ANALYST REPORT

LoRaWAN expands to cover wide area and hybrid networking

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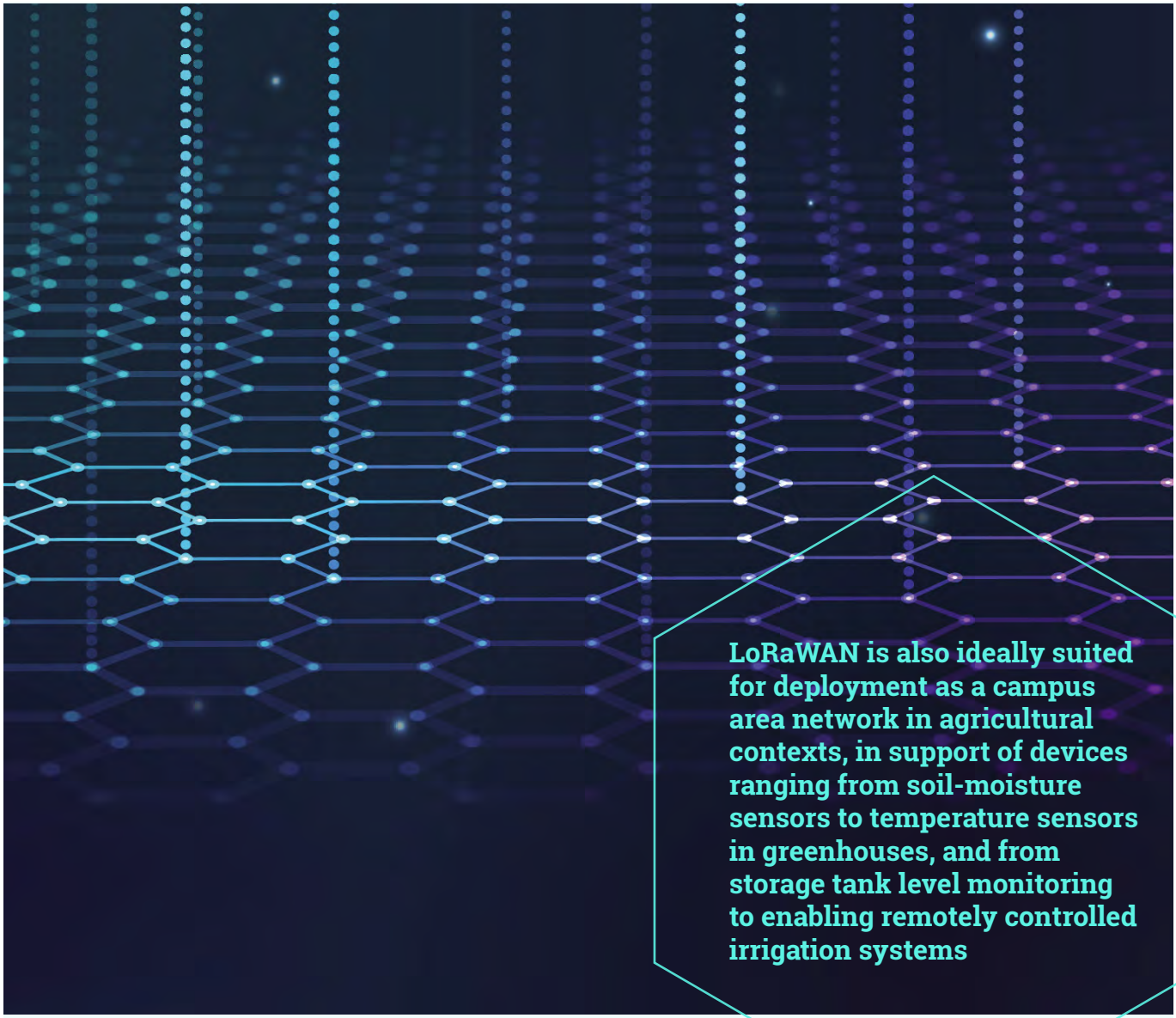
LoRaWAN focus shifts to wide area and hybrid networking

LoRaWAN is the leading technology in the licence-exempt low power wide area (LPWA) space, accounting for around 270 million end points as of August 2022. The ecosystem associated with the technology is dynamic and evolving. Initially, the technology gained traction in campus area private networks, but now momentum is growing in wide area and public network contexts bringing new network and data management challenges. This report, written by Jim Morrish, a co-founder of Transforma Insights, unpicks some of the detail behind these three stages

Jim Morrish
co-founder
Transforma Insights

LoRaWAN has two key characteristics that make the technology particularly suitable for certain IoT markets. Firstly, it is a LPWA technology meaning that LoRaWAN connected devices can be battery powered with battery lives of potentially several years and also LoRaWAN networks have the potential to be deployed as wide area public networks, much as cellular networks are currently deployed today. Secondly, LoRaWAN operates in licence-exempt spectrum which means that an end-user or network provider does not need to first procure radio spectrum before deploying a network. In combination, these characteristics make for cheap and easy network deployment to provide connectivity for battery powered sensing or actuating devices that can operate for potentially years with minimal maintenance requirements.

The trade-off for this flexibility lies in LoRaWAN's limited data rates, which are much lower than today's cellular technologies but are often perfectly adequate for IoT devices. By 2030, **Transforma Insights** forecasts that there will be 6.9 billion wide area wireless IoT connections, of which 36% will be traditional cellular technologies while ▶



LoRaWAN is also ideally suited for deployment as a campus area network in agricultural contexts, in support of devices ranging from soil-moisture sensors to temperature sensors in greenhouses, and from storage tank level monitoring to enabling remotely controlled irrigation systems

4.4 billion will be LPWA technologies. Of this figure, we expect that around two-thirds will be massive machine-type communications (mMTC) connections operating in licenced spectrum and one-third will be connected using licence-exempt LPWA technologies, but this split might vary depending on how quickly licence-exempt wide area public networks are deployed.

Gaining traction: LoRaWAN in a campus area private network context

Given the strengths of LoRaWAN as described above, it is unsurprising that much of the early adoption of the technology has been driven by campus area deployments of private networks. It is a simple exercise for any enterprise end-user to deploy their own network, connect devices, and reap significant benefits.

Key scenarios include the deployment of networks to support inventory management and monitoring, including stock level monitoring and warehouse management systems which can reduce the load on warehouse employees, freeing them up for other higher skilled tasks. Meanwhile, greater knowledge of the stored quantity of goods and their flow enables the optimisation of inventories, allowing businesses to operate with a leaner inventory reducing the space and capital dedicated to inventory, or for a greater variety of goods for a given floor space.

LoRaWAN is also ideally suited for deployment as a campus area network in agricultural contexts, in support of devices ranging from soil-moisture sensors to temperature sensors in greenhouses, and from storage tank level monitoring to enabling remotely controlled irrigation systems. In other enterprise contexts the technology is well-suited to monitoring the location and condition of various assets, enabling building automation solutions, and many other applications. ▶

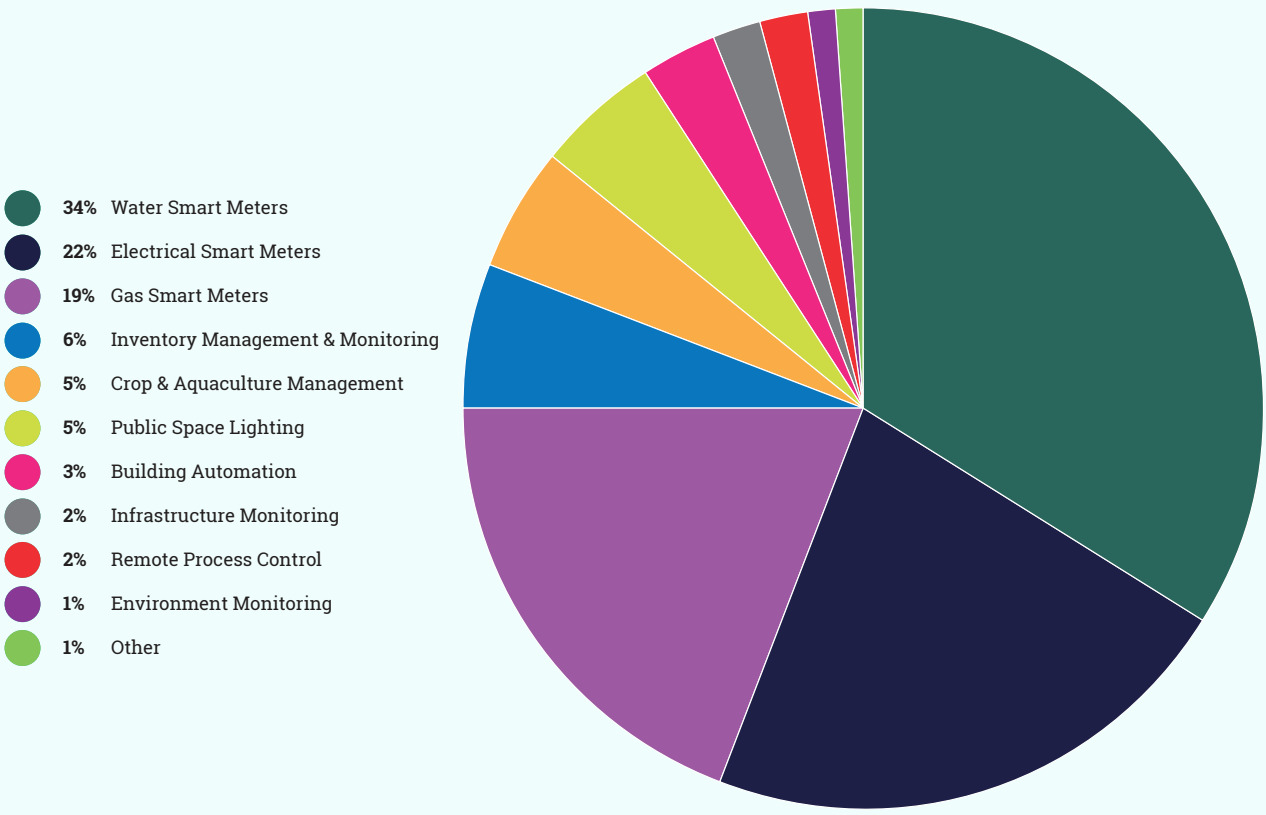
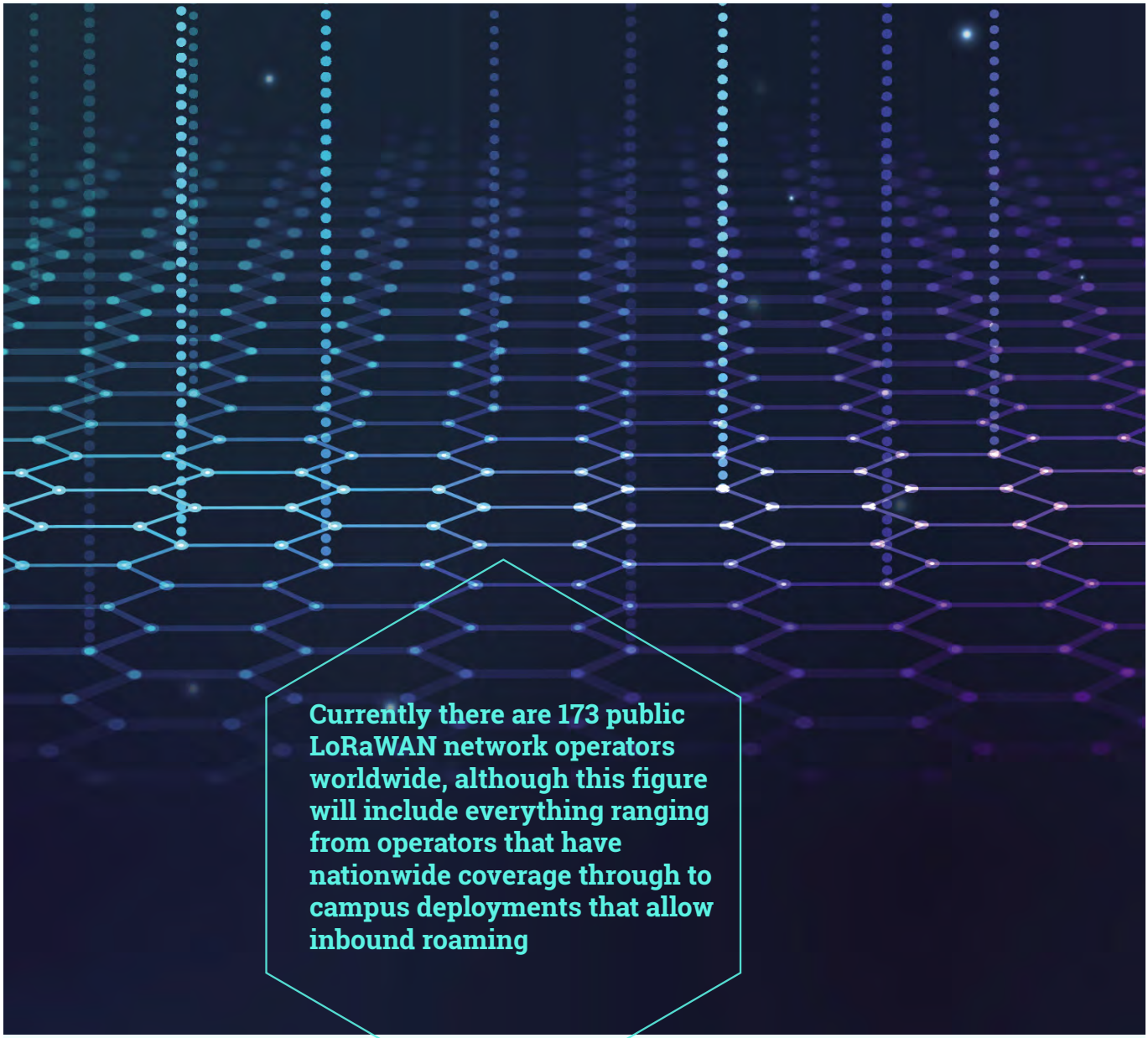


Figure 1: Licence-exempt private network LPWA connections, year-end 2022
[Source: Transforma Insights, 2022]

However, today's deployments of LoRaWAN networks have not been exclusively limited to campus area networks. Often networks have been deployed as wide area private networks, particularly to support applications such as smart metering and public space lighting, including street lighting. Deployment of networks for street lighting in particular can unlock new opportunities. For example, in January 2022, Sydney-based **National Narrowband Network Company** (NNNCo) signed a contract with technology provider **Wellness TechGroup**, to provide IoT network coverage to 70,000 smart streetlights in Montevideo, the capital of Uruguay. The project will cover 200 square kilometres and provide smart street lighting to more than 1.3 million people. It will also establish a LoRaWAN network that can be used to support other smart city initiatives, potentially including applications such as smart parking and road traffic monitoring and control.

To date, a significant driver for the deployment of LoRaWAN networks (and devices) has been for reasons of cost reduction and efficiency. But there are other factors that can drive deployment, including compliance with regulations and worker health and safety

A key factor to note here is that the wide area applications listed above will typically involve many more end points per deployment than will campus area deployments. Accordingly, whilst the centre of mass of the LoRaWAN market activity to date has been campus area private networks, it is in fact wide area private networks that account for the majority of connections. **Figure 1** summarises Transforma Insights market forecasts for 2022, ▶



Currently there are 173 public LoRaWAN network operators worldwide, although this figure will include everything ranging from operators that have nationwide coverage through to campus deployments that allow inbound roaming

highlighting the applications that comprise today's installed base of licence-exempt LPWA private network connections.

Extending reach: LoRaWAN as a wide area public network

Clearly, the deployment of LoRaWAN wide area public networks represents a significant opportunity for the entire LoRaWAN ecosystem since, as is clear from the profile of connections in Figure 1, the largest opportunities in terms of device count tend to rely on wide area coverage. So far that wide area coverage has generally but not exclusively been provided by private networks.

Currently there are 173 public LoRaWAN network operators worldwide, although this figure will include everything ranging from operators that have nationwide coverage through to campus deployments that allow inbound roaming. Amongst the most significant of these **Orange**, **Swisscom** and **KPN** all offer nominally nationwide LoRaWAN public networks in France, Switzerland and the Netherlands respectively.

However, the deployment of LoRaWAN as a wide area public network technology is rapidly gaining momentum. In this context, it is worth calling out three companies: **Everynet**, **Helium**, and **Senet**.

Recently, Everynet has pursued a strategy to roll-out such networks, starting in Brazil and following with the USA and Indonesia. The company's networks cover more than 50% of the population of Brazil and more than 40% of the population of the USA and Everynet will ▶

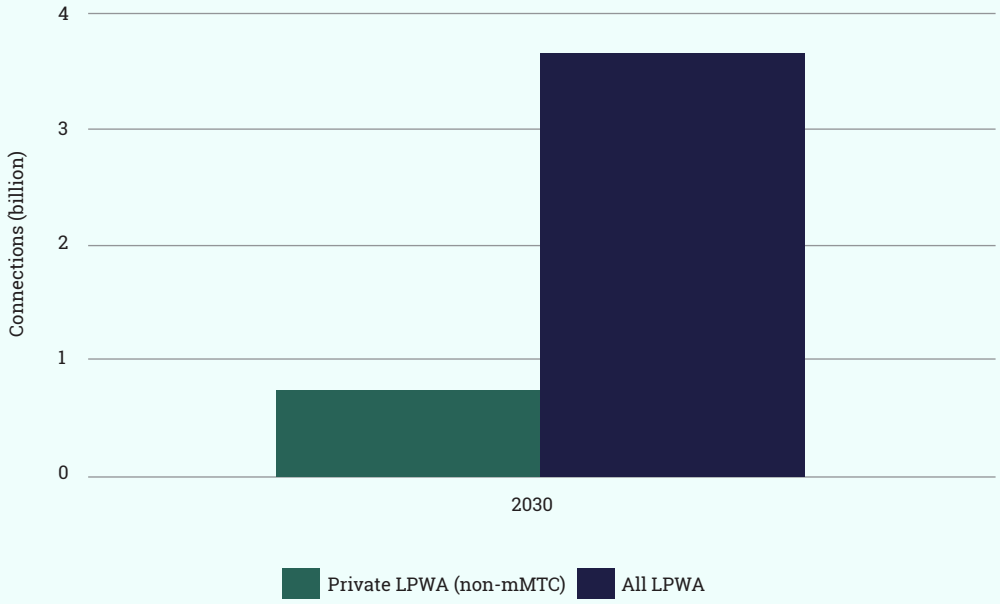


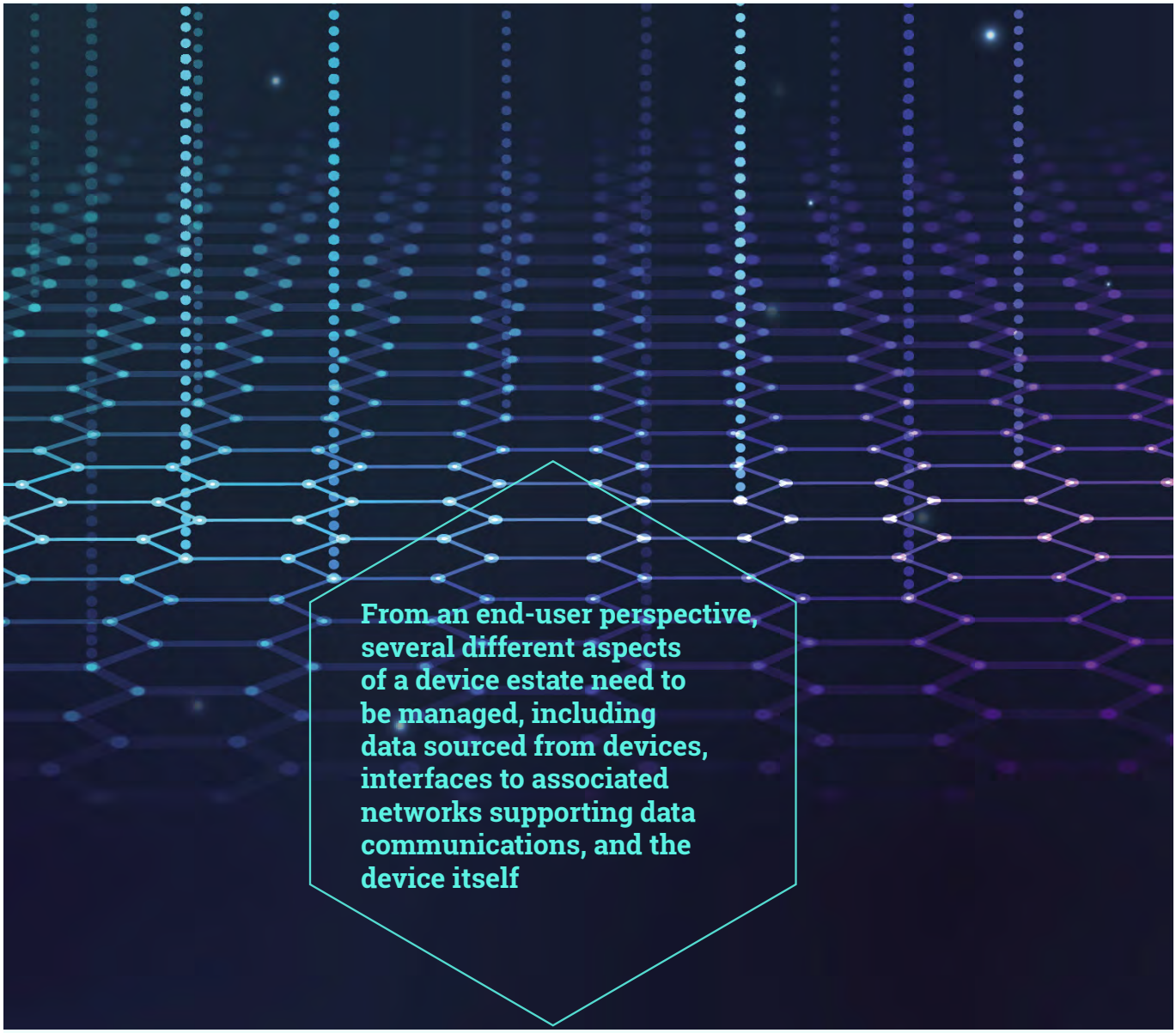
Figure 2: LPWA connections, private (licence exempt) and all, 2030
[Source: Transforma Insights, 2022]

enhance this baseline coverage according to customer demand. Next priorities include several larger European countries.

Meanwhile Helium claims to offer the largest LoRaWAN network in the world. Hotspots or access points can be deployed by any individual or business and offer coverage as part of the Helium network in return for payment, enabled and administered using distributed ledger - Blockchain - technology. Currently the Helium network is comprised of around 850,000 LoRaWAN hotspots. Senet positions itself as a carrier grade network provider and has a two-way roaming agreement with Helium. Senet itself, in September 2022, announced that it is has expanded the build out of its public LoRaWAN network across all five boroughs of New York City.

It is worth noting that a number of satellite operators also offer direct-to-satellite LoRaWAN coverage, supported by the long range - frequency hopping spread spectrum (LR-FHSS) enhancement to the LoRa standards announced in late 2020. LR-FHSS data rates significantly increase network capacity and robustness to interference. Operators include **EchoStar Mobile**, **Eutelsat**, **Fleet Space**, **Lacuna Space** and **Wyld Connect**.

Such wide-area public networks enable out of the box connectivity and allow for connected solutions can be sold to consumers through normal commercial channels. In addition, many enterprise IoT solutions also rely on wide-area public networks, for example fleet monitoring solutions, asset location solutions, and so on. **Figure 2** highlights the scale of the opportunity. The green colour represents our current forecasts of licence-exempt LPWA solutions deployed as private networks reaching 728 million connections by 2030, whilst the blue colour represents the full market opportunity for LPWA (including mMTC in licenced bands and devices supported by public LPWA networks) reaching ▶



a total addressable opportunity of 4.4 billion connections. As such, deploying LoRaWAN as a wide-area, public network technology unlocks a significant market opportunity.

Implications for network and data management

Clearly, LoRaWAN network coverage is fast evolving and is supported by a diversity of providers. However, this situation does bring about a range of challenges, not least in terms of how to manage a device estate that might potentially be distributed across many different networks (and network types and network providers). From an end-user perspective, several different aspects of a device estate need to be managed, including data sourced from devices, interfaces to associated networks supporting data communications, and the device itself. For instance, in the case of a supply chain monitoring solution (see p.64) devices might connect to any of multiple private campus networks and public wide area networks. To manage such a device estate efficiently an end-user will want oversight of all devices and connections from a single interface. The end-user will also want all data to feed in to a single platform so that data from different devices can be combined to support advanced applications and data analytics.

Such analytics could range from relatively simple benchmarking to identify any devices that return readings that are in some way unusual or unexpected, through to artificial intelligence (AI)-enabled dynamic system optimisation. In essence, the combination of data sourced from multiple devices and communicated via multiple networks into a single data platform enables an enterprise application to efficiently span the entire device estate, drawing on data from specific devices (and controlling and actuating those devices) as required. It also allows for significantly more sophisticated analysis of data from individual devices, and from the device estate as a whole, so enabling more effective and efficient management of end-to-end solutions. ▶

LoRaWAN supporting the cold chain: an illustrative scenario

The monitoring of cold chains serves to illustrate each of the three stages of development of LoRaWAN, from a campus private network context to a wide area public network context and highlighting some of the analyses that can be applied to data received from various sensors.

A campus area private network solution

Significant benefit can be gained from monitoring chillers and refrigerators in retail, hospitality, medical and warehouse contexts. In all these cases a simple LoRaWAN temperature sensor connected to a private network can provide regular temperature readings and help to ensure that refrigeration units are maintaining correct temperatures, so reducing spoilage and waste. Variances in the temperature profile maintained by refrigeration units can be an early indicator of imminent breakdowns and so alert engineers to undertake pre-emptive maintenance before a breakdown occurs. In turn, well-maintained refrigeration units will work more efficiently and so reduce electricity consumption.
In hospitality contexts in particular, a temperature sensor can provide useful insight into the frequency with which customers open a specific unit, providing information that can be used to help manage stock levels.

Besides economic benefits, temperature monitoring and control solutions can also unlock sustainability benefits due to reduced wastage of produce and by shifting electricity consumption to periods when more renewable energy is available. Pre-emptive maintenance can enable more efficient field force operations, significantly reducing vehicle mileage and fuel consumption.

Enhancements using wide area public networks

Extending the reach of monitoring solutions to include supply and distribution networks, including on-board vehicles and in distribution hubs, allows for significantly enhanced functionality. Such solutions can monitor chilled produce across an entire supply chain, possibly using LoRaWAN connected sensors integrated into packing crates to support temperature sensing at a very granular level and potentially also providing real-time location information. The benefits of such solutions are clear: managers responsible for a cold chain are able to monitor goods at every stage of distribution to identify and potentially take mitigating action if temperatures vary outside of specified bounds. This helps to ensure the quality of goods when they are supplied to customers. In addition, particularly solutions that include location information can help to combat the loss, or theft, of goods in the supply chain.

Insightful data analytics

Drawing together information provided by sensors across an entire cold chain better enables supply chain optimisation. Potentially real-time demand information sourced from refrigerated cabinets in hospitality contexts can be used to optimise delivery routes so that stocks can be replenished at appropriate intervals. Such an approach can again unlock significant efficiencies in distribution networks and also associated sustainability benefits due to reduced fuel consumption. Sensing demand at a more granular level can allow a hospitality industry supplier to pivot to an as-a-service business model, for instance committing to maintain certain stock levels within a wine chiller.

Central systems are also well-placed to monitor electricity tariffs and to optimise the temperature of individual refrigeration units by reducing temperatures immediately before peak tariff periods, so saving electricity consumed during those peak periods. Consumption can also be optimised to make the maximum use of electricity sourced from renewable generation. ■

How LoRaWAN increases productivity and improves operational efficiency across industries

Traditionally, we think of cellular networks as the solution for the primary mode of wireless connectivity; however, cellular can be ineffective when looking at connectivity solutions for widespread areas or urban locations. Widespread areas, such as buildings, factories and ports, seek secure connectivity solutions with better power consumption for their unique needs. Allowing for the mix of public and private networks, LoRaWAN answers the need for true flexibility, cost-effectiveness, and security. With a similar process of deploying a Wi-Fi network but with fewer gateways, LoRaWAN provides users with a simple network infrastructure that has the ability to connect anywhere

Outside of looking for a cost-effective, reliable, efficient connectivity solution, powering connectivity can pose a challenge. Utilising the power of LoRaWAN can solve a mix of connectivity challenges for things such as sensors and metering across industries, including smart cities, fleet, automotive, agriculture and industrial. There are many IoT implementations where energy is unavailable or unreliable, and battery life has historically been too short-lived to work as a solution.

With all the machines, people and processes required to be monitored, there are a lot of sensors to be deployed, and without connectivity, it can be a hurdle. For example, in the industrial sector, for safety measures, cranes have a strain gauge sensor that lets operators know which level of strain they are at while carrying heavy objects. These critical sensors for ensuring operational safety are currently read using a wire. The mobile nature of these cranes causes these strain gauges to break often. In order to avoid the negative impact of equipment malfunctions, a more permanent solution was needed to mitigate potential operational disruptions and safety risks.

By managing all necessary devices, networks and sites – both for public and private networks – anywhere in the globe on the same platform, ▶

SPONSORED CASE STUDY

In certain locations, utility companies distribute gas canisters or gas cylinders to residents

KORE allows organisations to grow as the demand grows. With no limits on the number of devices, providing an edge with border options working including cloud options or using the local instance, our hybrid approach syncs all the information, resyncs and resumes on its own in case of communication failures and supports various types of deployment models.

KORE's LoRaWAN platform, KORA, presents users with benefits such as safety, environmental compliance, efficiency, and productivity. KORA has a flexible environment to work with connectivity beyond simply managing the connectivity of applications; it serves as a hub to manage the messages between devices. Unlike cellular connectivity or Wi-Fi, which requires devices to be connected to an application, KORA has devices sending messages to one streamlined platform allowing the customer to manage their data in one place.

KORE brings together a cross-section of different deployment options from the cloud to on-premise, with a comprehensive end-to-end suite of applications. Whether for government mandates, safety measures, machinery or personnel to track, there's a flexible environment to manage your deployments across multiple networks and providers.

Many industries benefit from these solutions. For example, a leading industrial company needed to use a wireless sensor that could easily measure if objects are level. When the industrial team heard they could use wireless connectivity to measure in real-time, they rushed to integrate KORE's LoRa solution.

In certain locations, utility companies distribute gas canisters or gas cylinders to residents. Making the homeowners responsible for monitoring gas levels, which, if not diligent, can result in a lull of service while waiting for a replacement. Working with a utility provider that proposed uninterrupted gas, KORA connectivity allowed them to measure the contents of the bottle for the homeowner and service the gas when readings measure low for a monthly fee instead of by the bottle.

Needing to manage testing while also deploying two types of necessary communications with their existing devices and legacy systems, a vehicle tracking company used KORA to manage the data ingestion and adaptation between systems stopping any communication that wasn't compatible with their systems and allowing for communications across a central application as well as peer-to-peer.

The KORA solution provides customers with the comfort of knowing that projects will not only start but continue to be managed by KORE or a hybrid of KORE and the customer for years to come.

The Results

The use of **KORE's LoRaWAN platform, KORA**, was a success in many different ways. Each use case discussed experienced lowered costs, less energy usage, and higher flexibility. The ability to optimise better power consumption by strengthening battery life to last one to two years as opposed to months has given KORE the ability to lower operating costs for clients. In addition, the use of KORA has given the utility company the ability to provide the comfort of having pipe gas but with a bottle. The vehicle tracking company is on track to reach 30,000 communication devices by the end of this year.

Connectivity should be reliable and available. The future goal is to have cross-networks or multiple networks available rather than a few small carriers. With more flexibility to aggregate all types of networks and provide customers with access to shared networks, location is no longer an obstacle.

About KORE

KORE is a pioneer, leader and trusted advisor delivering transformative business performance. KORE empowers organisations of all sizes to improve operational and business results by simplifying the complexity of IoT. KORE has deep IoT knowledge and experience, global reach, purpose-built solutions, and deployment agility to accelerate and materially impact customers' business outcomes.

For more information, reach out to KORE to learn how we can help you achieve IoT Connectivity with LoRaWAN. **www.korewireless.com**

KORE

Laird™ CONNECTIVITY

Zenput always-on temperature monitoring elevates food safety execution

Zenput's sensors and cloud-based software help some of the world's biggest brands gain actionable insights into temperatures, expiration dates and other safety and compliance information across multiple sites. With Laird Connectivity, these companies stay nimble and flexible against changing conditions, supply chain delays and additional challenges in the food supply chain

One of the most popular use cases for IoT continues to be in cold chain monitoring. Particularly in the food service industry, the wireless sensor and gateway-based approach is a complete transformation of the legacy systems previously used to monitor compliance. Anything that can be captured digitally can be traced and monitored intelligently, and solutions providers are enabling unprecedented business outcomes via acquisition, monitoring and actionability of up-to-date compliance data.

Zenput is an operations execution platform that provides some of the biggest brands in the world with the tools to ensure consistency, compliance and safety in many locations simultaneously. Via its cloud-based platform, brands can gather the information they need to execute flawlessly on their food safety processes, brand standards and other operating procedures that are the difference between success and failure.

Brands accomplish this by abstracting away the outdated, ineffective means of logging and compliance that are no longer suited for a modern business. Paper-and-pencil compliance checks are no longer enough to ensure consistency and quality with up to-the-minute accuracy. Manual checks occupy dozens of hours a day across large organisations. They're vulnerable to errors and inaccuracies and can't be monitored collectively across locations in a centralised manner. In addition, they lag behind and are infrequent enough that predictive maintenance cues, such as rising temps in refrigeration equipment, may be missed until it is too late.

Zenput's software is designed to address the specific challenges and objectives of operators in industries like food service. The company's challenge was bringing the right hardware to the table. Having worked with previous hardware vendors, their offerings presented multiple challenges: inconsistent connectivity, as well as proprietary technologies that amounted to a black box and created supply chain bottlenecks that limited scale-up opportunities for Zenput's customers. ▶

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SPONSORED CASE STUDY

Laird Connectivity's global support team is available to help integrate new data points as Zenput and its customers identify new data points, applications, and new ways to achieve operational excellence

It therefore needed a partner to provide sensors with reliable, robust connectivity that were customisable and accessible via open wireless standards. It needed the transparency and flexibility offered by a true partner with a product designed for open, accessible development.

Room to grow

Zenput evaluated, and ultimately selected, **Laird Connectivity**'s line of Sentrius gateways and sensors to add to its range of supported IoT hardware. The Sentrius RS1xx sensors and RG1xx gateways presented the perfect combination of customisation, configurability and durable wireless connectivity. Where Zenput's previous hardware selections were based on proprietary RF protocols that made it difficult if not impossible to troubleshoot connectivity issues, the Sentrius series of IoT devices represented a fully- featured, truly useful hardware platform for collecting and acquiring IoT sensor data into the Zenput ecosystem.

Firstly, the protocol: The Sentrius sensors and gateways use LoRaWAN as their main connectivity interface. LoRaWAN, a standards-based protocol, allows wireless communications over very long ranges and also performs particularly well in Zenput's customers' target environments. In kitchens, coolers and other RF-reflective environments, LoRaWAN provides exceptional connectivity that resists scattering and other interference issues that can bring down other types of connections. It's a well-documented, growing, and accessible protocol that gives engineers the ability to see what's happening in the connection and troubleshoot issues accordingly.

Secondly, the RG1xx and RS1xx are open, fully-configurable devices that run on a Linux subsystem and present a truly useful development platform. More than simply a hardware offering, they represent a fully customisable, configurable data platform for emerging IoT applications. The RS1xx sensors support multiple RTD sensor options for low, medium and high temperature applications, meaning Zenput and its customers had access to temperature sensing from -100°C to +450°C. They're accessible via the Sentrius mobile application for configuration and debug logging, and they're compatible with any LoRaWAN network server or gateway. And the RG1xx gateway is configurable and accessible via a web-based GUI with pre-loaded support for several common LoRaWAN packet forwarders and a full onboard Linux OS.

These two lead to a third critical benefit: As Zenput looked to expand its hardware offerings, it found LoRaWAN IoT devices to provide the most flexibility and resilience to ongoing supply chain challenges. With its previous selection of proprietary hardware and a proprietary RF protocol, the lock-in factor limited original equipment manufacturers (OEMs) who wanted options to expand their device portfolios. But with standards-based devices, Zenput and its customers could mix and match LoRaWAN gateways and sensors as needed in the face of supply chain shortages and other unpredictable global factors. If one vendor's hardware suddenly becomes unavailable, it's as simple as integrating another standards- based piece of hardware that utilises the open and available LoRaWAN standard. No longer constrained and bottlenecked by availability, Zenput had the freedom to adaptively respond to challenges and continue to mix and match in its sensor and gateway network based on availability, not on a limited set of proprietary options.

A tailor-made system

Laird Connectivity's Sentrius RG1xx gateways and RS1xx sensors served as the next generation of Zenput hardware, giving customers a universal protocol for their IoT applications and a deeply customisable route forward for gathering actionable IoT data. Utilising a gateway with open RF standards means the ability to bring more sensors an more devices to the table: and as Zenput's use cases expand and more sensors are needed for new applications, it can rely on the transparent and accessible LoRaWAN standard as a compatibility guarantee for new devices.

Zenput brings operations excellence to customers in some of the biggest brands in the world, including **Taco Bell**, **Dominos** and **Chipotle**. The platform offers a real-time look at conditions across multiple locations on a growing number of measurables and gives operators visibility and control over processes like temperature checks, expiry dates, predictive maintenance, and ultimately a higher quality offering for their customers.

The Sentrius RG1xx gateways and RS1xx sensors provide robust connectivity, multiple backhaul routes to the cloud (Wi-Fi, Ethernet, and LTE) and full access for configuration and debugging. In addition, the gateways and sensors represent a clear and open route to expanding sensor applications in the future with well-established and accessible protocols that help Zenput expand its core business.

Laird Connectivity's global support team is available to help integrate new data points as Zenput and its customers identify new data points, applications and new ways to achieve operational excellence. Laird Connectivity's Sentrius series is the opposite of a closed, proprietary ecosystem that locks in OEMs and creates barriers to development. Rather, it serves as an open platform for development and a door to the future of actionable IoT intelligence.

To learn more about Sentrius RG1xx gateways and RS1xx sensors, please visit the Laird Connectivity website:
https://www.lairdconnect.com/rs1xx-sensors
https://lairdconnect.com/rg1xx-series