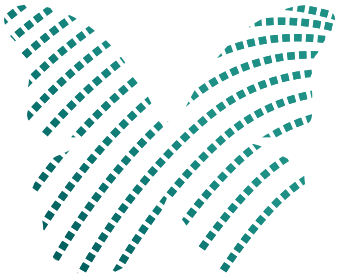

# SIGFOX

One network A billion dreams

## M2M and IoT redefined through cost effective and energy optimized connectivity

Whitepaper

# Introduction

The success of the Internet and the World Wide Web has resulted in more and more kinds of fixed and mobile computing devices being connected, and efficient wireless communication has therefore become of critical importance. «Although this first Internet/Mobile revolution changed the world profoundly, the next disruptive development, in which the majority of data traffic will be generated by 'things' rather than by human initiation, has the potential to change it even more.

This "Internet of Things" (IoT), or in some cases also referred to as "Machine to Machine" (M2M) communication, is well underway - after all, microprocessors are to be found in all manner of "things", domestic appliances, credit cards, cars, passports, CCTV cameras in your city, the elevator in your building, and many more. Add the powerful ingredient of Internet connectivity - or the efficient and affordable ability to be read by an Internet connected device- mixed with applications and services that make use of the data gathered by this vastly expanded network, and the next technology revolution becomes visible on the horizon.

***"The data are no longer in the computers. We have come to see that computers are in the data"***

Authors of "Trillions"

However there's a potential gap between a possible brave new technological world and a reality that could improve the quality of life of a significant portion of humankind. Whether the Internet of Things will be able to deliver in a satisfying and economically affordable way will depend on how the emerging M2M ecosystem, is architected.»*

This whitepaper describes how we at SIGFOX have redefined the network required and the access to Big Data generated to enable enormous scalability, whilst taking into account the financial and power constraints, which have thus far shelved many good ideas in an early stage.

* « The Executive's Guide to the Internet of Things », Jason Hiner, CBS Interactive Inc.

# Executive summary

Clearly the Internet of Things has its benefits, determining whether the technology is right for your organization, and where to start with it, takes an analysis of the business needs and how these can be resolved using Big Data. «Typically this starts with the question “do you have assets in the field” and if the answer is yes there is a conversation to be had as to whether you have full visibility and awareness of what those assets are doing.» *

The main reasons why companies consider IoT are listed in Figure 1 and show that cost savings are an important factor however customer service and sustainability through new business are rated even higher.

- ***Low energy consumption***
- ***Long range***
- ***Ease of use***
- ***Extremely cost effective***

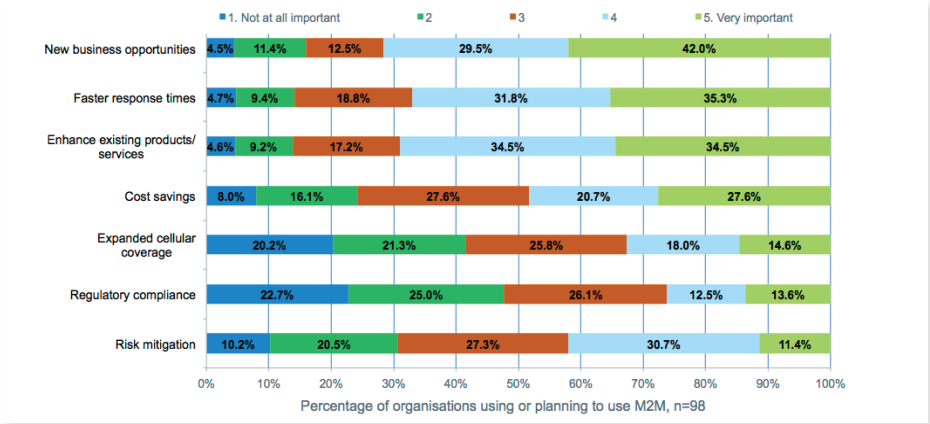


Figure 1. Business reasons to implement IoT - CBS Interactive survey

A result of IoT often mentioned is a painless service or the sensation that the service supplier is actively engaged in the customer relationship leading to better user experience, clear brand benefits and competitive edge.

«If the last 10 years of technology development were about making it easier for companies and people to exchange information with one another – Google, Skype, Dropbox, and so on – the next 10 years will be about making it possible, cost effective and easy for the physical world to transmit data to the Internet.» *

In hindsight however many companies currently deploying connected objects are struggling with the major drawbacks of traditional network solutions: steep pricing, the high-energy consumption and the complexity of deployment and maintenance.

* « The Executive’s Guide to the Internet of Things », Jason Hiner, CBS Interactive Inc.

The major conclusion derived from, sometimes painful, experience is that existing network solutions were not built for low throughput Machine-to-Machine (M2M) and Internet of Things (IoT) applications, and therefore cannot provide an adequate solution. An optimal solution will at least need to provide answers to the following requirements:

- **Energy consumption** as many assets are battery powered
- **Long range** to avoid high network and subscription costs
- **Ease of use** both for asset and back office system integration
- **Extremely cost effective** initial investment and running costs
- **Secure and reliable** to avoid interruptions and vulnerability

In this whitepaper we describe how SIGFOX provides answers to the above. Once you have understood the challenges it will become clear why we have had to purposely build a disruptive IoT network solution to meet these exact requirements.

***Because of improved visibility, they only need to go to where the attention is needed, that's a hard ROI for operations***

# Growing connectivity problems

The ability to have physical objects communicate allows for a multitude of opportunities, from optimization of existing business processes to the creation of entirely new business cases.

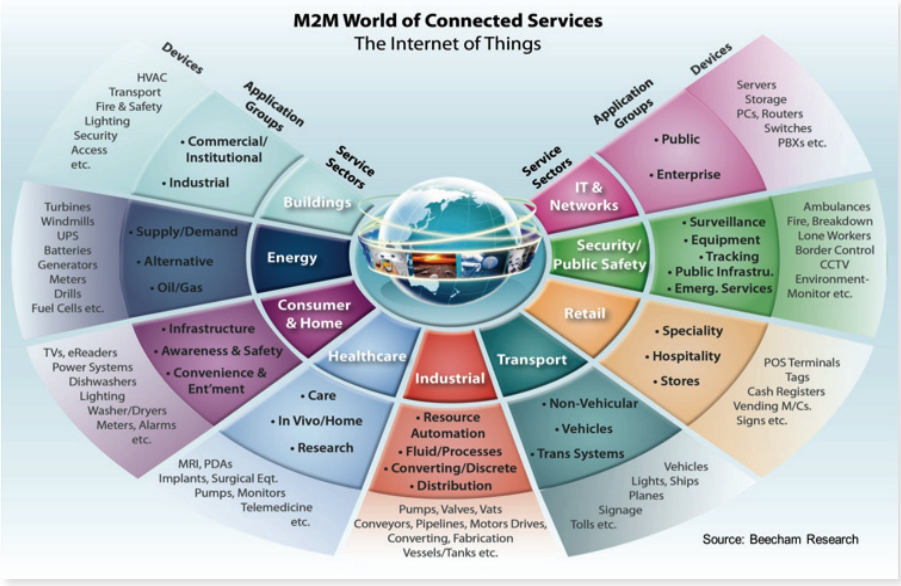


Figure 2. Application domains for M2M and IoT – Beecham Research

The service sectors and application groups shown in Figure 2 are wide spread and cover almost everything from industrial M2M (Machine-to-Machine) solutions to consumer oriented IoT (Internet of Things) applications.

***M2M and IoT will feature orders of magnitude more nodes than " human-to-human ", most of which will create low bandwidth, upload biased traffic.***

The use of connected objects in many industries is not entirely new, but the growth is accelerating very rapidly. Global object connections are estimated to have a potential increase from two billion at the end of 2011 to 18 billion at the end of 2022 and in terms of revenue the connected objects industry is set to have a potential growth from $200 billion in 2011 to $1.2 trillion in 2022, a CAGR of 18% .[2]

***"The momentum of the Internet of Things is now building.***

***The Internet changed our lives, and the Internet of Things will change us again."***

Jason Hiner

The connected objects are in many cases simple objects, often isolated and running on battery, with sensors that detect certain events or information and transmit that data to an IT system. The information can be anything from energy consumption, temperature, humidity, location, presence information, health data, and many more. These applications tend to have very different network and data transmission requirements with regards to connectivity than traditional network clients, such as mobile phones and computers.

A low throughput object – in terms of data transmission - would be expected to have very low power consumption and a reduced connectivity cost as the objects only send small messages once in a while. The challenge for traditional connectivity network providers is their ability to truly deliver on these aspects whilst they have not been built for this kind of network usage.

The lack of adapted connectivity solutions for low throughput objects already has proven to be and will remain to be one of the major obstacles in achieving the expected industry growth. Both network nomenclature and bill of material or component cost are high priorities and need to be rethought to allow for objects with relatively low throughput and long deployment in the field.



[2] http://www.machinaresearch.com/m2mglobal2022.html

# Expen$ive and energy consuming

Whilst consumers continue to demand more bandwidth to satisfy their needs for information driven by numerous apps, the existing and traditional connectivity solutions continue to develop and roll out their technology, networks and modems for high throughput applications. The typical network client profile, targeted for these solutions, both in B2B and B2C, is a computer or a mobile phone.

***Whilst established providers of connectivity focus on 4G deployment and licensing we focus on low throughput and subscriptions for objects with little power.***

As a result telecommunications operators have spent years on building out more and more advanced networks to cater for the growing needs of mobile devices, from 2G, to 3G and now LTE/4G. Lately the impact of their focus and priorities has become bluntly visible as early stage 2G networks are even announced to be closing down resulting in huge challenges for service providers that have deployed millions of connected objects using this communication backbone.

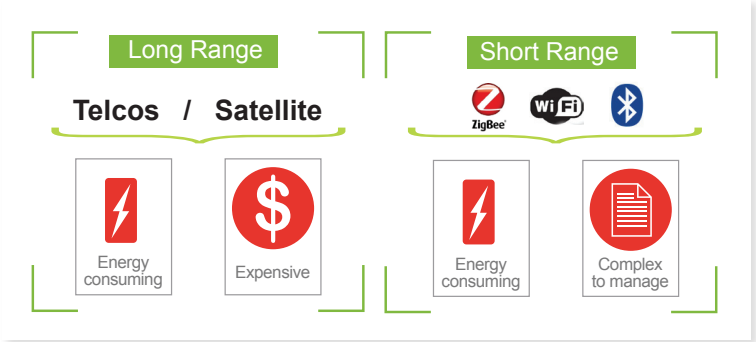


Figure 3. Long range and short range connectivity.

Clearly there are great advantages for certain use cases – like fleet management - for which the current communication solutions provide good and efficient solutions even if they were primarily not intended to serve the specific business needs of their current installed base. Let's not forget that technologies like TDMA - GSM - and CDMA were put in place to serve a voice driven need, and even SMS in in its early days was a control channel attribute and never intended to become an industry on its own.

As a result early adaptors of telematics virtually had no choice and accepted the technology and financial limits resulting in many good initiatives being shelved. Nowadays it has become painfully clear that M2M and IoT applications have very different

requirements than mobile phones, and the advances within the telecommunication networks are only making the problem worse for low throughput applications. The focus seems to be on increased bandwidth for a relatively limited human audience – without a doubt however also annoyed with ever increasing monthly cost and limited battery life – when compared to the billions of objects, and not on a couple of bytes per day for a fraction of the existing wireless subscriptions. Despite the fact of modem manufacturers coming down substantially in price over the past few years, assisted by the quite large demand for mobile phones, most business models involving the much larger objects pool do not fly with even half of the current component or chipset pricing.

***Connecting millions of objects without roaming restrictions and enabled by a very small, extremely low power modem, required our team to "think out of the box"***

Satellite connectivity has the advantage of providing a very rich coverage, even in remote areas, but the costs are even higher when compared to telecommunication network services which rules out satellites for M2M and IoT from the start.

Also from a technological perspective, both telecommunication networks and satellite connectivity are typically designed for a more or less constant communication between the network clients and the network itself. Worse case is when network clients are still communicating with the network even when there is no actual data to send. The obvious impact of the required constant communication is a very high-energy consumption, which besides having a negative climate impact will cause the batteries on non-wired objects to run out quickly.

Short-range connectivity solutions were not intended for low throughput applications either. They are bandwidth intensive and therefore consume a lot of energy.



The short-range connectivity solutions also have the inconvenience of being very complex to manage. Wi-Fi connectivity for instance requires the configuration of each object based upon which Wi-Fi network it will need to connect to. Others like ZigBee infrastructures require a high number of concentrators, resulting in high complexity to install and maintain and even higher energy consumption. For example each ZigBee based application requires the deployment of specific local infrastructures, which makes it very expensive and cumbersome to deploy.

When used for connected objects, the short-range connectivity solutions also have the drawback that monitoring of each object is complex if at all possible. If for instance objects are connected in local mesh networks and not directly to an operated network, it then becomes extremely complex to manage service level agreements.

To conclude : firstly large deployments of M2M and IoT connected objects do require long-range operated networks if not only for the advantage of providing visibility of the status of each, and many due to their coverage area, connected object. Secondly these objects require radios and components, which consume power in the order of low double digit Milliwatts to allow for many years of maintenance free operation.

# Connectivity redefined

The DNA of the ideal solution for low throughput connectivity requires an entirely new network solution, based upon a clear set of specific requirements. Depending on the service sector of choice the below criteria will be of primary importance.

- **Low cost** and thus allowing for any sort of object to be connected in high volumes
- **Low energy consumption** to increase battery life expectancy, lower maintenance (TCO), minimize climate impact
- **Ease of use,** both in regards to integration in objects but also in regards to object management and integration with IT systems
- **Long range,** to avoid having to deploy complex local infrastructures and to reach all objects
- **Operated,** to facilitate service level monitoring and object management
- **Frequency-independent,** for world-wide coverage and adaptability
- **Embedded subscriber identification,** to avoid additional cost and management of SIM cards
- **Penetration** should be deep and allowing for underground or otherwise stringent structural environment connectivity

The SIGFOX network and patented IP has been built to answer to these exact requirements and is 100% dedicated to fulfilling the needs of low throughput objects on a global basis.

# What is SIGFOX

SIGFOX provides an end-to-end solution for your communication chain, from your objects through to your information system, with unprecedented pricing models and low energy consumption.
As a network operator SIGFOX operates fixed-location transceivers enabling your objects to be connected "out of the box". However contrary to the telecommunication networks, the SIGFOX transceivers and the entire SIGFOX connectivity solution has been developed, built and deployed to only serve the low throughput M2M and IoT applications. As an operated long-range network, SIGFOX provides connectivity without the need to deploy specific network infrastructures for each application. Unlike other narrow band or white space solution providers we do not require our customers to invest in network equipment, the SIGFOX network is simply available to any object equipped with our certified connectivity solutions.

From an application point of view, the SIGFOX connectivity solution functions as follows:

- SIGFOX compatible modems are integrated within the physical objects by our certified partner network
- The objects instruct the modems to send messages whenever and wherever needed
- The transmitted data is picked up by the SIGFOX transceivers, and routed to our managed service
- The SIGFOX servers verify the data integrity and route the messages to the application's IT system.

An existing use case is a fire detector application where the smoke detector object contains a SIGFOX compatible modem and transmits daily heart beats (keep alive) to ensure the alarm will work when most needed and in the event of a fire sends alert messages. The 3rd party application is connected to our managed service through a simple and standards based API to receive the messages. The business benefit for the service provider is to optimize their customer service and retention in terms of alerts when the device is not operating whilst the consumer can have peace of mind to be warned when it is most needed. A derived benefit is to alert both the fire department and the subscriber in case of absence per SMS.

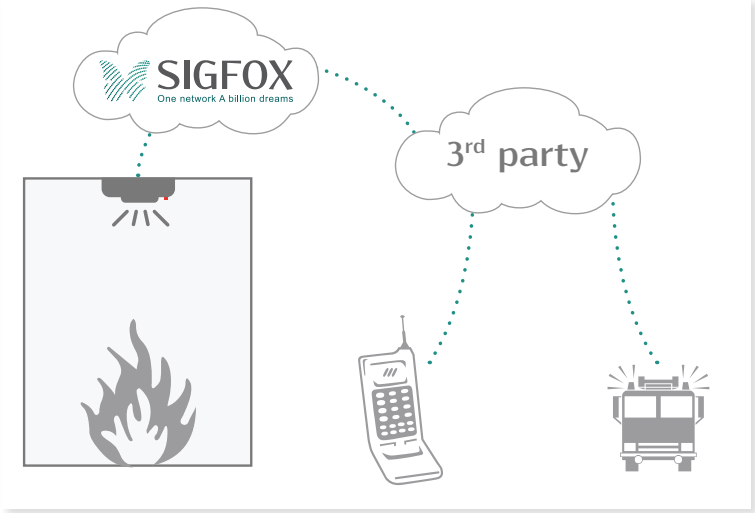


Figure 4. Fire detector solution

# A new approach for objects

## Ease of use

As an operated network there is no specific local network equipment to install when using SIGFOX. The network is always available and ready to use.

There is no need for complex and expensive platforms and tools to manage the connectivity for the devices. Easy to use integration APIs and management applications are included in the connectivity package.

## Operated

All objects are directly connected to the network, which enables a clear overview of the status of each object and thus the correct management of service level agreements and maintenance.

## Long range

The SIGFOX network technology allows for a very long range between objects and transceivers, which enables the network to easily cover large areas and reach underground and buried objects.

The SIGFOX technology allows for better penetration than traditional cellular networks such as GSM, while still ensuring high reliability and radically lower energy consumption.

***Average power consumption for an energy meter:***

- SIGFOX: 50 microwatts
- GSM/cellular : 5000 microwatts

## Frequency-independent

SIGFOX is not tied to any specific frequency. The network can adapt to the different ISM frequencies and therefore be available worldwide today, but can also if needed adapt to other frequencies, such as licensed bands or “whitespaces”.

## Low energy consumption

To minimize energy consumption, the SIGFOX network is only used when the object needs to transmit a payload. This fundamental principle is the major reason why objects that use SIGFOX consume radically less power than those using traditional connectivity solutions.

***Typical stand-by time (for a 2.5 Ah battery)***

- SIGFOX: 20 years
- GSM/cellular : 0,2 years

The exact power consumption over time obviously depends on how many messages are sent and how often. To illustrate the difference in power consumption between SIGFOX and traditional cellular networks, we compare the data for a typical use case, such as a smart energy meter object that transmits 3 messages a day using a 2.5 Ah battery. Existing solutions would typically last for months whilst SIGFOX enabled smart meters run up to 20 years.

## Low cost

SIGFOX communications costs are radically more attractive and justifiable for almost any business case in comparison with existing connectivity solutions. Included in the annual subscription fee SIGFOX provides connectivity, APIs, web-based administration and support as an all-inclusive fee without any additional charges.

The waterfall based pricing model is based on actual daily or monthly usage defined by bandwidth and the quantity of objects deployed. For further details please contact us to discuss the needs within your specific business case, solution or project.



# Is my application compatible ?

The SIGFOX network is not targeting specific industries and can virtually be used in any context in which there is a need for a low throughput connectivity solution. The definition of low throughput on the SIGFOX network can characterized as follows:

- Up to 140 messages per object per day
- Payload size for each message is 12 bytes
- Wireless throughput up to 100 bits per second

# Integration points

## Adding SIGFOX connectivity to an object

In order for an object to send messages using SIGFOX, it needs to integrate a compatible and certified modem. The SIGFOX modems are based on standard hardware chips on which the SIGFOX software stack is installed. These modems can be purchased from SIGFOX certified manufacturers.

Please refer to our website for a list of certified modem manufacturers: http://www.sigfox.com/modems

## Integrating SIGFOX with an IT system

To receive the messages sent from the objects, the IT system needs to be integrated with the SIGFOX servers. SIGFOX provides a web application, accessible through a regular web browser, which allows you to register HTTPS addresses of the IT application that needs to receive the messages. Whenever an object sends a message, it is forwarded to the configured HTTPS address.

## Managing objects

SIGFOX will alert the customer's IT system whenever there is a communication problem with an object and can furthermore provide operational information such as the ambient temperature and power supply status. Through the SIGFOX web application the customer can easily configure when and where to receive this information through standard HTTPS messages.

## Web application

A standard web based managed service provides a clear overview of the managed objects and provides access to the history of messages next to other relevant data.

# Unique characteristics

## Radio frequencies

The SIGFOX network operates in the unlicensed ISM radio bands. The ISM is available worldwide governed by regulation bodies such as ETSI (Europe) and the FCC (USA). The exact frequencies can vary depending on national regulations, but in Europe the frequency is generally 868MHz and in the US it is 915MHz.

## Uplink and downlink

SIGFOX provides mono and bi-directional communication. The capacity to provide mono-directional communication is very unique and allows extremely low power consumption in use cases where bi-directional communication is not required.

## Reliable connectivity

From the very beginning SIGFOX solutions have been designed to provide high reliability for applications looking to connect large numbers of objects. Several antennas receive each message and the network backbone has a redundant and continuously monitored infrastructure to guarantee a high level of service.

## Security and privacy

SIGFOX employs several techniques for securing the communication in order to avoid privacy issues and other security related risks.

SIGFOX does not impose specific data formats and only the customers know what they transmit and in which format. The communication protocol also implements mechanisms such as frequency hopping to avoid message interception and anti-replay mechanisms to avoid potential “false signals”.

## Standardization

SIGFOX is collaborating with ETSI on the standardization of low throughput networks.

# The network infrastructure

SIGFOX uses a patented radio technology based on what is referred to as UNB (Ultra Narrow-Band). The SIGFOX UNB radio communication uses the ISM bands, which are free to use without the need to acquire licenses, to transmit data over a very narrow spectrum to and from connected objects.

***SIGFOX requires substantially less antennas than traditional cellular networks, such as GSM***

The UNB devices have outstanding sensitivity, which results in huge resource savings. The technology allows SIGFOX to deploy a very effective, low throughput communications network by limiting the number of antennas (base stations).

The impact on cost is massive and results in very affordable subscriptions when compared to the upfront investments and running cost of other network technologies.
Furthermore, each of the modems used in the network (to emit and receive data) are significantly less energy intensive than devices using competitive technologies (such as GSM or broadband radio). These advantages allow SIGFOX to minimize the network's ecological and financial footprint and to provide the cheapest low throughput M2M and IoT communications solution on the market today.

In its current state each SIGFOX base station can handle up to a million connected objects, but the network is easily scalable to handle more objects, by simply augmenting the density of base stations.

The density of the cells is based on an average range of about 30-50km in rural areas and 3-10km for urban areas. Distances can be much higher for outdoor objects where messages in line of sight can travel over 1000km.

## A GREEN network

Achieving the same communication range as SIGFOX with traditional cellular networks would require the use of 10,000 times more power. Furthermore, the protocols used by traditional cellular networks, which remain efficient for the usage they were designed for, result in a 1% to 0.1% ratio for actual payload data/ protocol data, whereas for SIGFOX the ratio is in the degree of 20 to 50%.



***The power consumption required for a simple data transfer, with the same level of service, is 2000 to 5000 times higher with traditional cellular networks than with SIGFOX***

To complete the energy comparisons one would also need to mention the energy consumption of the network itself, being the base stations, the connection “backbone”, the managed service and related components. The SIGFOX network consumes 200 to 600 times less energy for the same amount of connected objects, again compared to traditional cellular networks.

***The amount of electromagnetic radiation, for similar network usage, is 2000 to 5000 times lower with SIGFOX***

To illustrate the overall energy consumption, a traditional cellular network would consume 170 to 440 Mega-watt/hour to connect a billion objects 10 times per day, whereas the SIGFOX network would only consume 120 Kilowatt/hour. It is a matter focus and optimized design of all pieces in the value chain leading to the unique offering we can provide you with today.

## Network coverage

SIGFOX is being deployed worldwide and thanks to the long-range UNB technology, the low cost and easy installation of the network infrastructure, the rollout is progressing rapidly.
Please feel free to contact us to know whether your target area is covered.

# How to get started

When you are ready to start testing your objects with SIGFOX you can purchase a starter kit. The starter kit package includes two evaluation boards with SIGFOX modems and everything needed to send and receive messages. Included in the starter kit is also a connectivity subscription, which covers the exchange of messages and use of the entire set of APIs to access our managed service for operational and administration purposes.

# Sample use cases

**MAAF Assurances**, one of the leading French insurance companies, anticipate the upcoming regulation that will impose by 2015 that each household be equipped with a smoke detector.

The fire and/or intrusion alert service that will be using the SIGFOX network will enable MAAF insured customers to be warned directly through SMS, in case the intrusion or smoke detectors send alarms and allow MAAF and their customers to be alerted if there is an anomaly, such as low battery, with the smoke detector.

**Clear Channel Outdoor** operates stations throughout France. In order to avoid constant manual inspection of the ad stations, a remote monitoring application has been deployed and the SIGFOX network is used to communicate status information from each ad station to the IT system.

# About the company

SIGFOX is the first and only operator of a cellular network fully dedicated to low throughput communication for connected objects. Leveraging on its patented UNB technology SIGFOX brings a revolution to the M2M and Internet of Things world by enabling large-scale connection of objects. The network already connects tens of thousands of objects in France and international cities.



***For further info:***

- contact@sigfox.com
- www.sigfox.com

SIGFOX
Bâtiment E-volution
425, rue Jean Rostand • 31670 Labège FRANCE
Tél. : +33 (0)5 34 31 03 16 • contact@sigfox.com
**www.sigfox.com**