Mobile IoT

Mobile IoT = **TRUSTED IoT**

# MOBILE INTERNET OF THINGS
# LOW POWER WIDE AREA CONNECTIVITY

# GSMA INDUSTRY PAPER

# EXECUTIVE SUMMARY

The growing usage of connected devices, machines and vehicles is making organisations more effective and enriching the lives of individuals. To support the development of this Internet of Things (the IoT), the mobile industry is developing and standardising a new class of technologies that will help network operators to tailor the cost, coverage and power consumption of connectivity for specific IoT applications.

Aimed at business leaders, this paper discusses low power, wide area (LPWA) technologies that will enable connected devices to have a battery life measured in years, rather than days or months. They will also make it cost effective to connect billions more devices, machines and vehicles to their owners, to the Internet and to each other. Strategy Analytics, for example, forecasts there will be well over one billion LPWA connections by the end of 2018 and more than five billion LPWA connections by the end of 2022.

Although the average revenue per LPWA connection is likely to be relatively low, this new technology will enable the mobile industry to add substantial value to the IoT. Analysys Mason forecasts LPWA technologies will generate $970 million globally in connectivity revenue in 2018, rising to $7.5 billion in 2022. By that time, Strategy Analytics estimates network operators could be generating more than $13 billion from LPWA connectivity, as well as significant additional revenues from value-added services, such as data analytics and security.

LPWA connectivity is particularly well-suited to IoT applications, such as environmental sensors, energy meters, logistics tracking and animal and crop monitoring, that require large numbers of widely dispersed devices to send occasional status updates. It can also be used to remotely activate devices, such as sprinklers, lights and air conditioning. As many devices won't be connected to an electricity supply, they need to be run on batteries and be frugal with power. As well as enabling many more devices to be connected, LPWA will be used to provide backup connectivity, or more robust connectivity, for some applications, such as intruder alarms or vehicle accident alerts.

Analysts believe LPWA connectivity will be widely used in utilities, heavy industry and manufacturing, building automation, agriculture and land management, transport and logistics, and smart cities, as well as enabling the development of new kinds of wearable devices for consumers.

**Mobile IoT refers to 3GPP standardised secure operator managed IoT networks. In particular, low power wide area networks designed for IoT applications that are low cost, use low data rates, require long battery lives and often operate in remote and hard to reach locations.**

**What can LPWA offer?**

LPWA technologies will have the following characteristics:

- Very low power consumption – a battery life in excess of 10 years for some applications
- Optimised for brief messages – about the length of an SMS
- Very low device unit cost – the connectivity module will eventually cost a few dollars
- Good coverage outdoors and indoors, enabling connectivity in rural and underground locations
- Easy network installation, reusing existing cellular infrastructure wherever possible
- Scalable – able to support large numbers of devices over a wide geographic area
- Secure connectivity and support for authentication appropriate to the IoT application
- Can be integrated into a mobile operator's unified IoT platform

The mobile industry is standardising three complementary technologies (each with different features) through 3GPP. These are NB-IoT, LTE MTC CatM and EC-EGPRS. 3GPP is on course to complete the initial specifications for LPWA solutions so they can be included in 3GPP Release 13, with the first pilot implementations in early 2016 and full commercial solutions following later in the year. Standardisation will enable the industry to achieve economies of scale and interoperability, as well as enabling mobile operators around the world to source equipment from multiple suppliers.

Mobile operators generally plan to provide LPWA connectivity and related services using licensed spectrum, which will enable more reliable and better quality services than unlicensed spectrum. Mobile operators already have proven, secure and reliable end-to-end IoT platforms, supporting device management, application enablement and data analytics capabilities, which can scale with customers' requirements. Mobile operators can also reuse their existing infrastructure and licensed spectrum to support LPWA networks.

As they already have extensive network infrastructure and backhaul capacity, mobile operators can also typically offer IoT customers national and, where appropriate, international and even global network coverage (through roaming agreements), as well as the benefits of a vibrant ecosystem developing standardised and consistent solutions. By integrating LPWA connectivity into their existing IoT platforms, mobile operators will be able to achieve further economies of scale, lower prices and enable new IoT applications.

**NEXT STEPS**

To support the development of efficient, trusted and reliable IoT services that can scale as the market grows, the GSMA's new Mobile IoT Initiative is seeking to accelerate the commercial availability of LPWA solutions in licensed spectrum. Backed by many of the world's leading mobile operators, device makers, security solution providers, chipset, module and infrastructure companies, the Initiative is facilitating demonstrations, proofs of concept and trials of a selection of complementary LPWA licensed spectrum technologies.

Businesses that work with mobile operators to pilot these technologies early will gain insights into their potential that could lead to a competitive edge over rivals. The GSMA is also providing analysis and feedback to assist its members in standardising the technologies through 3GPP.

# TABLE OF CONTENTS

Across the economy, companies and consumers are using wireless connectivity to make their devices, machines and vehicles both smarter and easier to control. As well as enabling innovative new applications, this emerging "Internet of Things" (IoT) is set to have a profound impact on individuals' productivity and their personal wellbeing.

**To support the development of the IoT, the mobile industry is developing a new class of technologies that will enable network operators to tailor the cost and power consumption of connectivity to the needs of specific applications. Importantly, these technologies will enable devices to benefit from low cost connectivity, while also enjoying a battery life measured in years, rather than days or months, for some applications.**

Known as low power, wide area (LPWA), these new technologies will make it viable to connect many more devices and machines to their owners, to the Internet and to each other. They will complement conventional wide area networks, which make use of 2G, 3G and 4G cellular technologies, and local area networks, such as those enabled by WiFi, Bluetooth and Zigbee.

Low power, wide area technologies typically meet the following requirements:

- Very low power consumption, enabling battery life to reach 10 years or more
- Optimised to transfer brief messages (small, intermittent blocks of data, typically containing a few hundred bytes)
- Very low unit cost for devices
- Good coverage outdoors and indoors
- Easy network installation
- Scalable
- Secure connectivity and support for authentication
- Can be integrated into a unified IoT platform

Aimed at business leaders, this paper explores the value LPWA connectivity and services can bring to individuals, organisations and the economy as a whole. It also outlines how mobile operators managing LPWA networks in licensed spectrum will be able to provide a reliable and robust connectivity solution.

## THE ROLE OF THE GSMA

The GSMA's new Mobile IoT Initiative is designed to accelerate the commercial availability of Low Power Wide Area (LPWA) solutions in licensed spectrum. Backed by many of the world's leading mobile operators, device makers, chipset, module and infrastructure companies, this Initiative is facilitating demonstrations, proofs of concept and trials of a selection of complementary LPWA licensed spectrum technologies. It is also providing analysis and feedback to assist mobile operators and vendors in standardising the technologies.

Given the wide diversity of potential applications, a single technology is not capable of addressing all of the LPWA use cases. The GSMA's Mobile IoT initiative is, therefore, supporting three proposed complementary licensed 3GPP standards: LTE Machine Type Communication, Extended Coverage GSM and Narrow band IoT technologies.

# MARKET OPPORTUNITY

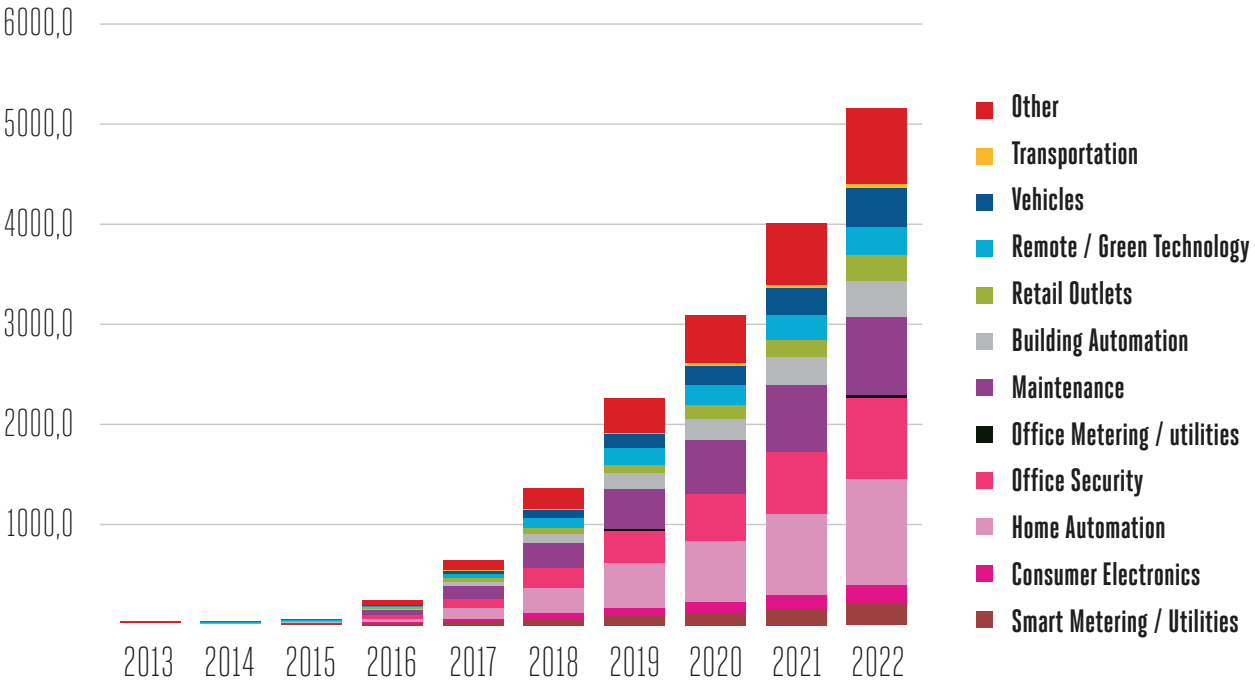
## CONNECTION AND REVENUE FORECASTS

As the value of connectivity becomes increasingly apparent, the number of connected devices, machines and vehicles is growing exponentially. "By 2020, we believe that there will be more than 25 billion objects connected in the world," Stéphane Richard, Orange Chief Executive Officer, noted in a recent statement[1].

Today the emerging Internet of Things (IoT) relies heavily on conventional cellular networks or local area networks, such as WiFi hotspots. The emerging class of Low Power, Wide Area (LPWA) technologies will make it easier and more cost-effective to deploy a wide range of IoT applications. Analysts anticipate the number of LPWA connections is likely to grow gradually over the next two years before surging in 2018 as standardised LPWA technologies gain economies of scale and are proven in the marketplace.

Strategy Analytics, for example, forecasts there will be well over one billion LPWA connections by the end of 2018 and more than two billion by the end of 2019 (see Figure 1), rising to more than five billion by the end of 2022.

**Figure 1: LPWA connections worldwide (in millions)**




**Source: Startegy Analytics**

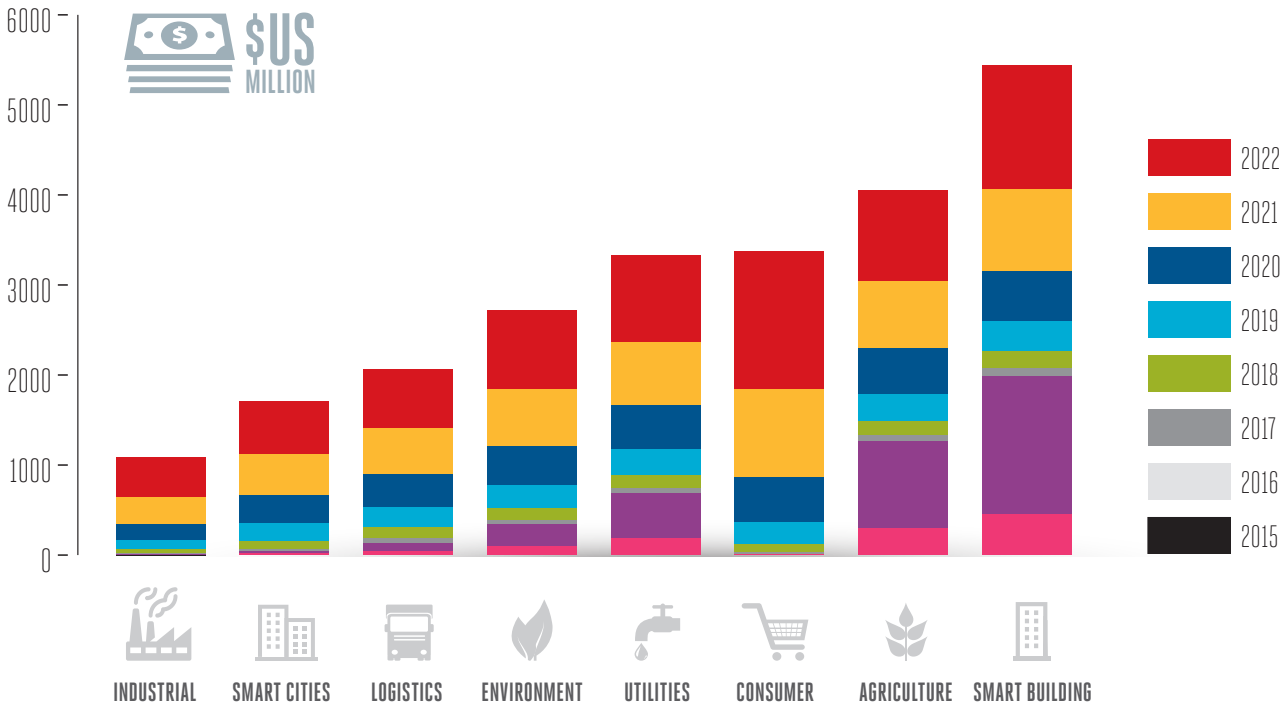
[1] Source: http://www.orange.com/en/Press-and-medias/press-releases-2015/Orange-deploys-a-network-for-the-Internet-of-Things

Analysts anticipate that the vast majority of LPWA connections will be entirely new, rather than substitutes for cellular connections.

Although the average revenue for LPWA connections is likely to be relatively low, this new technology still represents a significant opportunity for the mobile industry to add value to the IoT. Again, analysts expect the market will reach a tipping point in 2018 – Analysys Mason forecasts LPWA technologies will generate $970 million in connectivity revenue in 2018 – more than double the total cumulative revenue for 2015-2017 of $450 million. By 2022, annual connectivity revenue will reach US$7.5 billion, according to Analysys Mason. Strategy Analytics is more bullish, suggesting network operators could be generating more than $13 billion from LPWA connectivity by 2022, as well as significant additional revenues from value-added services, such as systems integration, security and data analytics.

Analysys Mason sees the top three LPWA markets in revenue terms as agriculture and environment (25% of the forecast for 2022), followed by consumer applications, which include pet, bicycle tracking and wearables (21%), and smart buildings (18%) – see Figure 2.

**Figure 2: The leading application categories by global LPWA revenue (US$ million)**



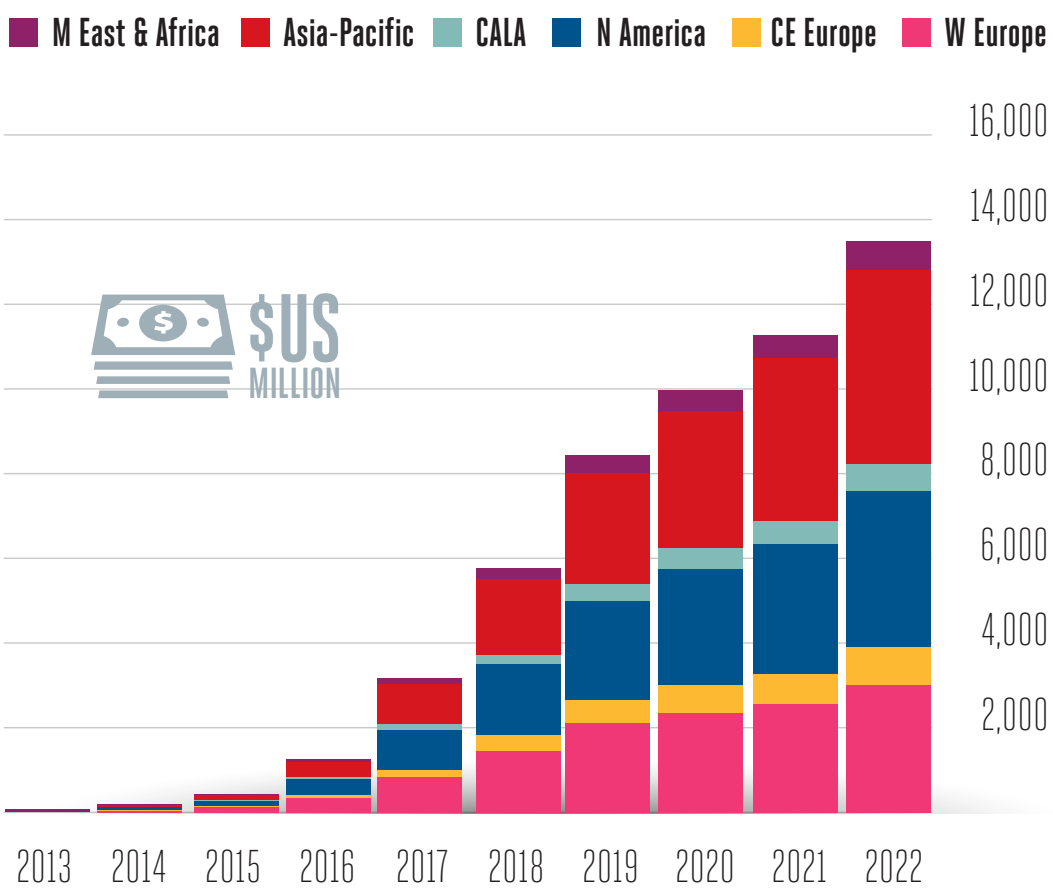

**Source: Analysys Mason, April 2015**

LPWA connectivity is likely to be widely used in both developed markets and emerging markets. In the latter, it could have a particularly significant impact on agricultural productivity and the efficiency of energy and water networks. Uptake is also likely to be strong in those countries building new smart cities or retrofitting IoT applications to existing urban areas.

Early LPWA networks are already being planned in France, the UK, the Netherlands, Spain, Russia, Germany, the US and Singapore, according to analysts.

By 2022, Strategy Analytics anticipates that Asia-Pacific will be the largest LPWA market, worth $4.6 Billion, followed by North America and Western Europe (see Figure 3).

**Figure 3: Forecast LPWA revenue by region (US$ millions)**




Source: Startegy Analytics

# KEY VERTICAL MARKETS AND EXAMPLE APPLICATIONS

Although LPWA technologies will be deployed right across the economy, some sectors will rely more than others on this new class of connectivity.

Once economies of scale kick-in, the cost of LPWA connectivity and LPWA modules is likely to fall significantly below that of alternative solutions, enabling connected devices to be increasingly deployed wherever required.

LPWA is particularly well-suited to applications, such as alarms and metering, which require the connection of widely dispersed devices that only need to send occasional status updates.

The GSMA has identified 26 initial use cases for LPWA (see Figure 4), but many others are likely to be discovered as the technologies mature. As many of the connected devices will typically be off-grid, they need to be run on batteries and be frugal with power. However, some devices that run off the mains electricity supply, such as home appliances, microgeneration and smart grid assets, will also benefit from LPWA connectivity's support for extended coverage and low costs.

**Figure 4: Examples of applications for LPWA connectivity**

### UTILITIES:

- GAS AND WATER METERING
- WATER DISTRIBUTION NETWORK MONITORING
- MICROGENERATION

### INDUSTRIAL

- INDUSTRIAL: EQUIPMENT STATUS, FACTORY CONTROL, PROCESS AND SAFETY MONITORING
- ENERGY INFRASTRUCTURE, OIL AND GAS MONITORING
- VENDING MACHINES

### LOGISTICS

- INDUSTRIAL ASSET, CONTAINER TRACKING: LOCATION AND STATUS UPDATE

### SMART BUILDING

- ALARM SYSTEMS, ACTUATORS
- HVAC SYSTEMS
- ACCESS CONTROL

### SMART CITY

- PARKING SENSORS
- SMART WASTE
- SMART LIGHTING

### CONSUMER AND MEDICAL

- WEARABLES
- WHITE GOODS/APPLIANCES
- VIP TRACKING (E.G. PETS, CHILDREN)
- SMART BICYCLES
- ASSISTED LIVING
- CLINICAL REMOTE MONITORING

### AGRICULTURE & ENVIRONMENT

- AGRICULTURAL APPLICATIONS (FISHING AND LAND MONITORING; LIVE STOCK TRACKING)
- ENVIRONMENTAL MONITORING (POLLUTION, NOISE, RAIN, WIND, RIVER FLOW SPEED, HEALTH HAZARD, BORE HOLE, ETC) - DATA COLLECTION AND NEAR REAL TIME MONITORING)

**Source: GSMA/Analysys Mason**

> *For many businesses, low power, wide area connectivity will be a game-changer, enabling a high degree of automation and yielding valuable insights that can save precious time and very significant sums of money*

**Angel David Garcia Barrio,** Vice-President M2M, Etisalat

As well as being used to greatly extend connectivity, LPWA will be harnessed to provide backup connectivity, or more robust connectivity, for some applications, such as intruder alarms or vehicle accident alerts.

"For many businesses, low power, wide area connectivity will be a game-changer, enabling a high degree of automation and yielding valuable insights that can save precious time and very significant sums of money," said Angel David Garcia Barrio, Vice-President M2M, Etisalat.

## UTILITIES

LPWA technologies are particularly well suited to metering and monitoring applications that require the periodic transmission of small amounts of data. They will, therefore, be used to meter water, gas and electricity usage of individual premises, as well as to detect leaks or unauthorised siphoning.

As a low cost, low power solution, LPWA connectivity will enable utilities to deploy sensors far more widely than in the past. For example, LPWA networks could enable detailed monitoring of wind turbines, solar panels, pipelines and electricity grids. LPWA will also be used to enable building and land owners to monitor the performance of microgeneration plants.

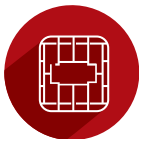
Water utility companies using smarter solutions could save between $7.1billion and $12.5 billion each year[2], according to Strategy Analytics, which estimates utilities worldwide will spend $2.3 billion on LPWA solutions by 2022.

## MANUFACTURING AND HEAVY INDUSTRY

In manufacturing and heavy industries, such as oil, chemicals and steel production, any downtime can be very costly. Low cost, low power wireless sensors can be used to monitor a vast range of equipment and components and detect signs of potential faults before they can disable a production line. Performance data collected periodically by wireless sensors can also be used to optimise the design of machines, and detect and reduce wastage.

## BUILDING AUTOMATION

Both businesses and consumers are increasingly deploying technology to make offices and homes more secure and less energy intensive. Although some smart building applications, such as video surveillance, require high bandwidth connectivity, others are well suited to LPWA connectivity.



For example, low power connected sensors can alert the building owner to maintenance issues, such as the need to change fire alarm batteries, restock a vending machine or a fault in a dishwasher. Or connected sensors can be used to perform automated tasks, such as switching off the lights and heating in unoccupied rooms. LPWA connectivity can also

[2] Source: Water 20/20 Bringing Smart Water Networks into Focus, SENSUS 2012.

be used as a backup in case a building's primary broadband connection fails. For example, a LPWA network could alert the homeowner and/or emergency services if a sensor detects that the property's fixed-line connection has been disabled. Some security solutions may use LPWA networks to connect each individual sensor directly to the monitoring system, as this configuration would be harder for an intruder to disable and easier to install and maintain.

As well as being low cost, LPWA networks are typically designed to penetrate the walls of buildings enabling reliable indoor connectivity. Strategy Analytics forecasts that LPWA building automation solutions will generate $3.2 billion in service revenue globally and $1.6 billion in network revenue in 2022.

## AGRICULTURE AND LAND MANAGEMENT

LPWA connectivity will make it viable for farmers, land managers and environmental agencies to track the health and whereabouts of both livestock and wild animals. Cattle, for example, could be fitted with a sensor that will send an alert if the animal's movement is out of the ordinary.

Such sensors could also be used to monitor soil conditions, temperature and humidity, helping farmers to determine when fertilizer or pest control treatments are needed and automatically activating irrigation systems, as required.

## TRANSPORT AND LOGISTICS

Today, GPS and conventional cellular networks are used to monitor the location of vehicles, large boats and other valuable mobile assets with large on-board batteries. But lower value mobile assets, such as parcels, luggage, crates and packages, are still largely unconnected and their location is periodically registered by scanning a barcode. LPWA connectivity will make it viable to track the location of these lower value items.

For example, a LPWA sensor on a crate could be configured to send its location and temperature to a logistics company three times a day, enabling the distributor to ensure fresh produce is delivered on time and in good condition. Similarly, a tool hire company could equip its inventory with LPWA sensors that will periodically transmit information on their location and condition to a central hub. Similarly, a hire bike could be equipped with a LPWA sensor that could be configured to transmit its location on request.

## SMART CITIES

City administrations need to monitor and maintain a wide array of assets dispersed across urban and suburban areas. LPWA networks could help local government control street lighting, determine when bins need emptying, identify free parking spaces, levy tolls and congestion charges and monitor the condition of roads, bridges, sewers, manhole covers, cables and other vital infrastructure.

For example, LPWA connectivity could be used to dim street lighting when there are no pedestrians or vehicles in the vicinity or change traffic signals according to the level of congestion. Municipalities could also use LPWA sensors built into the road or kerb to flag to motorists where car parking spaces are available.

They could even use connectivity to dynamically change the price of parking in line with the available supply. At the same time, trains, buses and other forms of public transport could use LPWA connectivity to transmit regular updates on their position. LPWA sensors can also be used for a wide range of environmental applications, such as monitoring local air quality, detecting local flooding or tracking when rodent traps have been activated.

### NEW KINDS OF WEARABLES

Today, most wearable devices, such as smart watches and fitness bands, rely on a short-range connection to the user's mobile phone to connect to the Internet. But LPWA technology will make it feasible for such devices to have their own long-range connectivity, enabling the development of new kinds of devices. For example, LPWA will enable the development of child trackers and pet collars with long battery lives that can send an alert when the wearer is outside a specific geographic area. Similarly, LPWA networks could also be used for health applications, such as transmitting information on the vital signs of people suffering from chronic or age-related conditions, such as diabetes and Alzheimer's disease.

# TECHNOLOGY PERFORMANCE

As the potential applications for LPWA connectivity are very diverse, the mobile industry plans to standardise several complementary network technologies, each with specific strengths, through the 3GPP standards mechanism. However, as discussed in the introduction, each of these technologies will have the same broad characteristics:

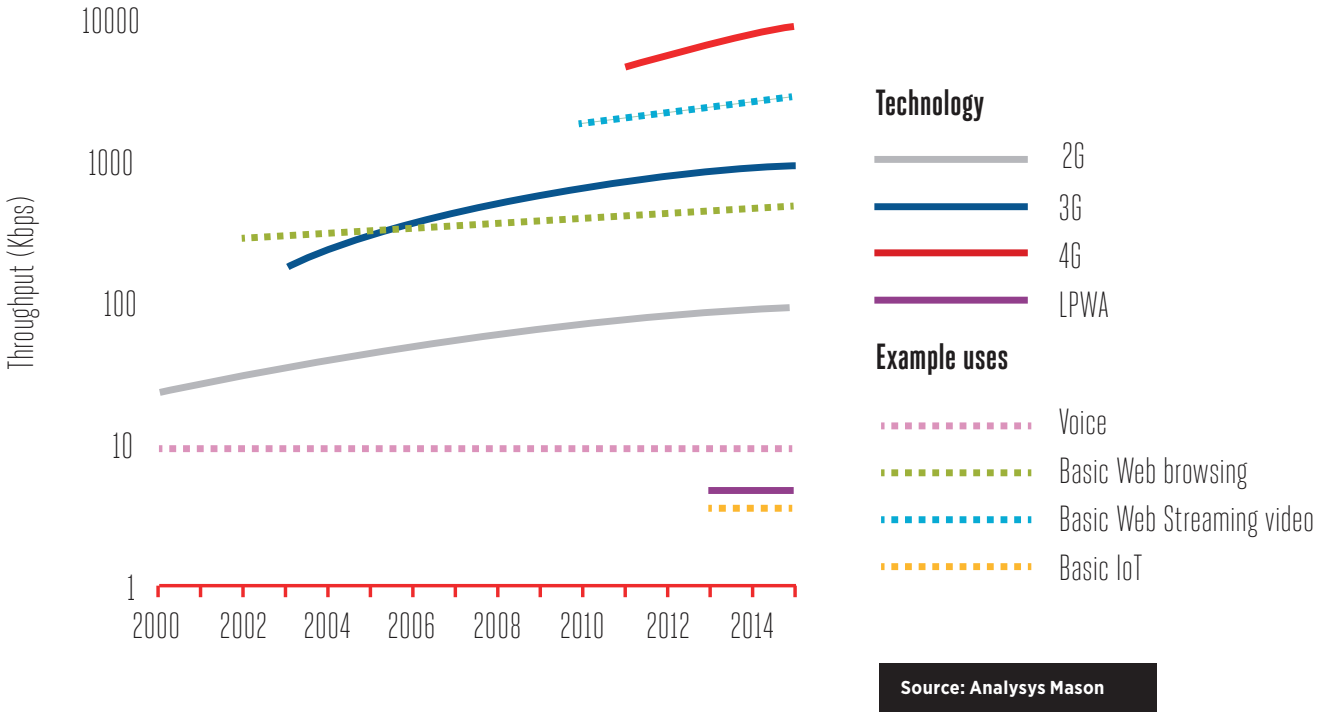
- Very low power consumption
- Optimised for brief messages
- Very low device unit cost
- Good coverage outdoors and indoors
- Easy network installation
- Scalable
- Secure connectivity and support for authentication
- Ability to be integrated into a unified IoT platform

## VERY LOW POWER CONSUMPTION

Ideally, the battery in some LPWA-connected devices may never need to be changed – it will last as long as the equipment itself. That's important because LPWA applications need a reliable power supply to keep maintenance costs down and allow deployment in remote or inaccessible locations, such as wildlife reserves, or in underground or elevated locations, such as electricity pylons and wind turbines. For some applications, batteries will need to be compact enough to be used in small form factor devices, such as pet collars or fitness bands.

Some of the LPWA technologies under development can potentially offer a battery life of between 10 and 30 years in scenarios when the device only needs to transit 200 bytes (approximately the equivalent of an SMS) once a day at relatively slow throughput speeds (see Figure 5). Moreover, this kind of performance can be achieved with a 5Wh battery.

**Figure 5: Low power, wide area networks are designed for low-bandwidth applications**




Source: Analysys Mason

### OPTIMISED FOR BRIEF MESSAGES

LPWA networks are typically designed to deliver brief, intermittent messages, typically containing a few hundred bytes of data. The networks are optimised to efficiently handle these short messages (and the related overhead for connection setup, interrogation, acknowledgement and the like), thereby maximising capacity and minimising power consumption. While some connected devices may be used primarily to report data, a bidirectional link will enable a device to be controlled remotely. A two-way connection can also improve the reliability of data transmission (through acknowledgments), and enable authentication mechanisms, and even remote software and firmware updates and patches.

### LOW DEVICE UNIT COST

As some organisations will want to deploy thousands or even tens of thousands of LPWA connected devices, the cost of each unit needs to be very low. As LPWA technologies gain economies of scale, the mobile industry is aiming to ensure that most LPWA modules will eventually cost just a few dollars, making it viable to deploy connectivity very widely.

### EASY NETWORK INSTALLATION

Mobile operators should be able to keep the cost of deploying LPWA coverage down by reusing some of their existing cellular infrastructure. For example, many LPWA deployments are likely to piggyback on operators' existing cell towers, backhaul network, data centre locations, Internet access points, licensed spectrum assets and operational support systems. Wherever possible, mobile operators will also seek to update their LPWA networks over the air using software, which will help to minimise the cost of deployment.

### GOOD COVERAGE OUTDOORS AND INDOORS

Most mobile operators are likely to deploy LPWA networks in low frequency spectrum (less than 1GHz) meaning only a modest number of base stations will be needed to cover a wide geographic area, minimising network deployment costs, and, thereby, keeping the cost of connectivity low. However, the denser the network, the more accurate location information will be for mobile applications, such as pet or child tracking. As some applications will require the connected equipment to be located inside a building or underground, LPWA networks are also designed to penetrate walls, ceilings and floors. Again, the use of low frequencies will help in this regard. At the same time, the use of higher frequency spectrum is also under consideration, to support some of the applications where a small module is an important requirement, for example, wearables.

### SCALABLE

Mobile operators plan to build LPWA networks in a way that will enable them to scale quickly to accommodate a rising number of connected devices. The network deployment will be able to support a "grow as you go" approach where operators can deploy a LPWA network with minimum capital investment and limited capacity, and then upgrade the network as the number of connected devices rises.

Again, the use of licensed spectrum will help to ensure that LPWA networks are scalable, as they won't have to compete for bandwidth with other wireless networks.

## SECURE CONNECTIVITY AND SUPPORT FOR AUTHENTICATION

Mobile operators are ultimately likely to offer LPWA connectivity both with SIM-based security and embedded SIM-based security, enabling customers to control access to the network, barring specific devices, where appropriate. Any sensitive data will need to be transmitted via a secure communications link between the end device and the access point to the Internet. Mobile operators will be able to provide LPWA connectivity with:

- Secure provisioning of device identity, network authentication credentials and communication cryptographic keys.
- Physical protection of device identity, network authentication credentials and communication cryptographic keys.
- Strong authentication of the device and network.
- Strong (and efficient) cryptography to provide secure communication channels.

Without a secure link, an IoT application will be more vulnerable to attacks, such as spoofing, where a fraudulent end device injects false data into the network or a fraudulent access point hijacks the data captured by a device.

## ABILITY TO BE INTEGRATED INTO A UNIFIED IOT PLATFORM

Ideally, a LPWA network will be integrated into a broader IoT platform that also supports other wireless access technologies, such as 3G and 4G cellular. Such a platform can enable a wide range of connected devices to exchange information with other devices and servers, as appropriate, enabling the development of innovative services that combine data from multiple sources.

Employing a central technology-agnostic platform, rather than siloed systems, should also increase efficiency and reduce costs for the mobile operator and its customers alike.

# OPERATOR-MANAGED LPWA

Mobile operators around the world are increasingly looking to integrate LPWA technology solutions into their broader Internet of Things (IoT) service offerings. Although new players are also venturing into this market, existing mobile operators have several competitive advantages.

> *"With our extensive experience and deep expertise in managing cellular networks, we can provide our customers with highly secure connectivity for a wide range of Internet of Things applications"*
>
> **Cameron Coursey,** VP Product Development, AT&T.

Mobile operators already provide proven, secure and reliable end-to-end IoT platforms, supporting device management, subscription management, billing, roaming, application enablement and data analytics capabilities, which can scale with customers' requirements. For example, mobile operators can use very compact removable or embedded SIM cards, either in individual modules or in gateways, to securely provision and store device identity and credentials, and to authenticate devices connecting to the network and ensure they are legitimate. Mobile operators can also analyse the data being captured by LPWA devices, detecting unusual behaviour that can indicate a problem or a security threat, or patterns that can help businesses improve efficiency and effectiveness, such as the frequency of faults in various areas of an industrial plant or bottlenecks in a utility network.

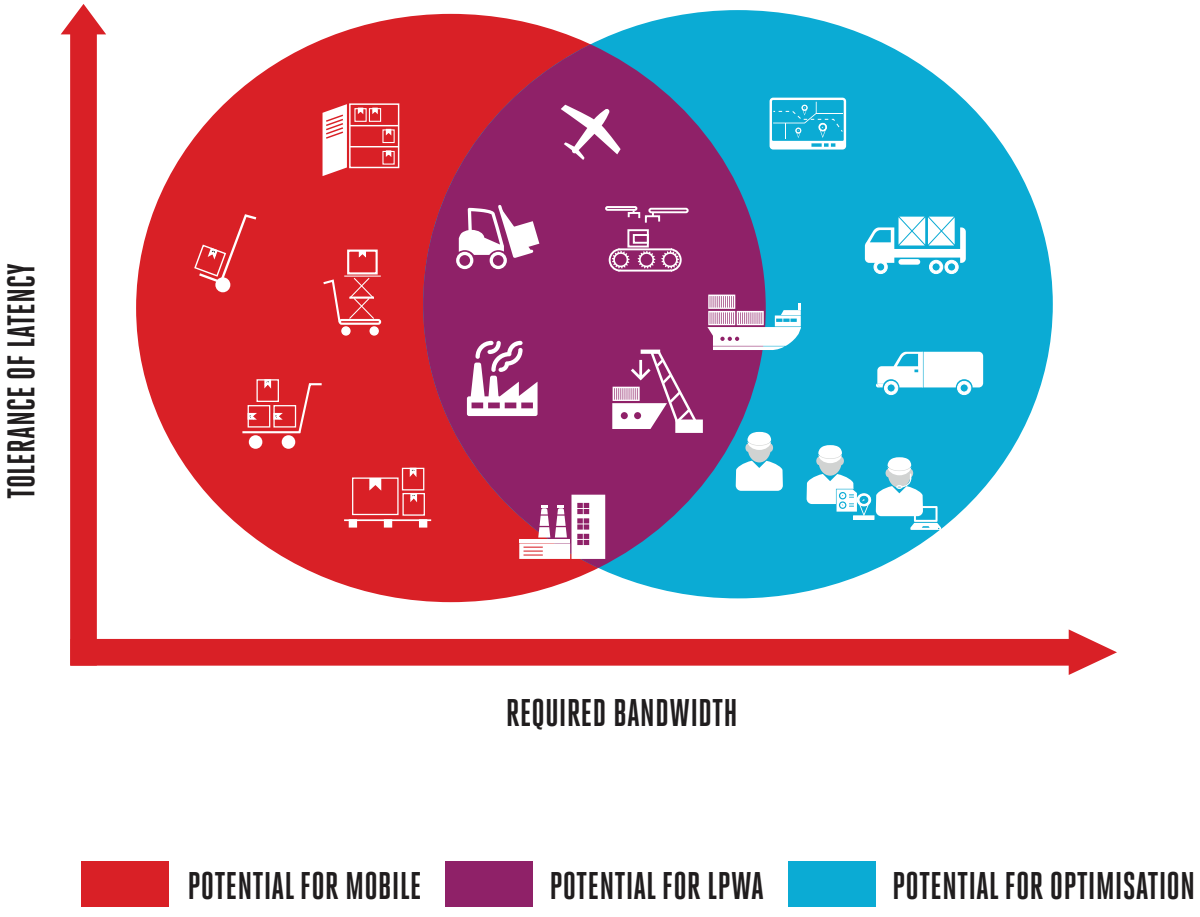
Mobile operators have a long track record of managing large numbers of SIM-enabled devices both in their domestic markets and abroad through roaming agreements with other operators.

Mobile operators will also reuse their existing infrastructure and licensed spectrum to support LPWA networks. As they already have extensive tower networks and backhaul capacity, mobile operators can also typically offer IoT customers national and, where necessary, international and global network coverage (through roaming agreements), as well as the benefits of a vibrant ecosystem developing standardised and consistent solutions.

By integrating LPWA connectivity into their existing IoT platforms, mobile operators will be able to build further economies of scale, lower prices and enable new IoT applications. Machina Research notes that if mobile operators "could integrate LPWA into their [existing IoT] solution, they would be able to optimise the connections to all of the devices in order to minimise costs, minimise the impact on their existing networks and to offer the most comprehensive and effective solution to their customers."

Figure 6 shows Machina Research's view of how a mixture of conventional cellular and LPWA connections could be used for a supply chain monitoring application. Whereas some of the connections will require the significant bandwidth provided by cellular, others will be better suited to LPWA. Machina envisages that mobile operators will play an important role in the area of overlap (marked in green), selecting the best technology for the specific set of local circumstances.

**Figure 6: A combination of LPWA and cellular connectivity could be used to monitor a supply chain**




Source: Machina Research

## LICENSED VERSUS UNLICENSED SPECTRUM

Although unlicensed spectrum is freely available and, therefore, superficially appealing, it also has significant drawbacks. As it can be used at no cost and is open to anybody, unlicensed spectrum is subject to interference and congestion, meaning it can't be relied upon to deliver a pre-defined quality of service. In some markets, regulatory restrictions might also apply to the use of unlicensed spectrum, making it difficult to generate global economies of scale.

> *"NB-IoT has strong industry support as an effective global standard for LPWA connectivity. It will deliver a step-change in the number and type of things that can be connected to the Internet by offering efficiency, the reliability of licensed spectrum, low cost, secure connectivity and a long battery life."*
>
> **Luke Ibbetson,** Vodafone Group R&D Director and Chair of the GSMA NB-IoT Forum

Given the limitations of unlicensed spectrum, mobile operators have a clear long-term preference to employ licensed spectrum for LPWA, as this approach will enable them to build a sustainable long-term global IoT market presence. Licensed spectrum can be dedicated to a specific use, eliminating interference, and can be harmonised internationally, enabling equipment suppliers to sell the same modules across multiple markets and achieve economies of scale. Furthermore, as spectrum is typically licensed to a single entity (such as an operator) in a given area (such as city, province, or country) its use is tightly controlled by the licensee. As a result, LPWA technologies in licensed spectrum can be deployed in a simplified and cost effective manner, while meeting key customer requirements, such as battery lifetime, coverage and security.

### OPERATOR SERVICE PLATFORMS

Mobile operators can support an IoT deployment on multiple different levels. Beyond simply providing connectivity, they can also provide provisioning, authentication, security, billing, device management, location-based services, application enablement and data analytics services. In some cases, mobile operators are likely to provide these capabilities to LPWA users as cloud services that can easily be accessed using application programming interfaces (APIs).

### MANAGED NETWORKS

Mobile operators will actively manage LPWA networks, as they do their existing networks. By continually aligning network resources in line with demand, network operators can minimise the impact of congestion and provide a specific quality of service, where required.

### CUSTOMER EXPERIENCE & SERVICE

Mobile operators can harness their existing customer service capabilities to support the use of LPWA connectivity. Operators typically have dedicated teams to provide technical support to both consumer and enterprise customers.

# STANDARDISATION

Through the 3GPP standards body, the mobile industry is standardising several different LPWA technologies. 3GPP is on course to complete the initial specifications for LPWA solutions so they can be included in 3GPP Release 13, with the first implementations in early 2016 and full commercial solutions following later in the year.

## THE NEED FOR A FAMILY OF TECHNOLOGIES

No single technology is ideally suited for all the different potential LPWA applications, market situations and spectrum availability. For example, the existing cellular infrastructure, which could influence the choice of LPWA technology, varies across countries and regions. Moreover, some applications may require a high degree of mobility, but low bandwidth, while other applications may require a faster data throughput from a fixed location. For some applications, very low module costs will be critical, while for others, performance considerations may outweigh cost considerations.

Mobile industry is therefore standardising three families of technologies through 3GPP and preparing deployment in licensed spectrum: LTE Machine Type Communication (4G), EC-EGPRS and Narrowband IoT Technologies.

For example, a smart city application, such as waste management, may employ a LPWA technology that can be deployed on the existing 2G networks, further enhancing the already extensive geographic coverage. A different technology might be used for water metering applications, which have some of the most extreme requirements, such as a 15 year battery life and connectivity in underground locations. Asset tracking applications that need international roaming, enhanced location capabilities, and support for a relatively high number of messages triggered by certain events might employ another technology again.

## THE IMPORTANCE OF STANDARDISATION THROUGH 3GPP

All of the network technologies that have been standardised through 3GPP, including 2G, 3G and 4G, have benefitted from widespread support from the mobile industry. Multiple vendors produce competing, yet interoperable, equipment enabling mobile operators and their customers to benefit from economies of scale, while avoiding being locked into a single vendor.

# NEXT STEPS

To speed up the development of LPWA technologies that can be used in licensed spectrum, the GSMA's full and associate members have proposed and agreed a new "Mobile IoT Initiative".

Through this Initiative, mobile operators are working with equipment vendors and 3GPP to enable commercial deployment as early as possible. That will enable the mobile industry to soon meet the pent-up demand for low power, wide area technologies outlined in this paper.

Businesses looking to harness the benefits of LPWA connectivity should work with mobile operators to begin evaluating these technologies now with a view to adopting these solutions as they are standardised and are available in uncongested licensed spectrum. Businesses that pilot these technologies early will gain insights into their potential and gain a competitive edge over rivals.