



Executive Briefing

NAVIGATING THE PRIVATE CELLULAR MAZE: WHEN, WHERE AND HOW?

Private cellular networks are expected to play a significant role in future on-premise connectivity but where they are best suited is still unclear. We explore the different opportunities and strategies for enterprises looking to take advantage of the capabilities that private cellular offers.

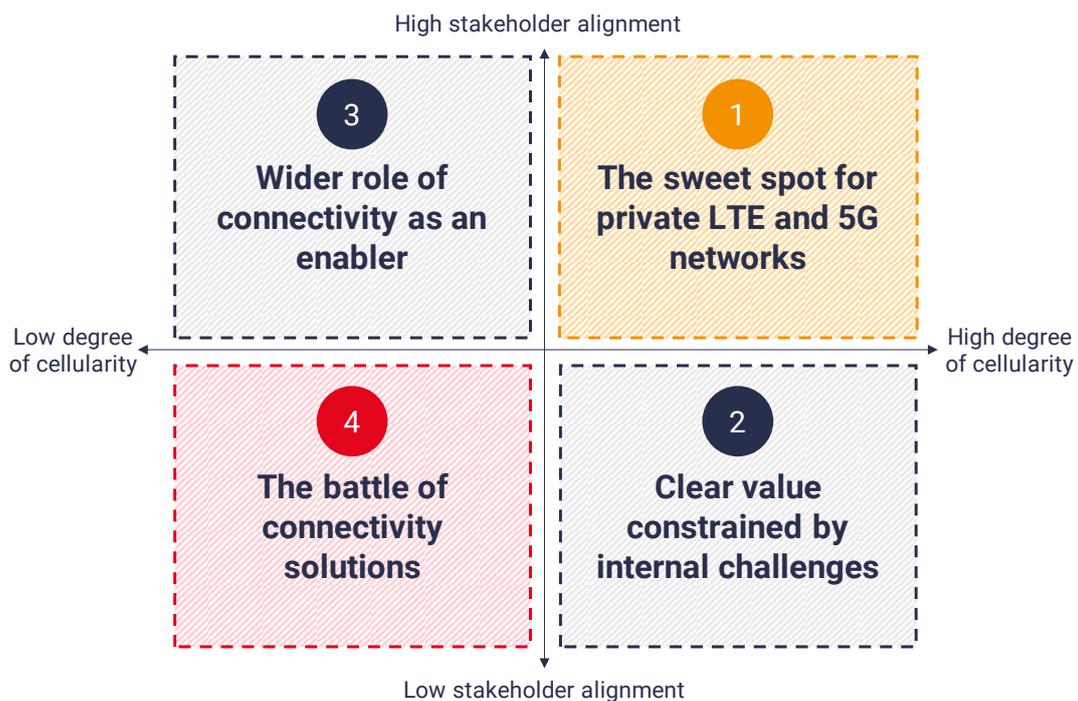


Executive Summary

The private cellular opportunity is rarely clear-cut

Private cellular networks (4G or 5G) are touted to be a key part of future wireless technologies for enterprise on-premise connectivity. They promise to bring enhanced capabilities over existing connectivity solutions, such as reliability, mobility and quality of service, tailored to customers' needs.

However, the nature of the private cellular opportunity does not look the same for every enterprise. The need and value for the private cellular capabilities depend heavily on technical requirements such as the nature of the operating sites and need for on-premise mobility but the ability to capture this value depends on stakeholder alignment and whether the organisation is able to capitalise on these capabilities. Therefore, we identify 4 archetype situations below to evaluate the private cellular opportunity and based on our insights from our interview and survey programme with over 200 enterprises globally, we identify headline strategies for different types of enterprises for considering private 4G or 5G.



Key recommendations for enterprises looking at private 4G/5G

As the private cellular opportunity differs significantly for enterprises in different situations and industries, we identify four essential guiding principles for any enterprise evaluating different options (including private cellular) for their on-premise connectivity.

1. **Define your connectivity vision based on your overall business goals with as much clarity and precision as possible.** Enterprises should see connectivity as a means of achieving your overall business objectives and executing your operational technology (OT) strategies, and develop a

clear multi-year vision and technology strategy associated to your on-premise connectivity deployments. Develop a detailed plan to serve this, which should articulate the specific timeframes, milestones as well as realistic scenarios to address any “unknowns” such as potential costs, spectrum availability and future 3GPP releases.

2. **Assess your connectivity needs and look to build as much flexibility as possible in defining your requirements.** Identify the key use cases and applications within your defined scope. However, the value and return on investment of a private cellular network depends on potential network synergies and the ability to consolidate fragmented systems. Therefore, enterprises should take their current *and* future needs into consideration and build flexibility into their deployments. Specifications should preserve as much optionality as possible and be future-proofed to be able to aggregate existing needs *and* serve any future needs.
3. **Identify if, where and how private cellular networking fits in your connectivity toolkit and build your roadmap around that.** Your connectivity vision should be the basis for a strong blueprint and roadmap so you should be able to clearly define the role that each connectivity solution plays within your arsenal and work with partners that fit into this.
4. **Seek to validate your deployments and use it as a means to inform and educate others.** See any proofs of concept (PoCs) or live deployments as a proof of value and measure any achieved benefits on key business metrics. Use these outcomes as a way to advise others on solutions aligned to your vision.

Key recommendations for telco operators and other providers

Based on our recommendations above, telecoms operators and other network providers should focus on selling hybrid solutions and avoid taking an approach too focused on selling one solution, whether it be private cellular, Wi-Fi or other alternatives.

- **Embrace your role as a network provider in formulating their on-premise connectivity vision, plan and roadmap and build as much specificity and flexibility as possible.** Help your key stakeholders articulate this vision to others within their organisation to establish and achieve better alignment.
- **Work with your customers to build the right connectivity toolkit and identify which tools are best placed to serve specific use cases and applications.**
- **Look to set up a sandbox or test lab as proof of value** to demonstrate the value of private cellular as a means of educating customers and driving better understanding, buy-in and eventually adoption within the enterprise organisation.

Table of Contents

Executive Summary.....	2
Table of Figures.....	5
Preface.....	6
Private cellular networks: A key enabler of transformation or just hype?	7
What do we mean by private cellular network?	7
Enhanced capabilities, reduced complexity but at what cost?.....	8
The relative private 4G/5G merits do not depend on technical factors alone.....	11
Level of stakeholder alignment.....	11
Degree of “cellularity”	14
Identifying the private networking sweet spot.....	16
Segment 1: The sweet spot for private LTE and 5G networks	16
Segment 2: Value constrained by internal challenges.....	17
Segment 3: Wider role of connectivity as an enabler	18
Segment 4: The battle of connectivity solutions	18
Recommendations for enterprises	19
Recommendations for telecoms operators and other private cellular providers	23
Conclusion.....	27
About Dell and Intel.....	28
Appendices.....	29
There are many different types of private cellular networks.....	29
A third of enterprises use four or more different connectivity solutions	31
Wi-Fi and ethernet is still widely adopted by enterprises.....	31
Security is ranked as the most important benefit of private networks	32
Reliability is also selected as one of the top three benefits of deploying a private network.....	32
Cost and the lack of a device/solution ecosystem emerged as key challenges.....	33
Telcos are still the preferred lead partner for private cellular	34

Table of Figures

Figure 1: A third of enterprises use four or more forms of on-premise connectivity 9

Figure 2: Wi-Fi and ethernet are still widely deployed by enterprises today 9

Figure 3: Factors that affect the potential value of a private cellular network 11

Figure 4: Key factors affecting level of enterprise stakeholder alignment 12

Figure 5: Security is ranked as the most important benefit of private cellular 13

Figure 6: Different levels of stakeholder alignment 13

Figure 7: Key factors affecting the degree of “cellularity” 14

Figure 8: Degrees of “cellularity” and their connectivity requirements 15

Figure 9: The private cellular networking opportunity matrix 16

Figure 10: Key recommendations for enterprises looking at private LTE or 5G 20

Figure 11: Although telcos are still preferred partner, there is interest in other players 23

Figure 12: Key recommendations for telecoms operators 24

Preface

The document has been prepared by independent consulting and research firm STL Partners and commissioned by Dell Technologies and Intel. It is based on the output of an extensive survey interview programme conducted by STL Partners with enterprises globally, as well as STL Partners' continuous research programme into the future for telecoms and network stakeholders, and how to get there.

STL Partners maintains strict editorial independence. Mentions or allusions to companies or products in this document are intended as illustrations of market evolution and are not included as endorsements or product/service recommendations.

Private cellular networks: A key enabler of transformation or just hype?

Private cellular networks (whether 5G or LTE) hold the promise to address key enterprise needs in reliability, security, coverage and performance, and be part of future wireless technology make-up of on-premise connectivity. There is a key potential opportunity for enterprises to exploit the enhanced capabilities that private cellular networks bring, as these dedicated networks can be configured specifically to an enterprise's requirements. They can also allow enterprises to consolidate the number of interfaces they have and reduce the complexity that many enterprises manage in having myriad networks and systems.

Our research is based on findings and analysis from a survey of 200+ enterprises in industrial sectors globally and an interview programme with enterprises, telecoms operators and solution providers. This includes the following industries:

- Manufacturing, including automotive;
- Energy and extractives, i.e. oil, gas and mining;
- Architecture, engineering and construction (AEC);
- Transport and logistics, including shipping and distribution

What do we mean by private cellular network?

Although private networks have existed for over a decade, there has been increased interest in private cellular networks over the last two years. This has been, to some extent, spurred by recent developments in localised spectrum allocation and licensing. Examples include licenses made available in Japan, 5G-suitable licenses for the industrial sector in Germany as well as the recent CBRS priority access license (PAL) auctions in the US.

However, a year on from our last report on private cellular networks¹, there is still confusion among enterprises and systems integrators on what constitutes a private cellular network. Part of the confusion stems from the lack of understanding of cellular technology but this is also exacerbated by the wide range of services offered today under the banner of 'private networks'. These range from local to wide area networks, using combinations of spectrum, radio and core networking from public mobile operators, enterprises themselves or other third parties (see Appendix 1 for a more detailed

¹ In more detail in our [Private and vertical cellular networks: Threats and opportunities](#) report

breakdown). Much of what is being offered as private enterprise networks does not fit our definition of a dedicated private cellular network.

For the purpose of clarification, we define a private cellular network using the following characteristics (see Appendix 2):

- **A dedicated local on-premise network** designed to cover a specific location, site or premises (e.g. port, factory, warehouse, mine, shopping mall, industrial or educational campus). In this specific document we do not include wide area private networks to address the need for national coverage to serve transport, rail or utilities²;
- Uses **dedicated spectrum**, which can be leased by a mobile network operator (MNO) or a third party, or owned by the enterprise. In certain instances, it may be possible to use unlicensed spectrum in a “quasi-dedicated” manner, for example in isolated locations;
- Has **dedicated operating functions** (radio, core and management). These can run on the enterprise’s own dedicated infrastructure, leased dedicated capabilities from an MNO or third party, or on dedicated assets under a managed services contract from an MNO or third party. Alternatively, some functions may run off infrastructure that is shared (on-premises with other edge workloads, off-premises with other entities as a public-private cloud).

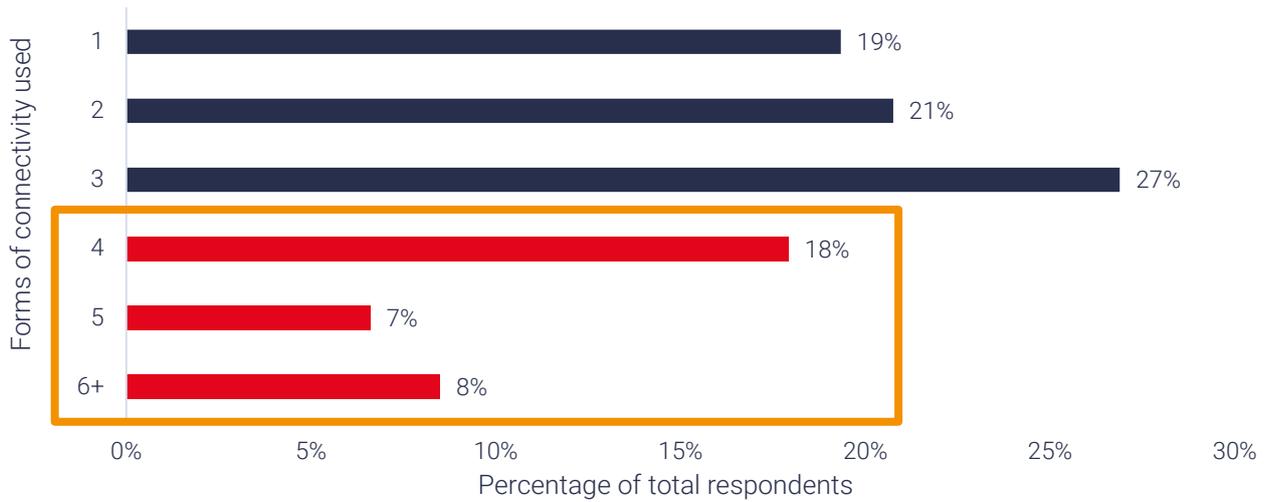
Enhanced capabilities, reduced complexity but at what cost?

Private LTE or private 5G can bring a combination of capabilities, in one solution, of both fixed and wireless connectivity. They can provide a level of reliability, capacity, mobility and quality of service (QoS) that is difficult to achieve with Wi-Fi. In addition to supporting use cases requiring high reliability, low latency and mobility, 5G can also (theoretically) support smooth transitions from private cellular to off-site public cellular but this is still far from reality due to technical and regulatory challenges. This combination of capabilities sets private cellular networks up to address a plethora of use cases.

Most enterprises we surveyed have multiple on-site networks and systems in operation. On average, our survey respondents identified three different forms of connectivity across their site operations with over a third of the sample using four or more, which is a headache to manage. Even so, we suspect this may be an underestimate. Often, each additional connectivity solution is linked to a specific application or use case, which results in fragmentation, a higher overall total cost of ownership (TCO) and a higher ‘attack surface’ for potential security breaches. In theory, private networks can help to reduce this. Although it is not realistic to have one network serving every single use case and application, private LTE or 5G networks have the ability to support multiple use cases, which provides enterprises with an opportunity for more consolidation.

² See our full definition of private networks in our [Private and vertical cellular networks: Threats and opportunities](#) report

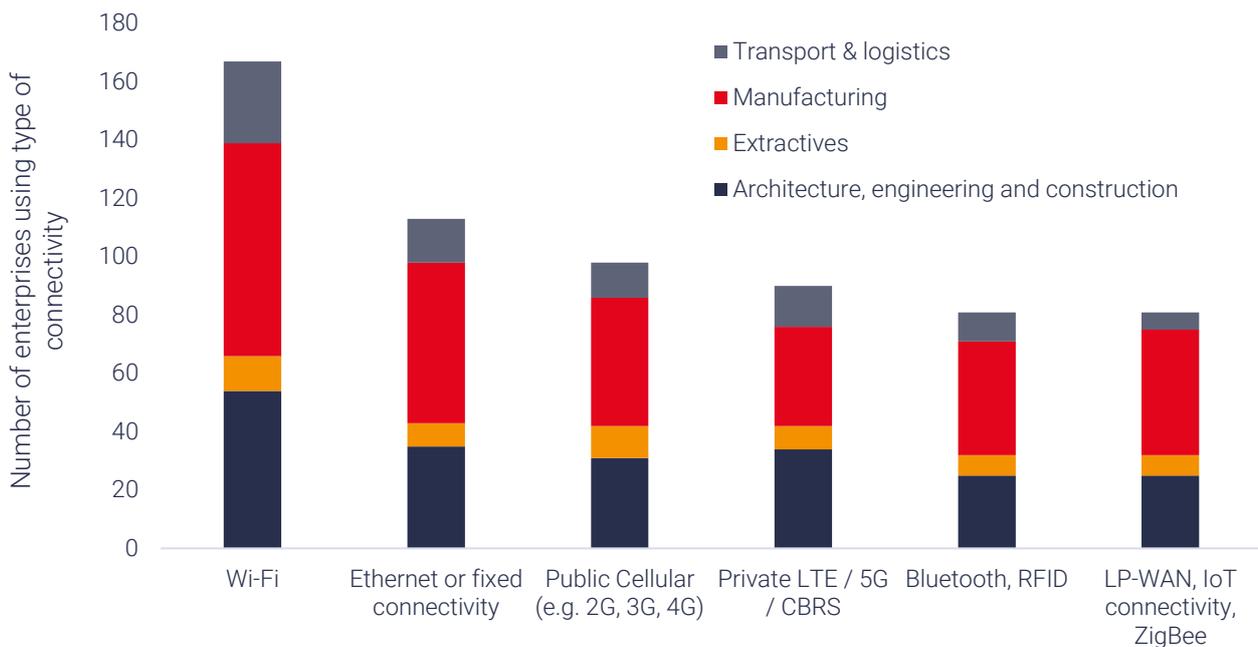
Figure 1: A third of enterprises use four or more forms of on-premise connectivity



Source: STL Partners survey (Oct 2020), n = 200

In reality, despite all these promises, private cellular networks will not be the be-all and end-all solution for on-premise connectivity and make alternatives obsolete. First and foremost, Wi-Fi still dominates as the most common form of connectivity used across most industries surveyed. Secondly, a private cellular network requires significant investment therefore enterprises need to build a business case to justify the need for these advanced capabilities. Thirdly, many established ecosystems have evolved to develop effective solutions within and around the limitations of existing connectivity. Lastly, there is also a lack of skills and expertise in enterprise-grade cellular networking; the number of Wi-Fi specialists working in private networking far exceeds the number of cellular specialists.

Figure 2: Wi-Fi and ethernet is still prevalent in enterprise on-premise connectivity



Source: STL Partners survey (Oct 2020), n = 200

Each form of connectivity including Wi-Fi and industrial ethernet has its place. Industrial ethernet has always been used to support mission-critical stationary assets such as large industrial computer numerical control (CNC) machines, whilst Wi-Fi can support different use cases ranging from asset tracking to automated guided vehicles (AGVs). We anticipate that hybrid networking will become the norm, but the increased presence of private cellular networking will continue in the next few years as enterprises start to deploy more advanced use cases and as existing use cases mature. This still raises questions as to what the entry opportunities for private networks are and how that will change.

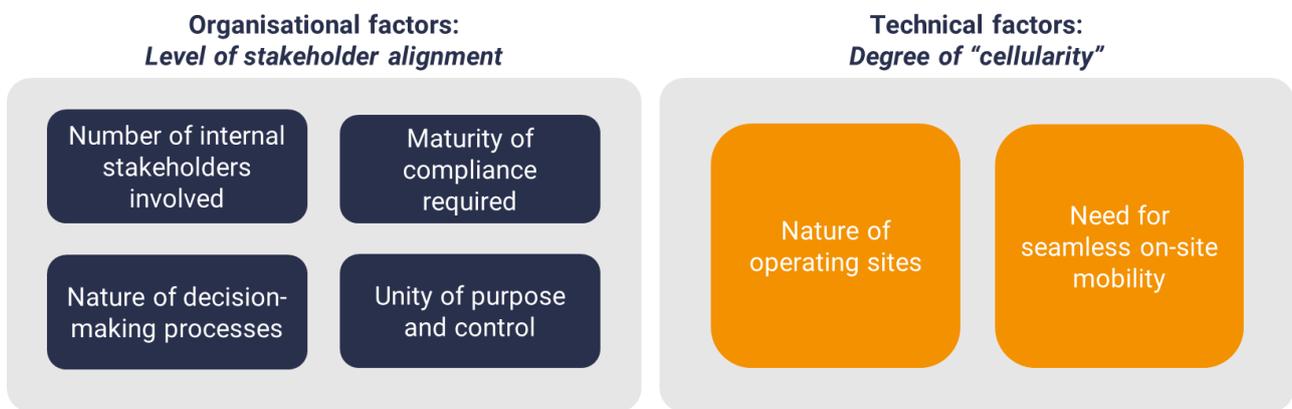
Therefore, in this particular report, we focus on answering the following key questions:

Where do private LTE/5G networks make sense? How can enterprises and telecoms operators address the opportunity?

The relative private 4G/5G merits do not depend on technical factors alone

The promise of private cellular is not the same for all and doesn't always apply for every enterprise and every site. Ultimately, the nature of this opportunity for each enterprise depends on a multitude of factors, based on each individual enterprise's situation, site characteristics, requirements and use cases. We have identified two categories of factors, organisational and technical, that affect the potential impact of a private cellular network on an individual industry, enterprise and use case basis.

Figure 3: Factors that affect the potential value of a private cellular network



Source: STL Partners

Level of stakeholder alignment

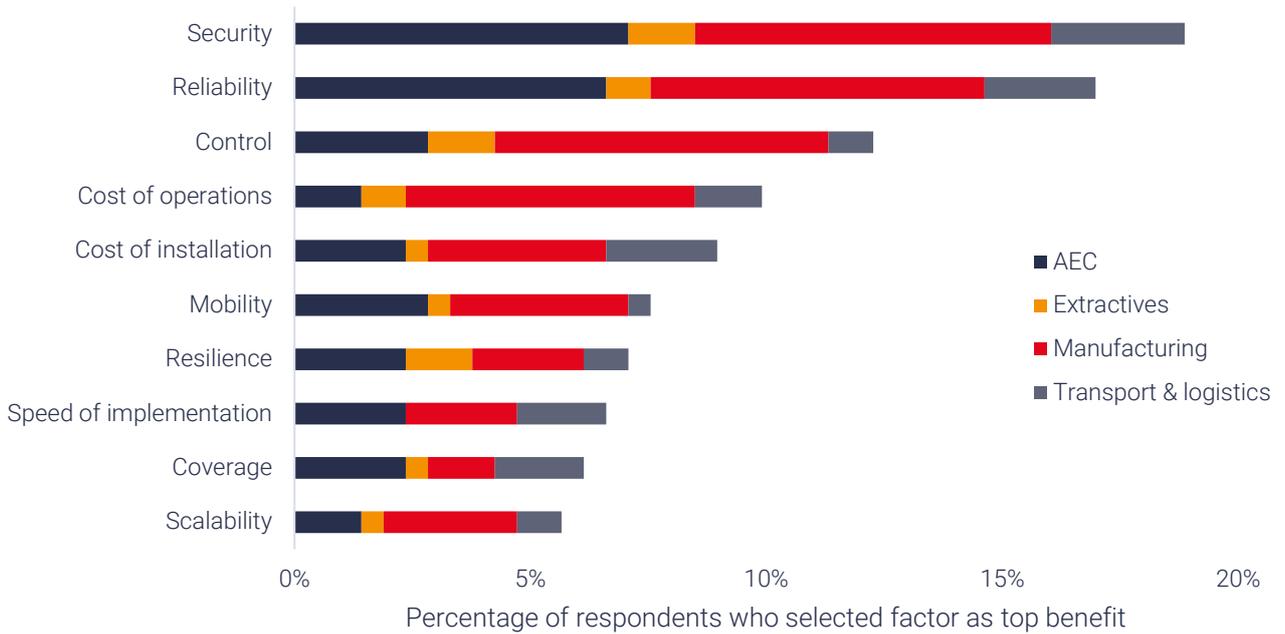
Besides enabling new use cases, we also discussed how private cellular networking is an opportunity for enterprises to consolidate the number of interfaces they have and to address multiple use cases with a single network. The challenge with this is that it requires alignment between different business units, teams and/or application owners, which is a common challenge across many organisations. This can inevitably act as a key barrier to the adoption of private networks.

We see four key factors that can affect these decisional processes and stakeholder alignment:

Figure 4: Key factors affecting level of enterprise stakeholder alignment

Key factors	How does this affect the level of stakeholder alignment?	Illustrative examples
1. Number of internal stakeholders involved	<ul style="list-style-type: none"> • A higher number of stakeholders involved in a decision can mean that differences in individual opinions are more likely. • Can typically lead to a more 'political', protracted decision-making process. 	<ul style="list-style-type: none"> • When it comes to implementation, the security function within the organisation will need to be satisfied that this meets their requirements, which are not always clearly defined, and doesn't present potential risks to the organisation.
2. Maturity of technical or regulatory compliance required	<ul style="list-style-type: none"> • Refers to the operational standards or compliance requirements that enterprise stakeholders are accountable for. Can refer to both regulatory and corporate compliance, and span across various areas such as health and safety, IT security, product quality and safety. The more compliance is required, the more likely the involvement from multiple teams. • Security in particular was cited as the number one potential benefit of private cellular by almost 20 percent of survey respondents (see Figure 5 below). The flip-side is that this is also often a compliance hurdle. • This is not necessarily a problem if compliance requirements are highly-codified and up-to-date. However, where rules are dated, vague and largely discretionary, the only resolution may be through escalation. 	<ul style="list-style-type: none"> • In some industries, such as oil and gas, there may be a need for ATEX-certified wireless equipment to protect against explosive atmospheres • Chemical manufacturing is particularly prone to stringent regulations not only around health and safety, but also the environment and waste management. In the US alone, the chemical industry is subject to acts such as the TSCA, EPCRA, RCRA, FIFRA, but also has to comply and deal with other federal, state and local regulations and agencies.
3. The nature of decision-making processes	<ul style="list-style-type: none"> • Refers to whether the enterprise has a more centralised (formal) or decentralised (informal) structure and decision-making process. • This has an impact on the speed and ease of decision making and execution. • This also affects the ability to coordinate and secure budgets for potential initiatives, including deploying a private cellular network to serve multiple applications which may be owned by different units within the organisation. 	<ul style="list-style-type: none"> • More centralised organisational structures have a clearer chain of command in terms of who the key decision makers are and therefore can benefit from faster procedure and execution of the decisions. • By contrast, decentralisation is often impeded by coordination problems and potential conflict between internal units, particularly when each unit is evaluated on similar metrics e.g. cost reduction.
4. Unity of purpose and control	<ul style="list-style-type: none"> • Refers to whether internal stakeholders have a shared vision. • Can also include the impact of having third-party stakeholders such as suppliers, contractors, sub-contractors and wider ecosystem partners that are involved in enabling specific applications. • If these ecosystem partners have built their solution or application around a particular type of connectivity, the enterprise's specifications and requirements need to change to embrace other stakeholders otherwise the need for a private network is diminished. 	<ul style="list-style-type: none"> • Construction companies typically have a lower unity of control given the sheer number of aspects of the overall process are typically contracted or subcontracted out. • Many automated mobile robot (AMRs) solution providers have designed their solution around Wi-Fi or designed to assume intermittent and unreliable connectivity.

Figure 5: Security is ranked as the most important benefit of private cellular



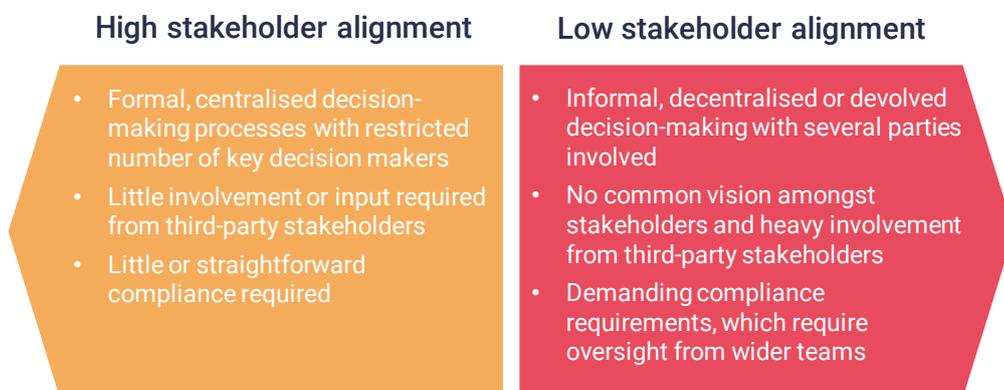
Source: STL Partners survey (Oct 2020), n = 200

One telecoms operator we spoke to spends most of its time with enterprise customers on figuring out who will own the private network deployment within the enterprise organisation and the decision-making process, not on the technical aspects. In their experience, this can manifest itself in two ways:

- Not being able to find the right team/unit/stakeholder within the enterprise organisation to champion and be accountable for the deployment;
- Too many stakeholders wanting to get involved or take ownership of the deployment, which results in potential fiefdoms and complex internal affairs.

Therefore, having higher stakeholder alignment within the organisation will significantly speed up decision-making and execution when it comes to deploying a private cellular network.

Figure 6: Different levels of stakeholder alignment



Source: STL Partners

Degree of “cellularity”

Private cellular networks are better suited to address certain technical requirements than other forms of connectivity such as Wi-Fi, ethernet, Bluetooth and other short-range wireless solutions. These technical requirements depend heavily on the type of use cases and applications being adopted as well as the nature of the sites. However, many of these are already being sufficiently served by existing connectivity solutions like Wi-Fi (see Appendix 4) which ultimately raises the question: when and where would you have technical requirements that warrant a private cellular network?

We identified two key aspects within this technical dimension that we refer to as “cellularity”, which primarily focuses around the need for certain network capabilities:

Figure 7: Key factors affecting the degree of “cellularity”



Source: STL Partners

1. **Nature of operating sites:** This refers to whether the site(s) is an indoor facility such as a building, warehouse or factory, or an outdoor one e.g. an open mine, construction site, port etc. For example, higher ceiling spaces that can be covered by a couple of private cellular access nodes, may need dozens of lower-powered Wi-Fi access nodes to achieve the same level of reliable coverage. Hybrid sites such as industrial campuses may have a collection of indoor and outdoor facilities within a contained local area. The indoor/outdoor nature of a site has implications around coverage requirements, where outdoor coverage is much more challenging for certain types of connectivity solutions to provide, but indoor coverage in large buildings such as factories can also be problematic.

The location of the site is an important consideration, whether it is in a rural or remote area or even offshore versus an urban area. The nature of a site can also have potential implications on availability and reliability of alternatives, particularly if it is somewhere without good public cellular coverage. Private 5G and LTE is particularly suited to support indoor-outdoor coverage, such as in industrial campuses, and also in remote and/or offshore areas where availability of public cellular is limited.

2. **Need for seamless (on-site) mobility:** Mobility refers to the need for coverage and seamless hand-over between different cells or access points within the operating site or premises and the potential connection loss involved if any. This is particularly important for certain use cases that

involve moving “things” that need to be connected at all times, such as robots, automated guided vehicles, location-tracked assets etc. A single 4G or 5G macro cell can cover a much larger area, including over the water in a port for example, which minimises potential connection loss as “things” move across or around the site.

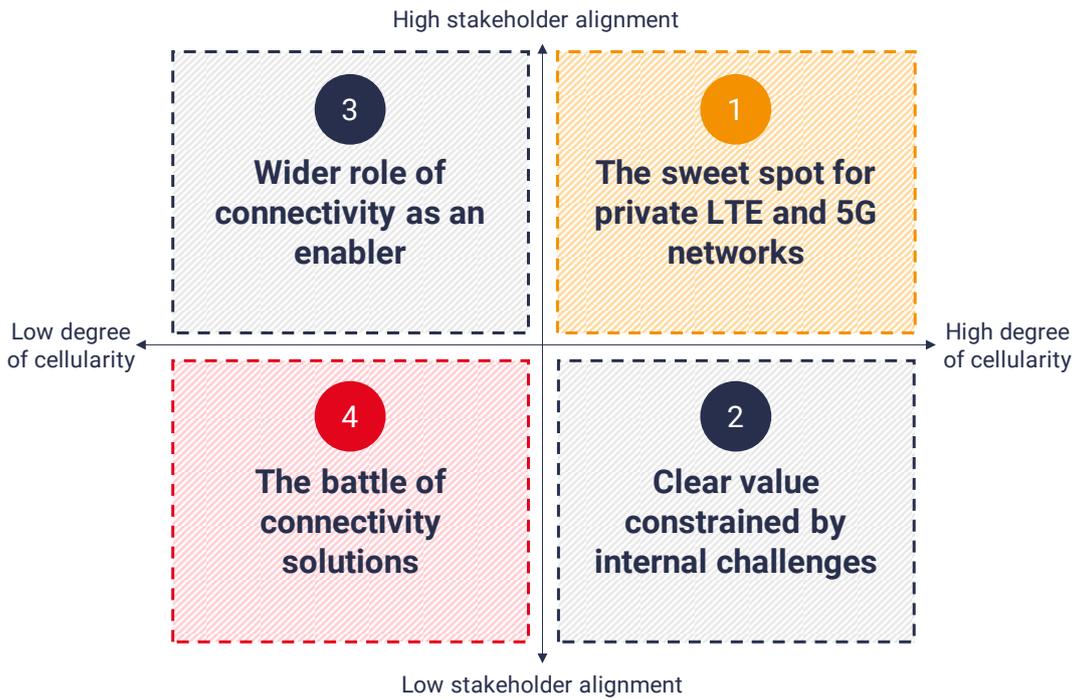
Figure 8: Degrees of “cellularity” and their connectivity requirements

High cellularity	Low cellularity
<ul style="list-style-type: none"> • More demanding coverage requirements due to outdoor or hybrid sites • Current forms of connectivity not good enough to meet reliability, resilience or stability needs outdoors • Can include remote sites that struggle with public cellular (2G, 3G, 4G) • Examples of outdoor sites include mines, ports, oil rigs. Hybrid sites include industrial campuses, plus other areas (even indoor) where vehicles or equipment need to move between access points • Desire to replace private mobile radio systems such as TETRA and P25 • Significant risk of congested Wi-Fi e.g. due to visitor/casual use that could block mission-critical applications (e.g. in airports) 	<ul style="list-style-type: none"> • Refers to indoor sites with no need for outdoor coverage, or no immediate need or adoption of mobility use cases or have limited risk of network congestion / interference when using other wireless technologies • Office or “carpeted” environments where most users have non-cellular devices such as laptops

Identifying the private networking sweet spot

We used our findings and understanding to set out the private networking opportunity across the two dimensions: level of stakeholder alignment vs. degree of cellularity. With the aim of helping others evaluate the extent to which they can take advantage of private cellular networks, we identified 4 archetype situations below and set out the different headline strategies for deploying private 4G or 5G.

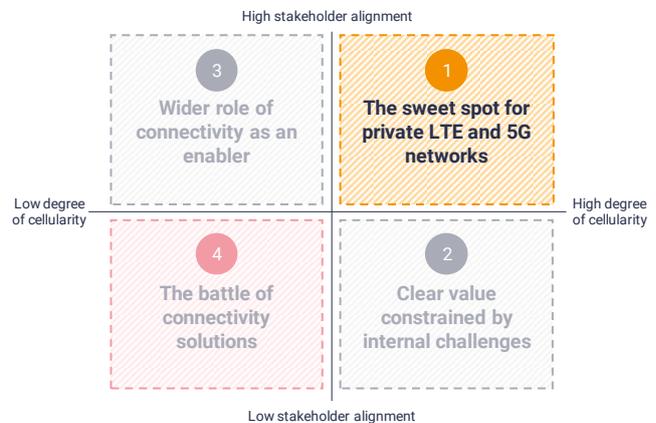
Figure 9: The private cellular networking opportunity matrix



Source: STL Partners

Segment 1: The sweet spot for private LTE and 5G networks

Private networking opportunities should be strongest when there is both a strong need for cellular networking characteristics and high stakeholder alignment. The strong need for cellularity is why we see the majority of live deployments today (not only trials) focused in industries such as oil and gas, mining and ports where there is a clear need for outdoor coverage, coverage from 100m to several km range and/or support for mobility use cases. One manufacturer of autonomous vehicles we spoke



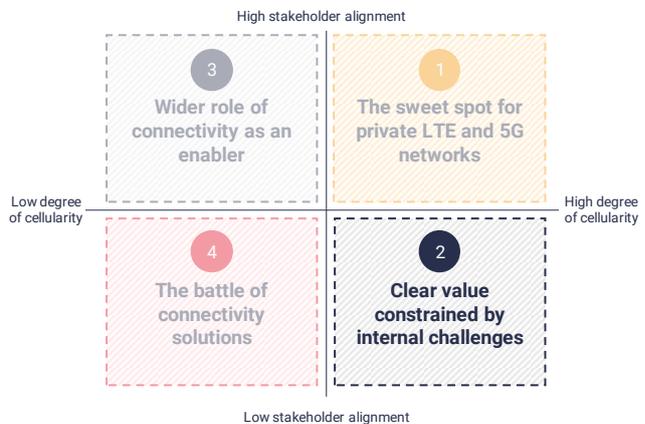
to stated that Wi-Fi is too unreliable in outdoor sites and is prone to being affected by changes in weather conditions, particularly for example for its customers in the ports industry.

More importantly, the size of this segment has also been increasing as more industries and enterprises are adopting mobility use cases, such as automated guided vehicles, or have more demanding coverage requirements for their hybrid or indoor sites. Replacements of old and expensive two-way radio systems with LTE-based mission critical push-to-talk (MC-PTT) is a secondary opportunity. Such industries include manufacturing, where leading manufacturers have large industrial campuses, and aviation, more specifically airports deploying wireless capabilities for maintenance in hangers and operational coordination for faster aircraft turnaround at gates.

Another area of opportunity for private networks is where security and reliability are key requirements. As previously mentioned, security was cited as the number one benefit of private cellular by almost 20 percent of survey respondents, closely followed by reliability with 16 percent of respondents (see Appendix 5). When asked to rank the top three most important benefits of private networks, both security and reliability appeared most commonly within the top three most important benefits, with reliability appearing most often as first, second and third rank (see Appendix 6). For some enterprises, security is an even greater matter of critical importance as it may pertain to public safety. One manufacturing company we spoke to is subject to constraints imposed on them due to stringent regulations, sometimes for certain customers with military technology and intellectual property, therefore they needed to demonstrate to the government that data was not leaving their premises.

Segment 2: Value constrained by internal challenges

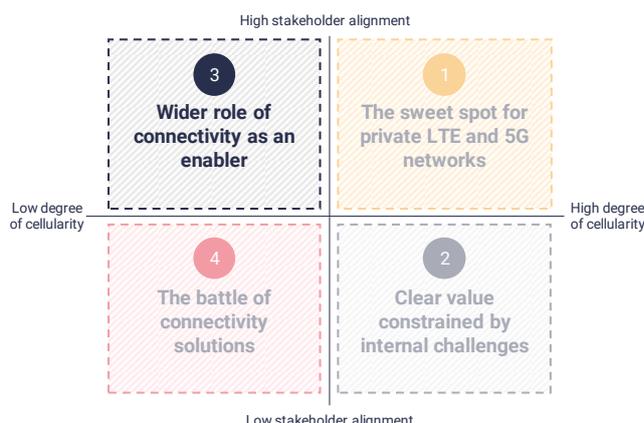
The potential value and return on investment (ROI) of a private cellular network are constrained by the number of use cases and applications it can support and your ability to implement these. Both ultimately depend on internal alignment of application owners and other stakeholders, which can be challenging for certain organisations. This can derail a potential private cellular deployment, even when there is a clear business and technical need for one.



Organisations that have a more decentralised structure, if not managed accordingly, may lack a larger strategic framework and face potential risks of organisational silos and inter-divisional conflict. With each division under pressure to meet certain KPIs, they may be more focused on their own needs rather than the collective needs of the organisation. Furthermore, there may be a greater number of individuals that all have different opinions on a particular business decision and therefore it is harder to come to a consensus. For example, in many cases, an enterprise may have two (or more) different departments, each with its own separate budget, where one would need to concede budget to the other in order to go ahead with the deployment but the other may be impacted (e.g. need to reduce headcount to approve cost savings in business case) in such a way that discourages approval for the deployment.

Segment 3: Wider role of connectivity as an enabler

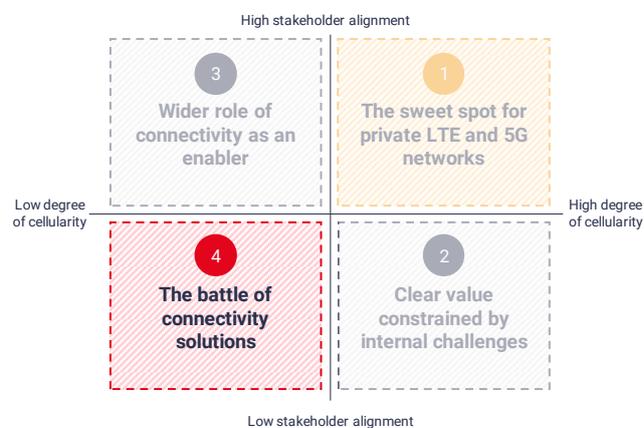
Many enterprise projects and transformations have heterogeneous connectivity needs. We see private cellular as an important part of the toolkit, but it should be viewed within a broader context and strategy rather than an end in itself. Each tool has its own unique capabilities and benefits but enterprises should think about how they can simplify their toolkit and select key tools that can help them address the majority of their current and future needs.



High alignment amongst stakeholders presents an opportunity for enterprises to evaluate the different use cases the enterprise would like to drive and the right network technologies best suited to serve these. This does not necessarily mean that private cellular will be part of the mix. For example, if the industrial automation solution provider or lead integrator recommends 5G for automated guided vehicles (AGVs) and industrial ethernet for the automated robots, then the enterprise should consider other applications that can benefit from the 5G network to maximise ROI, such as supporting video for critical communications systems, video analytics etc.

Segment 4: The battle of connectivity solutions

The advantage of deploying a private network is rarely clear-cut. It will be more difficult to justify the private cellular business case where its enhanced capabilities are seen as more of a “nice to have”, especially when there is a higher CapEx or OpEx associated with it. In many cases, alternative forms of connectivity may be more appropriate for most use cases, given the level of investment required for a private network.



In the grander scheme, most enterprise sites have predominantly “vanilla” office connectivity requirements, where other solutions such as Wi-Fi and ethernet are well suited. Public cellular is also a key alternative to private cellular, particularly in areas with strong coverage. In the future, 5G network slicing will be another important tool where (in theory) enterprises could have their own dedicated network slices tailored to the enterprise or use case needs but this is still far from being reality³.

³ In more detail in our [5G network slicing: How to secure the opportunity](#) report

Recommendations for enterprises

An enterprise's need for enhanced private networking capabilities ultimately depends on its immediate and future use cases, applications and operating site requirements but when looking at your on-site connectivity, we identify some key guiding principles for enterprises to follow:

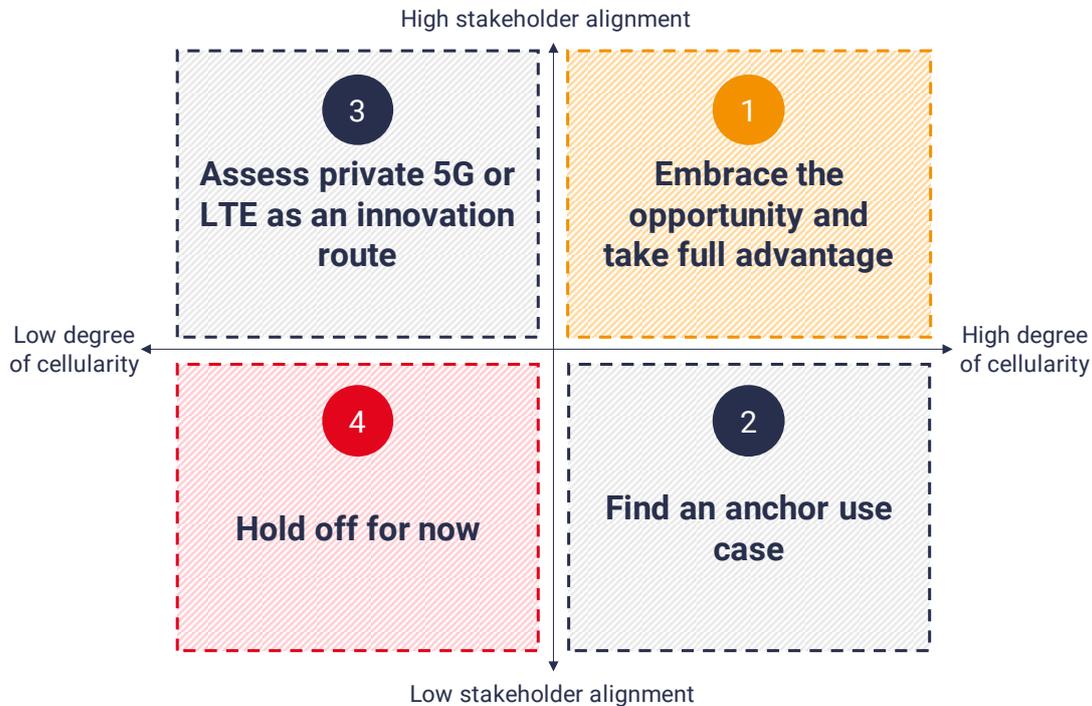
1. **Figure out your company's strategic vision for on-site connectivity and the approach you want to take.** Your connectivity needs should flow from your overall business goals as well as your ICT and OT strategy. Based on these goals, evaluate your connectivity approach and whether you view it more holistically as a platform for your business to build on or see your vision as more application-centric and a means of enabling application on a case-by-case basis.

If the former approach applies, you need a clear multi-year vision and technology strategy associated to your connectivity deployments (whichever solution you select) and develop a plan with as much precision and clarity as possible in terms of how to serve it. Explicitly identify the current "unknowns" and realistic scenarios and look to preserve optionality where possible. This could include potential costs, performance, spectrum availability and future 3GPP releases. If you adopt the latter more application-centric vision, then specific projects will determine connectivity needs for specific applications, so a more tactical approach will emerge.

2. **Assess your connectivity needs based on your defined vision, including the use cases and applications within your defined scope.** If you take the former more holistic approach, consider what your current needs are and what your future needs will be and how much flexibility you need to build into your deployment. Part of this vision is about consolidating fragmented systems so your specifications need to be future-proofed to be able to aggregate existing needs and plan for future needs. If you adopt the application-centric approach, any potential Request for Proposals (RFPs) will need to cater to each specific application on a project-by-project basis. Potential network synergies can be pursued opportunistically.
3. **Define the space that private cellular networking (and other solutions such as Wi-Fi and ethernet) can fulfil.** The way you implement your strategy depends on your relative influence as a stakeholder within the organisation. If your organisation is taking a holistic approach, use your vision to define a strong blueprint and roadmap and work with partners that fit into this. Otherwise, the application-centric approach will require a project-by-project analysis to advise and propose which connectivity solution is most appropriate.
4. **Leverage any proofs of concept (PoC) or live deployments to measure initial and achieved benefits of the private network on key business metrics.** Seek to use your private cellular network deployment as a means to inform and educate other stakeholders within the organisation. Ultimately, the decisions may be dependent on the application or site owners but use your deployment and outcomes to advise on solutions aligned to your vision.

Beyond these guiding principles, depending on how essential enhanced connectivity is to business operations and the level of stakeholder alignment you have within your organisation, we outline some key recommendations to enterprises considering deploying private networks:

Figure 10: Key recommendations for enterprises looking at private LTE or 5G



Segment 1: Embrace the opportunity and take full advantage

If you have specific relevant connectivity demands and have a clear strategic vision and alignment within the organisation, you should start taking some tangible steps towards deploying your own private network(s). Whether it be with LTE or 5G, a private network will be able to provide you with the capabilities and customisation you need for your operations and more mission-critical use cases.

Private networks can address both brownfield and greenfield deployment opportunities but for greenfield sites, think of your private networking connectivity from the outset when designing your facility. This should be considered within the same vein as other infrastructure-related services such as electricity, power and other utilities.

Work with your private network provider and other partners such as your lead systems integrator to pinpoint the critical use cases that can leverage the full capabilities of a private LTE or 5G network. Identify and audit current and projected future transformation projects, through the lens of connectivity. Liaise with relevant systems/solution vendors to better understand their vision for wireless support. Score and evaluate these use cases for mobility requirements, legacy system support and technical requirements such as latency, data throughput and reliability. Assess the physical environment they operate in, e.g. indoor, outdoor, lines-of-sight, and how they impact your connectivity requirements.

For example, if there are certain use cases such as if your critical communications systems are nearing end of life or are limited in features and you would like them to support more video, then consolidating this onto your existing private LTE or 5G network can provide your workforce with an enhanced and more reliable service at little additional cost. Migrating other applications to your existing private network will also significantly increase your return on investment and reduce your overall costs of running multiple networks.

Segment 2: Find an anchor use case “

If securing agreement from other application owners or divisions is going to be a challenge for you, focus on finding an anchor use case that can serve as a strong enough motivator for the overall investment, which not only includes the installation but also the ongoing maintenance and management.

Enterprises are unlikely to choose a standalone use case but you do need an anchor one that you can then integrate with your core operations, unless if its something like compliance or security

Communications Service Provider

30 percent of our respondents cited cost as the most pervasive challenge in deploying a private network (see Appendix 7). Therefore, this should be a use case where having a private network will have the biggest impact on key business metrics or the bottom line in order to justify the total additional cost of deploying a private network. The overall cost benefit analysis of a private network for this particular anchor use case needs to be more favourable than going with other connectivity solutions. These metrics could be around increasing operational efficiency, reducing unplanned downtime or reducing risk to your workforce, production and environment.

More importantly, to maximise the ROI of your private network deployment, when writing the Request for Proposal (RFP), consider how you may be able to expand the deployment to support secondary applications. Develop a roadmap of how you see the deployment evolving, even if this will change. The point here is to ensure you are future-proofing your deployment, so start with an anchor use case that is smaller but justifies itself easily, then aim to expand the scope of the deployment over time.

“

There still has to be an anchor use case, or a theme that wraps around a group of use cases. Ultimately, there needs to be an overriding reason otherwise it's hard for the traditional use cases.

Wi-Fi centric technology provider

Once you have your deployment, seek to measure and validate the expected benefits. With this validation, start showcasing the benefits to other stakeholders within the organisation and evaluate at other use cases that are similar in “theme”. This could be based on similar requirements e.g. use cases that may need high reliability, high bandwidth, low latency, outdoor coverage and so on, or it could be around a purpose like health and safety. There is

potential to support these additional use cases that could not be justified as a standalone use case. Work with these internal stakeholders to scale the private network deployment to these other use cases in order to maximise your return on investment.

Segment 3: Assess private 5G or LTE as an innovation route

Your existing use cases or location may not have an urgent need or call for a private network, and your existing connectivity solutions may be “good enough”, but private 5G or LTE can be a potential option for you to explore as a means of innovation. Your connectivity demands around data throughput, reliability and latency for example may increase as you start adopting more advanced or more mission-critical use cases, and your current connectivity solutions may be more of a hindrance than an enabler of these use cases.

“

We could start looking at use cases that we haven't been able to in terms of campus locations where we service production lines but this depends a lot on 5G as a technology and right now it looks like 4G with bells on.

Global logistics company

However, we acknowledge that it is still very early for 5G and many of these enhanced capabilities that 5G promises are not reality today. We still recommend that enterprises take a staged approach and start with an initial deployment of 4G (may be referred to as “private 5G-ready” or “private 4.9G”), to enable greater insights and gain skills and experience for when the evolution to 5G is ready.

Keeping this in mind, start getting involved and participating in one of the many trials, testbed programmes or industry alliances working on proof-of-concepts, such as the UK DCMS 5GTT and the EU-funded 5G CONNI. Work with your connectivity provider to assess your connectivity roadmap and figure out how that aligns with your use case roadmap and your strategic vision for your operations. Evaluate your existing applications and devices used, as well as where they are being deployed. Based on this, define your connectivity needs to support those applications and devices and look at options best suited to support these. Explore which new and more advanced use cases you can deploy in the future that can help improve your operations, and see how this affects your future connectivity needs. Private LTE or 5G could be one of the viable options depending on these requirements.

Segment 4: Hold off for now

Existing connectivity solutions, such as Wi-Fi, industrial ethernet, public cellular etc., may already be meeting your current needs based on the nature of your operating sites and the technical needs of your use cases. Future upgrades, to Wi-Fi 6 & 6E for example, may also be better suited even if you foresee your connectivity requirements increasing where you may require higher capacity and data rates for use cases such as AR/VR for maintenance and repair.

A private 5G or LTE network may not necessarily be required now but may be down the line. This applies particularly if you need indoor-outdoor coverage or if your security and reliability requirements become more demanding, for regulatory compliance for example, or if speed of implementation is crucial and you need something deployed within a matter of days. Given the level of investment required for a private network, it may be more challenging to justify the business case if you cannot secure alignment within the organisation to consolidate multiple applications onto a private network.

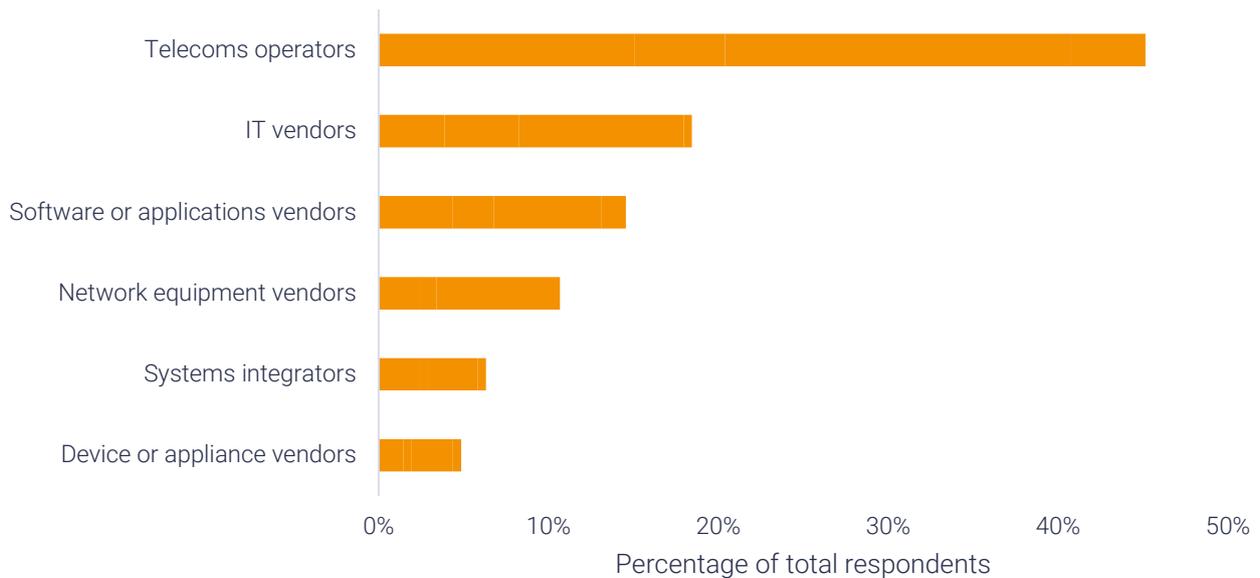
In the meantime, we recommend keeping a close watch on developments in private 4G and 5G. Enterprises can do this by joining relevant industry groups investigating and trialling the technology,

participating in relevant industry events and/or finding case studies of comparable companies and their experiences with private cellular networks. Organise regular discussions with your key automation systems providers, telecom operators and other solution partners to keep abreast of new developments and interesting use cases that emerge.

Recommendations for telecoms operators and other private cellular providers

Based on our survey results, telco operators emerged as the clear preference in terms of a lead partner for private cellular networks, regardless of the industry and enterprise size, but it is also worth noting that more than half of the respondents selected other preferred partners, which include network equipment providers, IT vendors and software or application providers (see Appendix 8 and Appendix 9). This indicates that there is an emerging interest in other private cellular network partners in the broader ecosystem.

Figure 11: Although telcos are still preferred partner, there is interest in other players



Source: STL Partners survey (Oct 2020), n = 212

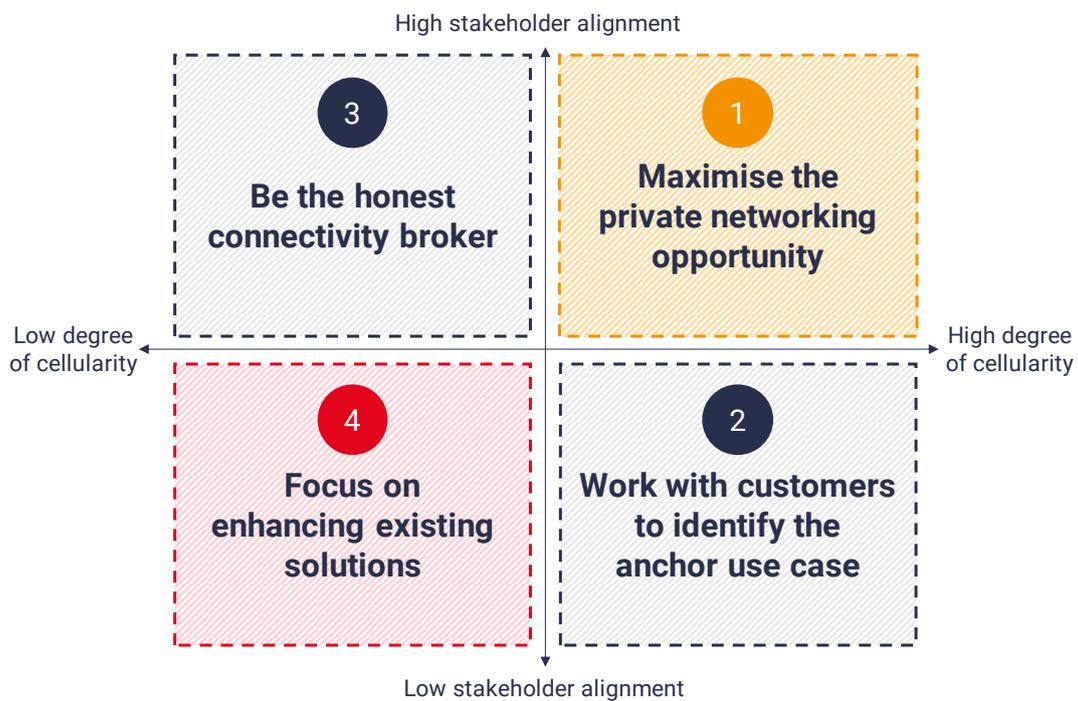
Given that hybrid networking (i.e. combination of different fixed and wireless connectivity solutions) will continue for the foreseeable future, our overall recommendation to telecoms operators and other network providers is to focus on selling hybrid solutions instead of an approach too focused on selling only private 5G or LTE.

Your role as a network provider is to help your enterprise customers formulate their on-premise connectivity vision with as much detail, clarity and precision as possible, which includes specific milestones and expected timeframes. Work with the key stakeholder(s) to articulate this vision to others within the organisation to achieve better alignment on those goals. Acknowledge the continued

importance of hybrid networking and help your customers define their wider connectivity strategy – this shouldn't be about promoting one solution. Any PoCs should be seen as “proof of value” and part of the education forming for the wider organisation, in proving claimed benefits and demonstrating this to wider stakeholders. Consider setting up a sandbox or test lab as a proof of value, particularly for bigger enterprise customers and use this as a catalyst to drive understanding, buy-in and adoption within the enterprise organisation. This should be not only as a technical PoC but more as an evidence of value for the enterprise's business.

In terms of the different nuances that depend on specific types of customers within each of our four identified segments, we outline some further recommendations:

Figure 12: Key recommendations for telecoms operators



Source: STL Partners

Segment 1: Maximise the private networking opportunity

- This is the sweet spot for private cellular networks where there is a clear need and unity in purpose for private networks. Interest and deployment of private cellular networking used to be relatively limited to specific types of customers where other forms of connectivity were not feasible, such as ports or mines, but the number of areas suited for private networking are also increasing at a fast pace.
- Work with your customers to showcase how a private LTE or 5G network can deliver and meet certain requirements where other solutions struggle. Favourable requirements for 5G revolve around different combinations of the following factors: latency, coverage, stability, reliability,

bandwidth and mobility. Focus on exploring and identifying different use cases and applications that can leverage the private network, in order to maximise your customers' ROI.

- Start engaging with industry groups like 5G-ACIA or 5GAA and government or academic testbeds and projects, such as the UK DCMS and 5G CONNI, to get involved within the ecosystem and collaborations between different ecosystem partners and industrial customers to realise the opportunities.
- Focus on leveraging the customer success stories from this segment to help change the behaviour with enterprise customers in segments 2, 3 and 4. Measure and showcase achieved benefits in productivity, efficiency and other key business metrics with these success stories to help drive adoption with other customers.

Segment 2: Work with customers to identify the anchor use case

- Given the internal organisational challenges your stakeholder may be facing, the key here is to help customers identify an anchor use case or subset of a site where the business case will justify the need for a private network. This needs to be where there is a unique need for private LTE or 5G in delivering the solution to get the expected benefits.
- Look at where the impact of a private network on key business metrics, such as unplanned downtime, operational efficiency, health and safety, exceeds the TCO and investment required. Work with your key customer stakeholder to find this standalone use case and see this as a foundation to build on gradually. In the initial Request for Information/Proposal (RFI or RFP) phase(s), ensure that the specifications are designed to support the wider needs and requirements of the organisation and other use cases.
- Once the network is up and running, focus on engaging with other application owners within the customer organisation in order to extend the existing deployment to support other use cases in the future if alignment can be achieved across application owners.
- For example, if the anchor use case is automated robots, i.e. robots that conduct core manufacturing processes autonomously using real-time data from sensors to inform decisions, private LTE or 5G can provide the latency, stability and reliability required for time sensitive networking to sync with other parts of the process or other robots within the production line.

Segment 3: Be the honest connectivity broker

- Connectivity can play a key role as an enabler of your customers' wider transformation journey, in enabling smarter operations, industrial internet of things (IIoT) and automation for example to drive better productivity and performance.
- Start by building a stronger understanding of your enterprise customer's business problems and requirements, and identify the appropriate connectivity solutions best suited to address their needs and use cases. Work with your enterprise customers to help them navigate the options and figure out what forms of connectivity work best for their needs.

- Analyse your customer's specific requirements based on their operations and assess the different use cases and applications they are currently adopting. Consider the future use cases they are looking to adopt and identify any gaps or future-proofing needs in terms of how these are being served by existing connectivity solutions.
- This is about rationalising and consolidating the radio technologies and management platforms. Private cellular (e.g. 5G) can be part of this but your role is to help your customers future-proof and be flexible so that they can easily adopt new or more advanced use cases in the future.

Segment 4: Focus on enhancing existing solutions

- The reality may be that other forms of connectivity such as Wi-Fi or ethernet may be more suited for existing use cases and applications. Therefore, you should focus on providing better versions of existing solutions (e.g. upgrading to Wi-Fi 6 / 6E)
- If your enterprise customers are currently using other connectivity solutions because it is an easier route due to internal stakeholder alignment challenges, recognise that this may not be a permanent situation.
 - If your customers start adopting more mobility use cases such as automated guided vehicles or moving robots, or have more demanding connectivity requirements around security, reliability or coverage when looking to support more mission-critical use cases, then they'll start moving into Segment 2.
 - Alternatively, if the internal stakeholders within these customers start working towards a common vision and establish a clearer strategic framework, then our recommendations for Segment 3 will apply.

Conclusion

Although private cellular networks can offer enterprises the opportunity to have enhanced connectivity configured specifically to meet their needs, the reality is that private cellular will continue to co-exist in a hybrid networking world with other connectivity solutions. Our research indicates that Wi-Fi is still the most prevalent wireless technology today and ethernet is also still widely adopted for on-premise connectivity in industrial settings.

The key thing that all enterprises should do is to see different connectivity solutions as tools to use to achieve wider business objectives and strategies, and evaluate where each tool is best suited to be used for current and future needs. Private cellular networks will be an important part of this toolkit but ultimately should be viewed in a broader context within hybrid networking. Once enterprises understand where and when they can be used and maximised, it can play an integral role in wider enterprise on-premise connectivity technologies and in digital transformation.

About Dell and Intel

It is clear from the research that enterprises will face challenges in adopting private cellular networks. To overcome these challenges and unlock the potential of private cellular networking, enterprises must leverage existing 4G networks and opportunities such as spectrum decoupling from the service (e.g. CBRS), as well as drive adoption of 5G. Dell Technologies and Intel Corporation work with an ecosystem of partners to address the following challenges of adoption of private cellular networks:

- **Cost of installation and operations:** The Dell / Intel Smart Edge solution is considered a converged edge device, designed to run RAN workloads, mobile core (4G/5G) and third-party VNFs (e.g. SD-WAN) as well as unlimited third-party applications. By running multiple workloads on a single converged platform, enterprises can reduce total cost of ownership and accelerate the deployment of new use cases/services. Flexible pricing of software components and “right sized” hardware components to address a wide range of use cases can help to optimise cost, from the most cost sensitive to the higher-end use case scenarios. The option to consume private cellular networks through an OpEx based ‘as-a-service’ model is also available.
- **Device and solutions ecosystem:** Dell and Intel have a rich ecosystem of partners that includes RAN/access point partners, mobile packet core elements (4G and 5G), credible system integrators (SIs), and a vibrant ecosystem of third-party ISVs enabling innovative use cases across key industry verticals including manufacturing, extractives, retail, healthcare and venues.
- **Availability of spectrum:** The joint private mobility solution is agnostic to the source of the spectrum; Dell and Intel are eager to follow client preferences whether they want to deploy a private mobility solution with an operator, SI, or directly themselves. When working with operators, the service relies on licensed spectrum and focuses on delivering a single, seamless experience for enterprises to manage their cloud and business outcomes.

If you are interested in knowing more about how Dell Technologies and Intel can help you, they would be happy to discuss your specific needs. Please reach out to:

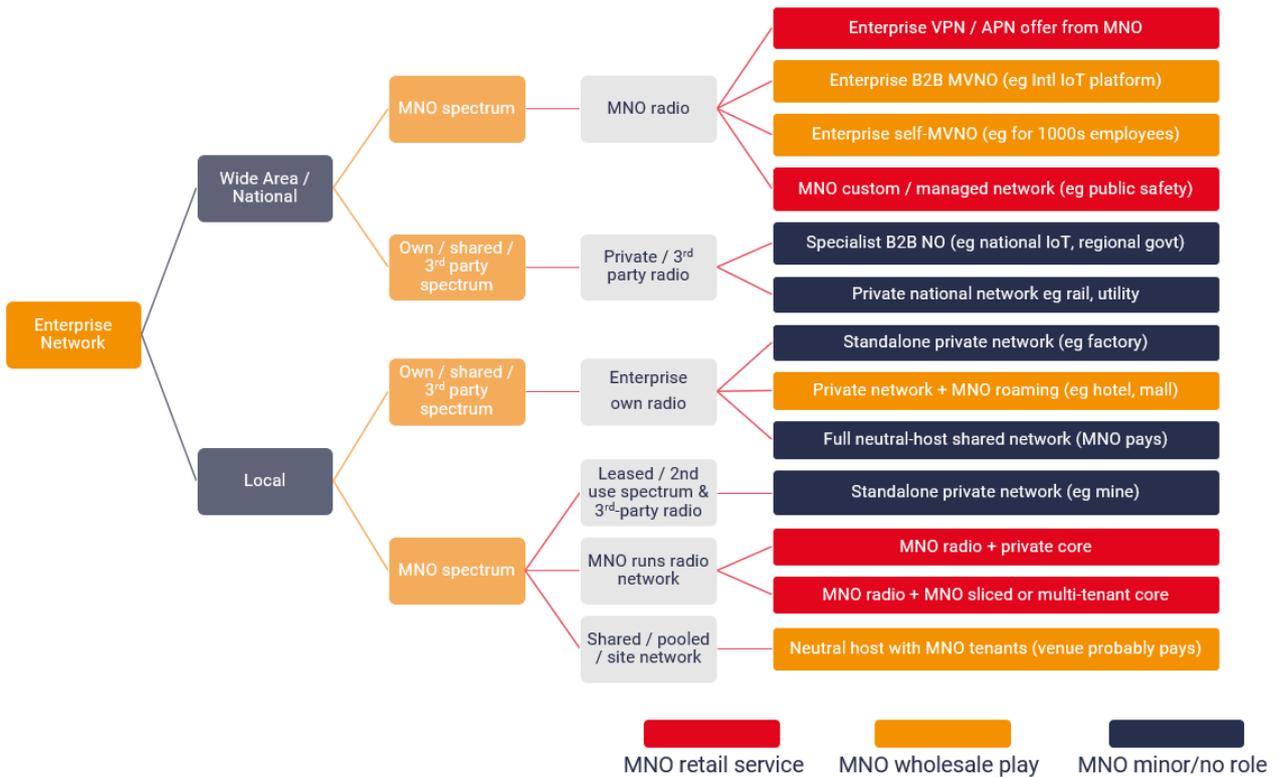
- **Dell Technologies:** Rodrigo Custodio (Rodrigo.Custodio@Dell.com) or
- **Intel Smart Edge:** Bob Pike (Bob.Pike@Intel.com) or Milan Djukic (Milan.Djukic@Intel.com).

Appendices

There are many different types of private cellular networks

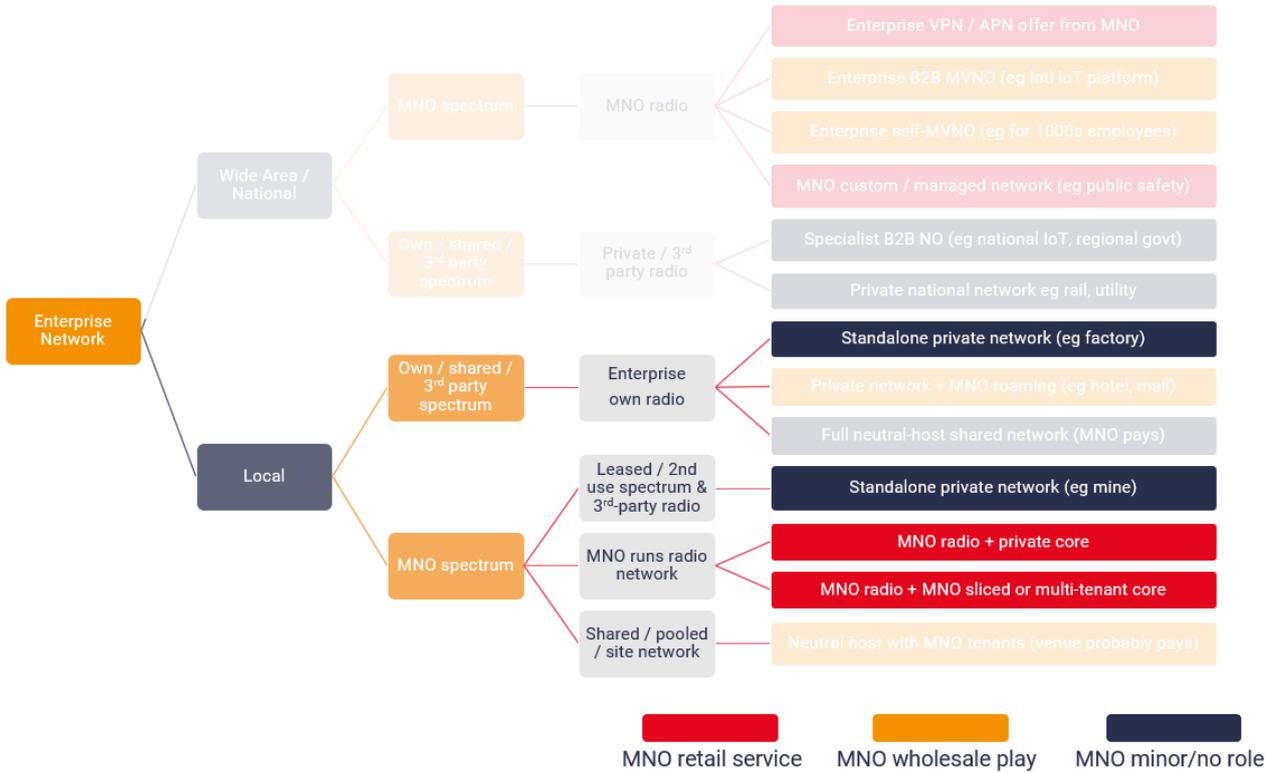
Our previous report on **private cellular networks** synthesises the different operating models and technical assets included in the greater world of private networking, or are being offered as “private networks”. Our report and definition of private cellular networks focuses on a specific subset of these private networks shown in Appendix 2.

Appendix 1: There are many types of vertical / enterprise / private networks



Source: STL Partners

Appendix 2: Our definition of a private cellular network

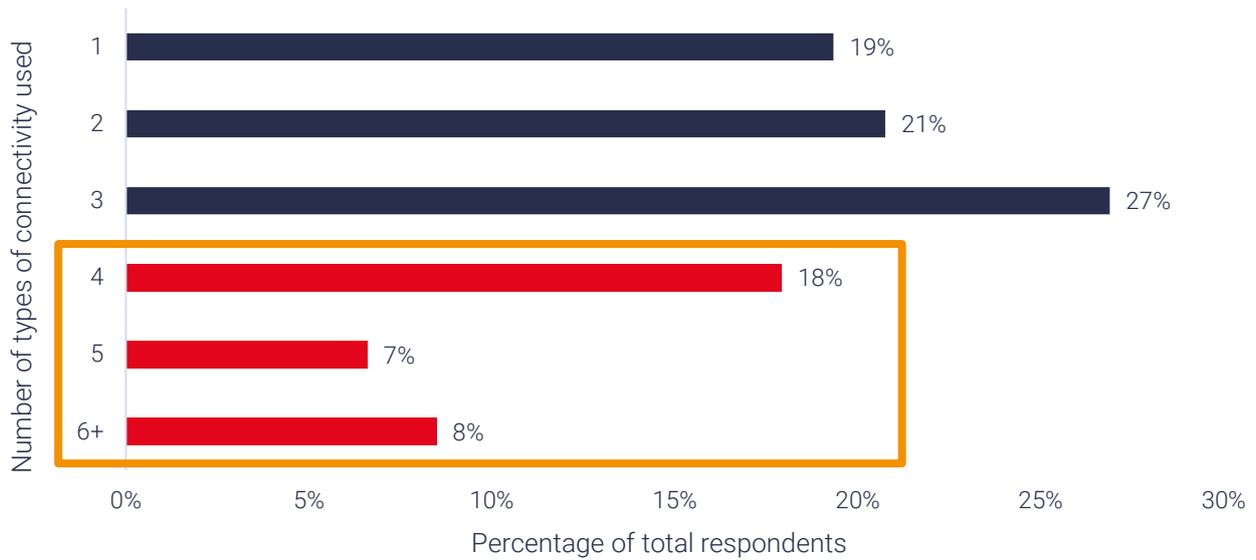


Source: STL Partners

A third of enterprises use four or more different connectivity solutions

Our enterprise survey respondents were asked to select the different forms of on-premise connectivity used for their operating sites, which included a range of wired and wireless solutions:

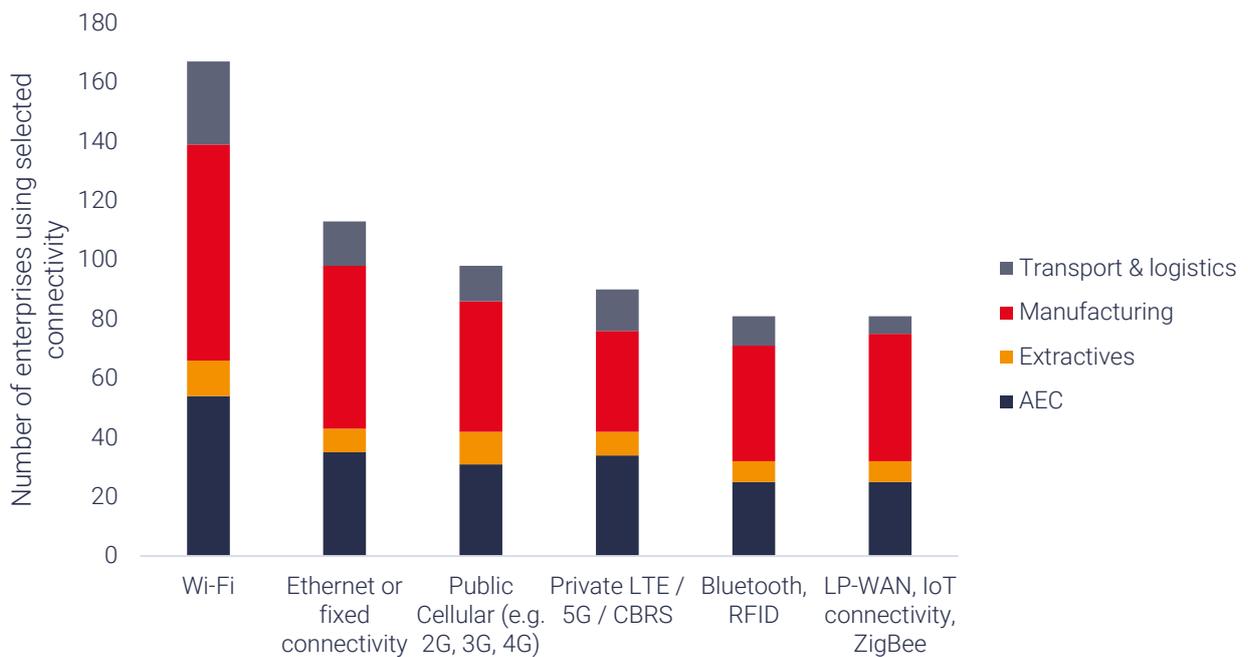
Appendix 3: 33 percent of enterprises deploy four or more forms of connectivity



Source: STL Partners survey (Oct 2020), n = 200

Wi-Fi and ethernet is still widely adopted by enterprises

Appendix 4: Wi-Fi is the most commonly used connectivity solution today

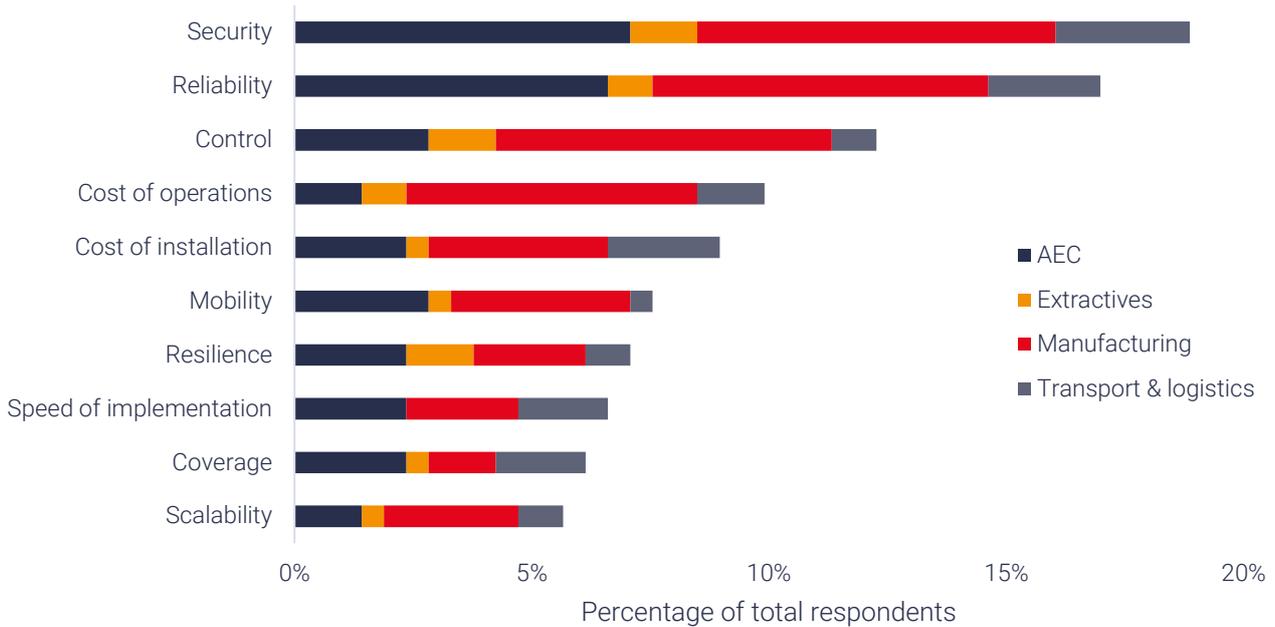


Source: STL Partners survey (Oct 2020), n = 200

Security is ranked as the most important benefit of private networks

Our survey respondents were asked to select and rank the top three most important benefits of private cellular networks in order of performance. Security emerged as the factor most commonly ranked number 1, closely followed by reliability.

Appendix 5: Security is the most important benefit of private networks

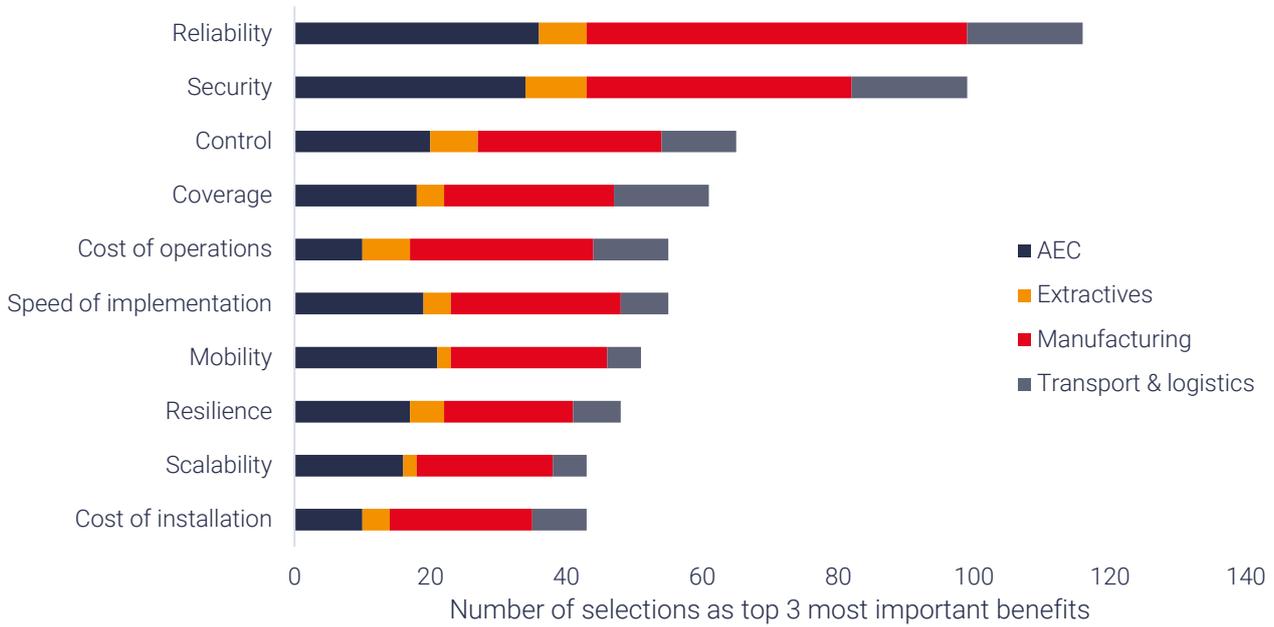


Source: STL Partners survey (Oct 2020), n = 200

Reliability is also selected as one of the top three benefits of deploying a private network

We also assessed which benefits appeared most commonly within the top three factors selected by the enterprise respondents. Although security was ranked most commonly as the top benefit, reliability appeared most overall within the first, second and third most important benefit of private networks but security was a close second.

Appendix 6: Reliability appeared most commonly within the top three benefits of a private network

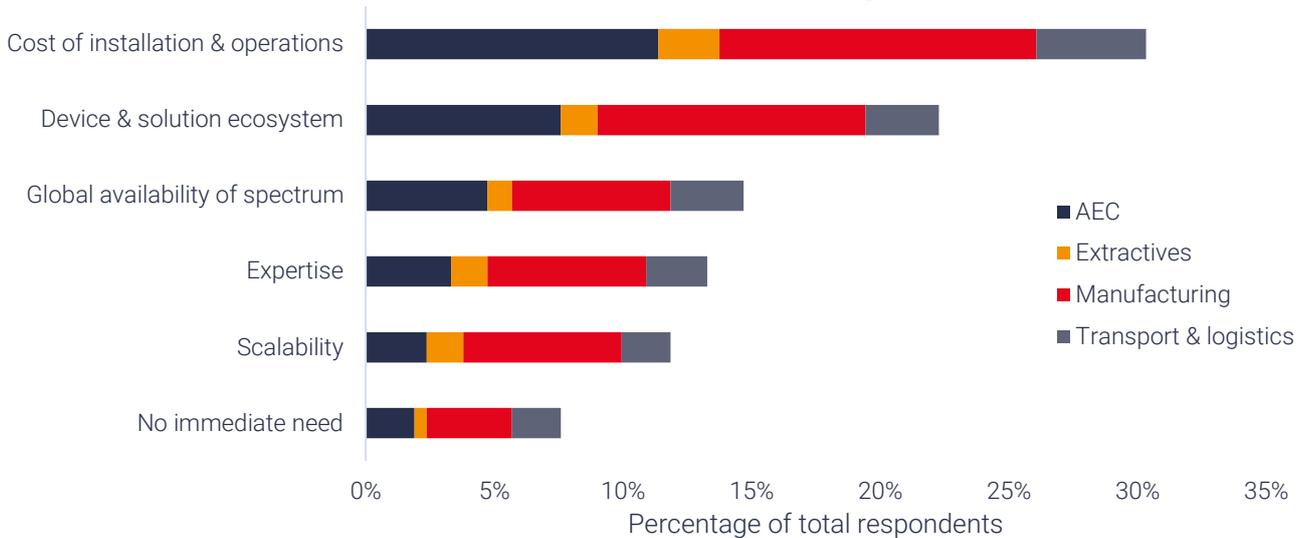


Source: STL Partners survey (Oct 2020), n = 200

Cost and the lack of a device/solution ecosystem emerged as key challenges

Survey respondents were also asked to select the most pervasive challenge when implementing private cellular network solutions. Besides cost, the lack of an established device and solution ecosystem was another cited challenge. This refers to the lack of supported devices which have a 5G/LTE/CBRE capability embedded in them, or a significant inertia in the installed base around other connectivity solutions (e.g. Wi-Fi).

Appendix 7: Cost is the most pervasive challenge for enterprises

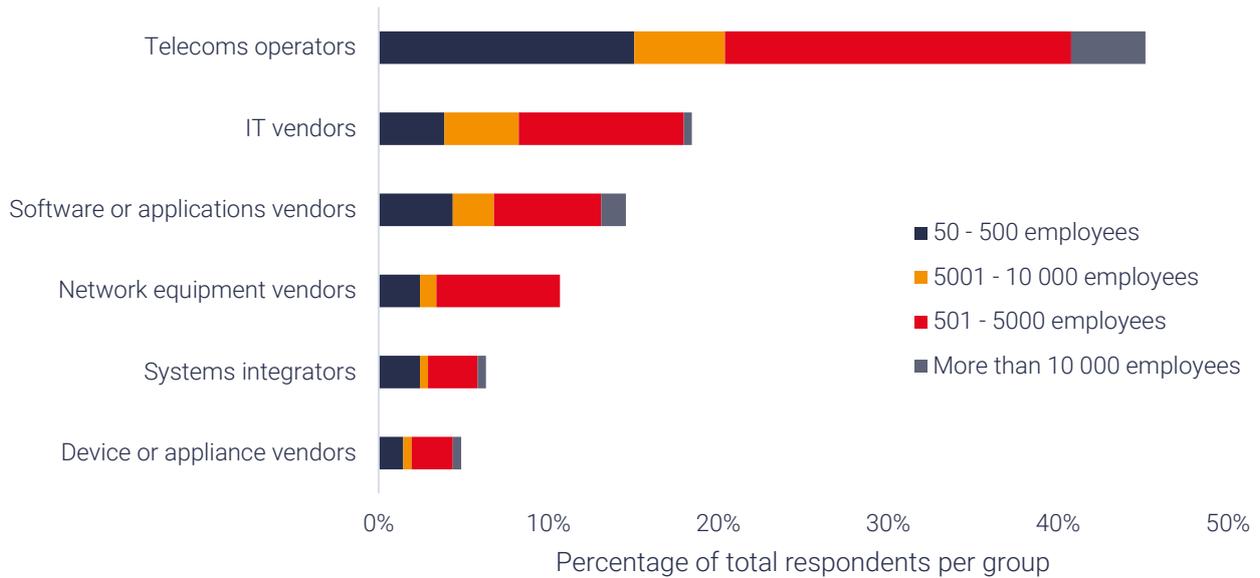


Source: STL Partners survey (Oct 2020), n = 200

Telcos are still the preferred lead partner for private cellular

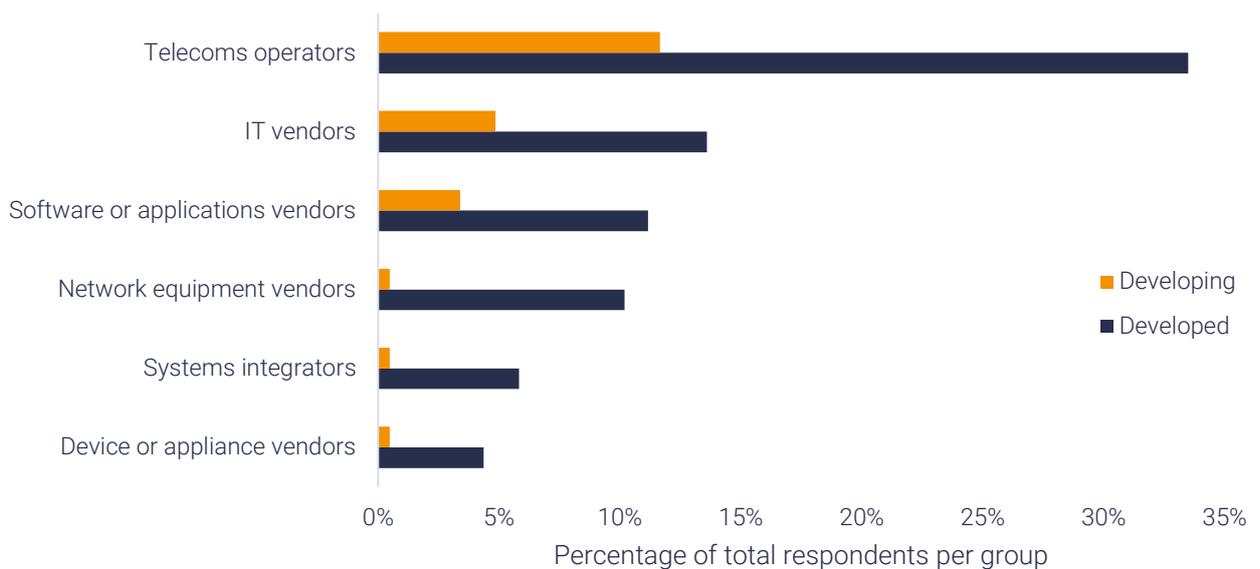
When asked who they see as the lead partner for providing, deploying and managing a dedicated private cellular network solution, telecom operators emerged as the preferred partners by enterprises of all sizes, and across developed and developing markets.

Appendix 8: Telco operators are the preferred partners for enterprises of all sizes



Source: STL Partners survey (Oct 2020), n = 200

Appendix 9: Telco operators are preferred partners across different types of markets



Source: STL Partners survey (Oct 2020), n = 200

PARTNERS



Research



Consulting



Events