LoRaWAN REPORT

DOES IT REALLY MEET MORE IoT CONNECTIVITY NEEDS MORE OF THE TIME?

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The low power wide area network (LPWAN) field is becoming increasingly crowded with options such as narrowband IoT (NB-IoT), Sigfox and LoRaWAN all available to connect IoT devices. These technologies are meeting the needs of many IoT applications because of their low cost, global coverage, ease of deployment and still-sufficient capacity for most use cases, writes George Malim, the managing editor of IoT Now

Each LPWAN technology has strengths depending on the applications it is being deployed to support but LoRaWAN is increasingly being adopted across the globe while NB-IoT is being deployed predominately in China and some parts of Europe. There are currently 148 LoRaWAN operators in 160 countries according to **LoRa Alliance** data and **Sigfox** claims presence in 74 countries and regions.

Appetite for all categories of LPWAN is growing. Analyst firm **IoT Analytics** has projected substantial growth in LPWAN device deployment in the period 2017-2023 in **Figure 1**, demonstrating that LoRaWAN is a significant contributor to a fast-growing segment of the IoT connectivity landscape. The COVID-19 pandemic is likely to have caused a slow-down in deployments this year. However, this will be offset quickly in subsequent years as LPWAN technologies are utilised in some markets for contact tracing and applications to ensure worker safety.

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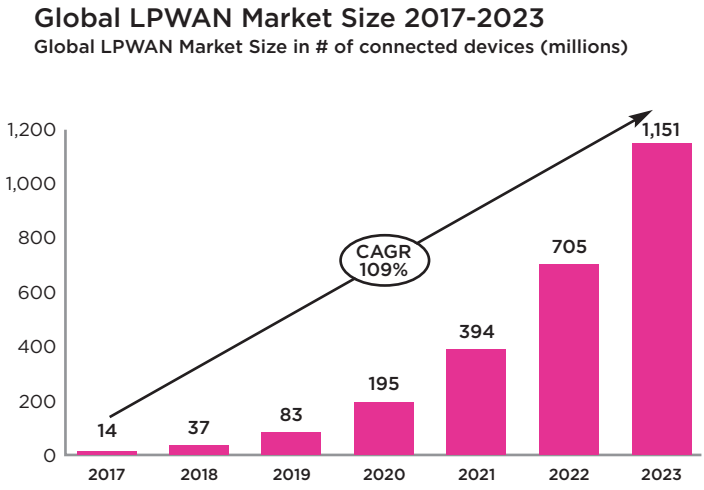

Figure 1: Global LPWAN Market Size 2017-2023
Source: IoT Analytics

The trade-offs between different LPWAN technologies for connecting IoT devices are detailed in **Figure 2**, which helps to illustrate the relative merits of each technology.

LoRaWAN has attractive capabilities in five key areas:

Mobility
People don't realize that an NB-IoT device in motion has to turn into a full powered cellular device as it moves between towers in order to attach to a new tower. It completely blows the Low Power benefits.

Low power consumption
Long battery life is critical for ROI and means no need for wired power supply or frequent battery replacement.

Indoor coverage
The ability for signals to penetrate deep within buildings. This is vital for a raft of applications including smart metering, connected manufacturing and control of smart buildings.

Wide ecosystem
The already-established worldwide ecosystem of app and device developers delivers wide choice of devices and software for organisations that choose to deploy LoRaWAN.

Ease of installation
LoRaWAN devices are simple to install and can be installed simply by non-specialised workers. This makes it particularly suited to the retrofit market and with the pandemic looking to minimise contact, LoRaWAN is increasingly suitable for self-configuration by users.

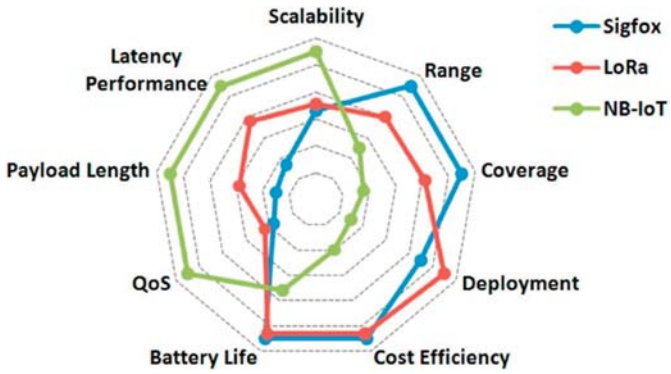

Figure 2. The respective advantages of Sigfox, LoRaWAN and NB-IoT

Source: The Korean Institute of Communications and Information Sciences (KICS)

Campus and public networks
LoRaWAN enables organisations to install a completely private network requiring no contract with a network operator or coordination with corporate IT infrastructure. In addition, public LoRaWAN can be accessed in markets where available.

Other important features include: extreme immunity to interference allowing it to effectively operate in the unlicensed band and to easily cover several floors of a building with a simple gateway; low power to enable long battery life of up to ten years: and security enabled via end-to-end encryption, mutual authentication and integrity protection.

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The drive to digitalise water utilities' distribution networks, for example, will result in an installed base of 400 million smart water meters worldwide by 2026, according to ABI Research

Use cases leading LoRaWAN adoption

The characteristics of LoRaWAN make it particularly well-suited to connecting smart meters for utilities. In many markets, governments have mandated the deployment of smart meters while for others, the economics of reduced physical meter reading and greater automation readily provide a strong business case for connected meter deployment.

Water utilities have been at the forefront of meter deployments and the security, low power consumption, high scalability and low implementation complexity of LoRa, in addition to the long lifespan of the technology are making it a popular choice.

The drive to digitalise water utilities' distribution networks, for example, will result in an installed base of 400 million smart water meters worldwide by 2026, according to **ABI Research**. Utility companies using LoRaWAN include **Mueller** and **Neptune Technology Group** in the US, as well as **Birdz**, **Maddalena** and **Axioma** in Europe. The density of deployments is illustrated by **Figure 3** a grab from LoRaWAN provider **Everynet**'s proprietary radio frequency (RF) planning tool in which each of the black dots are the actual meter locations. The mapping shows coverage and how strong a signal each meter can get. The streets are not marked on this map, but you can tell where they would be because of the number of meters shown.

One example, in Spain, involves the deployment of 20,000 water meters by the local utility **FACSA** in the region of Castellon de la Plana. The project was carried out by **IoTsens** on behalf of FACSA, which manages water control and tracking in more than 70 cities to serve more than four million citizens. It saw the connection of different water meters to the IoTsens cloud platform via LoRaWAN.

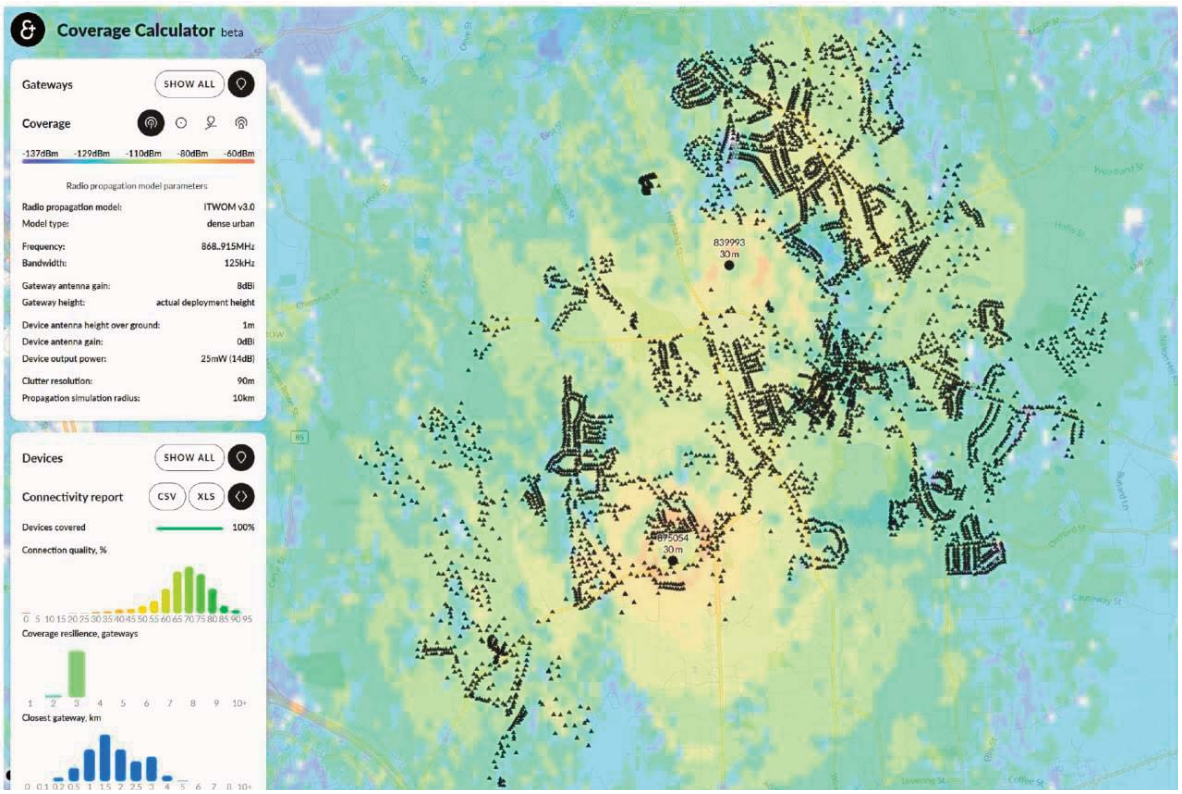

Figure 3: Mapping shows water meter density, streets themselves are not mapped.
Source: Everynet

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In fact, large telecoms operators are committing to LoRa for very large projects. **Nova Veolia** and its subsidiary **Birdz** are working with **Orange Business Services** to help them digitalise Veolia's water-related services in France. Their goal is to read more than 70% of their meters remotely by 2027 in a deal which will see more than three million water meters connected to public LoRaWAN networks covering more than 30,000 municipalities and 95% of the population of metropolitan France.

Finally, Lithuanian meter manufacturer **Axioma Metering** has won a tender for installation of 100,000 water meters in the Apulia Region of Italy. Axioma Metering succeeded in the tender organised by the largest Italian water supply company **Acquedotto Pugliese** together with its LoRaWAN partner.

Logistics, cold chain and COVID-19

LoRaWAN is increasingly being utilised in the asset tracking and logistics market to trace goods as they are transported. Earlier applications utilising sensors to ensure uninterrupted cold chain are set to have applications for the transportation of temperature-sensitive COVID-19 vaccinations and the technology has also been successfully adapted by LoRaWAN device-makers to enable accurate track and trace.

The simplicity of setting up LoRaWAN networks and devices is helping to enable a variety of employee and public safety applications in addition to apps such as sensors to monitor whether loads of 4k televisions have been transported upright. It is expected that super-low cost sensors which are now coming to market will open up new applications for tracking and logistics.

These new sensors will enable lower value shipments to be tracked and it is likely that these will soon be embedded in individual pallets. LoRaWAN is part of this narrative because it enables pallets to be tracked without the cost and power demand of GPS. This coupled with the low cost sensors substantially reduces the bill of materials cost of this type of solution, again opening up the market place to greater numbers of opportunities.

Analyst firm **Berg Insight** reports that he number of active tracking devices deployed for cargo loading units including trailers, intermodal containers, rail freight wagons, air cargo containers, cargo boxes and pallets reached 6.1 million worldwide in 2018. Growing at a compound annual growth rate (CAGR) of 27.3%, this number is expected to reach 20.4 million by 2023.

LoRaWAN is an excellent fit for the needs of the logistics market because it brings together competitive cost with the capability to handle extremely high device density at a given site. A logistics facility with the tens of thousands of containers, assets and parcels crossing it each day needs the device density and the ability to have deep indoor coverage, which is vital inside the large warehouses, some of which involve underground capacity. LoRaWAN has the capability to penetrate these large buildings, ensuring uninterrupted asset tracking.

Similarly, for COVID-19 tracking and tracing, LoRaWAN attributes offer the combination of coverage, cost-efficiency and connection density that such programmes demand. In addition, wearable devices that contain sensors and communications capability have already been developed and these can be used to keep workers safe, having been sent out via mail and configured simply and quickly. ■

Conclusion

Although 5G continues to attract huge interest, largely because of attention-grabbing applications in the consumer market, the reality is that 5G is far from ubiquitous. Capacity and modules are costly and few IoT applications truly need the low latency and upper-end capacity of 5G. LTE-M and other flavours of 4G connectivity offer more than adequate bandwidth for most applications and are more widely available, at lower cost and with roaming.

With 2G networks being retired and 3G spectrum likely to be refarmed or utilised for voice, LPWAN offers most of what IoT applications need from a network, more of the time than the alternatives. LoRaWAN specifically offers a balanced blend of capabilities, as shown in Figure 2, that matches well to applications in agriculture and smart cities and buildings as well as the logistics and utilities applications detailed here. It is for this reason that millions of devices now connect using LoRaWAN and the analyst predictions all show encouraging growth.

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CSPs need a portfolio of technologies reflecting the diversity of IoT

The connectivity landscape for IoT has changed significantly in the last decade. 2G and 3G networks are on their way out, 5G, low power wide area (LPWA) and private networks are on the way in. Limitations on permanent roaming and demand for supply chain efficiency led to the arrival of eSIM, network disaggregation, cloud cores and openRAN promises a new generation of connectivity services, edge computing is set to deliver greater functionality for automation applications, and hyperscalers Microsoft and AWS loom large in the consideration of anyone in IoT. The world has changed, writes Matt Hatton, a co-founder of Transforma Insights

Matt Hatton,
Transforma Insights

Communication service providers (CSPs) have also rapidly evolved their strategies, moving to be much more significant participants in the machine-to-machine, and then IoT, value chains. As highlighted in the recent Transforma Insights 'Communications Service Provider IoT Peer Benchmarking 2020' report CSP capabilities span devices, device management, connectivity, applications, data management, systems integration, and many other areas. These are diverse players, with diverse offerings, seeking to address a broad swathe of the IoT opportunity.

In light of the breadth of offering it is perhaps a little surprising that CSPs haven't focused more attention on having as broad as possible an offering in their sweet spot, connectivity. This article looks at the opportunities for CSPs to take a more diverse approach to the whole connectivity landscape.

New arrivals push the boundaries of IoT connectivity

Figure 1 illustrates the diversity of access technologies being used for connecting IoT devices today. In the last few years the technology landscape has pushed back the boundaries of what is possible, offering new options in a number of directions. The higher bandwidth connectivity options of 5G and Wi-Fi 6 open up opportunities for video-based

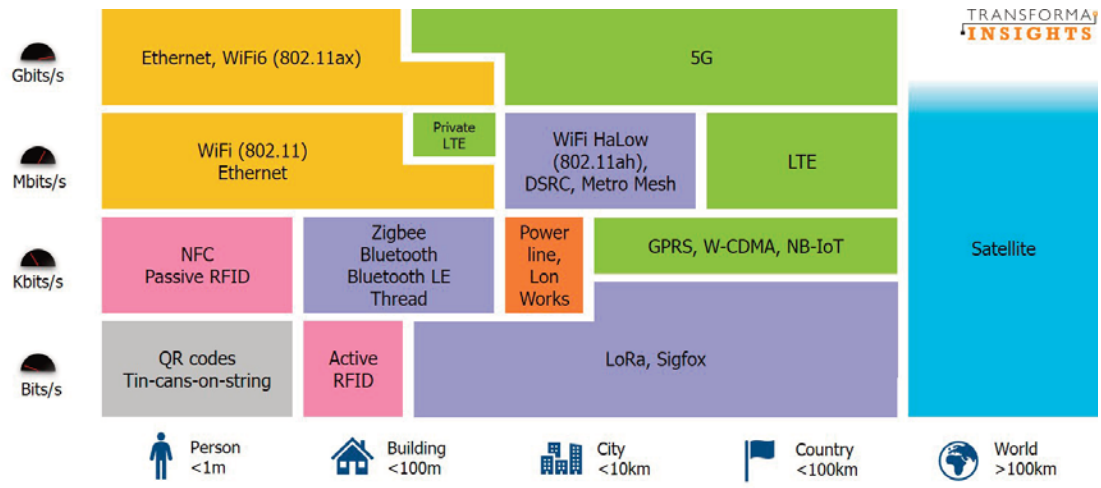

Figure 1: IoT connectivity technologies
[Source: Transforma Insights, 2020]

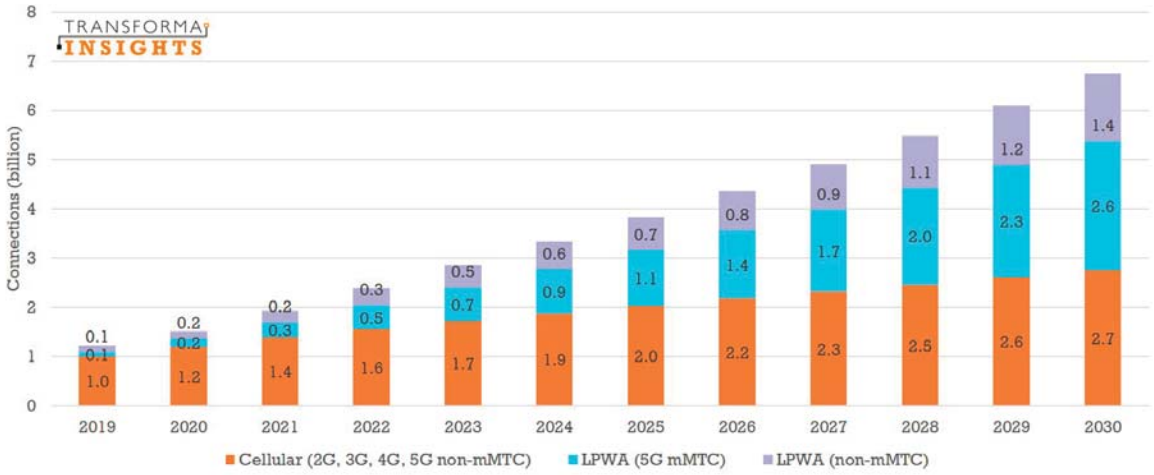

Figure 2: LPWA and cellular connections globally, 2019-2030 [Source: Transforma Insights, 2020]

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applications and autonomous vehicles. A new generation of low earth orbit (LEO) satellites promise to expand the geographical reach of connectivity. It is, however, in the arrival of technologies supporting very low bandwidth applications over wide area networks that promises the greater revolution in connectivity.

The LPWA technologies such as NB-IoT, LoRa and Sigfox, by virtue of their lower cost and long battery life, remove the barriers to hundreds of different applications that would previously have been undeliverable or unaffordable, particularly for remote asset monitoring.

LPWA: a big addressable market

Today the market for all these technologies is relatively small: at the end of 2019 there were around 100 million connections each for NB-IoT and LoRa and around 16 million for Sigfox. However, Transforma Insights expects significant growth. By 2030 cellular networks excluding the so-called massive machine-type communications (mMTC) LPWA-type technologies, such as narrowband IoT (NB-IoT), LTE-M and their evolutions, will account for 2.7 billion devices, up from 1.2 billion at the end of 2020. The mMTC cellular variants will grow from around 160 million to 2.6 billion over the period. Meanwhile, other LPWA technologies will go from 160 million to 1.4 billion, as illustrated in **Figure 2**.

Markets adjacent to licensed public networks represent new opportunities for CSPs

CSPs have a virtual monopoly on cellular technologies and the 5G mMTC LPWA-type technologies. There might be a few instances of new entrants, or private network deployments for NB-IoT, but ostensibly the established CSPs such as **Deutsche Telekom**, **Telefonica**, **Telia**, **Verizon** and **Vodafone** 'own' those markets. This contrasts strongly with the non-mMTC licence-exempt technologies where very few CSPs have a significant play. **Orange** has been perhaps the most active, with LoRaWAN networks in France, Romania and Slovakia. Elsewhere in Europe **KPN** has deployed a LoRaWAN network in the Netherlands, **Bouygues Telecom** (under the Objenious brand) in France, and **Proximus** in Belgium. Around the world, other existing CSPs that have rolled out LoRa include **SK Telecom** (South Korea), **NTT**, **Softbank** (both Japan), and **CAT Telecom** (Thailand).

The licence-exempt non-mMTC technologies today are largely deployed as private networks, which account for well over 90% of devices. However, over time this will change, with public networks supporting over 55% of non-mMTC devices by 2030. In total almost 750 million devices will be connected using public non-mMTC technologies by 2030. A significant opportunity, and one that is directly adjacent to the sweetest of sweet spots for CSPs: rolling out and operating public wide area wireless networks. This is inherently a CSP task, yet surprisingly few have yet

Smart metering and remote monitoring applications in particular represent a market that could equally well be addressed by licence-exempt technologies

pursued it with regard to non-mMTC technologies. After all, the biggest barrier to deployment of such networks is having ready access to sites and infrastructure, and access to an appropriately trained field-support capability, which mobile network operators certainly do.

It is also worth noting that even private network deployments of licence-exempt technologies shouldn't necessarily be ruled out for CSPs. They are already making forays into the market for in-building private connectivity through their sale of mobile private network (MPN) services, which has been one of the hottest targets for CSPs in 2020. In that case, they are using cellular technologies, specifically LTE and 5G, to compete with licence-exempt technologies such as Wi-Fi 6. For CSPs with a big professional services business, or aspirations to one, being able to support all relevant public and private network technologies that an enterprise customer might need, is clearly an advantage.

Transforma Insights therefore sees a big opportunity for non-mMTC technologies, and that CSPs are in a good position to pursue those opportunities, predominantly through deploying public networks, but also private as a counterpart to an MPN offering.

Horses for courses vs technology dogmatism

The main argument for CSPs not deploying licence-exempt non-mMTC technologies as public networks is that they already have their own equivalent technologies. Both NB-IoT and LTE-M were, to an extent, developed to counter the competitive threat of Sigfox and later LoRaWAN. However, the implication is that all of these technologies have very similar performance characteristics. That is not the case. Just considering three basic parameters of battery life, price and maximum throughput we can see that they all behave quite differently. LTE-M, for a start, certainly cannot deliver the ten-year battery life that the other technologies can provide; its capabilities will be measured in the months, rather than years. In terms of bandwidth, this can be as low as 1KB/day effective rate for Sigfox versus up to 127kbit/s for NB-IoT. LoRa sits between the two, with a peak speed of 50kbit/s. Turning to device costs, NB-IoT currently costs around US$3-5 per chipset, although with prices coming down. LoRa's equivalent price is US$1-2.

With variable performance parameters, it stands to reason that different applications will be more appropriately addressable by different technologies depending on their bandwidth, range or power consumption requirements. Similarly, some applications will benefit from the mesh network capabilities of technologies such as DECT 2020 NR for resiliency/ In the wonderful world of IoT the demands of the various applications diverge significantly, and some are best addressed using each of the technologies. **Figure 3** illustrates some characteristics of IoT applications, showing bandwidth requirements, power consumption and the size of the connectivity opportunity (for a typical European country).

Applications in the top right of the chart, with high bandwidth requirements and high power consumption, fall clearly to LTE and, in future, 5G networks. Those in the middle are going to be addressable by both existing cellular networks and by the new licensed LPWA networks, LTE-M and NB-IoT, both of which to an extent will fulfil the role that the old 2G/GPRS networks have until now. In the bottom left there is also a range of applications with relatively low bandwidth requirements and low power consumption, which might be addressable by more than one of the LPWA technologies, either licensed or licence-exempt. Smart metering and remote monitoring applications in particular represent a market that could equally well be addressed by licence-exempt technologies, and

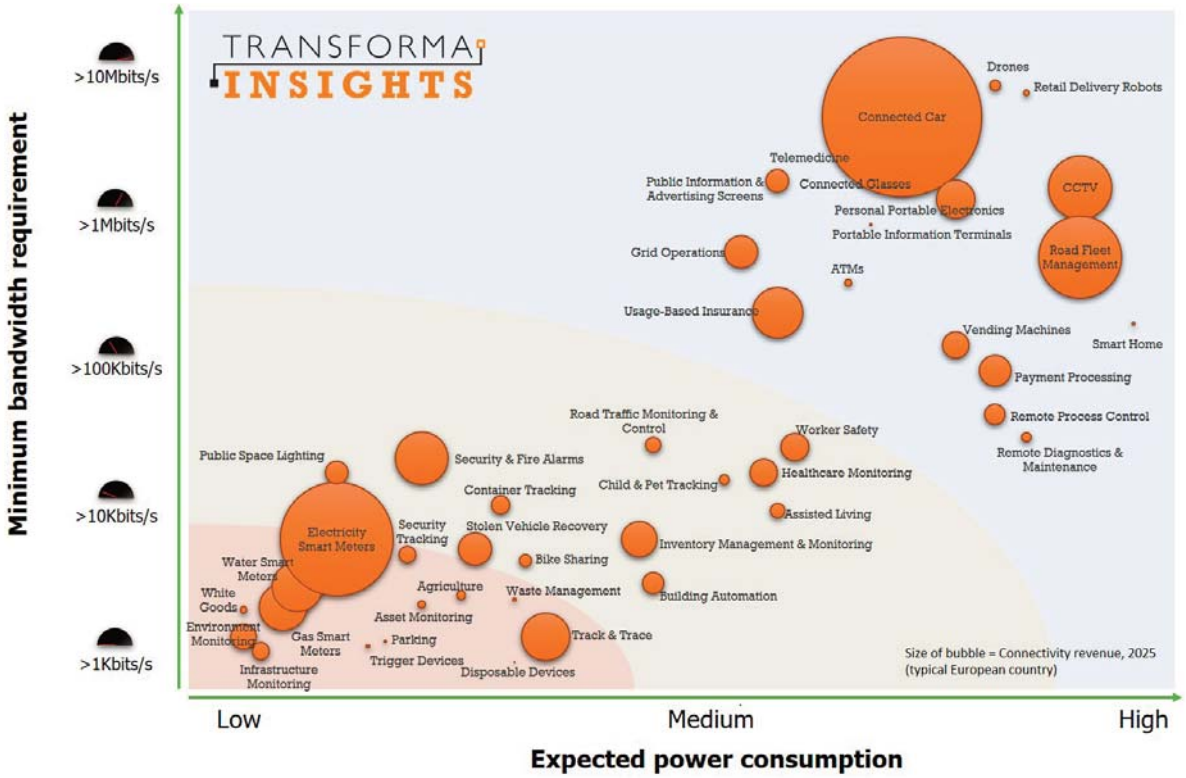

Figure 3: Wide area IoT applications [Source: Transforma Insights, 2020]

potentially more cost-effectively given disparities in unit prices. Such a consideration will, of course, depend on the incremental cost of deploying a new network to address them.

CSPs may take the view that they have an appropriate technology for addressing all of the technologies illustrated in the chart. That is true. However, NB-IoT or LTE-M may not be the optimal technology. They may instead find that LoRaWAN, DECT 2020 NR, or any number of other technologies, offer a cheaper or more easily deployed and scaled alternative. Dogmatic aversion to considering non-cellular technologies is certainly not the optimum approach.

Conclusions

CSPs would be well advised to consider all options for deploying networks. The addition of, for instance, LoRaWAN would make a certain element of the IoT opportunity more cost-effectively addressable. This must, of course, be measured against the various other costs of supporting that technology, most notably the cost of deploying and maintaining a network. Every technology is worth at least doing a cost-benefit analysis.

On a wider note, any CSP which is keen to focus more on being a solution provider for enterprise customers rather than simply a network operator, will want as wide a portfolio of products as possible. This will include both public and private, licensed and licence-exempt technologies. ■

Key LoRaWAN considerations are build or buy and national versus campus

As the founder of a market research and consulting firm that covers the Internet of Things (IoT) and machine-to-machine (M2M) communication, fielding questions from enterprises, OEMs, municipalities and others deploying IoT is a regular occurrence, writes James Brehm the founder and chief technology evangelist of James Brehm & Associates. Over the past year, there's been a significant increase in the number of questions to our team. The IoT landscape is evolving rapidly. New technologies including LPWA and 5G are maturing, adoption is increasing, new players of every size from startups to the hyperscalers are becoming more active, and COVID-19 is having a disruptive impact on much of the market accelerating some use cases while stalling others

James Brehm,
James Brehm
& Associates

Two of the most common questions we've received are around the debate regarding public versus private or national versus campus networks. More directly stated, these questions are all about whether to build it or buy it.

Most of these questions are coming from organisations who have already addressed the choice of cellular or not and whether to use licensed or unlicensed spectrum and have made the decision to use LoRaWAN. While both licensed spectrum and unlicensed spectrum wide area network (WAN) technologies have their own merits, volumes have been written on narrowband-IoT (NB-IoT) or LTE-M versus LoRa and Sigfox, so for the purposes of this discussion, I'm going to shy away from that topic and look at campus versus national networks using the industrial, science and medical (ISM) bands based on LoRaWAN technology.

A campus network is ideal for testing proof of concepts in a lab setting

What is ISM and why does it matter?

The ISM bands are publicly shared portions of radio spectrum reserved internationally for industrial, scientific and medical purposes other than telecommunications. ISM is being actively used for both campus-area networks and national or regional LoRa-based IoT networks.

Since there is no licensing cost associated with ISM, it is perfect for IoT solutions which are ultra-low-cost and price sensitive, massive IoT solutions - solutions that are less latency sensitive and have relatively low throughput requirements, but require a huge volume of low-cost, low-energy consumption devices on a network with excellent coverage. Some examples include electricity, gas and water meters, asset tracking devices, flood detection, and a host of other applications.

Differences

What's the real difference between a campus network and a national network? It's really about two things, ownership of the devices and the geographic footprint. A campus network is smaller and the hardware and operation of the network are the sole responsibility of the enterprise deploying it.

Many organisations choose to build their own campus networks because they believe they have more control or that they are more secure than a national network. This simply isn't the case. The decision about which route to choose is more a question of cost and coverage versus security and control. LoRaWAN security is primarily a function of key management, best practices and investment. At the end of the day, he who has the keys has the control.

A campus network is ideal for testing proof of concepts in a lab setting. Campus networks are also a necessity when national coverage is not available. But if a national network is available, why tie up your available capital to procure the hardware and build the network? Why tie your resources down with the added operational costs? The decision on what type of network to use should be about the four C's – cost, current, connectivity and coverage. It is important to analyse the total cost of ownership (TCO) including hidden management costs before deciding to build a stand-alone campus or enterprise-wide network.

Like you, I've got a cellphone and I made and received text messages this morning. But I didn't erect a cell tower or buy an SMSC before I sent my first text today. National networks reduce the friction and time-to revenue for IoT for organisations who want to scale quickly without a massive capex investment and get their IoT applications deployed and generating value.