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IoT OPPORTUNITIES FOR TELECOMS OPERATORS

VOLUME V

Contents

Introduction

Welcome to our fifth collection of articles based on the IoT market and the impact of IoT developments on telecoms operators.

With this collection, as with the previous editions, we aim to bring you a selection of the best of our thinking on IoT from our consultants and analysts.

If anything, the IoT market is developing more quickly now than before. NB-IoT and LTE-M have moved from test labs to real, large-scale networks. In turn, this is leading to different business models, which may be better exploited by MVNOs, creating a possible threat for operators.

Responses to the persistent question of value chain position are also changing. Horizontal capabilities are becoming increasingly commoditised, and operators (and the vendors that support them) need to grapple with the solutions for vertical markets, even if this takes them into unfamiliar territory.

There are also new opportunities, such as in the vehicle-to-everything (V2X) market, which operators may be able to exploit.

All of these developments take place against a backdrop of IoT revenue that is growing but not booming. Tricky questions will be raised if this growth begins to slow, as this this could jeopardise investment plans.

The following articles are included in this issue.

- **IoT revenue and connections continue rapid, but not explosive, growth.** We explore the published data from operators on IoT revenue and connection numbers.
- **Contract wins by IoT MVNOs mean they should not be ignored by MNOs.** We consider what impact IoT MVNOs are having on the market and how all suppliers should differentiate their offer.
- **KPN's modular approach to IoT may inspire other telecoms operator.** KPN's model for IoT and its role on the value chain has evolved over the years. We outline the lessons for other operators.
- **Vendors must offer telecoms operators more than a horizontal platform to realise operators' IoT ambitions.** We describe how vendors can help to unlock the IoT market for operators.
- **China will lead the world in NB-IoT, which will benefit Chinese vendors and the ecosystem worldwide.** China is at the forefront of NB-IoT. We assess the implications for other players in the NB-IoT world.

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- **Cellular V2X (C-V2X) could fulfil a market need, if the commercial timing is right.** We examine the potential for C-V2X to support connected and autonomous vehicles.

As always, please let us know of your feedback or comments on these articles.

Finally, we produce a monthly newsletter highlighting our latest research. Please contact me if you would like to be included in the mailing list.

IoT revenue and connections continue rapid, but not explosive, growth

TOM REBBECK
Research Director, Enterprise and IoT

> "If the growth in IoT revenue or connections were to slow, it could raise some difficult questions, especially for less-committed operators."

Operators' enterprise reporting is poor and reporting on IoT is even worse. We are aware of only four operators (Telstra, Telefónica, Verizon and Vodafone) that regularly report IoT revenue, and only 11 that report connection numbers. For a segment that is supposedly key to future growth, operators are remarkably shy about providing progress updates.

The operators that do provide information are, by definition, atypical. That they are providing data at all probably skews the sample. We can, however, still glean some useful insights by exploring the data that is available.

IoT revenue growth is fast, but may not be fast enough

The key metrics for the IoT business are positive for almost all operators, with rapid, if not explosive, growth, but IoT remains a relatively small part of a mobile operator's business. If growth were to slow, it could raise some difficult questions, especially for less committed operators.

The main points from the financial results are the following.

- **IoT revenue grew quickly for all operators.** Operator IoT revenue grew between 7.9% (Telstra) and 30.4% (Telefónica) during the calendar year 2017, compared to 2016. Verizon's figure was higher (we estimate that it grew by 70%) but is not comparable as much of this growth was due to large acquisitions. The average organic growth rate (15%) is comparable to that for other IoT companies or divisions, such as Intel's IoT Group (which grew at 20.1%).
- **IoT is still only a small part of operators' business, despite the fast growth.** For each of the four sample operators that provide data, IoT constitutes less than 2% of their total revenue (Figure 1). Even at an annual growth rate of 15%, it would take until 2026 for an operator to grow IoT from providing 1.6% of the total revenue to over 5% (assuming a flat top line). All of this has implications for IoT divisions within operators; IoT is likely to be a long, hard struggle, and teams will have to fight to gain resources and attention from other parts of the company. It also suggests that more radical approaches (such as that Verizon has taken through acquisition) may be necessary to grow faster.
- **IoT is already a USD1 billion business for some operators.** In absolute terms, especially for the larger operators, IoT already generates significant revenue. IoT is worth over USD1 billion a year for Verizon, probably more for AT&T (it does not split out IoT revenue) and EUR720 million (USD890 million) for Vodafone. If IoT were a standalone business, it would be considered large; it is only small in comparison to the core business.

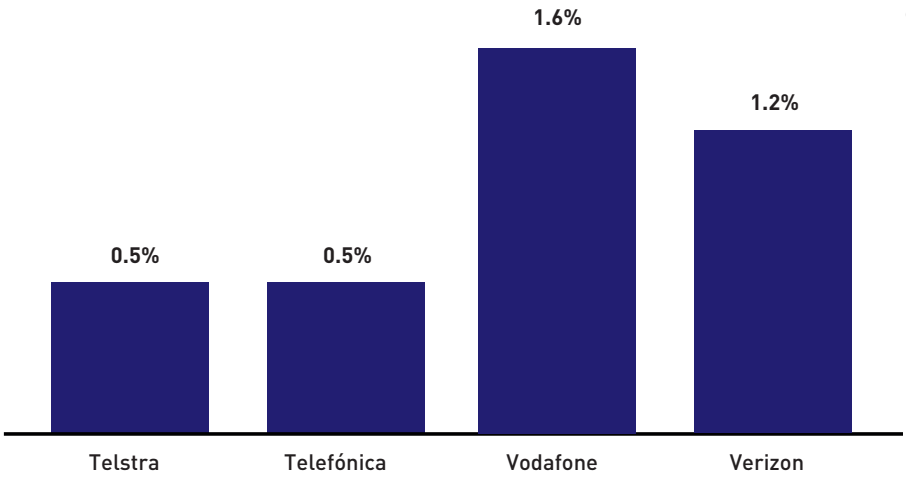

FIGURE 1: IOT REVENUE AS A SHARE OF THE TOTAL REVENUE, 2017
[SOURCE: ANALYSYS MASON, 2018]

- **IoT may help to defend existing revenue.** IoT may have a value beyond the direct revenue opportunities. As more organisations require IoT solutions, they may want to buy all connectivity, traditional mobile as well as IoT, from a single connectivity provider. A strong IoT offering may be needed for an operator to defend its broader enterprise communications business. We have heard of operators using IoT as a beachhead from which to bid for larger enterprise contracts.

Connections are also growing extremely quickly, even from a high base

The number of IoT connections is also showing fast growth. The key points to note here are the following.

- **Scale may be helping some of the larger operators to grow more quickly.** As we can see in Figure 2, almost all operators are seeing rapid growth in the number of connections, even from a relatively high base. For example, Vodafone grew its connection numbers by 34% in a year, taking it from just under 50 million at the end of 2016 to around 65 million by the end of 2017. Scale may even be helping the operators with a large base to grow faster – operators with a large base will have a big base of reference customers, have (in most cases) mature systems and processes, and may be willing to offer lower prices as any fixed costs will be spread across a larger base. Clearly, this scale factor is not universal – the fastest growing operator of all was Bouygues Telecom in France, which had fewer IoT connections than local rivals Orange and SFR.
- **Connection numbers can go down as well as up.** As the results from Telefónica Colombia show, it is not a given that the number of IoT connections will increase for a telecoms operator. The loss of a major contract or the cancellation of a large-scale pilot can lead to a fall in the number of connections. While over a year, the connection numbers tend to grow, we have also seen other operators face quarter-on-quarter declines in the number of connections (for example BT's connection numbers for 3Q 2017 were slightly down on those from 2Q 2017).
- **The average revenue per connection (ARPC) is falling for most operators, but not for Telefónica.** For Telstra and Vodafone, connections are growing more quickly than revenue. For Telefónica though, the reverse is true. This suggests that either Telefónica's ARPC is growing, or it is having success in selling more than just connectivity (or both). Whatever the reason, it is an encouraging result for Telefónica. On average, revenue per connection is falling by between 5–10% per year. If we assume that average contract lengths are two years, this means that (all else being equal), contracts are being renegotiated at around a 10–20% discount – not dissimilar to enterprise mobile contracts. This still suggests that there is strong price competition and that operators have been unsuccessful in moving away from pure price competition for IoT contracts. (We wrote about how operators can try to move away from pure price competition here: *http://www.analysysmason.com/Research/Content/Short-reports/connectivity-iot-value-Aug2016-RDME0.)*

We will be updating our *IoT price and connections tracker* each quarter and may provide further commentary on the data.

Questions?
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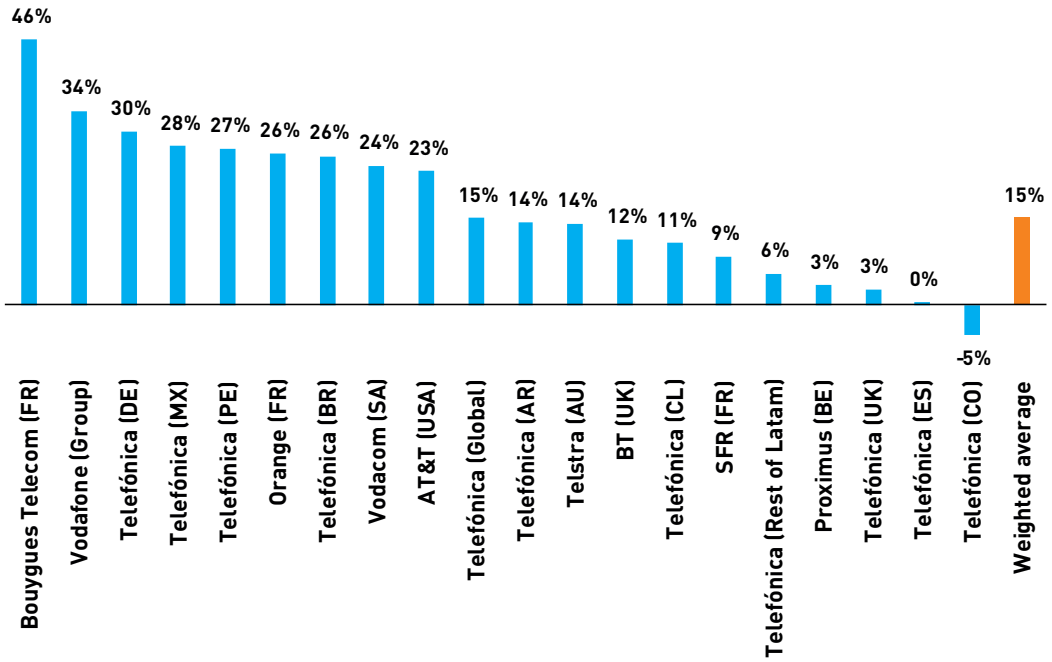

FIGURE 2: GROWTH IN THE REPORTED NUMBER OF IOT CONNECTIONS, 2016–2017
[SOURCE: ANALYSYS MASON, 2018]

Contract wins by IoT MVNOs mean they should not be ignored by MNOs

MICHELE MACKENZIE
Principal Analyst, Research

> "Smaller IoT MVNOs have been winning some significant benchmark deals with major companies – other connectivity providers should consider their response."

Traditional, global MNOs continue to win the vast majority of IoT contracts. However, IoT MVNOs, such as Cubic, Globetouch, Truphone and others, pose a threat and have successfully won high-profile benchmark contracts, with customers in the automotive industry that include Audi, GM and Kia Motors. We estimate that at least 20 firms (excluding MNOs) are offering worldwide or regional IoT connectivity.

The threat to large established operators from smaller players is increasing with these highly visible, well-publicised reference deals with car companies, which lend the MVNOs credibility and from which the MVNOs will gain experience and revenue. MNOs need to consider how to counter these smaller competitors, starting with an assessment of why they are losing contracts. This article is based around two of Analysys Mason's recent reports: *IoT MVNOs: case studies and analysis* and *IoT MVNOs: strategy responses of established operators.*

Over half a billion connections for IoT could be awarded as part of regional deals

We estimate that contracts awarded as part of a global or regional contract for IoT connectivity will account for 275 million of the 1.3 billion cellular connections and 250 million of the 3.4 billion LPWA connections by 2025 (see Figure 1). We expect that, with the exception of extremely large countries (such as China and the USA), most embedded connectivity contracts for cars will be awarded as part of a regional contract, as has been the case with most contracts to date (for example, for BMW, General Motors, Volkswagen and others).

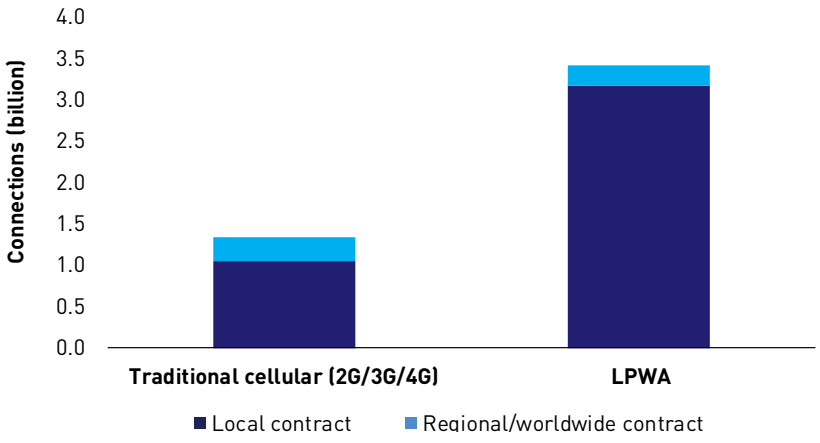

FIGURE 1: THE ADDRESSABLE IOT CONNECTIVITY MARKET, WORLDWIDE, 2025
[SOURCE: ANALYSYS MASON, 2018]

The large number of connections involved in connected car contracts means that almost half of cellular connections could be awarded as part of a regional deal (as is the case in Western Europe).

For LPWA, we expect a smaller share of connections to be included in regional deals because many of the use cases are for solutions such as smart cities or smart meters, for which connectivity will be contracted locally.

The numbers shown in Figure 1 represent Analysys Mason's forecast for IoT connectivity worldwide in 2025, but this forecast potentially underestimates the impact of regional deals. For example, if a popular consumer electronics device (such as a new Apple Watch) is supplied with connectivity as part of regional contract, this could significantly increase demand for a regional deal.

Customers are demanding regional contracts for connectivity because they want:

- to connect devices that will roam between countries (for example, tracked shipping containers);
- to simplify the procurement and management of connected devices such as monitored industrial hardware, even if they do not roam (or even move in some cases);
- some combination of these two demands (such as for connected vehicles or consumer electronics).

MVNOs are winning contracts through a combination of flexibility and price

No single factor explains why IoT MVNOs are winning significant deals (and, as noted earlier, MNOs are winning the majority of deals and of connections), however, some of the following factors may explain these wins.

- **MVNOs may simply be cheaper, and may be more willing than MNOs to accept low-margin connectivity contracts.** Venture-backed MVNOs may be using some of their investors' money to win deals to help gain market share and, with it, credibility.
- **MVNOs may offer more commercial flexibility.** MVNOs may be more flexible in how contracts are structured, for example by eliminating any upfront costs or minimum commitments.
- **MVNOs may offer more technical flexibility.** Customers of regional and global connectivity are likely to have specific technical requirements, such as multiple APNs and MVNE offerings, that standard mobile operators are unwilling (or unable) to offer.
- **MVNOs may simply want the business more.** For most MNOs, IoT is only one division and it must compete for resources and attention with other (much larger) parts of the organisation. For companies such as Aeris, Cubic, Globetouch and Sierra Wireless, IoT is their primary business, and resources will be focused on winning these contracts, from the CEO down.

Suppliers need to be clear on their differentiators and address any perceived weaknesses

Any provider hoping to compete for connectivity contracts needs to have a clear understanding of its potential differentiators. Differentiators could include the following aspects.

- **Financial solidity.** Many IoT MVNOs are funded by venture capital and are, we presume, loss making. For any potential customer, such as an automotive original equipment manufacturer (OEM), aiming to sign a medium- or long-term contract, the provider's financial position will be an important consideration.
- **Reliance on multiple customers**. Smaller players will have fewer customers and their reliance on each will be greater; a contract loss could result in financial difficulties.
- **Long-term commitment to IoT.** Most major MNOs have had IoT (and, before that, M2M) teams for almost a decade and can demonstrate a long-term commitment to the sector. This contrasts with some of the other firms chasing IoT contracts (both MVNOs and divisions of other telecoms firms) for which IoT is a more-recent activity (although some MVNOs have been in business for over a decade).
- **Connectivity coverage and quality.** Many IoT MVNOs can claim to offer connectivity in over 100 countries, but these often do not include 4G and many IoT MVNOs do not offer connectivity in major markets such as Brazil, India and Russia. NB-IoT, LTE-M and even LoRa will play an increasingly important role in regional and global deals, which should benefit established operators.

Other differentiators that suppliers should explore include security capabilities, existing customer relationships, brand and the ability to provide other IoT capabilities (such as hardware or software platforms).

However, each of these differentiators could instead be perceived by potential partners as a weakness and any connectivity supplier needs strategies to address these problems. For example, IoT MVNOs can point to the size and sources of their funding to assuage concerns about financial stability.

Smaller connectivity providers should not be ignored

The types of contracts being won by MVNOs means that they cannot be ignored by other connectivity providers. MVNOs are winning these contracts partly because they are paying more attention to customers and are more-flexible about meeting their needs. Any operator – MNO or MVNO – needs to be clear about its differentiators and mitigate against any weaknesses; connectivity providers should understand their customers' priorities and consider how they perform against these factors.

Questions?
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KPN's modular approach to IoT may inspire other telecoms operators

TOM REBBECK
Research Director, Enterprise and IoT

> "KPN provides an interesting model for generating more money from IoT than connectivity alone."

Operators need more than connectivity revenue if the impact of IoT is to be more than marginal.[1] Successfully selling end-to-end solutions would give operators the largest share of revenue but will be incredibly challenging.[2] For IoT solutions for the enterprise market, most vertical markets require expertise and have established players – acquisition is the surest way of gaining a position but is something that few operators have the appetite for. The consumer IoT market is attractive as a potential extension of the current consumer mobile business, but it remains unclear what exactly will gain traction and again, competition will be fierce, judging by the investments of the web-scale players.

As we have argued before, it may be more sustainable for operators to focus on the capabilities that all IoT solutions need and provide components, rather than a complete solution.[3] This article explores KPN's approach to IoT and how it fits with our framework.

KPN is providing a modular approach to IoT

As with many European operators, KPN has been working on IoT and M2M for over 8 years and has changed strategy and personnel several times. KPN's current approach is a pragmatic and sustainable way for a telecoms operator to feel its way in IoT.

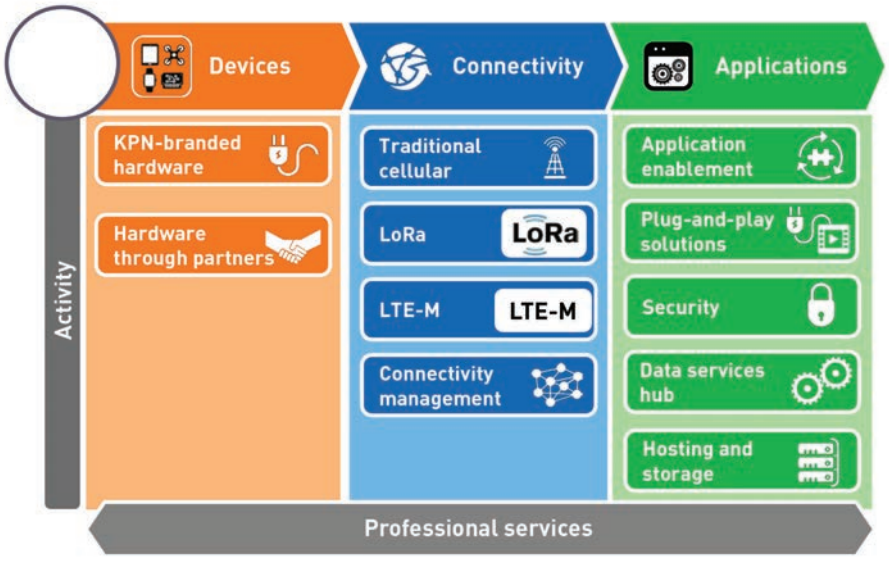

FIGURE 1: OVERVIEW OF KPN'S APPROACH TO IOT
[SOURCE: ANALYSYS MASON, 2018]

KPN's approach is to provide a series of capabilities or modules, across the value chain (see Figure 1) with the emphasis on these modules, rather than on providing end-to-end solutions (although it does offer a small number of full solutions).

In Figure 1, we use the same basic value-chain illustration that we have used in previous reports, simply dividing IoT into devices, connectivity and applications.[4] Within each of these three categories, there are potentially hundreds of different activities; KPN is focused on a subset under its IoT brand KPN Things.

- **Devices:** KPN offers its own branded hardware, and collaborates with other hardware partners whose products work with KPN's services.
- **Connectivity:** KPN has traditional cellular networks, as well as nationwide LoRa and LTE-M networks. It also uses connectivity management platforms from Cisco Jasper and Actility (ThingPark).
- **Application:** KPN offers Cumulocity's application enablement platform, four ready-built 'plug-and-play' applications (asset management, level tracking, climate control and rodent control), hosting and security solutions. The data services hub allows different parties to upload and access IoT data, with restrictions on who can access what. The hub is being used by Talking Traffic Partnership, a traffic management project that includes stakeholders such as the national, local and regional governments of the Netherlands and private companies.

All of these activities are underpinned by KPN's professional services team.

The building blocks that KPN is providing are being sold to solution providers, integrators and direct to enterprise customers.

The solutions offered by KPN could be used by organisations in any vertical market, but KPN is targeting four in particular: healthcare, government, manufacturing and agriculture, as part of its broader enterprise strategy to focus on local opportunities that fit well with KPN's position in the Dutch market.[5]

As well as products, KPN is holding a series of workshops, some of which are held in conjunction with the IoT Academy, which KPN sponsors. Both the workshops and the academy provide awareness and training sessions for organisations that are interested in developing IoT solutions. KPN has trained more than 500 people during its 28 developer workshops and has held almost 200 'awareness' workshops. As we have written elsewhere, awareness is a major challenge for IoT.[6]

Analysys Mason believes that KPN's approach to IoT could work for other telecoms operators, but that it also has limitations

We like the KPN model for the following reasons.

- KPN is not trying to do everything; it can focus on where it has differentiators or particular expertise.
- The approach can easily be adapted over time. If some of the elements are not successful they can be dropped. If other capabilities are requested, they can be added.
- KPN can focus on offering elements that are known to work together; it does not need to provide the 'best' individual components. For example, KPN is unlikely to be able to compete with Amazon Web Services (AWS) for hosting but it can offer hosting, along with security, connectivity and a module that will all work together. This simplifies development and procurement for its customers in a way that may more than balance the lack of any individual feature.
- KPN is not exposed to significant risk by committing lots of resource to one product or vertical market.
- The workshops and academy can help build demand for KPN products in a market where skills and awareness are among the key barriers.

KPN's strategy does have its limitations.

- It still requires its potential customers to do much of the work to create an IoT service (or to pay for a customised solution). This will appeal to innovators and early adopters, but it may not be enough to appeal to the mass market that wants off-the-shelf solutions. KPN does have some a small number of end-to-end solutions, but these are spread across a range of vertical markets (from pest control to building management). KPN could develop a more coherent set of applications for a given vertical market to help build a position in that market.
- The strategy will also require continued investment from KPN to remain competitive across a number of different fronts. If not, KPN's services may be swapped out for other providers over time.
- Finally, it is likely to take time for KPN to yield significant results. Its approach to IoT is different from the traditional telecoms operator model and this approach will require patience and support from senior management.

KPN provides an interesting model for generating more money from IoT than connectivity alone for an investment that is relatively modest (especially relative to more radical approaches such as venture capital investment or acquisition). It is also a bold move for a relatively small incumbent (KPN's revenue was EUR6.5 billion in 2017), competing against two of the largest European carriers, Deutsche Telekom and Vodafone, both of which have significant IoT ambitions.

Questions?
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[1] For more information, see Analysys Mason's IoT will have little impact on revenue for most mobile operators. Available at www.analysysmason.com/About-Us/News/Newsletter/iot-will-have-little-impact-on-revenue-Apr17.

[2] For more information, see Analysys Mason's Operators will struggle to replicate their role in fleet management in other sectors. Available at www.analysysmason.com/Research/Content/Comments/fleet-management-comment-rdme0.

[3] For more information, see Analysys Mason's Operator approaches to IoT: from connectivity to platforms and full solutions. Available at www.analysysmason.com/Research/Content/Reports/Operator-approaches-IoT-Jan107-RDME0.

[4] For more information, see Analysys Mason's Operator approaches to IoT: from connectivity to platforms and full solutions. Available at www.analysysmason.com/Research/Content/Reports/Operator-approaches-IoT-Jan107-RDME0.

[5] For more information, see Analysys Mason's KPN analyst day: its focus is on healthcare, government and manufacturing verticals in the Netherlands. Available at www.analysysmason.com/Research/Content/Comments/KPN-analyst-event-May2017-RDME0-REN01-REN02.

[6] For more information, see Analysys Mason's Enterprise survey 2017: A lack of awareness of IoT is holding back its adoption more than technology issues. Available at www.analysysmason.com/Research/Content/Comments/IoT-enterprise-adoption-RDME0.

Vendors must offer telecoms operators more than a horizontal platform to realise operators' IoT ambitions

AHMED ALI
Senior Analyst, Research

"Operators can use their local market assets to differentiate in IoT verticals with the help of their vendor partners."

Telecoms operators want to leverage IoT platforms to move along the value chain and offer more than just connectivity. However, with a few exceptions, they have been slow to assert their roles and adopt clear roadmaps for achieving this aim. Vendors that target telecoms operators need to offer more than generic horizonal platforms; they should also provide vertical solutions and support that goes beyond the provision of technology.

This article is based on Analysys Mason's new report *IoT technology: vendor strategies to support telecoms operators beyond horizontal platforms* and discusses how vendors can extend their support to drive more engagement from operators.

Operators' behaviour in the platform market suggests lower commitment despite their intention to play larger roles in IoT

With a few exceptions, such as AT&T and Vodafone, both of which were early to develop platforms, operators are licensing vendor solutions to offer platform services and grow their IoT revenue. While operators continue to deploy IoT platforms from vendors (as outlined in Analysys Mason's *IoT platform contracts tracker*), challenges, such as those below, remain for the vendors in this market.

- Most platform deals still focus on connectivity management platforms (examples include Cisco Jasper and Ericsson DCP). In comparison, application enablement platforms (AEPs) have not attracted the same level of activity from operators. Of the 357 platform deals that we have tracked, 238 are for connectivity management.
- Operators that have deployed AEPs sometimes lack the skills to build apps themselves and instead resort to reselling access to these platforms, which provides little differentiation.
- When operators expand in the IoT stack, they often deploy multiple platforms. Examples include Bell Canada, Deutsche Telekom and Telenor. While operators try to avoid vendor lock-in and spread their deployments across many platforms, revenue for each vendor will be limited.
- Even with multiple platforms across the stack, long-term commitment is uncertain. Operators are using vendor platforms to secure market entry, but they are still considering or in the process of building their own platforms as a long-term alternative. Regardless of the feasibility of such approach, it will limit operators' long-term commitment to vendor solutions.

Operators can differentiate in IoT verticals, but they need support from vendors that will go beyond technology

Operators are not competitive as platform providers, whether using their own platforms or licensing those offered by vendors. Many players in the IoT platform market are better placed to provide generic horizontal capabilities, including firms such as AWS and Microsoft. Such companies, with their global infrastructure and existing experience in the IT services and platform markets, have been forceful in claiming the centre stage in the IoT horizontal platform market.

Operators can instead look for differentiation in IoT verticals. In addition to owning the access networks in their local markets, operators have other assets to ease their entry. These include the operators' established brands, their sales and support channels and their existing relationships.

Vertical markets, such as smart cities, healthcare and manufacturing, present potentially attractive opportunities for operators, but they will need support from technology partners. However, vendors will have to offer more than just the technology to support operators. They also need to align their level of support to the type of operators they are targeting, as shown in Figure 1.

Vendors can help operators as they develop their business cases and as they deliver their applications to IoT verticals

Beyond the technology itself, vendors should also help operators by:

- reducing up-front costs and ongoing costs (because vendors can share costs across a larger base)
- providing specific vertical market understanding and expertise
- offering support with global standards
- providing and managing a broader selection of partners – from hardware vendors to application providers
- helping to develop and illustrate the business case.

Operators, especially ones that are late to enter the market, are held back by concerns about high initial costs and low margins for their IoT investments. They require vendors' support, not only at the initial stages of a project, but also on a long-term basis to continue helping them to establish sustainable and growing IoT revenue.

Vendors that seek to collaborate with operators should adapt their strategies to accommodate their partners' long-term needs. Although platform technologies are important, demonstrating differentiating non-technical expertise will be key aspects of vendors' proposition to operators.

Questions?
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	Large single-country operators	Large multi-country operators	Others
Description	Tier 1 operators with large domestic markets and substantial investments in IoT	Tier 1 operators in mid-size markets with high- to mid-level investments in IoT	Follower operators, including those in Tier 2 and Tier 3, in large and mid-size markets, as well as incumbents in small markets
Example	• AT&T • China Mobile • KT • SK Telecom • Verizon	• Deutsche Telekom • SoftBank • Telefónica • Vodafone	• du • Eir • Etisalat • MTN
Platform Strategy	• Primarily build their own platforms • Only rely on vendors to complement their offering with specific components • Can sell access to platforms to developers and enterprises • Can build and sell own applications.	• Rely both on building and licensing components for their IoT platforms • Resell access to vendors' platforms • Support customers' IoT projects through services • Can build and offer their own IoT applications.	• Rely largely on vendors' platforms • Resell access to vendors' platforms • Limited expertise in developing IoT services and applications • Limited resources to support IoT services.
Vendor opportunity	• **Technology:** offering specific technology components • **Beyond technology:** collaborating in delivering specific requirements for vertical customers.	• **Technology:** offering horizontal platforms • **Beyond technology:** offering additional support to enter and operate in specific verticals such as manufacturing and healthcare.	• **Technology:** offering horizontal platforms and, possibly, apps • **Beyond technology:** offering strong support to operators to help them to start and grow their IoT business • Helping identify vertical opportunities.

FIGURE 1: THE TYPES OF OPERATORS AND THEIR ROLES IN THE IOT PLATFORM MARKET
(SOURCE: ANALYSYS MASON, 2018)

China will lead the world in NB-IoT, which will benefit Chinese vendors and the ecosystem worldwide

TOM REBBECK
Research Director, Enterprise and IoT

> "Developments in China will boost the NB-IoT ecosystem worldwide and will particularly benefit Chinese hardware and software companies that are planning to export."

Few operators have launched commercial NB-IoT networks since the technology was standardised in 2016, despite the strong push from Deutsche Telekom and Vodafone. However, China's operators are the exception. Backed by strong government support, all three operators claim to have rolled out the technology to tens of thousands of base stations. Developments in China will benefit the entire NB-IoT ecosystem, not least Chinese hardware and software firms looking to export to other countries. This article explores the progress that China is making with NB-IoT, the implications for the technology, and what it means to other operators.[1]

Chinese operators are making important progress in developing NB-IoT, which will benefit all NB-IoT ecosystem players

The Chinese government has been actively driving the development of NB-IoT. The Chinese telecoms regulator, the Ministry of Industry & Information Technology (MIIT), announced aggressive targets as well as guidance to promote the NB-IoT standard in June 2017 (see Figure 1).

In accordance with the MIIT, all three Chinese mobile operators are investing heavily in NB-IoT networks and device/module manufacturer subsidies. They are also developing capabilities beyond connectivity to cover more of the value chain (Figure 2).

The steps taken by the Chinese operators should help the NB-IoT ecosystem globally. The Chinese networks are on a massive scale, which should help reduce prices and resolve initial problems. This should also benefit Chinese companies, such as Huawei, that are heavily involved with the technology, as they look to markets outside of China, as well as Chinese manufacturers and app developers.

Chinese operators are looking beyond connectivity for a return

The network connectivity business depends heavily on scale to generate returns, and even Chinese operators, especially China Mobile, will see negative RoI from NB-IoT for years. The upgrade plans of the three operators are as follows.

- Most of the 310 000 base stations of **China Telecom** that have been upgraded for NB-IoT are new-built FDD-LTE stations refarming its 800MHz CDMA spectrum, which just require software upgrade. China Telecom's list price is CNY20 (USD3) per year per NB-IoT connection.[6]
- **China Unicom** also has an FDD-LTE network but most of its base stations operate at 1800MHz, which many existing modules do not support. Therefore, it chose to upgrade its 900MHz FDD-LTE stations first to support NB-IoT, such as its 900MHz network in Shanghai.
- **China Mobile** is building new base stations to support NB-IoT, as its existing TD-LTE network does not support the FDD-based NB-IoT standard and most of its GSM base

Timelines	Geographical coverage	Number of base stations	Number of connections
End of 2017	All major cities in China	400 000	More than 20 million
2020	Nationwide coverage	1.5 million	More than 600 million

FIGURE 1: MIIT'S TARGETS FOR NB-IOT DEVELOPMENT IN CHINA
[SOURCE: MIIT AND ANALYSYS MASON, 2018]

stations would require extensive hardware and software upgrades. It has announced aggressive goals for its NB-IoT network roll-out with the initial phase including a reported 146 416 base stations.[7] In total, it plans to build more than 400 000 NB-IoT base stations in 2017 and 2018.

The operators are looking to diversify beyond connectivity, because all three are likely to offer similar pricing and coverage. Extra services may include vertical solutions, application development, system integration as well as enabling services such as platforms, hosting and security.

China Mobile has a "terminal-pipe-cloud" strategy: beyond the pipe (connectivity), it also develops its own devices (such as AndMu[8]) and modules as well as cloud and big data services built on its connectivity management platform and OneNET platform.[9]

China Unicom has developed smart sewage-well-cover solutions to offer real-time information on the location, status and the tilt angle of the well covers based on NB-IoT. It also offers end-to-end solutions in areas including smart streetlighting, smart metering and smart grid.[10]

China Telecom is developing one-stop solutions integrating smart appliances and smart home services with its partners.[11] All three Chinese operators have built platforms and portfolios of enabling services, and can offer end-to-end solutions with the help from partners in key verticals.

China may also have a significant impact on LoRa. Dr. Peng, the fourth-largest fixed broadband ISP with over 100 million households, is building a LoRa network. As with NB-IoT, the scale that China offers, both in terms of demand, but also in terms of hardware and software supply, could help to accelerate the development of LoRa.[12]

Questions?
Please feel free to contact
Tom Rebbeck, Research Director, at
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	China Mobile	China Telecom	China Unicom
Position in China's mobile market (3Q 2017)	Number 1 (both connections and service revenue)	Number 2 (connections) Number 3 (service revenue)	Number 2 (service revenue) Number 3 (connections)
Position in China's fixed broadband market (connections and service revenue, 3Q 2017)	Number 2	Number 1	Number 3
Network roll-out	NB-IoT across 346 cities. Commercial launch in selected cities planned for end of 2017.	The first in China to achieve nationwide NB-IoT coverage in May 2017, with 310 000 base stations upgraded.	Pre-commercial NB-IoT networks in selected key cities by November 2017. More than 300 cities are ready to be quickly activated for NB-IoT.
Ecosystem support	Formed the China Mobile IoT Alliance and announced in November 2017 that it would invest CNY2 billion (USD300 million) in 2018[2]	Announced that it would invest CNY300 million (USD45 million) to help subsidise modules/ devices.[3]	Announced its CNY1 billion (USD150 million) subsidy plan as well as CNY10 billion (USD4.5 billion) industry funding.[4] Backed up by a consortium of investors including Internet players.
Platform	Launched OneNET open platform in July 2015.	Released an IoT open platform in June 2017.	Launched an IoT connectivity management platform in 2015.[5]
Key verticals	Automotive, smart cities, transport and logistics, consumer electronics.	Smart manufacturing, smart cities, smart home, automotive.	Smart manufacturing, smart cities, transport and logistics, retail.

FIGURE 2: NB-IOT INITIATIVES BY OPERATOR, CHINA, 3Q 2017
[SOURCE: ANALYSYS MASON, 2018]

[1] For more information, see Analysys Mason's China IoT market report 2018. Available at www.analysysmason.com/china-iot-market-rdme0.

[2] Source: Caixing Global: www.caixinglobal.com/2017-11-25/china-mobile-to-invest-two-billion-yuan-on-iot-services-in-2018-101176272.html.

[3] Source: Digit Times: www.digitimes.com.tw/iot/article.asp?cat=158&cat1=20&cat2=10&id=0000501946_wzjl97kk36q8x374wjodh.

[4] Source: CWW: http://221.179.172.81/pdf/2D9DADB3128048F1A4D58AE3E522E151.pdf.

[5] Source: CNII: www.cnii.com.cn/telecom/2017-09/12/content_1888228.htm.

[6] Source: Sina: http://tech.sina.com.cn/roll/2017-07-08/doc-ifyhweua4391708.shtml.

[7] Source: Sohu: www.sohu.com/a/193880770_203761.

[8] AndMu is a smart camera developed by China Mobile. More details available at www.andmu.cn/.

[9] Source: CWW: www.cww.net.cn/article?id=410035.

[10] Source: CNII: www.cnii.com.cn/telecom/2017-09/13/content_1888574_2.htm.

[11] Source: China Telecom: www.chinatelecom.com.cn/news/02/201712/t20171228_37678.html

[12] Source: IoT Business News: https://iotbusinessnews.com/2016/11/22/80140-semtech-lora-technology-enables-iot-services-chinas-largest-private-telecom-network/.

Cellular V2X (C-V2X) could fulfil a market need, if the commercial timing is right

JANETTE STEWART
Principal, Consulting

> "For cellular V2X to fulfil a market need for wireless connectivity for connected and automated vehicles, it must be rapidly commercialised."

V2X will enable communication between vehicles, and between vehicles and infrastructure. It will potentially complement on-board sensors in vehicles by providing enhanced information (such as data from other vehicles) over a longer range.

Cellular V2X (C-V2X) is a technology developed by the Third Generation Partnership Project (3GPP) to deliver V2X services, including a direct vehicle-to-vehicle (V2V) mode (called 'PC5' in 3GPP specifications) and a network communications interface for vehicle-to-network (V2N) communication. The former short-range communications mode is designed to use spectrum designated for intelligent transport systems (ITS) in the 5.9GHz band for V2V and vehicle-to-roadside infrastructure (V2I) messaging, whereas the V2N mode will utilise the spectrum assigned to mobile operators within cellular networks.

There is also an existing, short-range, wireless technology that has been standardised for V2V and V2I connectivity, based on IEEE 802.11p. These standards have been developed over the past decade, although applications based on IEEE 802.11p have not seen widespread adoption to date. Both IEEE 802.11p and C-V2X can be considered as possible solutions for the deployment of co-operative intelligent transport systems (C-ITS) such as those being proposed both in Europe and globally.

The 5G Automotive Association (5GAA) is a cross-industry association between the cellular and automotive industries, set up to develop, test and promote C-V2X communications solutions, initiate their standardisation and accelerate their commercial availability and global market penetration, with applications such as automated driving, ubiquitous access to services and integration into smart cities and intelligent transportation. The 5GAA commissioned Analysys Mason to conduct a study on the socio-economic benefits of C-V2X in Europe after recognising that the European Commission (EC) was holding a public consultation closing in December 2017 on the deployment of C-ITS. Our report was completed in December 2017 and has been published by the 5GAA.[1] In this article, we discuss the report's key findings.

Features of C-V2X include its low deployment costs and wide-area coverage potential, as well as a clear medium-term evolution path to 5G

A key reason for C-V2X developments is to meet demand within the automotive sector to enhance automated driving technologies with improved wireless connectivity. Such automated driving technologies are evolving rapidly and are widely expected to transform driving experiences, provide safer cars and improve the efficiency of car travel. C-V2X will potentially complement on-board sensors (used within automated driving solutions currently) by providing enhanced information (such as data from other vehicles) and enabling operation over a longer range. For car drivers, this will contribute to further improvements in the safety, efficiency and convenience of car travel.

Both C V2X and IEEE 802.11p technologies have the potential to bring improved safety and efficiency to transport. We identified in our study, however, that using the currently defined long-term evolution (LTE) technology for V2V ad-hoc short-range communication, combined with LTE cellular networks for V2N, has the potential to bring additional benefits, including:

- better coverage for V2N, by exploiting existing cellular network coverage provided by lower-frequency spectrum
- reduced infrastructure deployment costs and improved service reliability, by using existing mobile infrastructure, and thus making use of cellular technology integration and economies of scale, rather than building independently operated roadside infrastructure
- the potential for V2X and other telematics services in vehicles (such as infotainment) to be provided through a common cellular interface
- increased deployment flexibility, along with the ability to provide coverage for both short-range and wide-area applications
- the opportunity for integration with smart cities and other connected-transportation initiatives that also use cellular technology
- enhanced security, through the use of mobile subscriber identity module (SIM) cards

- certainty of future evolution, which will enable C V2X communications to progress seamlessly into the 5G era (while offering backward compatibility with earlier C V2X solutions).

Net benefits in Europe could reach EUR43 billion by 2035

As part of the study, we defined four scenarios to help us quantify the changes in the magnitude of the overall costs and benefits associated with different timescales and volumes of V2X adoption. We also wanted to distinguish relative differences in the net benefits, depending on whether LTE/4G PC5 and the forthcoming 5G PC5 or IEEE 802.11p technology is adopted in vehicles, and the extent to which synergies with cellular networks are exploited for the provision of V2I/vehicle-to-pedestrian (V2P). When quantifying the costs and benefits of C V2X, we considered the time period from 2018 to 2035.

A summary of the net benefits that we calculated, per scenario, is as follows:

Rapid completion of end-to-end tests and commercialisation is now needed

Road authorities across Europe are actively considering digital infrastructure requirements and several governments are actively supporting the roadside connectivity agenda through the funding of research and development and trials.

C-V2X has the potential to meet the future digital infrastructure requirements for connected and autonomous vehicles, initially using the latest LTE-based specifications (as per Release 14 of the 3GPP specifications), and subsequently with 5G. The re-use of cellular networks to provide V2N will reduce road infrastructure costs significantly, and might also allow high infrastructure penetration from the point of C-V2X launch (resulting in benefits from V2I/V2N services being realised sooner). Our study also found a greater likelihood of C-V2X integration into smartphones, compared to IEEE 802.11p, meaning that V2P services – a further component to enable future automated driving – can be more rapidly achieved.

In conclusion, the study made several recommendations in relation to the European ITS policy. Firstly, the cost-benefit results from the study indicate strong benefits to the European market from synergies between the different modes of C-V2X, and with the wider eco-system of mobile infrastructure already deployed in Europe. Hence, it is recommended that European ITS policies encourage these synergies to be realised. Secondly, it is recommended that the European C-ITS policy should be designed to encourage migration from the current V2X technologies to 5G once forthcoming 5G PC5 technology is available.

Questions?
Please feel free to contact Janette Stewart, Principal, at janette.stewart@analysysmason.com.

Scenario	Summary	Net benefits by the end of the modelling period (2035)
1 – Base case	The adoption and timing of the deployment is determined by automotive original equipment manufacturers (OEMs), in the absence of any regulatory measures.	EUR39 billion
2 – 2020 EC mandate on V2V/V2I	An EC mandate requiring all new vehicle models to support EC defined 'Day 1' and 'Day 1.5' services from 2020 results in C-ITS services using IEEE 802.11p technology for V2V and V2I. Provision of V2I using IEEE 802.11p requires an extensive roll-out of 5.9GHz roadside units (RSUs).	EUR20 billion
3 – 2023 EC mandate on V2V/V2I	An EC mandate requiring all new vehicle models to support 'Day 1' and 'Day 1.5' services from 2023 results in C-ITS services using LTE PC5 technology for V2V and V2I. Provision of V2I using PC5 requires an extensive roll-out of 5.9GHz RSUs	EUR27 billion
4 – Equitable 5.9GHz use	C V2X and IEEE 802.11p technologies co-exist in 5.9GHz spectrum, with the division of spectrum enabling the adoption of both technologies based on market demand.	EUR43 billion

FIGURE 1: SUMMARY OF SCENARIOS FOR QUANTITATIVE ANALYSIS
[SOURCE: ANALYSYS MASON, 2017]

[1] http://5gaa.org/news/5gaa-study-the-cost-benefit-analysis-on-cellular-vehicle-to-everything-c-v2x-technology-and-its-evolution-to-5g-v2x/

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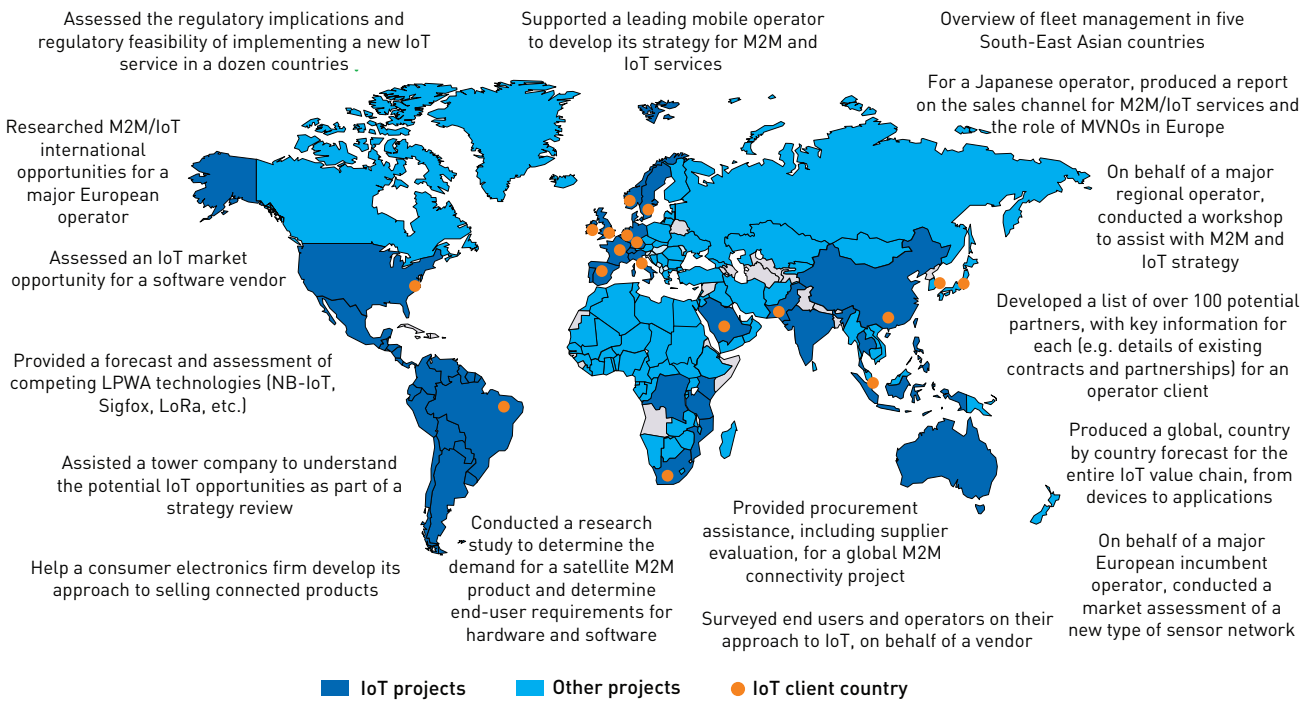

Examples of recent IoT and M2M client projects, by geography

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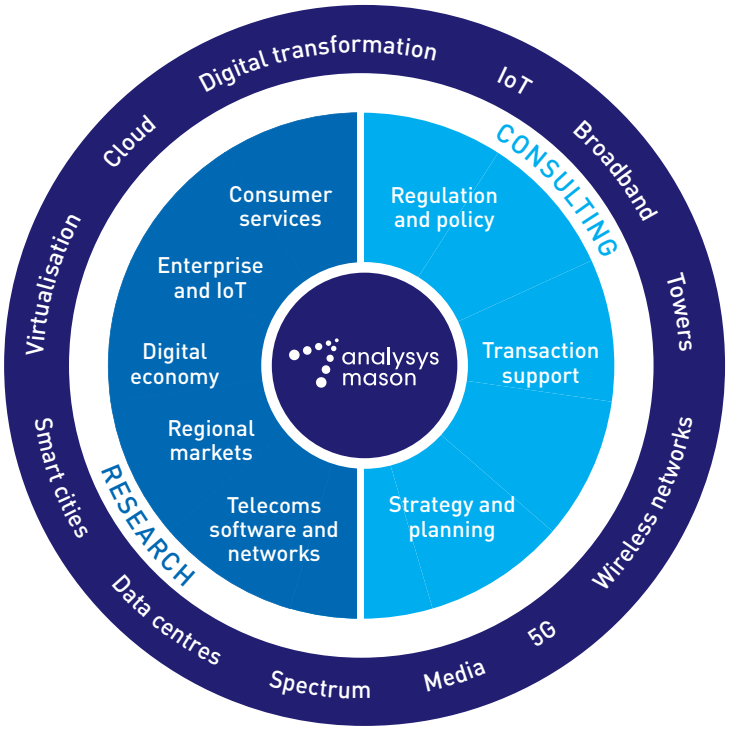

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