techUK

THE SIGNIFICANCE OF A NATIONAL LOW POWER WIDE AREA NETWORK (LPWAN)

INTRODUCTION

Businesses are increasingly using the Internet of Things (IoT) to reduce costs and improve operational efficiencies. The IoT market has vastly grown with an increasing number of practical applications in many fields including utilities and smart metering, security, asset tracking, agriculture, smart cities, and smart homes.

IoT applications have a range of requirements with many enterprise applications relying on long-range, low data rate, low energy consumption, and cost effective connectivity. Solutions based on cellular communications (e.g., 2G, 3G, and 4G) can provide larger coverage but they consume excessive device energy. Therefore, the requirements of IoT applications have driven the emergence of a new wireless communication technology: Low Power Wide Area Network (LPWAN). These comprise a range of technologies which offer large coverage and low energy consumption, often using unlicensed spectrum.

Digital infrastructure is central to the future of the UK economy in the Future Telecom's Infrastructure Review, This national strategy can create the right market and policy conditions to secure world-class connectivity for all, but it needs to be accompanied by changes from within the sector. Industry has a critical role in delivering the world-class connectivity we need, and the focus should be on growing the market and improving consumer experiences[1].

Despite the importance of LPWAN technologies to realising the potential of IoT, the telecoms review published by the Department for Digital, Culture, Media and Sport (DCMS) does not provide any focus on LPWAN technologies. This lack of Government focus is exacerbated by there being, for a range of reasons, no commercial deployments of LPWANs by the four UK Mobile Networks Operators. However, there are several trials and projects in the UK.

Currently, many different industrial applications are delivered using connectivity solutions supported by Wi-Fi, mobile and IoT technologies including proprietary technologies. New connectivity platforms based on 5G and future Wi-Fi evolutions could enable more innovative applications to increase flexibility, agility and responsiveness[2].

Some applications require low power and long-range connectivity (over 20km) using devices with long battery life in case of deployments in remote and hard to reach areas. Common applications include smart metering, smart lighting, asset monitoring and tracking, smart cities, livestock monitoring, energy management, manufacturing, and industrial IoT deployments. These use cases can be satisfied by LPWAN technologies.

In conjunction with the rapid growth of the IoT market, LPWANs have become a popular low-rate long-range radio communication technology. Analysys Mason forecasts that the total number of IoT connections will reach 5.4 billion in 2027 and LPWA is likely to accelerate the overall growth[3]. Some of the leading technologies are Sigfox, LoRa, and Narrow Band IoT (NB-IoT) that compete for large-scale IoT deployment[4].

As recently as early 2013, the term "LPWAN" did not even exist. Many LPWAN technologies have arisen in the licensed as well as unlicensed frequency bandwidth. Among them, Sigfox, LoRa, and Narrow Band IoT (NB-IoT) are the leading technologies.

LPWAN IS INCREASINGLY GAINING POPULARITY IN INDUSTRIAL, UTILITIES, AGRICULTURE, AND RESEARCH COMMUNITIES BECAUSE OF ITS LOW POWER, LONG RANGE, AND LOW-COST COMMUNICATION CHARACTERISTICS. IT PROVIDES LONG-RANGE COMMUNICATION UP TO 10 TO 40KM IN RURAL ZONES AND ONE TO FIVE KM IN URBAN ZONES. IN ADDITION, IT IS HIGHLY ENERGY EFFICIENT FOR EXAMPLE WITH ITS 10 YEARS PLUS BATTERY LIFETIME. THE TECHNOLOGY IS ALSO INEXPENSIVE.

1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf
2 https://www.ofcom.org.uk/__data/assets/pdf_file/0020/135362/supporting-role-wireless-innovation-uk-industry.pdf
3 Analysys Mason, IoT forecast: connections, revenue and technology trends 2018–2027
4 https://www.sciencedirect.com/science/article/pii/S2405959517302953

THE TECHNOLOGY

LORA/LORAWAN

LoRa, which is short for "Long Range", defines the physical communication layer that uses the proprietary spread spectrum modulation technique developed by start-up Cyleo, back in 2009, and subsequently acquired by Semtech in 2012. LoRaWAN, on the other hand, refers to the most popular MAC layer used for LoRa, and developed by the LoRa Alliance as an open standard. However, it should be noted that Semtech is still the provider of the LoRa chip.

In 2015, LoRa was standardised by LoRa-Alliance and is deployed in 42 countries and is under rollout in other countries owing to the investment of various mobile operators (e.g., Bouygues and Orange in France, KPN in Netherlands, and Fastnet in South Africa).

NB-IOT

NB-IoT is a cellular technology related to LTE, designed specifically for LPWA applications, using licensed spectrum on a range of possible bands and compatible with existing cellular network infrastructure. According to GSMA, NB-IoT in combination with LTE-M (which are both Mobile IoT) have already been launched commercially by 59 mobile operators in 52 markets across North America, Latin America, China, South-East Asia, South Africa, the Middle East and in many European countries[5]. NB-IoT is the LPWA standard introduced by 3GPP in their Release 13 in 2016, with the purpose of providing a cellular solution for wide-are coverage for the IoT. It is a licensed technology based on cellular network and can co-exist with GSM and LTE.

SIGFOX

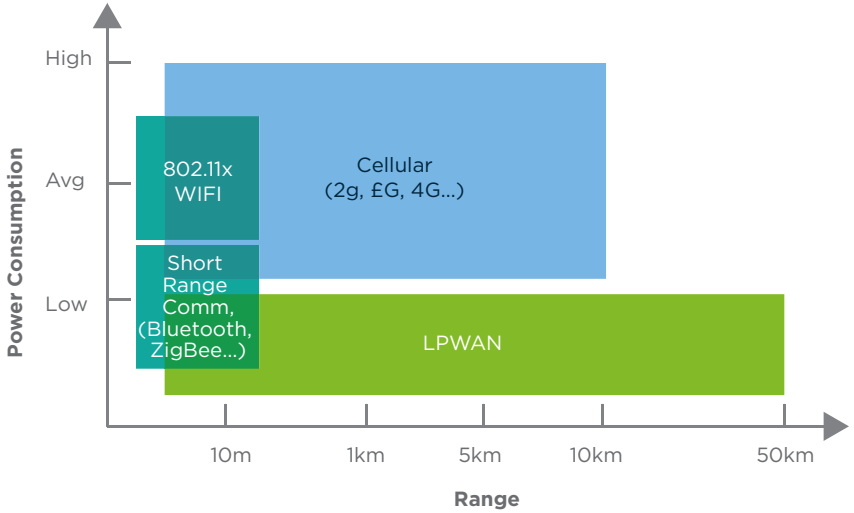
Sigfox is a French company that was founded in 2009. It commercialises its own ultra-narrow band proprietary communication technology, which operates in unlicensed Sub-1GHz ISM spectrum.
The company is an LPWAN network operator that offers IoT connectivity by deploying its proprietary base stations. Sigfox operates and commercialises its own IoT solution in 31 countries and is under rollout worldwide owing to the partnership with various network partners.

INGENU

Ingenu, founded in 2008, is a company provider of wireless networks. The LPWAN solution proposed by Ingenu is a technology called Random Phase Multiple Access (RPMA), which is a form of Direct Sequence Spread Spectrum (DSSS). This proprietary solution operates in the globally available 2.4GHz ISM band (that of WiFi and Bluetooth). RPMA has a better uplink and downlink capacity, compared to some of its competitors, however, it might suffer from higher interference, less building penetration, and a shorter battery life.

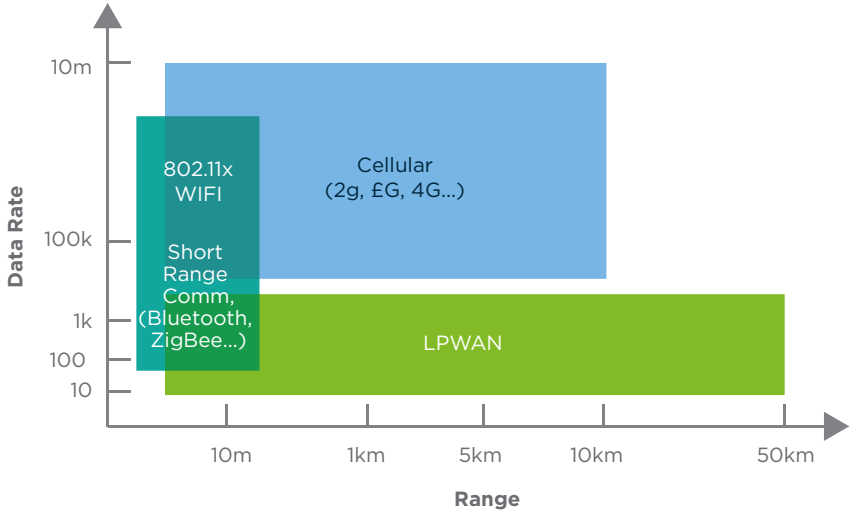
5 https://www.sciencedirect.com/science/article/pii/S2405959517302953

FIGURE 1: WIRELESS STANDARDS POWER VS. RANGE (COMPARISON)



Ref: Gemserv[6]

FIGURE 2: WIRELESS STANDARDS THROUGHPUT VS. RANGE COMPARISON[7]



6 Gemserv
7 https://www.etsi.org/deliver/etsi_gs/LTN/001_099002/01.01.01_60/gs_LTN002v010101p.pdf

OVERALL BENEFITS OF LPWAN

CAPACITY

LOW DATA capacity of 100kbps to 1mpbs in LPWAN technology matches real-data usage in IoT devices, particularly in low throughput transmissions over specific periodic timeframe. Specific IoT devices, such as wearables, require the most advanced LPWAN technology (licensed LPWA technology) with big rate and real-time transmission options.

CONSUMPTION

LOW POWER consumption with expected battery life of about 10 years involves low-duty cycle and very little energy consumption in idle state. Low power also means low energy consumption, which suggests less need for continuous battery change or upgrades (required on sensors and smart meters for water utilities, smart industries, and remote stations.

COVERAGE

WIDE AREA (LONG RANGE) coverage of more than 100m compared to Zigbee, Bluetooth, and wi-Fi. This facilitates IoT applications in diverse industries covering areas such as urban, rural, underground parking, and more importantly, those with no cellular coverage or blank spaces.

COST

Since LPWAN uses an unlicensed spectrum of less than 1GHz frequency, the absence of hefty spectrum fees allows for LOWER COST benefits compared to cellular technology, Due to lower data volume, LPWAN technology consumes less power, prolonging battery life in IoT devices and leading to reduced operational expenses for companies. Another critical advantage is scalability that results from easy installation, convenient maintenance, and simple functionality.

FIGURE 3: COMPARISON COSTS[8]

	Spectrum cost	Deployment cost	End-device cost
Sigfox	Free	>4000€/base station	<2€
LoRa Free	>100€/gateway	>1000€/base station	3-5€
NB-IOT	>500 M€/MHz	>15000€/base station	>20€

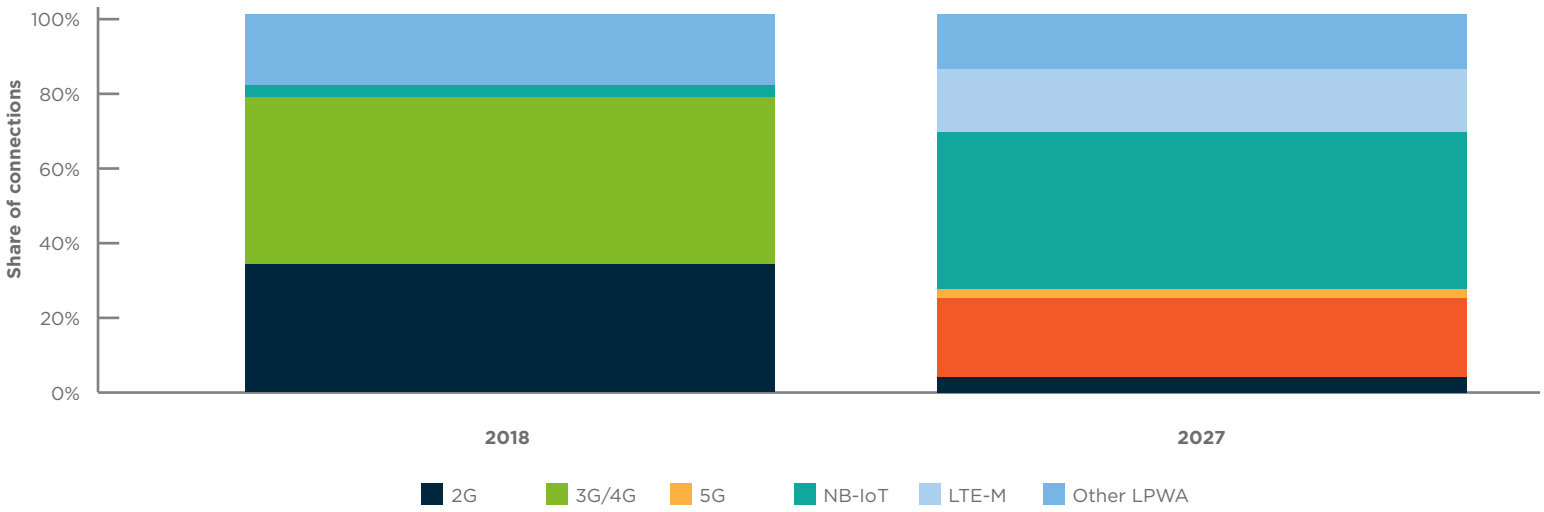
The benefits of using the unlicensed vs. licensed services can be seen as a trade-off of security vs. quick installation process.

	Sigfox	LoRaWAN	NB-IoT
Coverage	160dB	157dB	164dB
Technology	Proprietary	Proprietary	Open LTE
Spectrum	Unlicensed	Unlicensed	Licensed (LTE/any)
Downlink data rate	<0.1kbps	<10kbps	0.5-200kbps
Uplink data rate	<0.1kbps	<10kbps	0.3-180kbps
Battery life (200b/day)	10+ years	10+ years	15+ years
Module cost (today)	-	-	>$6
Security	Low	Low	Very high

Source: Pushing the boundaries of IoT, Vodafone White Paper[9]

8 https://www.sciencedirect.com/science/article/pii/S2405959517302953#fig4
9 https://www.vodafone.com/business/news-and-insights/white-paper/narrowband-iot-pushing-the-boundaries-of-iot

Based on the current outlook, NB-IoT will start achieving scale from 2021 and according to Analysys Mason by 2027 the dominant majority of active LPWA connections will be in licensed spectrum and particularly NB-IoT and LTE-M10.



The catalyst for the development of NB-IoT technology seems to be the arrival of non-3GPP LPWA technologies — namely, LoRa and Sigfox. Leveraging unlicensed bands, these network technologies have challenged the traditional model of mobile network operators delivering managed M2M services over licensed radio spectrum. Consequently, as a competitive response to the new entrants, NB-IoT was designed to be deployed primarily by using licensed spectrum and existing cellular network infrastructure. Sigfox, which started in 2009, built the first modern LPWAN network in France and their €100 million got everyone in the industry (especially in Europe) excited about using LPWAN devices. This came at a time when radio technology was becoming less expensive, and the tools for integrating applications were becoming easier for people to use.

10 https://www.analysysmason.com/Research/Content/Comments/IoT-predictions-2019-RDME0-RMA17/

APPLICATIONS OF LPWAN

ELECTRIC METERING

In the electric metering market, companies typically require frequent communication, low latency, and high data rate. Generally, they require neither low energy consumption nor long battery lifetime as electric meters have continuous power source. Moreover, companies need real-time grid monitoring to make immediate decisions, e.g., load, outages, and interruptions. Thus, Sigfox is inappropriate for this application as it does not handle low latency. On the contrary, electric meters can be setup using class-C LoRa to ensure very low latency. However, NB-IoT is a better fit for this application because of the required high data rate and frequent communication. Moreover, electric meters are typically found in stationary locations in densely populated areas. Therefore, it is easy to ensure NB-IoT coverage by cellular operators (LTE).

SMART FARMING

In agriculture, the long battery lifetime of sensor devices is required. Temperature, humidity, and alkalinity sensors could significantly reduce water consumption and improve yield. The devices update sensed data a few times per hour as the environment conditions have not radically changed. NB-IoT applications include animal welfare monitoring, crop monitoring, animal tracking and soil monitoring. NB-IoT has a large global footprint, which is attributed to the fact that it can be deployed where there are still 2G networks as well. Thus, all technologies (NB-IoT, Sigfox and LoRa) are ideal for this application.

MANUFACTURING AUTOMATION

Real time machinery monitoring prevents industrial production line down and allows remote control to improve efficiency. In factory automation, various types of sensors and communication requirements exist. Some applications require frequent communication and high-quality service, thus NB-IoT is a better solution than Sigfox and LoRa. Other applications require low-cost sensors and long battery lifetime for asset tracking and status monitoring; in this case, Sigfox and LoRa are a better solution. Because of the various requirements, hybrid solutions could also be used.

SMART BUILDING

Temperature, humidity, security, water flow, and electric plugs sensors alert property managers to prevent damages and instantly respond to requests without having a manual building monitor. The buildings' cleaning and usage could also be carried out more efficiently. These sensors require low cost, long battery lifetime and some application require increased communication security. They do not require quality of service or frequent communication, therefore all technologies, NBIoT, Sigfox and LoRa are suitable for this class of applications.

RETAIL POINT OF SALE TERMINALS

Sale-point systems require guaranteed quality of service as they handle frequent communications. These systems have continuous electrical power source, thus there is no constraint on battery lifetime. There is also a strong requirement of low latency, i.e., long latency times limit the number of transactions that a store can make and they need to be highly reliable. Thus, NB-IoT may be the best fit for this application.

PALLET TRACKING FOR LOGISTICS

Currently, pallets tracking to determine the goods' location and condition are highly desirable in logistics. In this application, the most sought-after requirements are device cost and battery lifetime. Pallet tracking is a good example of a hybrid-deployment solution. Logistics companies can have their own network to ensure guaranteed coverage in their facilities. Low-cost IoT devices could be easily deployed on vehicles. Sigfox or LoRa public base stations can then be used when vehicles are outside the facilities or when goods arrive at customer locations. However, LoRa allows more reliable communications than Sigfox when moving at high speeds[11]. For NB-IoT, the LTE network is highly reliable but might not be available in all logistic locations, typically in rural areas. Owing to the low cost, long battery lifetime, and reliable mobile communications, LoRa might be a better fit for this application.

CONNECTED CITIES

City infrastructure (e.g. smart lights, parking meters) typically require low amount of data (no voice) and transactions, are delay tolerant and have the lowest power consumption. NB-IoT networks, with their data rate, deep coverage and battery performance are the most suitable solution to enable Connected Cities. They are a good fit for street lighting, smart waste, smart transport, road traffic monitoring, smart parking and infrastructure sensors.

HEALTHCARE

IoT sensors in houses of the old and vulnerable could afford them more freedom to live alone but with the ability for health professionals to monitor them remotely. The same goes for people with conditions such as diabetes, heart conditions, or patients just released from hospital. Hospitals would be a great application of smart building and smart/health use cases.

In summary, LPWAN is highly suitable for IoT applications that only need to transmit small amounts of data in long range.

11 https://www.sciencedirect.com/science/article/pii/S2405959517302953#bb3

THE UK MARKET

Historically the UK has been a champion in mobile telecoms. However, other countries have established themselves as leaders in LPWAN development from an early stage[12]. In 4G terms, the UK was behind more than 40 countries to launch services[13], indicating a loss of outright technological and commercial leadership, perhaps due to the ultra-competitive nature of the UK Telecoms market and a need for effective state intervention.

12 See Ofcom Connected Nations Report 2018 -https://www.ofcom.org.uk/__data/assets/pdf_file/0020/130736/Connected-Nations-2018-main-report.pdf
13 https://www.theguardian.com/technology/2012/oct/29/ee-launches-uk-4g-mobile-network

LPWAN provides a significant shift in terms of hardware, deployment, and connectivity costs. This enables much cheaper IoT devices to be built and connected over longer periods of time without maintenance. This is essential for improving the business case for IoT solutions. In an international study it was found that over half of the most sophisticated adopters of IoT were making use of LPWAN[14].

The slow pace of LPWAN deployments in the UK has been partly driven by high competition amongst operators – resulting in radio site sharing agreements and fears of breaking apart their own existing M2M businesses. DCMS issued The Future Telecoms Infrastructure Review, which promises to make the UK the best place to start and grow digital businesses, highlights the need for investment to build fixed and wireless networks that are fit for the future, and emphasises the opportunity to take advantage of the benefits of fixed and mobile convergence. These technologies have the potential to transform productivity, and to open up new business models[15]. Unfortunately, the paper lacks any reference to the variety of other available technologies, such as LPWAN, and the benefits they could provide.

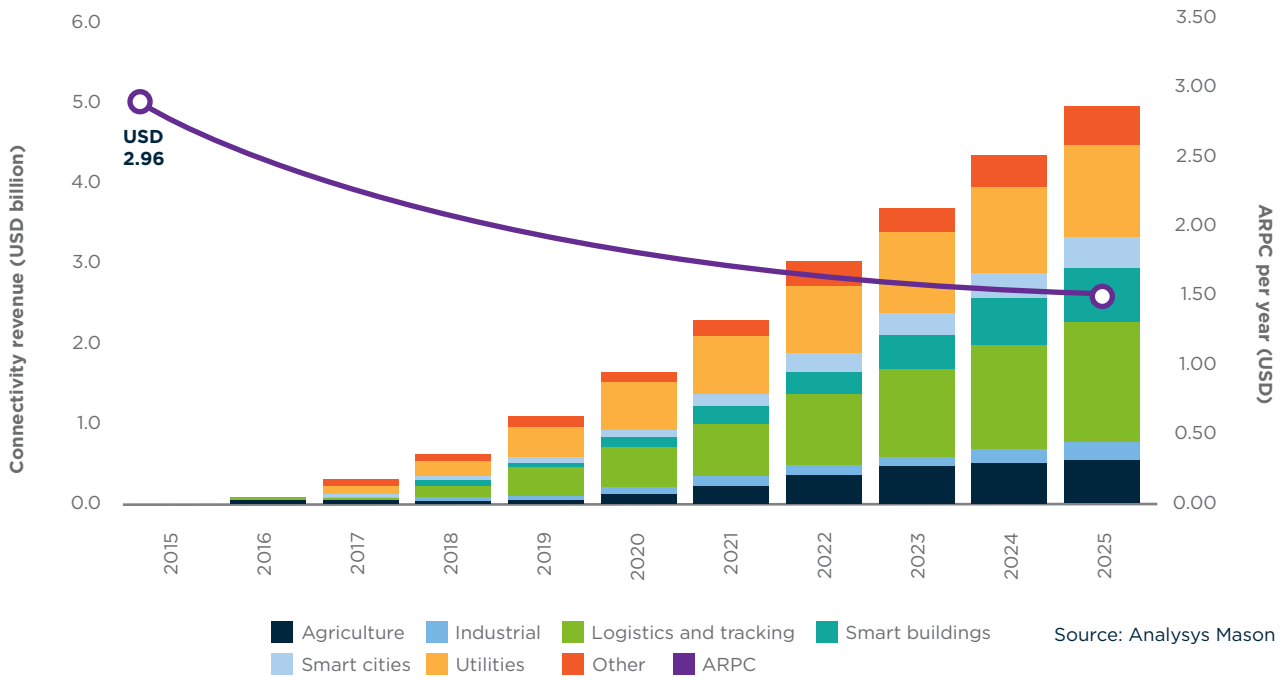
THE LACK OF LPWAN NETWORKS IN THE UK HAMPERS IOT INNOVATION, BECAUSE UK BUSINESSES ARE STARVED OF THE OPPORTUNITY TO EXPERIMENT WITH NEW PRODUCT AND SERVICE IDEAS DEVELOPED ON TOP OF THESE NETWORKS.

The lack of national LPWAN networks also makes scaling successful technology pilots to other customers across the country difficult, if not impossible. This significantly limits the size of the total addressable market in the UK.

Other countries have taken full advantage of the technology on national scale for several reasons. First, as more and more things are connected to the internet, people are starting to look at low-cost and low-data devices. This is useful for a whole list of applications, from environmental sensors to oil and gas monitoring.

14 https://www.vodafone.com/business/news-and-insights/white-paper/vodafone-iot-barometer-2019
15 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf

FIGURE 4: LPWA CONNECTIVITY REVENUE AND ARPC PER YEAR, 2015-2025



Source: Analysys Mason

CASE STUDY ONE

ENERGY EFFICIENCY

GERMANY

VODAFONE AND TECHEM

Techem is a world-leading provider of energy billing and management services for the property sector. The company's services help to increase heat and water efficiency within the property sector. Its products and solutions save around 6.9 million tonnes of CO_2 per year. A key element of Techem's range of services is reliable and legally compliant metering of heat and water consumption in rented and owner-occupied homes, as well as commercial properties.

CHALLENGE

The company has been using radio-based technology for this for many years. Meter readers use a 'walk-by' process to collect readings from electric meters using mobile devices. Plausibility checks are then carried out to avoid transmission errors and other issues.

In certain circumstances, Techem also uses a stationary radio solution to read meters. It installs fixed data recorders in buildings to collect the readings from the meters around them. The data recorders then transmit this information onto a master data recorder, which uses GPRS to transmit the readings to the Techem server via the Vodafone mobile network. The main disadvantage of mobile data collection is that the company still has to send an employee to the relevant property to take the meter readings. With stationary collection, every master data collector needs 230 volts power supply. Its location also must be chosen carefully to ensure that it has sufficient mobile coverage. Plus, the radio standard currently in use has limitations as it is unable to penetrate thick concrete walls and transmit signals from deep cellars.

CASE STUDY ONE

SOLUTION

Unlike the other technologies they tested, NB-IoT impressed the development engineers at Techem with its low energy consumption, highly reliable data transmission, ability to penetrate building materials, and the Europe-wide consistency and availability of its radio network. The first step was to swap the fixed, stationary data collectors for devices with integrated NB-IoT. Master data collectors were then no longer required as every device could transmit the readings it collected to Techem itself at determined intervals. This more robust and energy efficient method of data transmission itself is going to prove to be of great benefit to Techem and its customers – meter readings can be taken considerably faster and more easily. The use of NB-IoT also supports the further digitisation of Techem's business processes.

On top of this, the modern technology also gives us a foundation for further improvements, particularly in terms of developing new applications and business models

IMPACT

The company's better understanding of energy flows and consumption opens up new opportunities for improving energy efficiency in the field of smart buildings and smart homes. As well as taking meter readings and billing heat and water consumption, Techem also offers its customers expert advice on how to reduce their energy consumption. This helps them not only to lower their bills, but also reduce their CO_2 emissions and therefore help protect the climate.

AS WELL AS TAKING METER READINGS AND BILLING HEAT AND WATER CONSUMPTION, TECHEM ALSO OFFERS ITS CUSTOMERS EXPERT ADVICE ON HOW TO REDUCE THEIR ENERGY CONSUMPTION.

CASE STUDY TWO

SMART AGRICULTURE

NEW ZEALAND

SENSYS, SPARK NZ, AND ACTILITY[16]

CHALLENGE

Many farms in New Zealand are remotely located, often surrounded by mountains, making it difficult to provide stable connectivity. Farmers, situated in rural areas, typically lack the capital to invest in new devices with long-lasting, cost-effective batteries that can gather data remotely. The owners of South Auckland farms are trialing LPWA technology, supported by SenSys (LoRaWAN sensor developer) and Spark New Zealand (a digital service company) to address these challenges, improve business operations, particularly the management of available resources.

SOLUTION

Spark, in partnership with Actility, is rolling out LPWAN for farmers to access their management systems in real-time with one gateway connecting about 100 farms to the network. LoRaWAN sensors allow connectivity through radio frequency up to 15km radius around a base station. Once the network is operational and the farm is connected, SenSys is ready to install a wide range of LoRa-ready products to address the following areas:

- S3P Soil Probe – measures soil moisture and temperature
- WaterMon – analyzes farm water levels, leaks, and usage
- RainMon – reports rain volume hourly
- Octometer – monitors and reports on milk care and hygiene
- Gate-State – reports on gate or door security - the-t products are connected to a centralized system indicating day-to-day farm performance while monitoring environmental parameters and other real-time factors critical to farming viewable on an online dashboard with alerts sent

IMPACT

- Efficient management of resources via monitoring soil moisture, air temperature.
- Profit maximisation and cost efficiency through accurate usage of fertilisers and nutrients as well as storage leakage prevention.
- Regulation compliance on milk storage and control of milk throughout supply chain.

16 https://rfdesignuk.com/uploads/9/4/6/0/94609530/murata_lpwan_study.pdf

CASE STUDY THREE

BERINGAR – NHS

UK

CAITHNESS GENERAL HOSPITAL

Beringar provided a complete asset management solution that tracked the position of 40 hospital beds and continuous monitored comfort levels of 12 hospital wards.

CHALLENGE

Many farms in New Zealand are remotely located, often surrounded by mountains, making it difficult to provide stable connectivity. Farmers, situated in rural areas, typically lack the capital to invest in new devices with long-lasting, cost-effective batteries that can gather data remotely. The owners of South Auckland farms are trialing LPWA technology, supported by SenSys (LoRaWAN sensor developer) and Spark New Zealand (a digital service company) to address these challenges, improve business operations, particularly the management of available resources.

SOLUTION

In this particular case study, the benefit of flexibility gave LoRaWAN a better advantage over for example to SigFox. The desire was to send data every minute and SigFox would not allow that. LPWAN technology also had the benefit of great range and the ability to work from deep within building.

Work with LoRaWAN meant that the focus had to be on packaging the data in a way that could fulfil the demand to count and position people in a building, report the environment and understand space utilisation, all in a few bytes transmitted once per minute. This reduced data transmission, storage and management. The other benefit of LoRaWAN is the ability to be in control of the deployment. Beringer could choose how many gateways and when they will be installed in order to manage the network effectively and deliver a high-quality service.

IMPACT

Of course, however, LoRaWAN has challenges - its radio being the principle one. Doing large scale firmware updates is not trivial and there are occasional dropped packets - but the pros outweigh the cons. It is fast to deploy; you are in control and it is quite reliable; it has great range with low cost hardware, and you can remain independent of the large carriers[17].

17 https://www.beringar.co.uk/blog/2019/1/24/why-are-we-using-lorawan

CASE STUDY FOUR

ROYAL NAVY AND DEFENCE

UK

DIGITAL CATAPULT

ROYAL AIRFORCE

The RAF needs to keep track of high-value assets whilst in storage and during transit, often in extreme and challenging safety-critical environments. Understanding the conditions an asset is exposed to is essential to ensure it is stored and maintained appropriately, and that it is fit for purpose.

CHALLENGE

The RAF's Rapid Capabilities Office (RCO) wanted to prove the concept of using environmental data logging sensors in conjunction with a low power wide area network (LPWAN) infrastructure to monitor assets within an operational military airfield environment.

Digital Catapult and RCO designed, deployed and ran a trial to help prove the potential of LPWAN technologies in this scenario. Its purpose was to test the concept of using environmental data logging sensors in conjunction with a low power wide area network (LPWAN) infrastructure to monitor a range of assets within an operational military airfield environment.

SOLUTION

Working with the RCO and RAF, Digital Catapult designed and delivered a complete remote monitoring solution, including the deployment of a LPWAN network covering approximately 10 square km of an operational RAF airfield.

Environmental monitoring sensors were programmed and attached to a range of assets to automatically detect shocks and changes in temperature and humidity. The condition of each asset is measured every 15 minutes and the data transmitted to the network server.

Geolocation of assets was also a primary objective of the trial and LPWAN has inbuilt capabilities that allow the location of sensors and assets to be estimated. The benefit of this, as opposed to using GPS based solutions, is that the device costs and power consumption are lower and location can be achieved even if the sensor is inside a structure. The location is calculated by using a combination of the signal time of arrival and the signal strength at the serving gateways.

Our user experience and design team worked closely with RAF stakeholders and end-users to design a bespoke dashboard,

CASE STUDY FOUR

to visualise the current status and location of assets. Users receive warnings and alerts when sensors detect a change approaching or exceeding predefined thresholds. Alarms are also triggered whenever an asset is subjected to shock.

LPWAN technology is uniquely suited to address the RAF's challenge as it provides wide-area coverage, is fast to deploy and requires limited infrastructure and minimises set up costs. One of the key attributes of LPWAN technology is the fact that devices and sensors require very little power and therefore can be run from batteries for a long period of time which, if optimised, can be many years. This makes the technology ideal for scenarios where remote sensors are attached to assets that don't intrinsically have a constant and reliable power source. The frequencies and transmission protocols used by LPWAN solutions are well suited for deep in-building and underground coverage and operate effectively over long distances and through challenging radio conditions.

IMPACT

The trial concluded that LPWAN technology is a strong candidate to support the RAF's unique use cases and can fully meet the requirements. Benefits include:

- A LPWAN network can quickly be deployed and operate within the challenging conditions of an active RAF operating base.
- RAF ground personnel are able to track the location and condition of assets in near real-time via a bespoke dashboard application
- Warnings and alerts are sent to users when conditions approach unacceptable limits or thresholds are exceeded.
- Personnel can analyse the conditions an asset has been exposed to in the past, in order to help plan maintenance schedules.

As a result, the RCO is now developing the business case for a full-scale deployment of the solution across its entire operation[18].

18 https://www.digicatapult.org.uk/case-studies/raf/

Case studies from within the UK are only one way to establish that there is an appetite and a market potential for the technology. More so, the Scottish Government has pledged plans to invest £2.7 million in the three-year project, with £113,000 coming from Scottish Enterprise, £30,000 from Highlands and Islands Enterprise and the rest of the money from network infrastructure provider Boston Networks. Named IoT Scotland, the network will have a longer reach than any LoRaWANs deployed so far in the UK. It will enable devices to collect and send data without the need for 3G, 4G or Wi-Fi and support the development of new IoT applications. The Scottish Government hopes that the network could support the country's public and private services. It cited the possibility of increasing the use of smart bins that wirelessly inform local authorities when they need emptying, and the development of energy saving measures in office buildings[19].

The wide-reaching network will be rolled out in cities, towns and rural areas across the country. The network will allow a wide range of users, from small IoT start-ups to multinationals to focus on the deployment of sensors and applications, rather than network build.

SSE, the Scottish Energy Supplier has immediately responded to the opportunity and while the company is not directly involved in the IoT Scotland initiative, the IoT is an enabler for several of its projects. One of these is the use of innovative motion detection sensors installed on the trident transmission line on the Isle of Skye for remote monitoring for outage prevention and response. The EkkoIoT early warning system from UK sensing provider EkkoSense, originally developed in association with SSE subsidiary Scottish and Southern Electricity Networks (SSEN), uses a 9-axis inertial measurement unit to detect and monitor the movement and stability of utility poles and tracks performance in different weather conditions over time. SSEN has installed these devices on 809 poles carrying the line covering an area of over 1,000km^2 on Skye. SSEN also intends to incorporate IoT more in the future, particularly as the network operator transitions to a distribution system operator, the spokesperson told Engerati. SSEN is just one player where they have set out an action plan, including an over £100m upgrade of IT systems and rollout of a new communications infrastructure for data capture, for the years to 2020 and beyond.

The clear signs are that businesses in the UK are changing strategy and upgrading their systems. They are investing millions of pounds in security the best way forward in a strategic manner to protect their assets. LPWAN networks could ensure that there are a variety of solutions available to those businesses and provide at least an option for a combination of pairing technologies for a better return on investment.

19 https://www.ukauthority.com/articles/scottish-government-to-invest-in-national-lorawan/

A MISSING PIECE IN THE NETWORK

Getting LPWAN off the ground in the UK has become a 'chicken and egg' situation. The technology is advanced enough and mobile operators – and other companies - have the capability to roll out the infrastructure. However, doing so requires a sizeable investment, so they want to make sure that there is a ready market. Without the infrastructure, IoT businesses are unable to develop prototypes to demonstrate the market's potential. This stalemate is a significant barrier to progress, which the UK must overcome if it is to catch up with more mature markets in the Netherlands, Germany, France, Spain, and Ireland. Adopters need a better understanding of the potential return on investment and wider transformational benefits. The impact of a lack of IoT development **and in particular a national LPWAN network** is not only limited to businesses that are part of the immediate IoT supply chain, but also to the competitiveness of various adopters at large.

Adopters need a better understanding of the potential return on investment and wider transformational benefits[20]. The impact of a lack of IoT development is not only limited to businesses that are part of the immediate IoT supply chain, but also to the competitiveness of various adopters at large.

Commercial (industrial) IoT has been slow to be adopted, but their use cases have multiplied in recent years offering productivity gains (including improved crop yields) and improvements to health and safety across a range of sectors. But with so many demand types, there can be no "one size fits all" connectivity solution. Instead, the right connectivity solution for each use case will depend upon a range of factors.

The emergence of 5G, the fifth generation of wireless mobile communications, will have a major impact on how IoT services will be delivered. Among the potential advantages, 5G brings are high data rates, reduced latency, energy savings, cost reductions, and higher system capacity, with network slicing providing service level agreements for specific service types. This revolution will deliver by far the most intelligent mobile network the world has ever seen, as well as being the most "open," creating exciting new opportunities for IoT innovation at the edge. 5G will not only enrich experiences for existing applications but also enable new IoT use cases which cannot be enabled by 4G, but also serve and change how we think about connectivity for home, enterprises and automotive.

The UK Government's Digital Strategy[21] is helping to pave the way for the future roll out of 5G with initial investment of £25 million, and up to £200 million more expected to support UK-wide test beds to spearhead efforts to make the UK a world leader in 5G.

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20 https://www.raconteur.net/technology/iot-challenges
21 https://www.gov.uk/government/publications/uk-digital-strategy

LPWAN OPPORTUNTIES IN THE WIDER NETWORK

Each technology has a distinct mixture of strengths and weaknesses. It is crucial to understand how each one fits onto the landscape and how to weigh the cost and the benefits of different technologies in the space.

AREA

For larger areas, like farms, campuses or cities, where small-volume data transmissions are needed, self-contained LPWANs (LoRaWAN and SigFox) are a perfect option. When talking about covering regional areas and across boundaries, a cellular protocol, like NB-IoT or Cat-M, may look increasingly practical.

SCALE

For networks that connect an area larger than a single small building or warehouse, LPWANs usually make the most sense. Cellular IoT protocols provide IoT services on a regional, country-wide or even transcontinental scale without the need for pre-established gateways to create a coverage area. This also means that the IoT solution will have the same blind spots the cellular networks do, and if the network connection is interrupted, the solution will go down. Still, ease of deployment and the coverage area often overweigh the costs and limitations of dependence on a cellular provider.

National roaming, as suggested by Ofcom, would support mass deployment of IoT without the need to implement other network technologies. A national IoT network could be built on top of 4G today.

THE PREVIOUS HISTORY OF 4G DELAY IN THE UK SHOWS THE NEED TO HAVE A MORE COHESIVE PLAN FOR LPWAN – COMPETITION IS NOT THE ONLY ANSWER. IT IS OFTEN THE CASE THAT THERE IS NO COMPETITION DUE TO THE LACK OF A VALID BUSINESS MODEL, WHICH REQUIRES THE ADOPTION OF MORE COMMERCIAL AND OPERATIONAL CO-OPERATION AND PUMP PRIME SUBSIDISATION.

MAINTENANCE

If an LPWAN is deployed, like LoRaWAN, as opposed to connecting to cellular IoT, the cost will be the same or less and the deployment will own more elements, being responsible for monitoring, support, maintenance and repairs when things go wrong. The advantage is that everything will be pre-integrated and designed to work securely together, and the direct contact to support and maintenance.

SECURITY

Network security needs to be determined a LPWAN solution, while the cellular networks are responsible for the network security.

REQUIREMENT FOR IOT IMPLEMENTATION

IoT is not only about selecting the technology. There are the main requirements that should be part of every IoT implementation.

- Device management: IoT devices need to be secure, communicate efficiently and updated with new features.
- Data management: Data from multiple devices and sensors needs to be collected and processed so cloud-based analytics platforms can use it.
- Edge computing/analytics: Data needs to be analysed in real time allowing quick responses to events.
- Service integration: Integration is crucial for IoT competency, implementing the integration of various IoT component with each other and back-end systems.
- Security: Security is a core element and work to ensure that any potential leaks are stopped before hackers find them.

Successfully implementing the IoT implementation requires distinct IoT solutions ensuring these requirements depending on each business's requirements, expected outcomes, levels of IoT and data skills, and technology infrastructure maturity.

Last, but not least, it is critical that any government initiative, aiming at promoting LPWAN infrastructure, should ensure technology neutrality and a level playing field between cellular vs non-cellular LPWAN.

- Certain rules need to be in place to secure a policy outcome (e.g. consumer protection), but they only apply only to cellular applications - thus leaving a (protection) gap where the IoT service is provided via non-cellular connectivity; and
- Certain rules are in place (but they are not proportionate) – therefore causing an unnecessary burden on those providers using cellular IoT technologies, but not on those that make use of non-cellular connectivity.

REPORT RECOMMENDATIONS

1. A more focused approach and inclusion of LPWAN infrastructure into the Government's overarching telecoms strategy.
2. Analyse the economic opportunity cost for the UK to not have the infrastructure in place compared to other countries.
3. Measure the coverage of LPWAN's in the UK in Ofcom's Connected Nation Report.
4. Share knowledge – publish case studies to inform the market and the consumer.
5. Government should promote and support networks and technologies based on open 3GPP standards.
6. Create a national inventory of state-owned and local government owned infrastructure assets that could be exploited to accelerate deployments.
7. Supply funding to develop planning tools to support LPWAN, including business modelling tools.
8. Create legislation to introduce and encourage a national asset register – both public and private assets – building on trials being carried out by the Geospatial Commission[22].
9. Ensure there is more focus on the benefits of network and infrastructure sharing, including research into the financial and operational benefits.

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