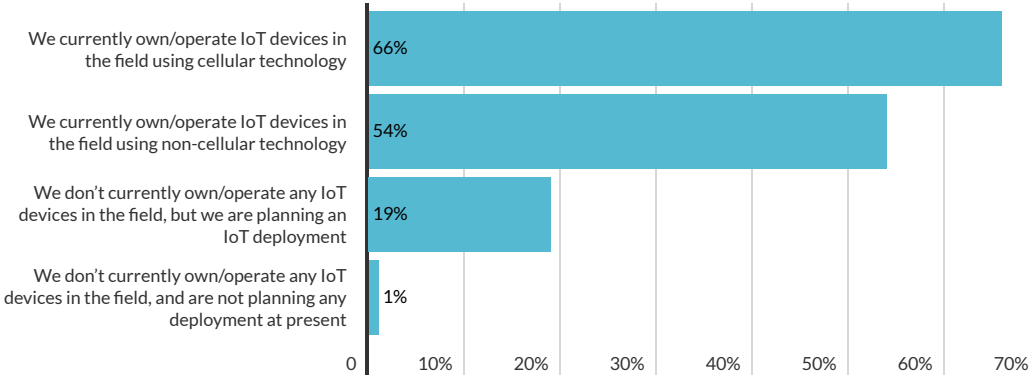
State of IoT - Smart Cities

Kaleido Intelligence

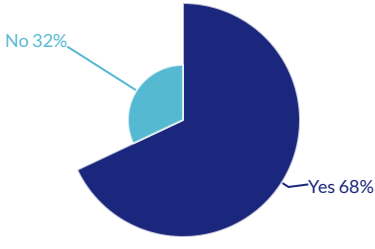
Consistent with survey results that were acquired in 2022, enterprises within the smart cities vertical have some of the highest cellular IoT adoption levels, with some **66% of respondents reporting that they have an active deployment in the field. This proportion is relatively consistent with 2022 results, where 69% of respondents reporting they have an active or previously had an active cellular IoT deployment.** Thus, at the surface, it appears as though growth in the industry has been relatively marginal over the past 12 months.

What is your organisation's current status in regard to IoT? (All Respondents)

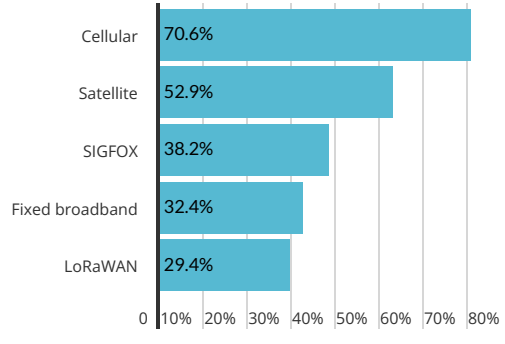


Nevertheless, IoT deployment intentions among cellular IoT non-adopters are much more favourable when compared to last year: **68% of respondents stated that they intend to deploy IoT within the next 2 years, of which 71% reported that they view cellular technology as a key technology to enable wide-area IoT communications**. In contrast, 2022's survey saw only 12% of cellular IoT non-adopters stating that they intended to deploy cellular IoT within a 2-year timeframe.

Does your organisation plan to adopt IoT over the next 12-24 months? (Cellular IoT Non-Adopters)



Which technology(ies) for wide-area connectivity do you view as most viable for IoT deployments? (Cellular IoT Non-Adopters)



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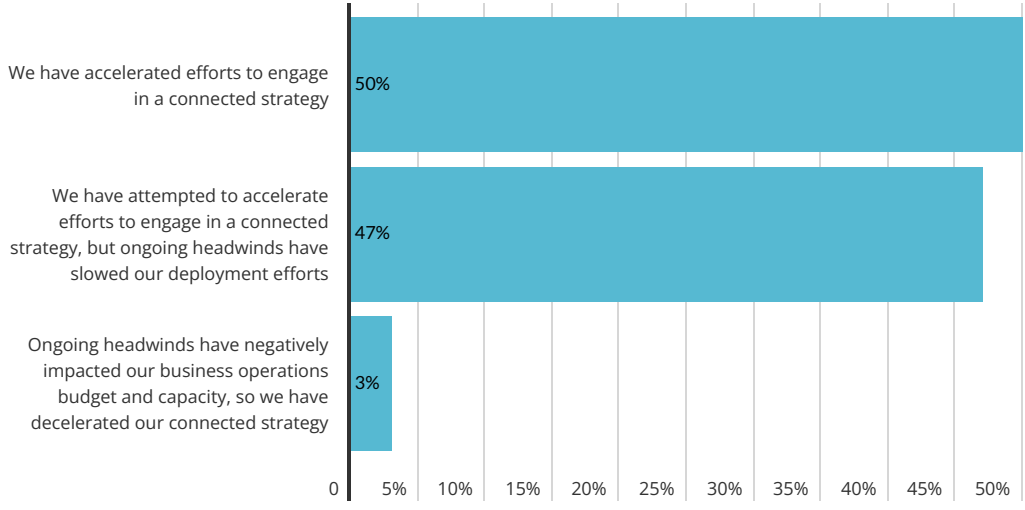
As is the case with many of the other verticals analysed in this report, the smart cities vertical presents a diverse set of potential use cases, ranging from smart parking to waste management, connectivity for the public at large as well as smart street lighting. It is thus not surprising to see that cellular technology is viewed as a key enabler behind many of these use cases on account of the diverse capabilities afforded by various RATs. Indeed, the ability of cellular technology to support hardware gateways to connect different technologies and aggregate connectivity over a number of devices is perhaps a key reason behind 44% of cellular IoT non-adopters stating that cellular technology is commercially favourable for potential deployments: it enables efficiencies from a hardware perspective that are difficult to match with other WAN technologies.

Importantly, the current headwinds experienced by enterprises as a result of the tail-end effects of the COVID-19 pandemic as well as ongoing broader economic challenges, have not deterred smart cities enterprises from intending to adopt IoT. Here, **50% of respondents reported that they have accelerated their efforts to adopt IoT** in spite of the above factors, which is well above the survey average of 41%. As such, it is evident that there is a growing opportunity among CSPs to capture new market share for smart city connectivity services over the next 24 months.

Which technology(ies) for wide-area connectivity do you view as most viable for IoT deployments? (Cellular IoT Non-Adopters)

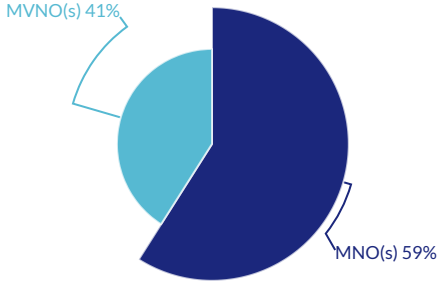


Complexity – Smart Cities

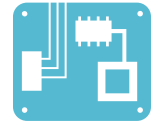
Kaleido Intelligence

In line with the majority of other verticals, enterprises within the smart city vertical were in agreement that **hardware complexity and the need to establish commercial relationships with multiple CSPs for international deployments represent the top 2 barriers towards scaling IoT up.** Notably, the second challenge is likely compounded by the fact that **59% of cellular IoT adopters have chosen an MNO for their connectivity solution, where the ecosystem status quo currently means that even customers of large Tier 1 MNOs must often engage and integrate with separate entities and platforms across divisions of a common parent.** On the other hand, this is something where MVNOs have, for the most part, a critical advantage in the ability to deliver multi-country connectivity via a single commercial relationship and integration with a single platform. Regulations mean that achieving this on a global scale is impossible, given the need for entirely local services in some countries. Nevertheless, this must be noted as a key differentiator in the MVNO community targeting smart cities enterprises.

What type of connectivity service provider have you chosen to engage with for your cellular IoT deployment? (Cellular IoT Adopters)



Challenges in scaling IoT up - Hardware complexity (All Respondents)



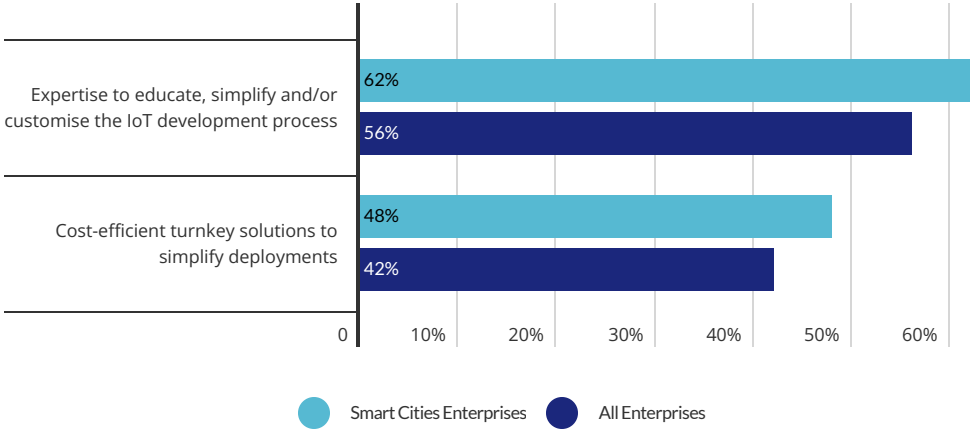
Rank 1

Challenges in scaling IoT up - Need to engages with multiple CSPS (All Respondents)

Rank 2

Meanwhile, it is evident that enterprises within this vertical have a greater need for ecosystem simplification compared to others. In this context, 62% of respondents reported a lack of expertise to simplify deployments or professional services to help guide enterprises through the deployment process, compared with a survey average of 56%. Additionally, respondents cited a strong lack of turnkey solutions for deployments, according to 47% of cellular IoT adopters and 50% of cellular IoT non-adopters. Given the high level of respondents reporting they intend to adopt cellular IoT over the next years, it is apparent that there is a potential market niche for service providers to specialise within specific areas of smart cities connectivity and solutions, where expertise in hardware in addition to vertical-specific solutions could be offered in conjunction with connectivity.

What do you perceive as lacking in the present IoT connectivity ecosystem? (All Respondents)



Indeed, in the context of VAS, **61% of cellular IoT adopters reported a very high interest in bundled and tested plug-and-play hardware offerings, with 45% of the same cohort reporting the same for vertical-specific tools and solutions.** What is evident, however, is the enterprises within this vertical do not expect full end-to-end solutions from CSPs, as this capability was not ranked as a major (top 5) capability in terms of a potential CSP's product; rather, the ability to offer considerable depth in reporting, flexibility in commercial and technical arrangements and the provision of security services were deemed as much more important.

Top priorities for CSP capabilities - Customer Support (All Respondents)

Rank 2

Top priorities for CSP capabilities - Technical & Commercial Flexibility (Cellular IoT Adopters)

Rank 3

Notably, customer support was ranked as a top 2 priority for CSP capabilities, which is in part linked to complexity in international scenarios; either when multiple partners are engaged for connectivity services or where roaming is involved through a provider, but inconsistent support is provided by the roaming partner enabling the CSP. This is certainly an area where smart cities CSPs can endeavour to offer a point of differentiation, but this depends on the entity gaining sufficient visibility over devices in international scenarios. In this instance, ownership of core network infrastructure is essential in order to gain insight into signalling traffic, while self-hosting any roaming sponsor IMSIs will likely prove beneficial in terms of visibility and management. Without this, strong SLAs must be in place between roaming partners, although this is unlikely to be achieved on a consistent basis where CSPs with smaller volumes of connections and traffic are concerned, on account of the lower revenue opportunity afforded to the inbound MNO.

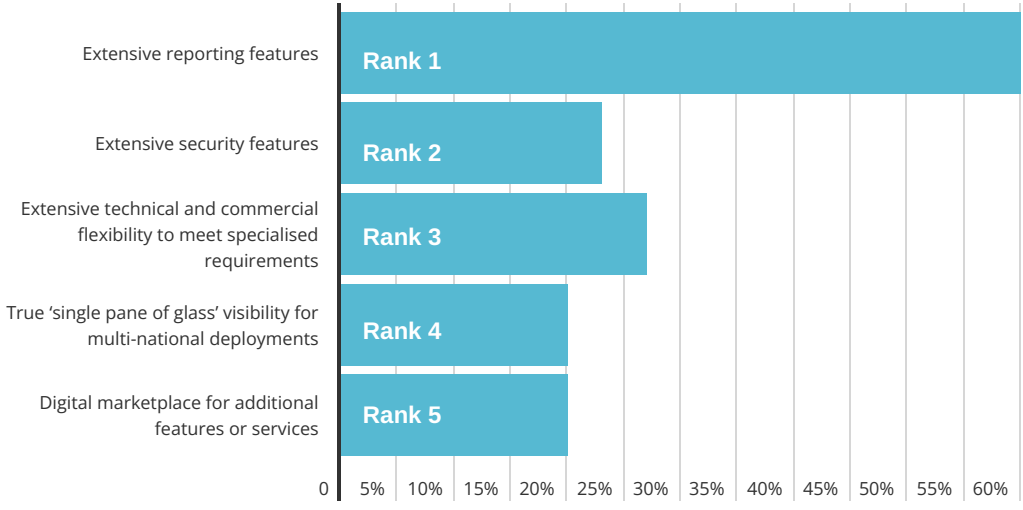
Sophistication - Smart Cities

Kaleido Intelligence

Increasing sophistication among smart cities enterprises is observable through their expectations of CSPs' capabilities when it comes to delivering products. While reporting reaches the top rank, in line with other verticals, and highlights a need for a significant level of information for enterprise analysis, ranks 2, 4 and 5 are composed of security features, single pane of glass capabilities, and digital marketplace offerings to enable new services.

These items highlight that enterprises within this vertical have significantly higher expectations from CSPs beyond mere connectivity provision: security evidently plays a critical role in addressing smart city connectivity requirements, given the nature of deployments and potentially sensitive or critical data involved with deployments. As such, having the capability to monitor traffic sessions and enable enterprises to determine risk levels and apply threat

What are the top 5 factors that you look for/would look for in an IoT connectivity partner's product? (All Respondents)



mitigation actions would undoubtedly offer a point of differentiation. Meanwhile, due to the diverse range of technologies involved with smart city connectivity (where smart parking for example may make use of short-range RF capabilities in conjunction with a cellular gateway), the ability to not only support the management of a range of RATs through a single portal, as well as the ability to support connectivity management through a range of international deployments will likely be seen as beneficial.

Finally, the marketplace concept for VAS is an interesting one, given that it is not widely applied within the CSP ecosystem. Indeed, most survey respondents expect that VAS are delivered through traditional sales channels. Nevertheless, Kaleido notes that a number of CSPs have added the digital marketplace to their existing product or product roadmap, and such a modular, seamless approach to upselling will likely prove an efficient mechanism for creating additional value for CSPs moving forward.

Staying with the theme of CSPs' product, the survey highlights how thedevelopment of CMP offerings needs to evolve to allow more efficient management of devices. In the first instance, the fact that it is too challenging to manage the device fleet was cited as a top 5 issue among survey respondents, while cellular IoT adopters reported that a high-quality CMP was the number 2 priority they look for when choosing a potential CSP. Efficiency here can be found in many forms, including the GUI layout and performance, the API suite and accompanying documentation, in addition to reporting capabilities as well as the ability to optimise the inventory according to automated actions. Many existing CMPs have placed a heavy focus on automated rules based on traffic consumption thresholds, but these are by now largely table stakes features. More powerful capabilities, such as the ability to generate custom reports based on any number of variables collected by the platform would likely prove as beneficial, while features that enable customers to rapidly identify problematic SIM cards via a combination of a simplified 'wizard' in addition to more extensive information made available to expert uses offer new differentiation points.

Top technical influencing factors in choosing a CSP - Quality, efficient CMP (Cellular IoT Adopters)

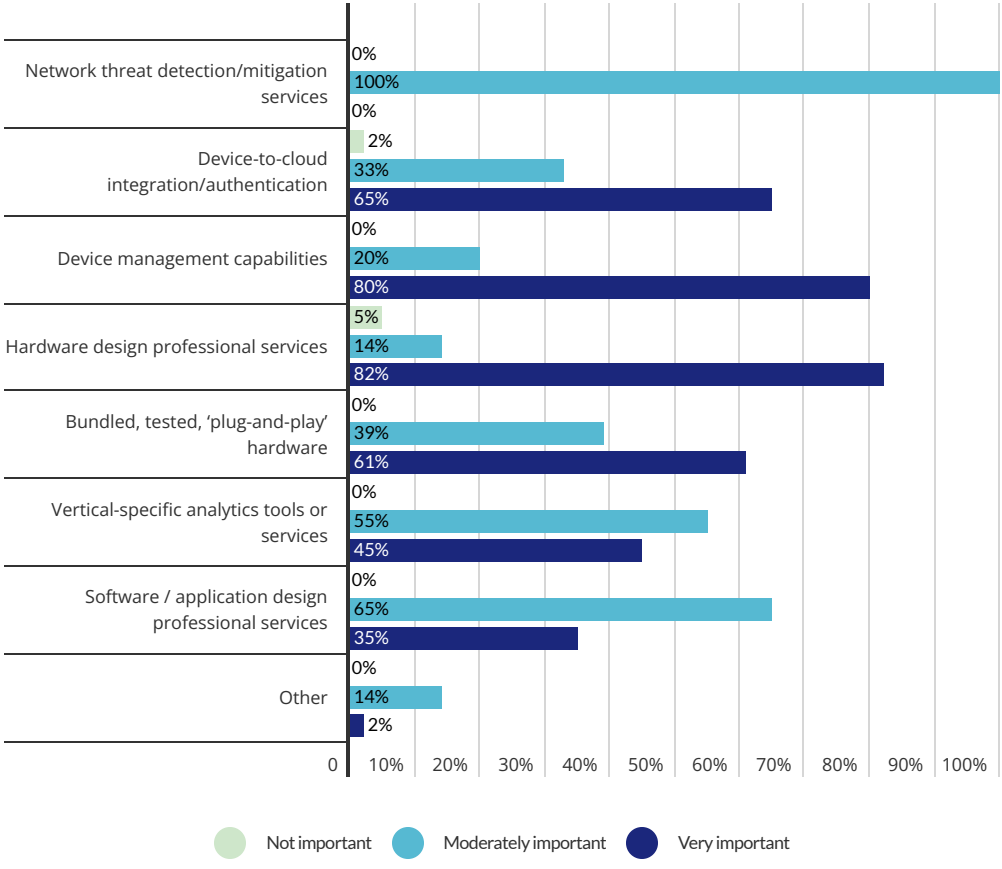
Rank 2

Top challenges in scaling IoT up - Difficulty in managing device fleet (All Respondents)

Rank 5

Notably, enterprises in this vertical a highly aware of the potential pitfalls involved with IoT connectivity within their segment and view risk avoidance as a key priority. In this context, cellular IoT adopters ranked the ability to adhere to in-country regulations as a top 2 priority for cellular IoT connectivity, which means that CSPs serving this vertical must have expertise at hand to aid enterprises where data privacy and processing, hardware, currencies and taxation and licencing are concerned. Within the smart city domain, of particular concern is the ability to safeguard any citizens' data, which means that robust security offerings are essential. In line with this concept, 80% of cellular IoT adopters reported a desire for device management capabilities, where firmware update capabilities are likely viewed as an essential component of maintaining security and mitigating the risk of sensitive data exfiltration.

Beyond connectivity, what are the most important value-added services you expect your cellular IoT connectivity service provider to offer? (Cellular IoT Adopters)

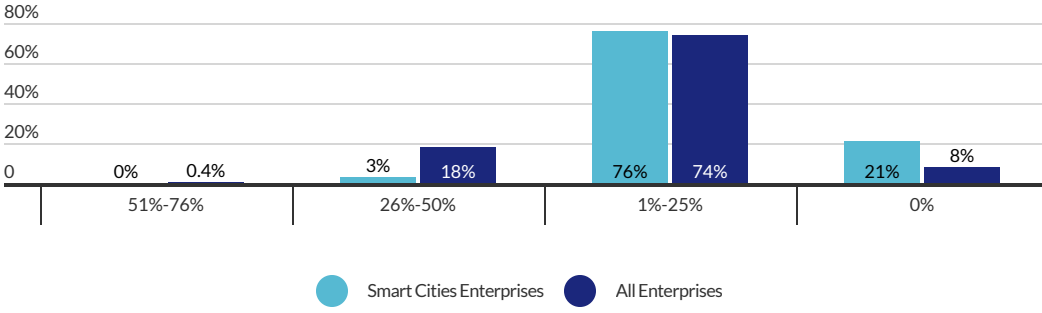


Roaming - Smart Cities

Kaleido Intelligence

Enterprises active in the smart cities vertical have a comparatively lower demand for international connectivity, with 21% of cellular IoT adopters enterprises reporting that all of their devices are located within a single country, compared to an overall survey average of 8%. Meanwhile, only 3% of respondents reported that more than 26% of their device fleet is located internationally, compared with a survey average of 18%. Without a doubt, this is due to the fact that many tenders for smart city connectivity are by nature on a national basis, with fewer players competing at an international level.

What proportion of your organisation's cellular IoT device fleet requires international or multi-regional connectivity? (Cellular IoT Adopters)



Nevertheless, even in this vertical, roaming still plays a considerable role, considering that **79% of the respondent base stated that they require some form of international connectivity support.** With devices often performing sensing-based use cases, this means that LPWAN connectivity is likely to play a considerable role in deployments, whether on the national or international stage; therefore, CSP support for these technologies is essential. As a result of these factors, permanent roaming concerns represent a significant concern for smart cities enterprises, with cellular IoT adopters and cellular IoT non-adopters ranking it as a top 3 and top 4 challenge, respectively, where issues with scaling IoT up are concerned. Additionally, cellular IoT adopters ranked a lack of LTE-M or NB-IoT support internationally as a top 4 issue with scaling IoT up, making it evident that players should focus on bilateral or sponsored roaming agreements to improve coverage in this domain.

Challenges in scaling IoT up - permanent roaming (Cellular IoT Adopters)

Rank 3

Challenges in scaling IoT up - permanent roaming (Cellular IoT Non-Adopters)

Rank 4

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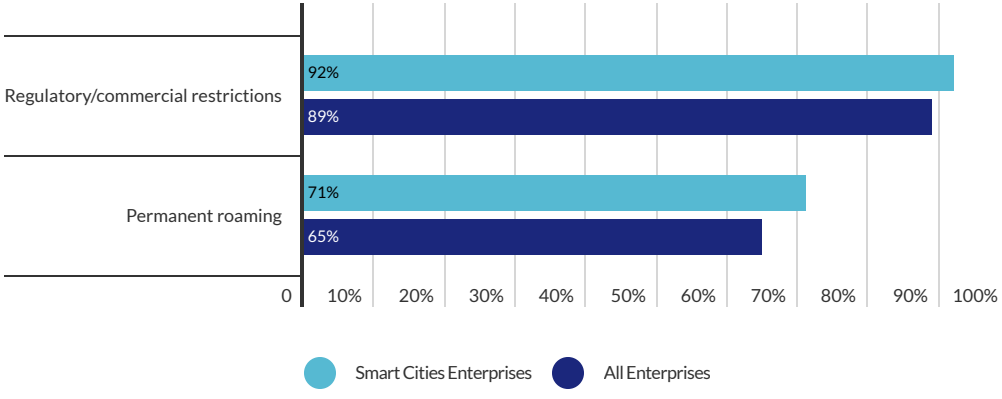
With permanent roaming comes the issue of whether coverage can be supplied in a given country. Evidently, this is more of an issue for those who have already entered the cellular IoT connectivity ecosystem, with respondents in this cohort stating that **coverage in countries with commercial or regulatory restrictions is a top 2 priority, compared with non-adopters, who only view it as a top 5 priority.** At this point, one must bear in mind that this concern does not only touch permanent roaming: where personal data is involved, many countries and regions have by now established data protection regulations, which limit the flow of cross-border data. This means that CSPs must not only have commercial arrangements in place to enable permanent roaming, where regulations do not restrict it but also ensure that they have a physical presence on a country or regional basis to ensure that cross-border data regulations can be met. Naturally, this will limit the pool of potential CSPs vying for business to those that already have a local presence, in addition to larger international connectivity players. It is thus not surprising to see that **59% of cellular IoT adopters reported that they have engaged with an MNO for their connectivity needs, given the more domestic nature of deployments: MNOs are evidently seen as a simpler route to connectivity enablement.**

Regulatory/commercial restrictions & Permanent Roaming selected as top 5 concerns (All Respondents)

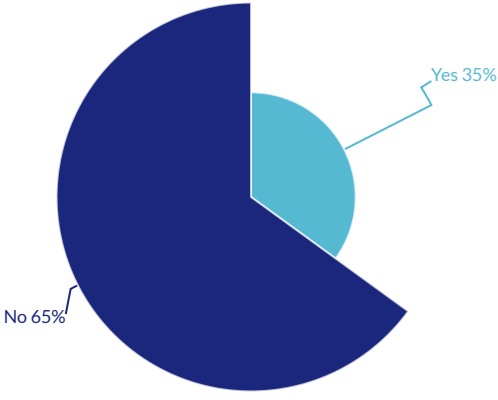


eSIM - Smart Cities

Kaleido Intelligence

eSIM adoption among smart cities verticals is roughly in line with the survey average, with **35% of cellular IoT adopters reporting using the technology, compared with 36% across all verticals.** The relevance of eSIM in smart cities deployments, particularly as deployments tend to be more domestic-based, is interesting; however, what many frequently miss is the fact that the long-term flexibility of eSIM is as relevant on the domestic stage as it is on the international one. For example, if they domestic connectivity service provider experiences network issues or lacks optimal coverage within a particular area of a city, eSIM opens the possibility of optimising affected SIM cards' connectivity without any reliance on national roaming agreements between the originally contracted MNO.

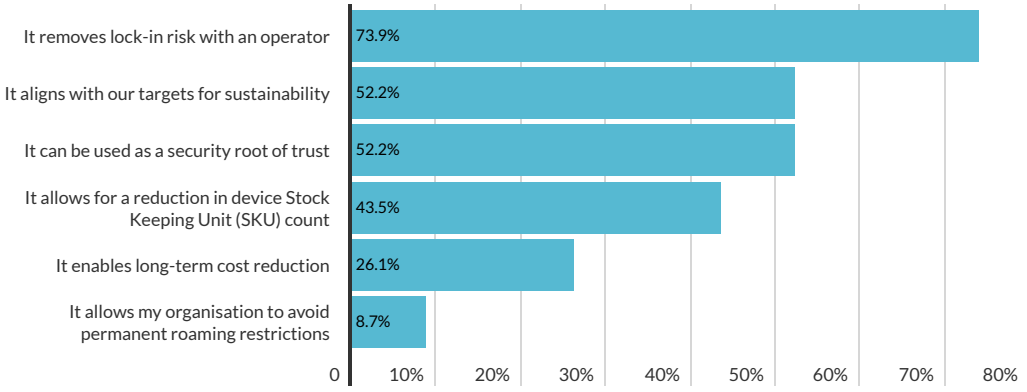
Have you decided to use eSIM (eUICC) as part of your IoT deployment? (Cellular IoT Adopters)



This sentiment is further reflected in the results, which show that **74% of respondents have chosen eSIM on account of its ability to avoid lock-in risks with operators, while only 9% of the same cohort report that a key factor behind eSIM deployment is to avoid risks associated with permanent roaming.** As such, one can infer that eSIM is simply leveraged as a long-term guarantee for connectivity, and as such is likely to continue to be used in 'insurance mode', without leveraging the full OTA capabilities afforded by RSP architecture. For eSIM specialists, this perhaps means less of an ongoing revenue opportunity when compared to other verticals, where network profile switching, particularly under the new IoT specification, is likely to be more desirable moving forward.

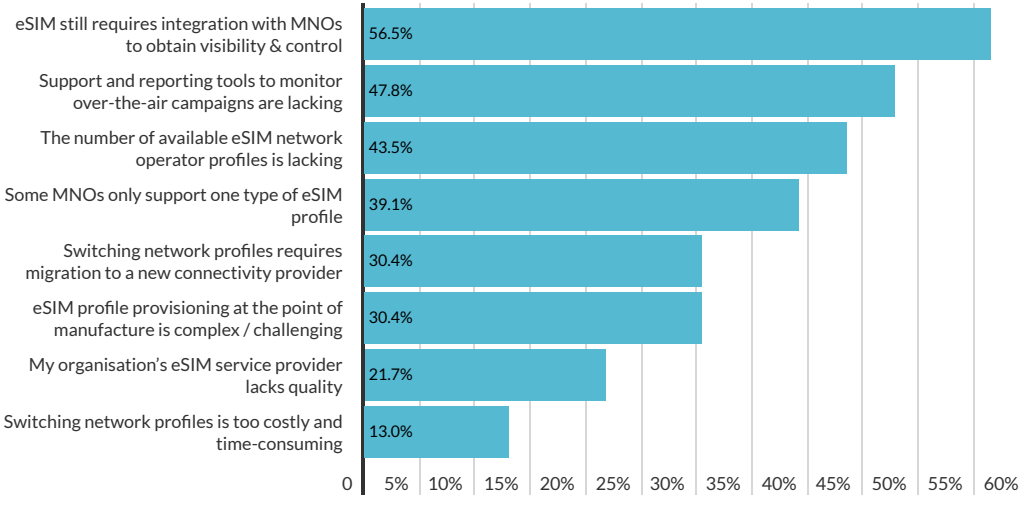
Nonetheless, it is possible to present an alternative viewpoint where eSIM choice is concerned. As stated previously, LPWAN connectivity demand is likely to feature heavily across many smart city use cases, with the exception of video-based public safety and traffic connectivity requirements. Previously we have observed how permanent roaming risks are top-of-mind for enterprises, even in the smart cities vertical, naturally raised as a point of concern due to the fact that NB-IoT and LTE-M connections are roaming on a permanent basis in the majority of use cases (NB-IoT more so than LTE-M, which lends itself better to mobile use cases). At the current stage of eSIM ecosystem development, the industry has not yet found a standardised mechanism to reduce the size of an eSIM profile to the order of bytes rather than kilobytes, which creates challenges where LPWAN OTA campaigns are concerned. Therefore, one might view the low level of agreement that eSIM is suited to avoiding permanent roaming as a result of this current ecosystem status quo.

What factors made you choose eSIM (eUICC)? (Cellular IoT Adopters)



Challenges identified with existing eSIM deployments largely relate to the existing M2M specification: **the strongest agreed-upon issue among respondents, with 57% selection, was the fact that eSIM requires MNO integration to maintain control of the device.** Within the M2M specification, this means that complex work must be done to achieve this if the CSP has not already integrated with a particular MNO. Many of the dependencies that exist in the M2M specification are removed, which will remove much of the pain associated with the process, and as such, one can expect a much more favourable reaction to eSIM deployments as the IoT specification is commercialised among enterprise customers in this vertical. Overall, extant challenges that we observe here are lessened by IoT MVNOs, which typically have a library of available eSIM profiles that customers can leverage without additional integration work required. Notably, on the MNO side, the customer is typically fully migrated from one CSP to another during the process, which presents an enormous time and cost penalty for the customer; as connectivity aggregators, this issue is considerably dampened by IoT MVNOs.

What factors made you choose eSIM (eUICC)? (Cellular IoT Adopters)

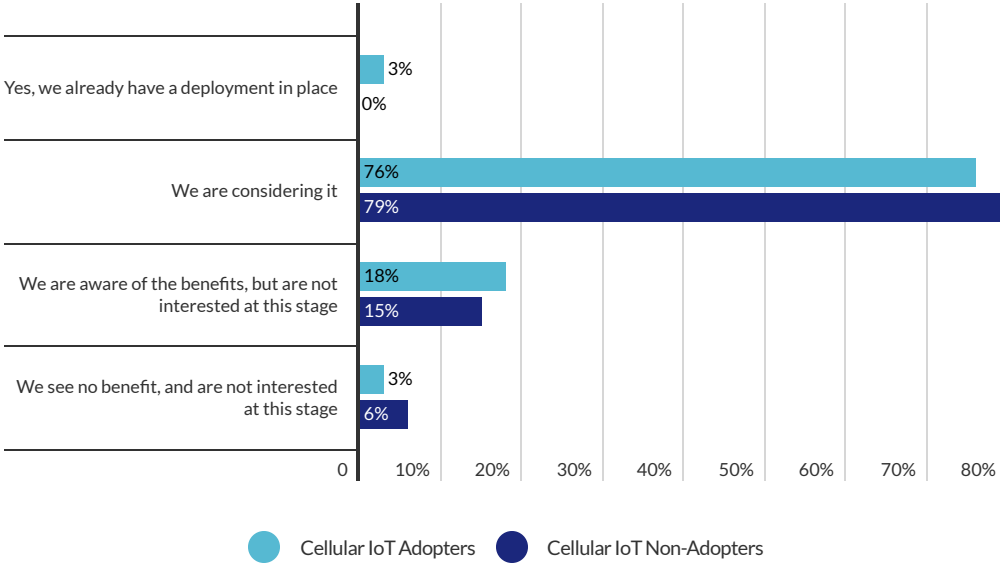


Private LTE/5G - Smart Cities

Kaleido Intelligence

Private LTE or 5G reported adoption was the lowest among all of the verticals analysed in the survey, with **only 2% of enterprises stating they have an active deployment, compared to a survey average of 9%.** By and large, this is understandable given the fact that public network coverage is typically best in cities, while the use cases involved do not often have near-realtime or very high bandwidth requirements. Nonetheless, private cellular networks can offer significant benefits in certain smart city use cases, such as with emergency services, smart traffic applications and even connectivity for public events and commercial areas.

Does your business unit have an interest in Private LTE/5G to enhance business operations? (All Respondents)

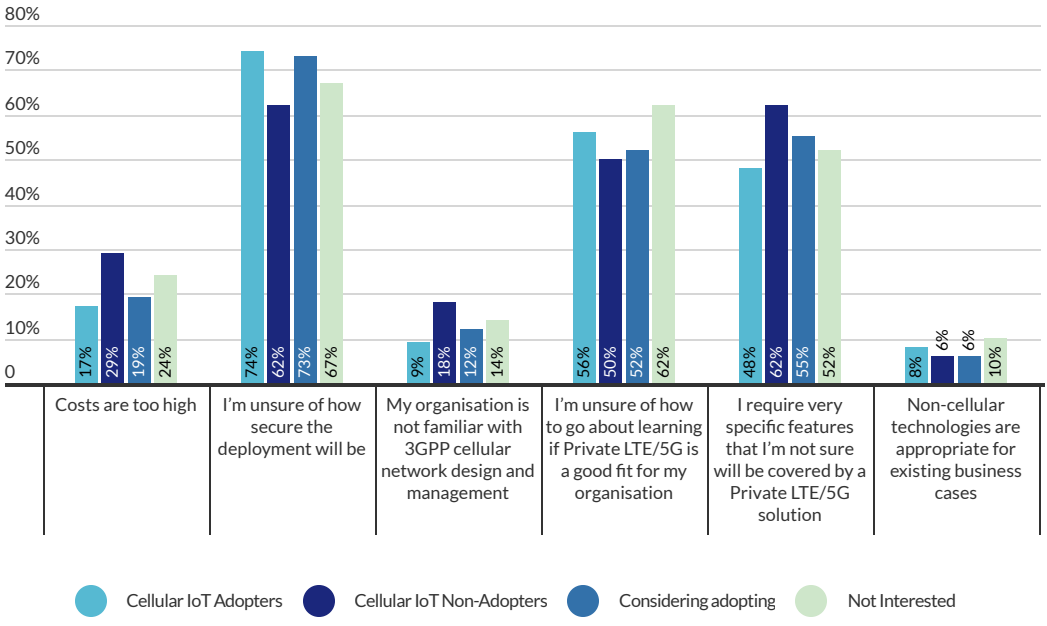


Although current adoption is low, interest in smart cities is markedly high: **77% of respondents stated they are considering a potential deployment, compared with 68% where all verticals are averaged.** It is evident that the market remains at an early stage here, with potential customers requiring a firmer grasp on the benefits and costs involved in order to evaluate investment potential.

Interestingly, the belief that non-cellular technologies for private network applications are more suited to deployments was the lowest among all verticals, with only 7% of respondents believing as such compared to a survey average of 13%. **Cellular is clearly viewed as a superior technology for connectivity even when compared to potential alternatives such as LoRaWAN, which offers potential growth potential as the market matures and greater ecosystem simplification is achieved.** However, once again, concerns over potential deployment security raise their head, particularly where cellular IoT adopters are concerned:

74% of respondents cited concerns over security, compared with 62% of cellular IoT non-adopters.

What are your main concerns over a potential Private LTE/5G deployment? (All Respondents)



Meanwhile, **the view that Private LTE or 5G costs are too high is the lowest among all verticals, with 21% of smart cities enterprises believing so, compared to a survey average of 26%.** Assuming other issues over security and suitability of private cellular networks can be overcome through market maturation and education, it is apparent from the survey that there is strong market potential for smart cities moving forward.

That said, education and simplification will be critical factors in being able to tap into the potential of the market. In common with other verticals, concerns over device choice and configuration were identified as key challenges for potential customers, in addition to concerns over network design and technology choice. Indeed, for many smart city use cases, LTE is likely to suffice, although 5G may prove more economical in more demanding use cases due to lower infrastructure investment requirements for performance and coverage across the same area. Additionally, customers will need to understand whether cellular is the optimal technology at all, where combined Wi-Fi with city fibre infrastructure may offer comparable performance at lower cost, albeit with security compromises. **It is certainly evident that concerns over devices moving between public and private networks are lower in this vertical: 36% and 39% of respondents cited potential issues over network attach and roaming, compared with 46% and 35% across all verticals.**

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IoT Connectivity Challenges & Opportunities:

Healthcare

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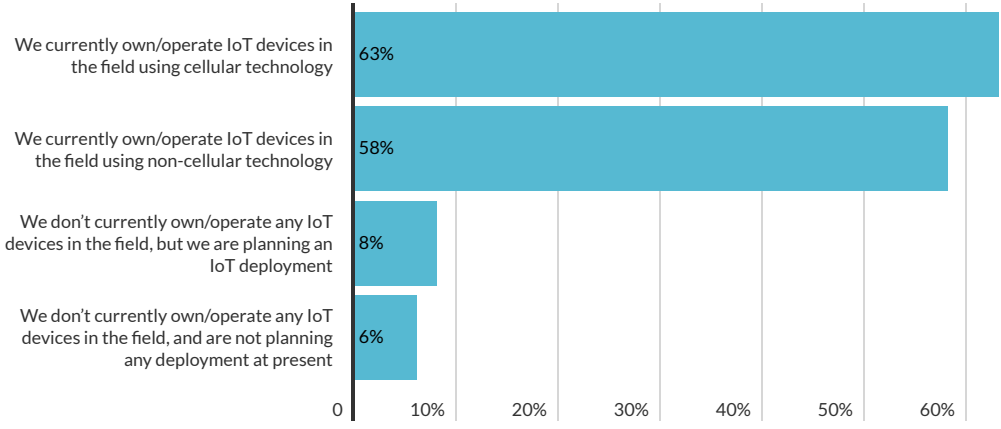
State of IoT - Healthcare

Kaleido Intelligence

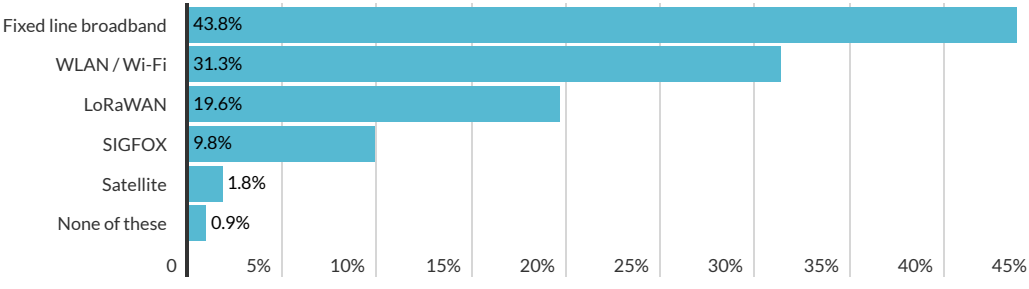
Enterprises in the healthcare vertical reported higher levels of cellular IoT adoption compared to the survey average, with **63% of survey respondents stating they have an active cellular IoT deployment, compared with 58% of enterprises across all verticals.** The results are interesting when positioned against those collected in 2022, where 49% of respondents reported a cellular IoT deployment, in addition to nearly half of the non-adopter cohort stating an intention to deploy cellular IoT in the next 2 years. **Evidently, strong growth has been achieved within the healthcare vertical, undoubtedly due to continuing efforts to digitise caregiving as a result of the COVID-19 pandemic.**

What is your organisation's current status in regard to IoT? (All Respondents)



Use of other communications technologies for IoT is common within the healthcare vertical, with **69% of cellular IoT adopter respondents using additional technologies to support IoT operations.** Most commonly, these implementations leverage fixed-line broadband communications, which, at 44% of respondents, is higher than the 40% seen across all verticals, although lower than transportation and logistics and energy and utilities.

Apart from cellular technology, are you deploying IoT using devices with other communications technologies? (Cellular IoT Adopters)



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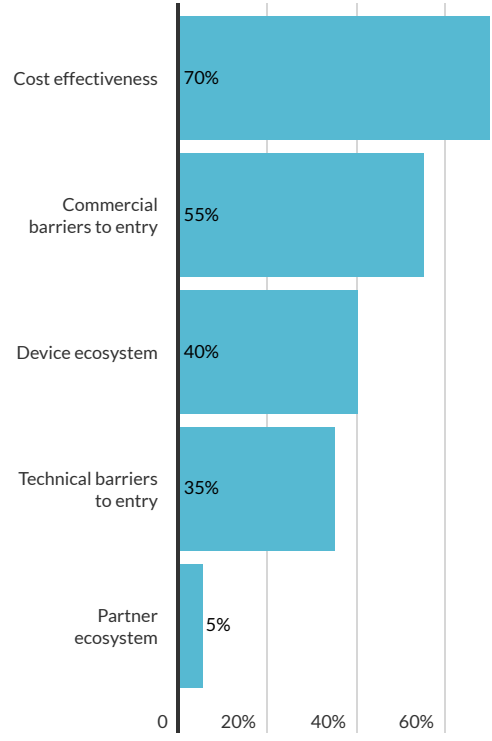
Digital healthcare services have undoubtedly benefitted from the onset of the COVID-19 pandemic, which saw a large proportion of the global population issued with stay-at-home orders and with limited physical access to general healthcare services. Teleconsulting services, which pre-pandemic were limited in scope, are now relatively commonplace across developed regions, while renewed emphasis has been placed on remote patient monitoring solutions for chronic disease and cardiac outpatients, with a plethora of devices using various communications technologies to transmit data to caregivers. In addition to this, the market has seen a drive towards greater efficiency in caregiving locations through asset and worker connectivity.

The survey points to positive sentiments where cellular technology is concerned, acting either as a direct means for connectivity or as an aggregation tool through gateway devices connecting data from non-cellular devices. This is observed first throught the level of cellular IoT adoption witnessed earlier, in addition to perceptions from the non-adopter cohort: 70% of respondents view cellular as a key technology for wide-area digital health connectivity.

However, it should be noted that, **among those that did not select cellular in the survey question displayed above, cost-effectiveness was cited as the main reason for not choosing the technology by 70% of respondents; much higher than the survey average of 58%.** As such, it is important to consider where extraneous costs may exist within the ecosystem and if any mechanisms exist to alleviate those issues. One likely source of unwanted cost is likely to stem from complexity, which is particularly acute in the healthcare industry. This will be examined in the next section.

Why do you perceive cellular connectivity as unsuitable for IoT deployments? (Cellular IoT Non-Adopters)

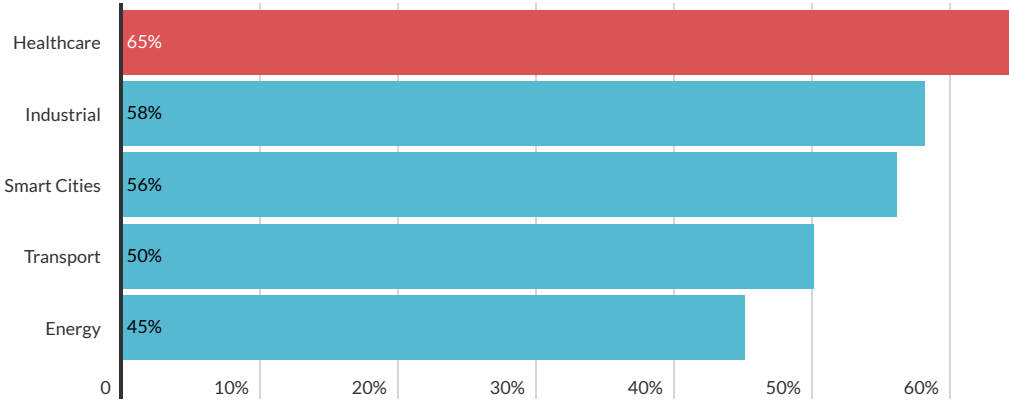


Complexity - Healthcare

Kaleido Intelligence

According to the survey, hardware complexity is more evident in the healthcare vertical than others: **65% of cellular IoT adopters reported that hardware experience on the part of a CSP's capabilities is their number one concern when looking for a partner.** This proportion is well above other verticals, and likely for good reason: certifications for medical device use are challenging to say the least, and in many cases, a change in the hardware will require the process to repeat itself. As such, there is a strong desire to optimise from the outset which, as we have seen throughout the survey, is not an easy task for adopters or non-adopters of cellular IoT. **Hardware is of such importance to cellular IoT adopters that the ability to bundle hardware and connectivity was cited as the second highest priority in terms of a CSP's capabilities.**

Device & Hardware Experience Ranked Top Priority for CSP Capabilities (Cellular IoT Adopters)



Simply from the results above, it is apparent that being competitive in the healthcare vertical requires a considerable level of specialisation beyond mere connectivity. For most players, this can only be achieved through M&A activities, which are likely difficult to justify on account of the comparatively small size of the market at present compared to some other verticals. Inevitably, this vertical represents a long-term opportunity for CSPs, although specialisation at this juncture will mean they are well-positioned to capture market share as traction and adoption gather pace.

Further challenges are found through results that healthcare enterprises also suffer from having to engage with multiple CSPs to meet their connectivity requirements; here, 28% of respondents ranked this as their number 2 challenge in scaling IoT deployments up. When one considers the level of specialisation expected from healthcare vertical CSPs, it is apparent that the pool of available CSPs able to meet requirements is diminished when compared to many other verticals, which makes the ability to scale up even more challenging. This relates not only to the issues with hardware described earlier but also to the technical capabilities of the CSP to ensure that devices retain a

high level of security and data privacy. Indeed, end-to-end security was ranked as a top 5 priority for cellular IoT connectivity among cellular IoT adopters.

Challenges in scaling IoT up - Need to engage with multiple CSPs (All Respondents)

Rank 2

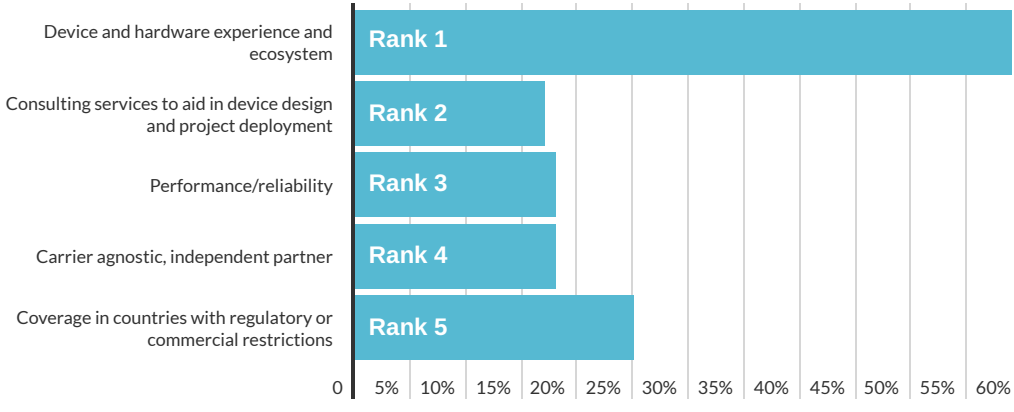
By nature, digital health solutions can have a positive or negative impact on an individual's health, depending on whether the solution is functioning reliably or not. As such, connectivity reliability is perhaps even more important in this vertical when compared to others, given the risks involved with lengthy downtime: revenue may not be the only thing at stake. This is reflected in the survey results, with healthcare respondents ranking connectivity performance and reliability as a top 3 priority where a CSP's capabilities are concerned. This complexity is not necessarily felt at the end-customer level but rather at the service provider level.

Top priorities for IoT connectivity - End-to-end security (Cellular IoT Adopters)

Rank 5

Considerable effort must be made on the part of CSPs to ensure that high-quality, resilient links between the CSP and connectivity partners are established so as to maximise performance and reduce potential downtime. In addition to this, the CSPs must have strong capabilities to identify network issues rapidly. If robust SLAs are struck between the CSP and its connectivity partners, this would undoubtedly prove a strong point of differentiation, given that customers can be assured of reliability. It is notable that other verticals also selected this capability among their top 5 prioirites, albeit lower down the list. This may offer some investment incentive, given the differentiator is not exclusive to the healthcare vertical.

What are the top 5 factors that you look for/would look for in an IoT connectivity partner's capabilities? (All Respondents)

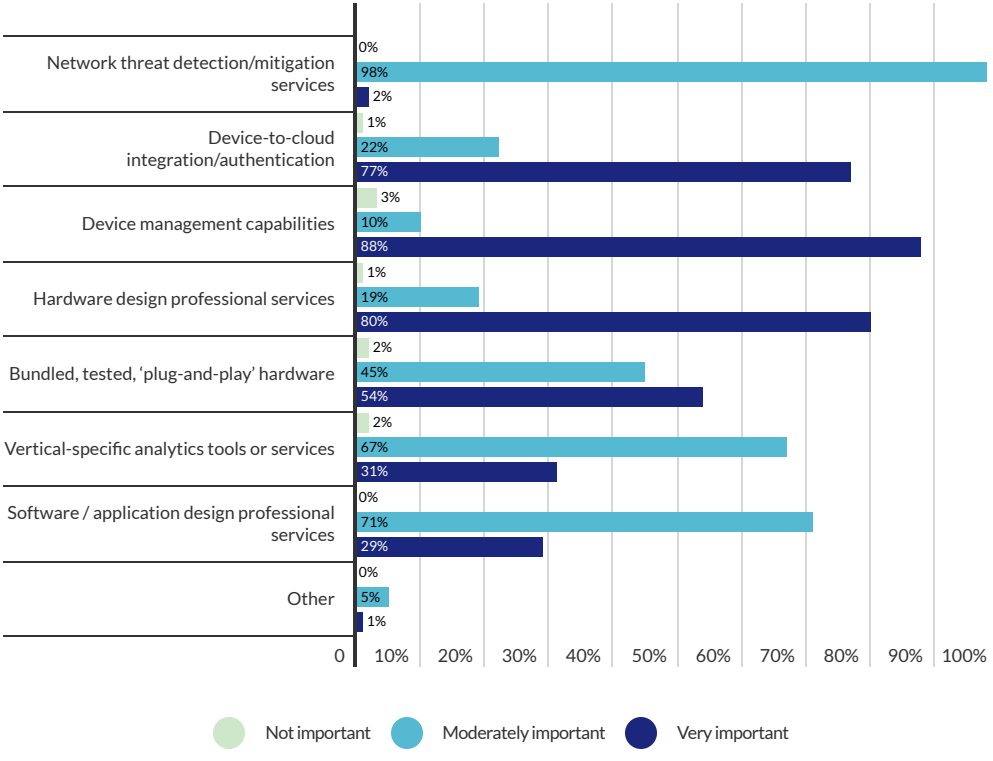


Sophistication - Healthcare

Kaleido Intelligence

Sophistication in healthcare enterprise vertical demands is not limited to the expertise requirements outlined in the previous section. The ability to deliver VAS components in addition to connectivity appears to be a key factor for existing cellular IoT customers, with **88% of respondents reporting that device management capabilities are of the highest importance.** In part, this is likely liked to a perceived need to simplify IoT deployments by sourcing the capability to manage the connectivity, device firmware and device software from the same provider. However, one can envision how in reality, this might run into trouble: earlier, we observed how customers must frequently source connectivity from more than one provider, which leads to the logical conclusion that device management solutions should be sourced via an agnostic third-party. That said, CSPs with device and hardware portfolios and expertise, which are evidently favoured by healthcare enterprises in principle, will likely offer device management capabilities at some level; this is certainly the case where hardware OEMs are concerned.

Beyond connectivity, what are the most important value-added services you expect your cellular IoT connectivity service provider to offer? (Cellular IoT Adopters)

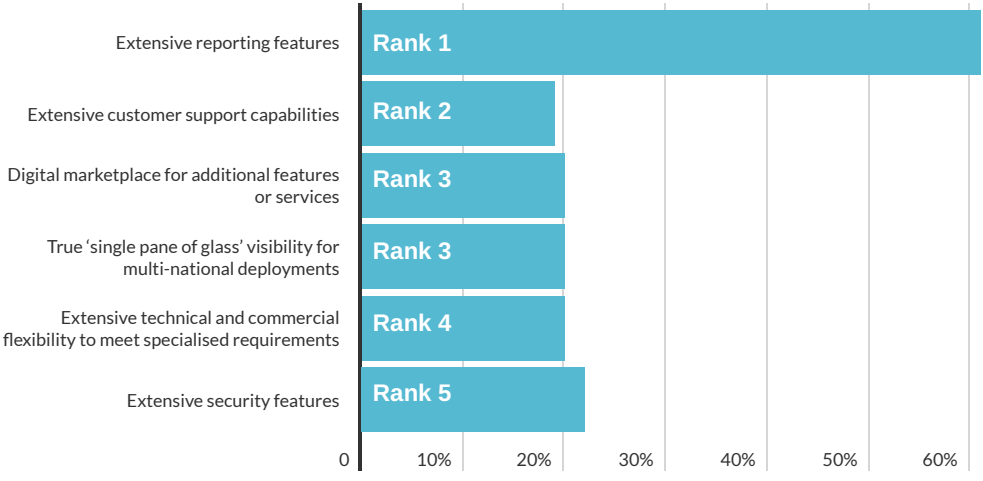


Security services are clearly important in the healthcare domain and are perhaps more so in this vertical due to the nature of activities and data involved. It is interesting to note, however, that security threat detection and mitigation solutions are cited as moderately important for the most part, despite security expectations playing a greater role in the survey results in terms of CSP capabilities. From this perspective, one can infer that typical security solutions, such

as private IP addressing, private APNs and VPN flavours are viewed as broadly sufficient in terms of how CSPs should present the offering. It is likely that many enterprises in this vertical are unaware that compromised devices using cellular technology may not necessarily be detected as such by traditional enterprise detection and response tools, which focus on data gathering from cloud services or enterprise data centres. Tools to enable visibility into device activity within the cellular network itself will undoubtedly be beneficial, but education is clearly required at this stage to help enterprises better understand the potential risk profile.

This is perhaps in part reflected in enterprise sentiments regarding CSP product capabilities, where reporting tools were ranked as the number one feature most important in the context of CSPs' products. These types of capabilities not only involve enterprises' ability to gather metrics that help them understand the root cause of potential issues with SIM cards, but also to gather information that can be leveraged for further business intelligence, particularly when device management capabilities and associated reporting metrics can be combined with connectivity data.

What are the top 5 factors that you look for/would look for in an IoT connectivity partner's product? (All Respondents)



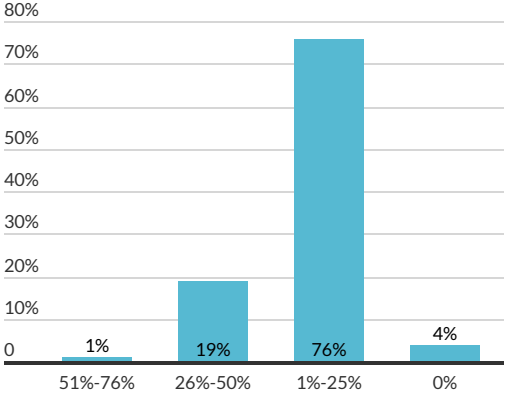
Although such capabilities may not be available in typical out-of-the-box offerings, the rankings highlight that enterprises are open to adding new services to the solution on a case-by-case basis. Here, digital marketplace models are desirable, given the sales and implementation simplification offered by a purely digital self-service approach. Naturally, this will rely on the CMP having been developed in a modular, rather than monolithic approach, which offers some advantage to CSPs in control of their own CMP development rather than relying on a third-party supplier. Further emphasis on this is found in the fact that enterprises demand a highly flexible technical and commercial approach to services, which ranked as a top 4 priority for CSPs' products. Older platforms are certainly at a distinct disadvantage here, owing to protracted roadmap development times and heavy emphasis on developing features that are likely to be adopted by all customers rather than opening services to specific niches.

Roaming - Healthcare

Kaleido Intelligence

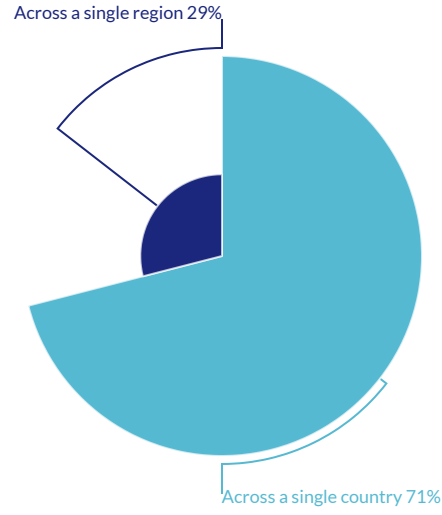
Alongside the industrial and manufacturing vertical, healthcare showed the highest demand for international connectivity support, with **only 4% of cellular IoT adopter respondents reporting they require domestic connectivity only. This is in stark contrast to those who have not yet adopted cellular IoT, where 71% of respondents reported that their future deployment will only require connectivity in a single country.** This may be a case of 'start small' for those who have not yet adopted, but it is clear from those already in the ecosystem that connectivity needs have spread beyond what was originally envisioned.

What proportion of your organisation's cellular IoT device fleet requires international or multi-regional connectivity (Cellular IoT Adopters)

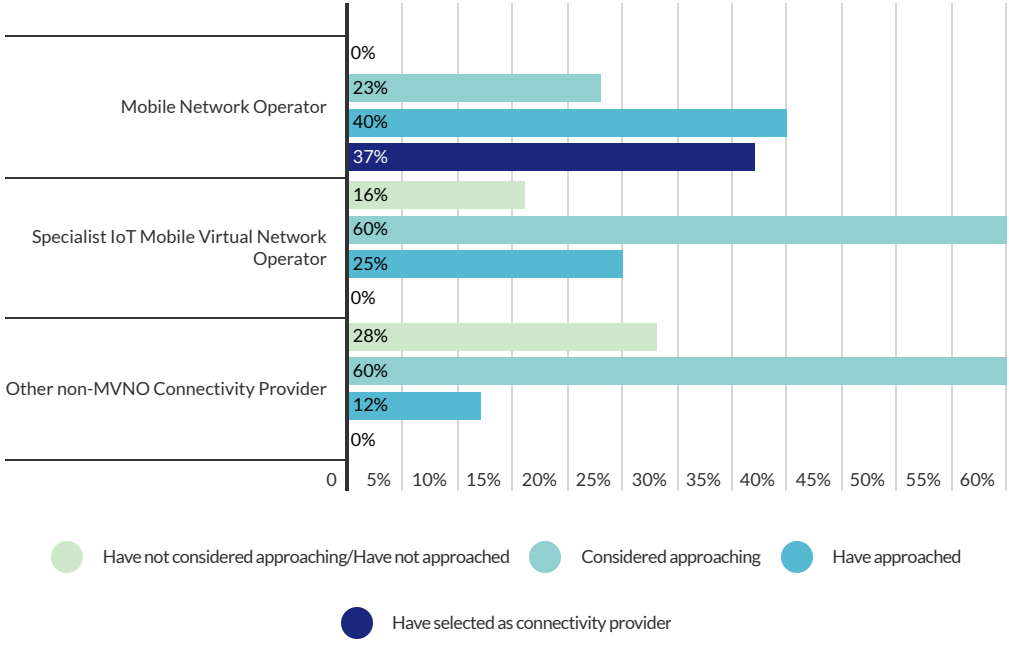


In part, this desire among non-adopters for single-country connectivity helps explain the high prevalence of respondents preferring the MNO market over aggregator specialists, with **77% of respondents either having approached or engaged an MNO for connectivity requirements, compared with 37% of respondents that have considered approaching alternative service providers.**

How do you expect your organisation's IoT devices to be distributed? (Cellular IoT Non-Adopters)

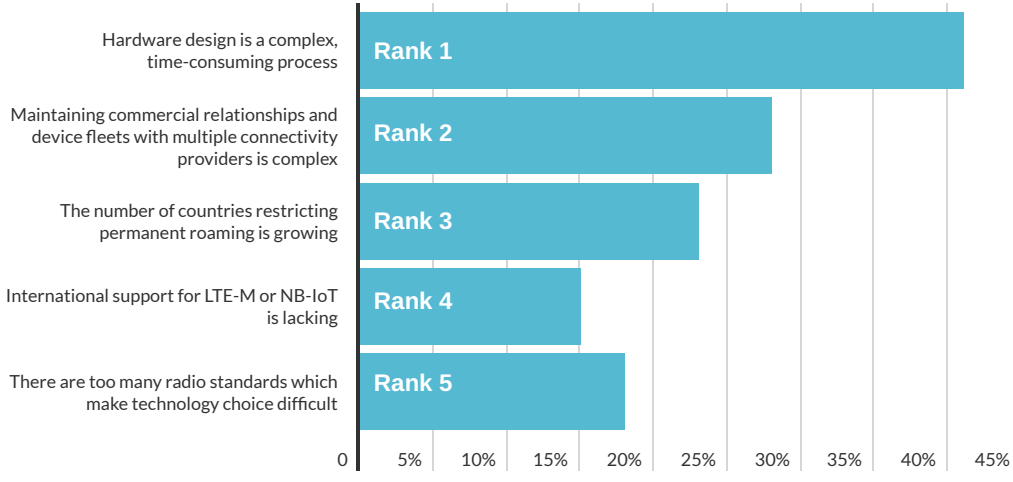


What types of organisations are you considering approaching or have you approached for your IoT connectivity needs? (Cellular IoT Non-Adopters)



Roaming challenges rank highly in terms of the ability to scale deployments up: permanent roaming concerns were cited as the third-highest challenge here, with a lack of support for cellular LPWAN connectivity ranked as the fourth-highest challenge. **Meanwhile, the ability to safeguard a solution from regulatory or commercial restrictions was in turn, ranked as a top priority by respondents.**

What do you perceive to be the top 5 challenges where scaling up cellular IoT connectivity deployments is concerned? (All Respondents)



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Regional presence is evidently essential to go about addressing some of these concerns, particularly due to the more stringent regulations for healthcare data cross-border data flows. Control over data routing must form a part of the CSP's capabilities, while mechanisms to localise connectivity through multi-IMSI or eSIM technology will likely prove as a differentiator. At the commercial level, efforts to secure roaming connectivity for NB-IoT or LTE-M should be made for all verticals, but healthcare is evidently one of the verticals more impacted by the current status quo; notably, **robust coverage for international deployments was cited as the fourth most important factor for IoT connectivity,** which only increases pressure on CSPs where cellular LPWAN is concerned. Here, agreements with roaming hub providers may prove beneficial, owing to the one-to-many access model applied by such hubs for roaming connectivity; often, such players have relatively strong commercial market power, enabling them to sign permanent roaming agreements with operators and thus avoiding risk.

Top priorities for IoT Connectivity - Assurance against commercial/regulatory restrictions (All Respondents)

Rank 1

Top priorities for IoT connectivity - Robust coverage for international deployments (All Respondents)

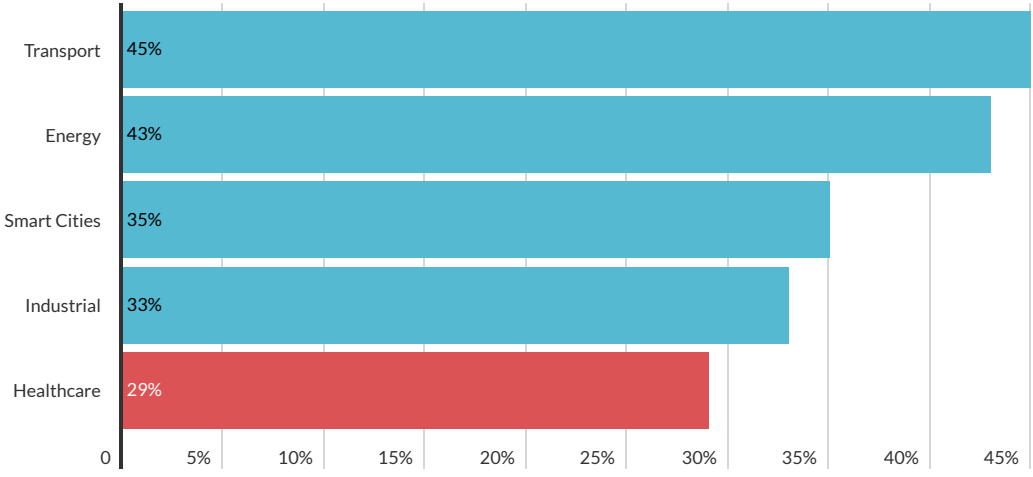
Rank 4

eSIM - Healthcare

Kaleido Intelligence

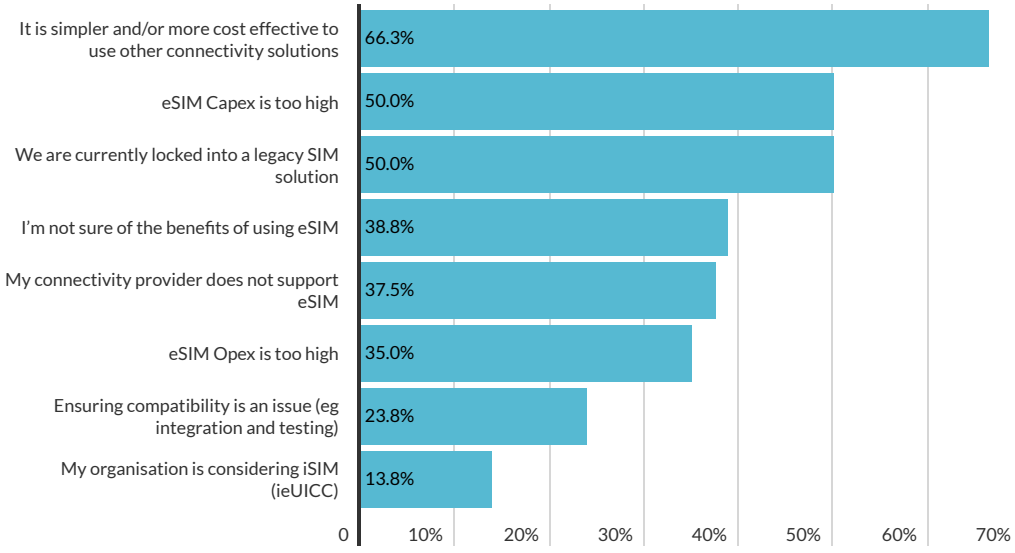
Somewhat surprisingly, eSIM adoption among healthcare enterprises is lower than the survey average, with **only 29% of cellular IoT adopters reporting using the technology, compared to a survey average of 36%.**

Have you decided to use eSIM (eUICC) as part of your IoT deployment? (Cellular IoT Adopters)



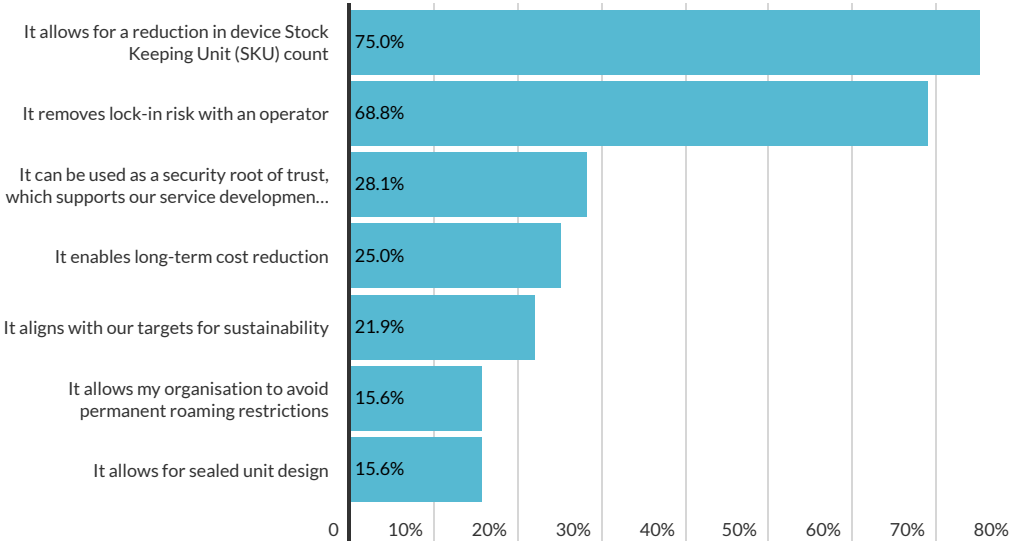
In part, this lower adoption can be linked to issues concerning eSIM Capex, where the price of the eSIM itself is higher than a traditional SIM card, while the acquisition of a digital eSIM profile may incur additional costs. When the fact that the complexity of hardware design in this particular vertical is higher than in most other verticals, it is evident that additional entry costs imposed by eSIM present a barrier for enterprises. On the other hand, healthcare is a highly regulated industry, with many risks and challenges, as we have observed in earlier sections. While other SIM solutions might well lower the entry barrier to cellular IoT, in the long-term these may prove to be more costly if changing to a new connectivity provider is required for any reason. Industry education is critical if only to help enterprises understand how eSIM can reduce risk; meanwhile, alternative business models for eSIM deployment could be considered, such as bundling the cost of eSIM into the overall connectivity package.

Why have you chosen not to use eSIM (eUICC)? (Cellular IoT Adopters)



The hypothesis that cost reduction is top-of-mind is confirmed by the fact that **75% of those that have adopted eSIM cited the potential reduction in SKU count as a key reason for leveraging the technology. Once again, this represents a hardware concern, and the ability of eSIM to minimise complexity at some level is clearly appreciated by those that have absorbed the additional costs of moving away from traditional SIM solutions.** The survey response average for this benefit, at 59%, is much lower than in the healthcare vertical, underlining the link between hardware and cost sensitivity.

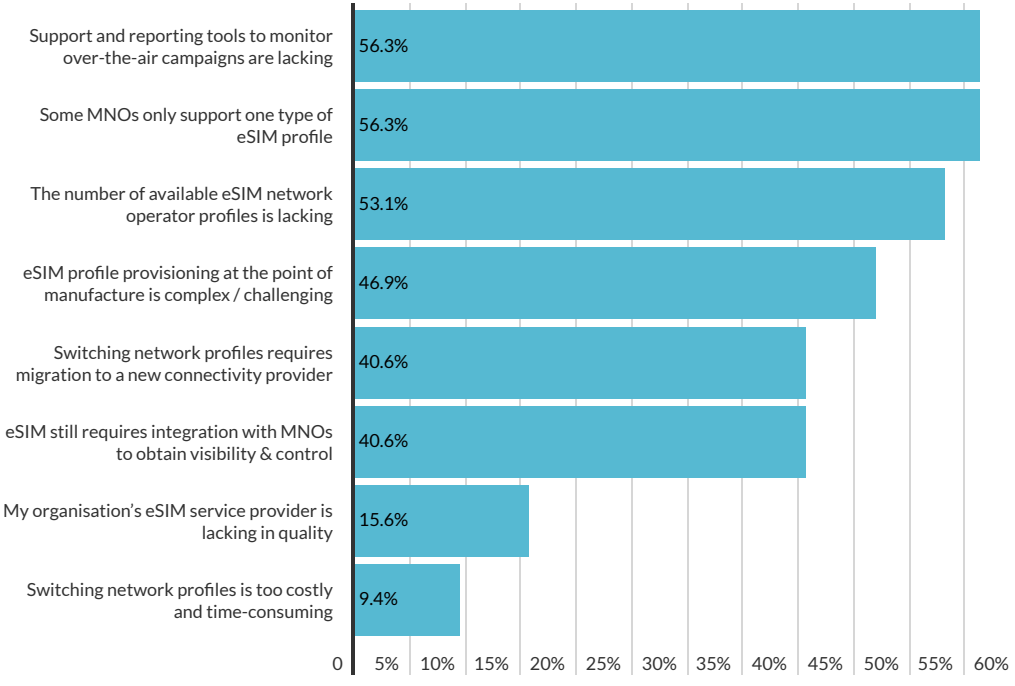
What factors made you choose eSIM (eUICC)? (Cellular IoT Adopters)



Earlier, we observed how enterprises in this vertical would like to see improved reporting features, enabling business intelligence and diagnostics capabilities to be opened up. This sentiment carries over to the eSIM domain, with **56% of eSIM adopters citing a lack of support and reporting tools for OTA campaigns. This is felt more acutely in this vertical, with 51% of respondents citing the same issue when all verticals are considered.** In part, this can be attributed to requirements revealed earlier, where connectivity reliability and uptime factored strongly among enterprise needs. Clearly, the risk of OTA campaigns failing and leaving devices without connectivity is unacceptable among enterprises, and as such, tools are demanded in order to ensure that campaigns are run smoothly.

Meanwhile, a high level of concern was also cited regarding operators' support for eSIM profile types, with **56% of the respondent base reporting that operators often only support one of the consumer or M2M profile types.** Given the range of devices involved in healthcare connectivity, support for both profile types will, historically, have been a benefit. With the forthcoming publication of the IoT specification in summer 2023 however, these issues will gradually be overcome, given the fact that the new specification reuses many components of the consumer eSIM specification. As such, devices using the consumer or IoT specifications can be supported with a relatively marginal additional investment on the part of the operator rather than the large sums involved with establishing support for consumer and M2M specifications.

What are your main issues with your current eSIM (eUICC) solution? (Cellular IoT Adopters)

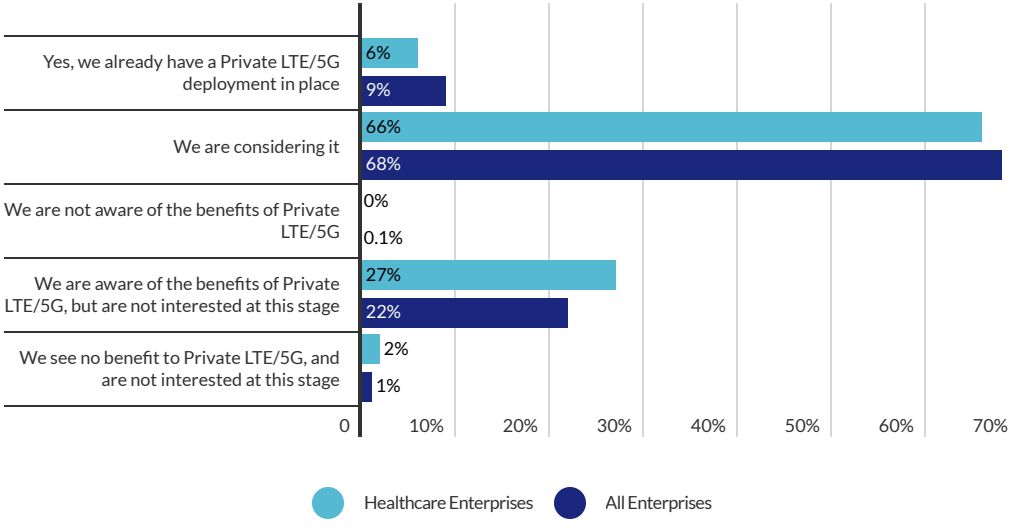


Private LTE/5G - Healthcare

Kaleido Intelligence

Enterprises in the healthcare domain reported the second lowest adoption levels of private LTE or 5G solutions, with **only 6% of respondents reporting an active deployment, compared to a survey average of 9%.** Meanwhile, the level of respondents **that are aware of the benefits, but are not interested in a private cellular solution, at 27%, is notably higher than the 22% identified in the cross-vertical analysis**. While it is certainly the case that private LTE or 5G speaks strongly to the high security and privacy requirements in the healthcare vertical, challenges evidently exist that means that a large proportion of the market is not yet ready to enter the ecosystem.

Does your business unit have an interest in Private LTE/5G to enhance business operations? (All Respondents)

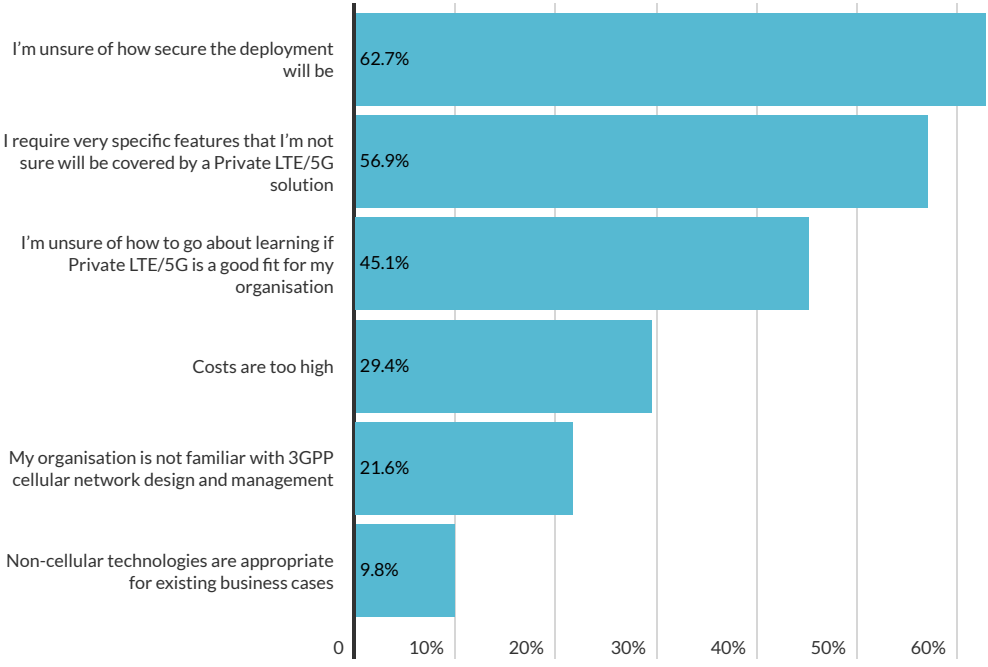


When examining only the cohort that is not considering a private cellular deployment, the reasons for eschewing the market become clearer. Here, **security concerns continue to be top-of-mind, in line with results seen in other verticals. Importantly, 57% of the respondent base reported being unsure if the features they need will be enabled by a private LTE or 5G solution, while 45% of respondents reported being unsure of how to educate themselves on the suitability of a private cellular deployment.**

This raises a similar theme observed in 2022's survey results, which highlighted a lack of education among enterprises regarding the deployment and benefits of private LTE or 5G. It appears as though little has changed in the interim in terms of demystifying the market, and highlights that opportunities, particularly in the healthcare vertical, remain at a nascent stage. This presents an interesting dilemma for service providers, given that 5G features such as network slicing, which can potentially offer similar benefits in terms of QoS and performance, will eventually make it to market, albeit in around 3 years. Without a doubt, fixed healthcare locations will benefit to a greater degree using private LTE or 5G, on account of security and privacy benefits, particularly where the core

network is located on-site. Nevertheless, entry costs for private networks are likely to be higher and, as we have seen earlier, this is a cost-sensitive vertical.

What are your main concerns over a potential Private LTE/5G deployment? (No interest in a solution)



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Afterword

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About the authors

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