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Enterprise Cellular IoT Demands & Opportunities: Smart Cities

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.

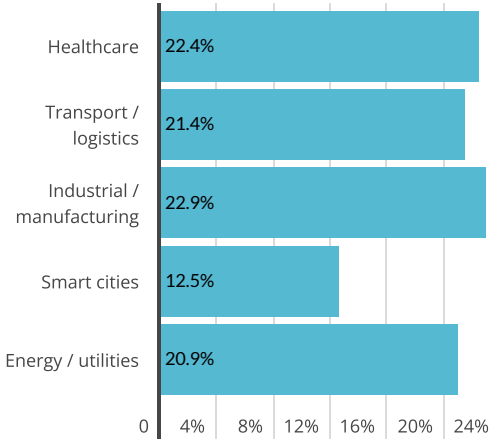
This year's survey has set out to take a deep-dive into where the key pain points in the context of cellular IoT connectivity lie and represents an expansion of the 2022 survey effort. Some 800 enterprises were surveyed during February-April 2023, representing activities in five key IoT industry verticals:

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

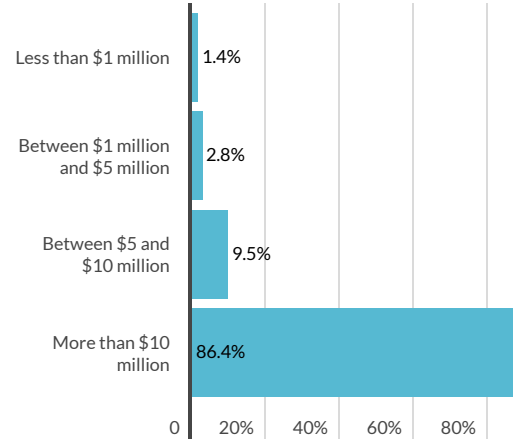
All respondents were all decision-makers at managerial level or higher within their organisation, in addition to having a good knowledge of the cellular IoT ecosystem. In order to understand a broad picture of perceptions, respondents included companies that had adopted cellular connectivity for IoT, 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.

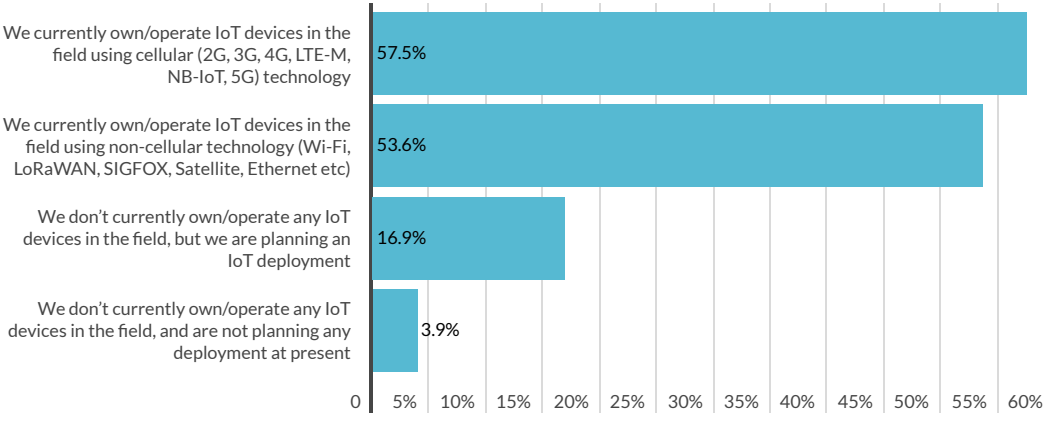
In what market segment does your business unit primarily operate?



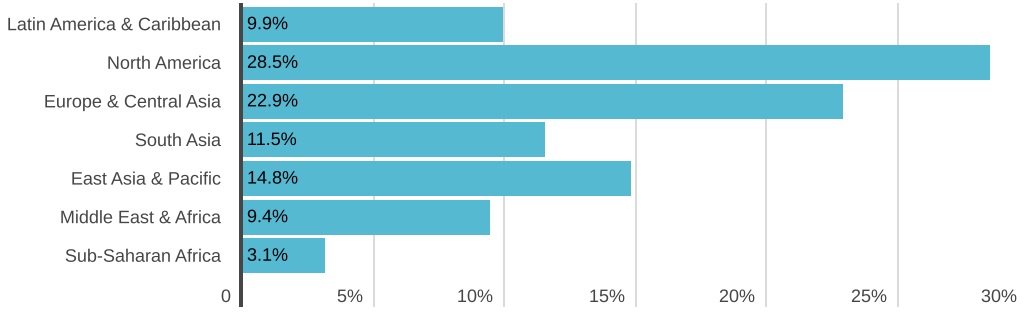
What was your organisation's turnover in 2022?



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:

Smart Cities

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State of IoT - Smart Cities

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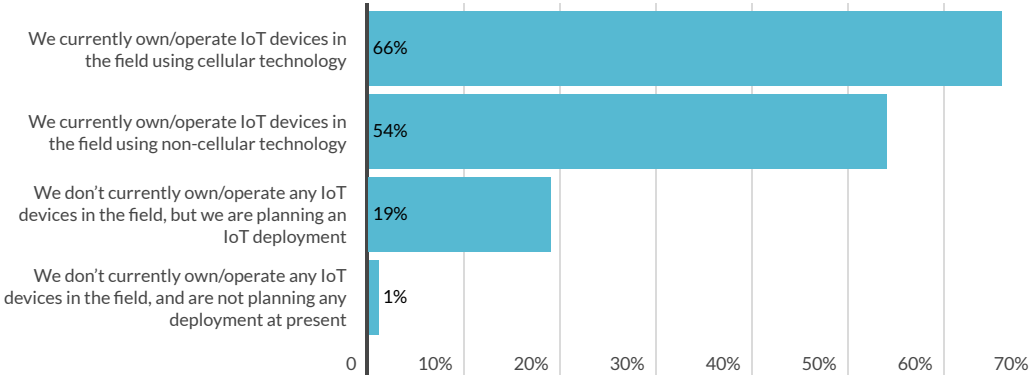
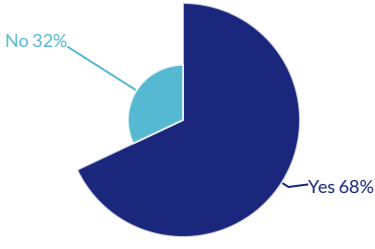
Consistent with survey results that were acquired in 2022, enterprises within the smart cities vertical have some of the highest cellular IoT adoption levels, with some **66% of respondents reporting that they have an active deployment in the field. This proportion is relatively consistent with 2022 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)

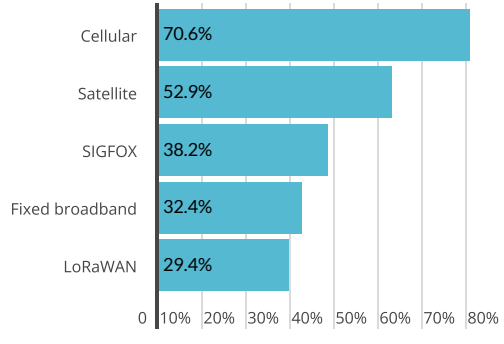


Nevertheless, IoT deployment intentions among cellular IoT non-adopters are much more favourable when compared to last year: **68% of respondents stated that they intend to deploy IoT within the next 2 years, of which 71% reported that they view cellular technology as a key technology to enable wide-area 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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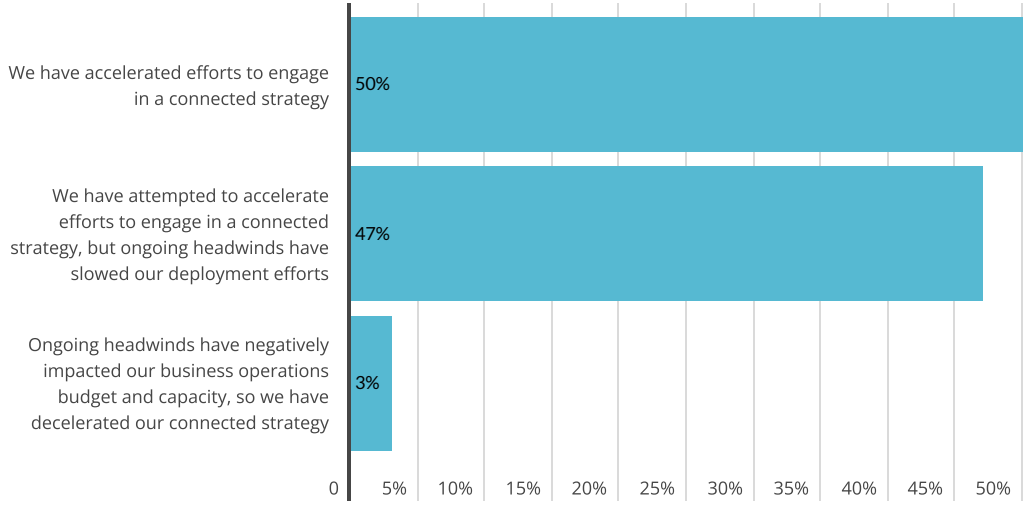
As is the case with many of the other verticals analysed in this report, the smart cities vertical presents a diverse set of potential use cases, ranging from smart parking to waste management, connectivity for the public at large as well as smart street lighting. It is thus not surprising to see that 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

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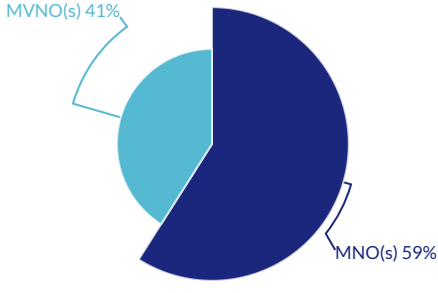
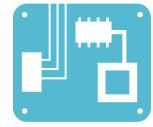
In line with the majority of other verticals, enterprises within the smart city vertical were in agreement that **hardware complexity and the need to establish commercial relationships with multiple CSPs for international deployments represent the top 2 barriers towards scaling IoT up.** Notably, the 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)



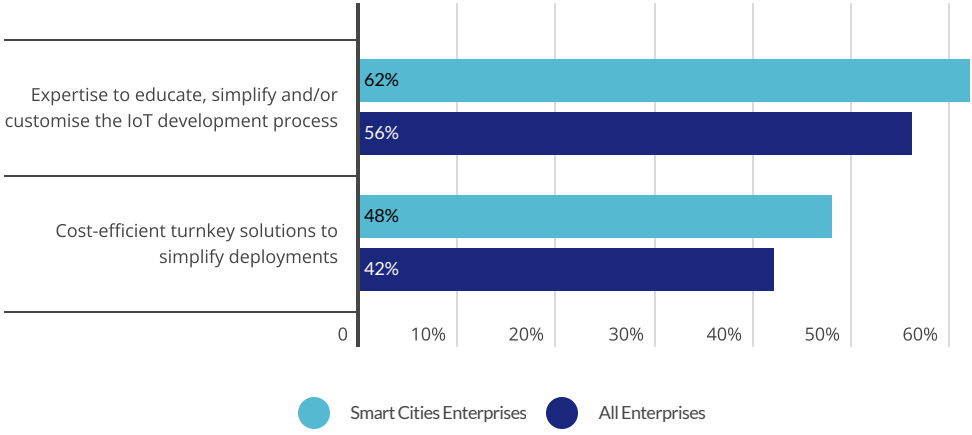
Rank 1

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

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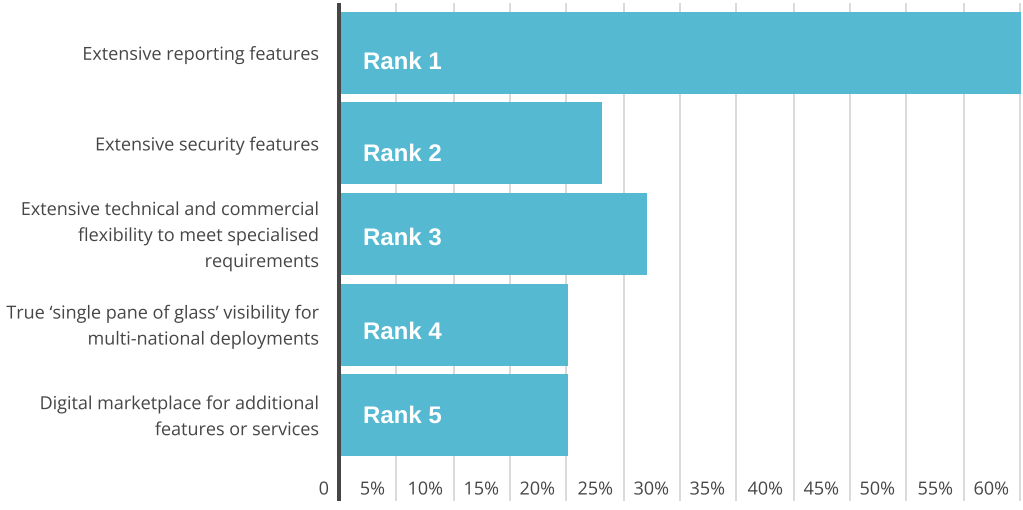
Increasing sophistication among smart cities enterprises is observable through their expectations of CSPs' capabilities when it comes to delivering products. While reporting reaches the top rank, in line with other verticals, and highlights a need for a significant level of information for enterprise 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)

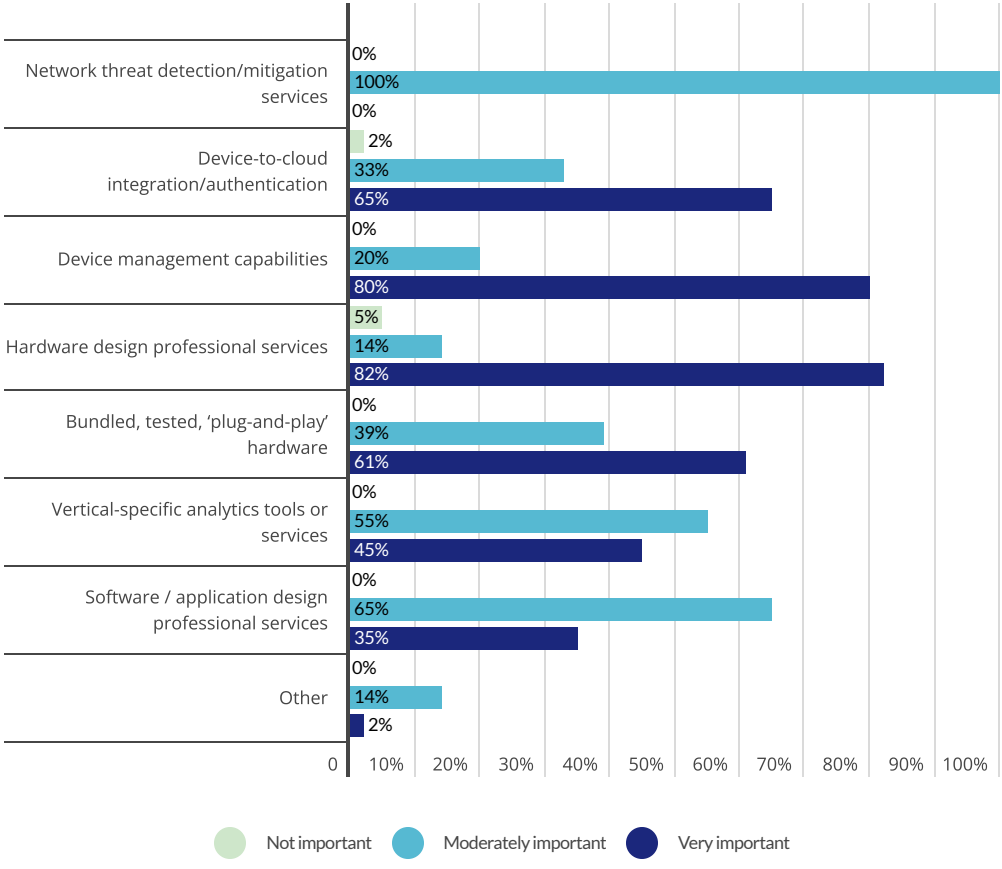
Rank 2

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

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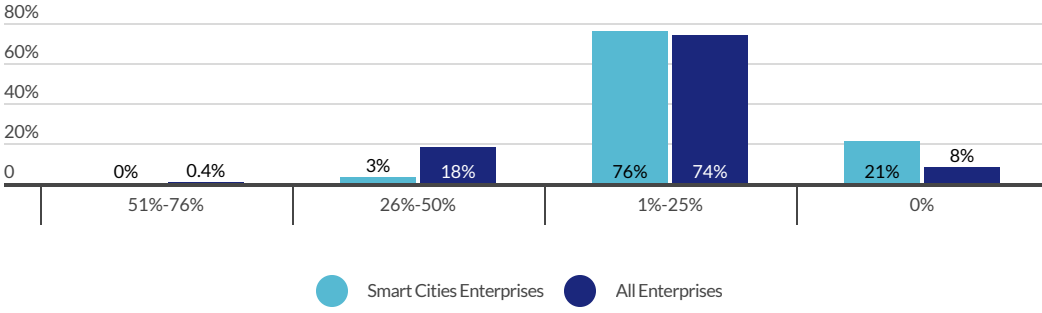
Enterprises active in the smart cities vertical have a comparatively lower demand for international connectivity, with 21% of cellular IoT adopters enterprises reporting that all of their devices are located within a single country, compared to an overall survey average of 8%. Meanwhile, only 3% of respondents 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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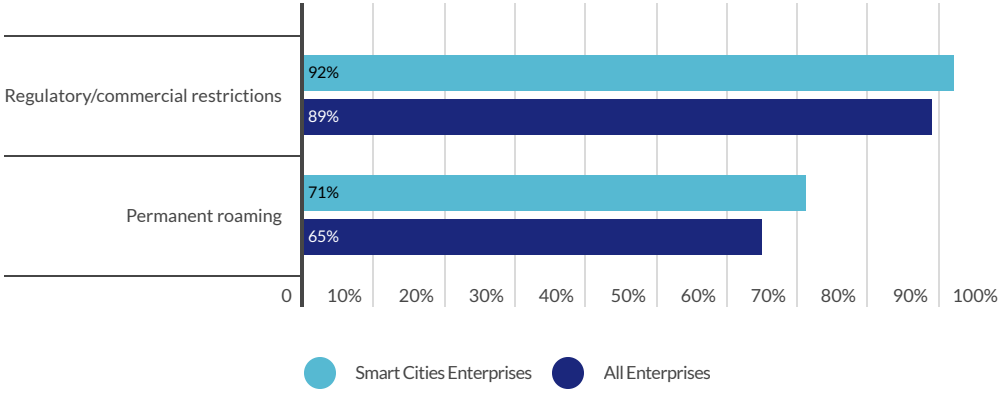
With permanent roaming comes the issue of whether coverage can be supplied in a given country. Evidently, this is more of an issue for those who have already entered the cellular IoT connectivity ecosystem, with respondents in this cohort stating that **coverage in countries with commercial or regulatory 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

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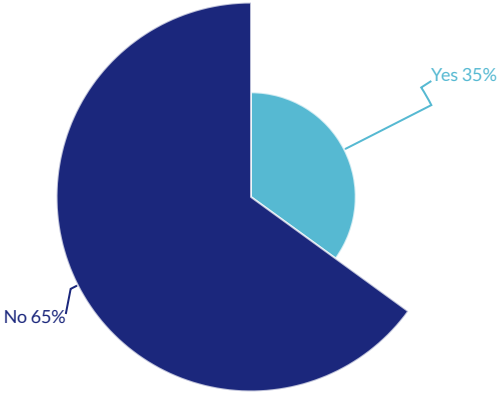
eSIM adoption among smart cities verticals is roughly in line with the survey average, with **35% of cellular IoT adopters reporting using the technology, compared with 36% across all verticals.** The relevance of eSIM in smart cities deployments, particularly as deployments tend to be more domestic-based, 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.

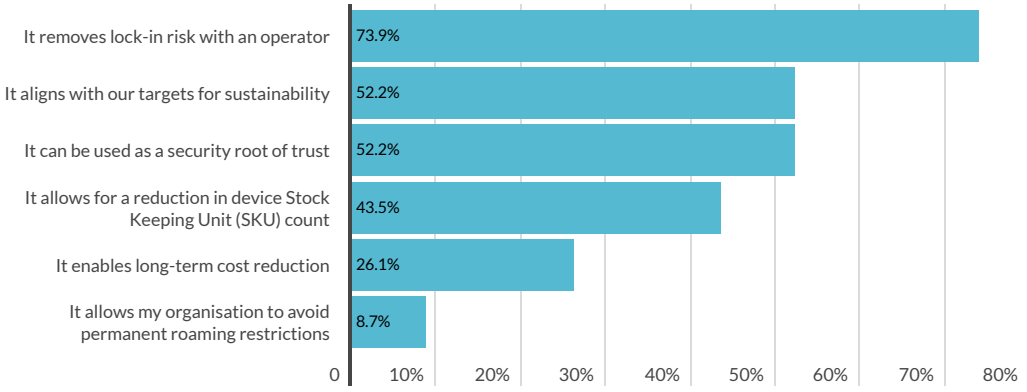
Have you decided to use eSIM (eUICC) as part of your IoT deployment? (Cellular IoT Adopters)



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.

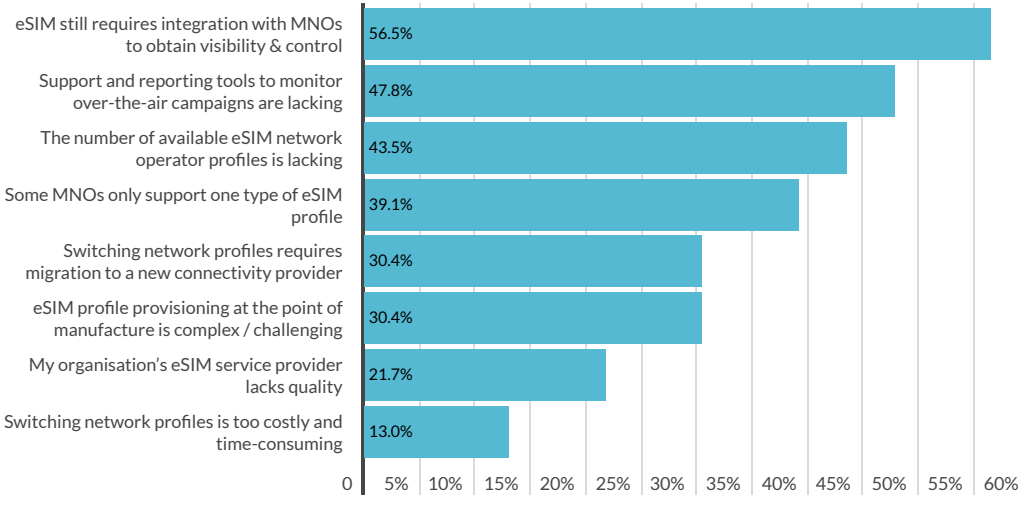
Nonetheless, it is possible to present an alternative viewpoint where eSIM choice is concerned. As stated previously, LPWAN connectivity demand is likely to feature heavily across many smart city use cases, with the exception of video-based public safety and traffic connectivity requirements. Previously 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

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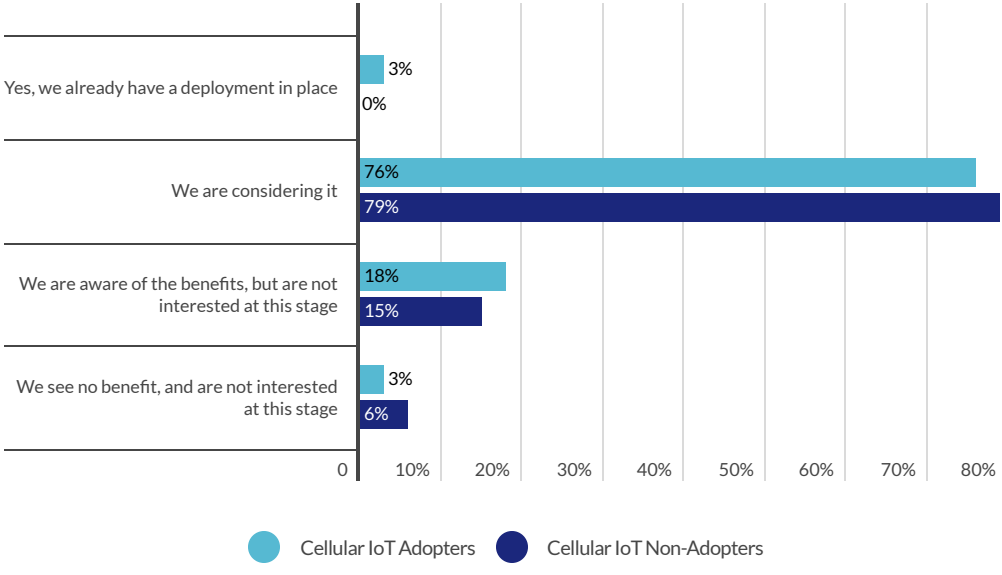
Private LTE or 5G reported adoption was the lowest among all of the verticals analysed in the survey, with **only 2% of enterprises stating they have an active deployment, compared to a survey average of 9%.** By and large, this is understandable given the fact that public network coverage is typically 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)

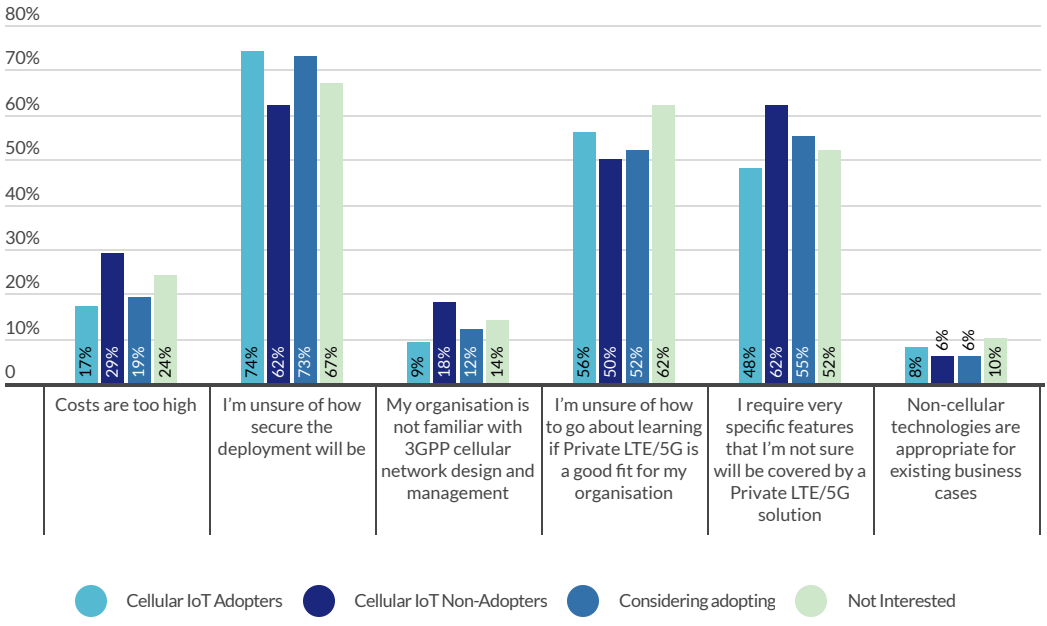


Although current adoption is low, interest in smart cities is markedly high: **77% of respondents stated they are considering a potential deployment, compared with 68% where all verticals are averaged.** It is evident that the market remains at an early stage here, with potential customers requiring 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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Afterword

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About the authors

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