WIRELESS BUILDING MANAGEMENT SYSTEMS

The "Killer Application" of LoRaWAN Technology

A success story from Voytech Systems & Robustel

About Voytech

Voytech Systems was founded by Dr Richard Fargus in 2014 in order to develop the next generation of Building Management Systems using Cloud computing and IoT technologies. The company has extensive experience in product development and manufacturing within this market. As well as in-house product development the company provides consultancy and R&D services to 3rd parties.

The Voytech Sitelink product incorporates multiple automation protocols including BACNet, Modbus and LoRaWAN, this allows the product to be deployed in a wide range of applications from IoT integration with conventional BMS to stand-alone monitoring and control of Heating, Air-Conditioning and Ventilation systems in a wide range of different building sectors.

Background & Solution Overview

For many years, the cost of cabling for sensor installation has been a dominant variable in the cost of BMS Systems. Whether as a new installation, or as an upgrade to an existing system, the addition of distributed sensors attracts significant cost.

As such, cabling cost has long been recognised as a business problem to solve, typically by the use of Wireless protocols such as Zigbee, proprietary 868/915Mhz, BLE or even WiFi.

There are many reasons why previous attempts have failed to gain traction – these include:

TRADITIONAL BARRIERS TO WIRELESS BMS DEPLOYMENT:

Lack of range/in-building penetration on 2.4Ghz protocols, e.g. Zigbee

TM

Proprietary nature of license exempt RF band solutions on 433/458/868MHz

Lack of significant sensor ecosystem for proprietary 433/458/868MHz systems

Integration challenges of a vendor's proprietary wireless system with 3rd-party BMS Controllers

Resistance to new technologies by those with a vested interest in wired systems or by those with little interest in taking risks to embrace new technology.

LoRaWAN can offer a solution to all of the above from a technical standpoint and even the final more "human" issue to a lesser extent due to LoRaWAN's strong association with the "IoT" (Internet of Things). This association means it benefits from all the hype and hyperbole around IoT which is driving companies to try new things and look harder for technological solutions to age old problems.

There is a significant difference between LoRa and LoRaWAN – jump to Appendix A if you would like to understand more before reading further.

The LoRaWAN® specification is a Low Power, Wide Area (LPWA) networking protocol designed to wirelessly connect battery operated 'things' to the internet in regional, national or global networks, and targets key Internet of Things (IoT) requirements such as bi-directional communication, end-to-end security, mobility and localization services. LoRaWAN uses LoRa radio technology as part of the overall system architecture as indicated in the overview diagram below.

Solution Topology

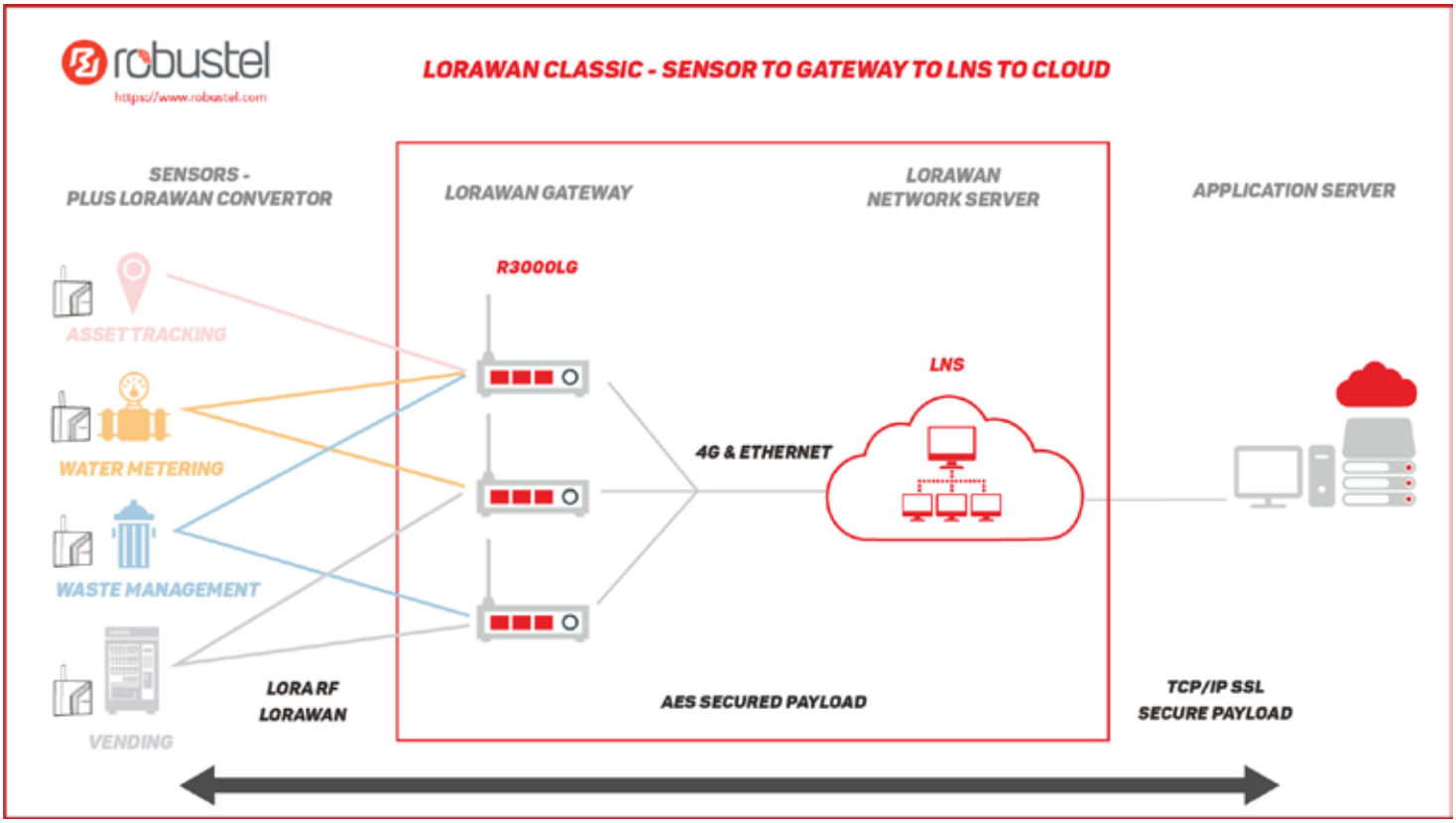

Figure 1.1 – End-toEnd LoRaWAN Deployment

So, Why LoRaWAN?

Fundamentally, LoRaWAN has become the frontrunner for Wireless BMS for two reasons:

1. Excellent in-building propagation

This is the technical way of saying that LoRa signals go through walls, ceilings, metalwork and other building materials better than most. And for the uninitiated, the first experience of LoRa can be quite amazing. In a recent project in London, the proof of concept phase demonstrated a LoRa link comfortably spanning 14 floors of the building and the authors have seen similar performance in shopping malls, government buildings and sports stadiums.

In March 2021, Voytech deployed over 200 sensors to an installation across a 3-story office building. The sensors were supplied activated and powered on and were initially stored offsite in a storeroom located 100m from the office building where the LoRaWAN Gateways had already been installed inside plant rooms.

During this initial, pre-deployment period, 100% connectivity of the sensors and associated data to the BMS System was achieved. The system worked even when the sensors were bulk stored in a separate building – such is the range/propagation of LoRaWAN.

2. Ease of coverage expansion

In some instances, the in-building propagation of LoRa is not sufficient to "illuminate" an entire building but thanks to the simple architecture of LoRaWAN, its possible to add 1 or several more LoRaWAN gateways at convenient locations to bolster coverage.

This simple but critical benefit of LoRaWAN is often overlooked.

In other wireless systems, filling in black-spots and radio planning can be much harder. With LoRa, each Gateway is considered to be part of one continuous, single, logical antenna so capacity increases are relatively simple to implement. This puts control back in the hands of the integrator and most importantly reduces the risk of installing a non-working wireless system.

The best and simplest comparison here is with using a cellular (3G/4G) network to get the data from sensors out of the building. If the cell-tower location and frequency is not enough to provide a signal that reaches into the bowels of a plant room, there is nothing you can do about it. You could lobby the relevant mobile network operator but your chances of getting them to install new services just to get you out of a hole are negligible.

When two worlds collide

Despite the fact that LoRa goes a long way in solving the pure RF considerations of wireless BMS, there are a number of challenges to successful LoRaWAN integration in traditional BMS Systems. In particular, the cloud-based architecture, the different protocols used in BMS, the skill set of on-site commissioning engineers, and the limitations of wireless devices.

Architecture: The cloud-oriented paradigm of LoRaWAN is not generally suited for building control, in particular routing device data via the cloud reduces the reliability of a control system.

A far more robust approach is to place the LoRaWAN network server and application server on-site, local to the Building Management System.

Protocol: Integration of LoRaWAN devices with BMS requires translation of the wireless data into a format suitable for BMS products. The BACNet protocol is ideal for this as it is supported by all of the most common BMS manufacturers.

BACNet is ideal for integration with LoRaWAN as it allows low level integration of individual data values such as binary statuses, temperatures and setpoints.

> *I am convinced that LoRaWAN finally solves the challenge of integrating wireless monitoring and control components into conventional BMS applications.*
>
> *LoRaWAN overcomes all of the limitations of other radio technologies that have lead BMS integrators to treat wireless technology with great caution.*
>
> *In particular, the spectacular range of LoRa allows wireless devices to be used without the need for detailed site plans or the installation of numerous repeaters.*
>
> *For small buildings only a single gateway is generally required; for larger buildings, simple rules of thumb can be used to position a few gateways around a building to ensure adequate coverage.*
>
> *The available range of wireless sensors and actuators is growing rapidly, allowing many different features to be easily added (or retrofitted) to a building control system, examples include metering, air quality sensing and fault monitoring.*
>
> **Dr Richard Fargus,**
> **Managing Director**
> **Voytech Systems**

Commissioning: Deployment of LoRaWAN hardware within a conventional HVAC setting requires the installation and commissioning of the LoRaWAN devices to be performed by electrical and controls contractors. It is essential that device installation is as 'plug-and-play' as possible to avoid the need for specialist on-site LoRaWAN engineers, otherwise the significant cost-savings of LoRaWAN may not be realised.

Wireless vs Wired: Wireless sensors can easily be integrated for monitoring applications, but controlling equipment over LoRaWAN is more challenging due to duty-cycle restrictions and the less reliable nature of wireless communications.

Wireless control is feasible in cases where the LoRaWAN hardware locally performs control functions, products such as the "MClimate Vicki Digital Radiator Valve". This uses local control functions to control the temperature in a room, the BMS can use LoRaWAN to read the system demand, alter setpoint targets, perform time scheduling and monitor local conditions and alarms.

How Voytech Solves the BMS & LoRaWAN disconnect for System Integrators

Voytech Systems' "Sitelink" Controller is the glue between LoRaWAN Gateways and BMS.

It takes the raw LoRa data from Robustel's R3000LG LoRaWAN Gateway, unpacks and decrypts it and then repackages it as a succession of BACNET objects.

> *Robustel's R3000LG LoRaWAN Gateway is a cost-effective and feature rich Gateway, ideal for applications like BMS and Industrial Automation.*
>
> *When it is coupled with Voytech's Sitelink Controller, its 'value' multiplies many times as the combined solution gives unrivalled deployment flexibility, increased reliability and saves effort in complex configuration / software.*
>
> *We are delighted to be partnered with Voytech on this mission to revolutionise the BMS market.*
>
> **David Evans,**
> **Global IoT Solution Architect**
> **Robustel Technologies**

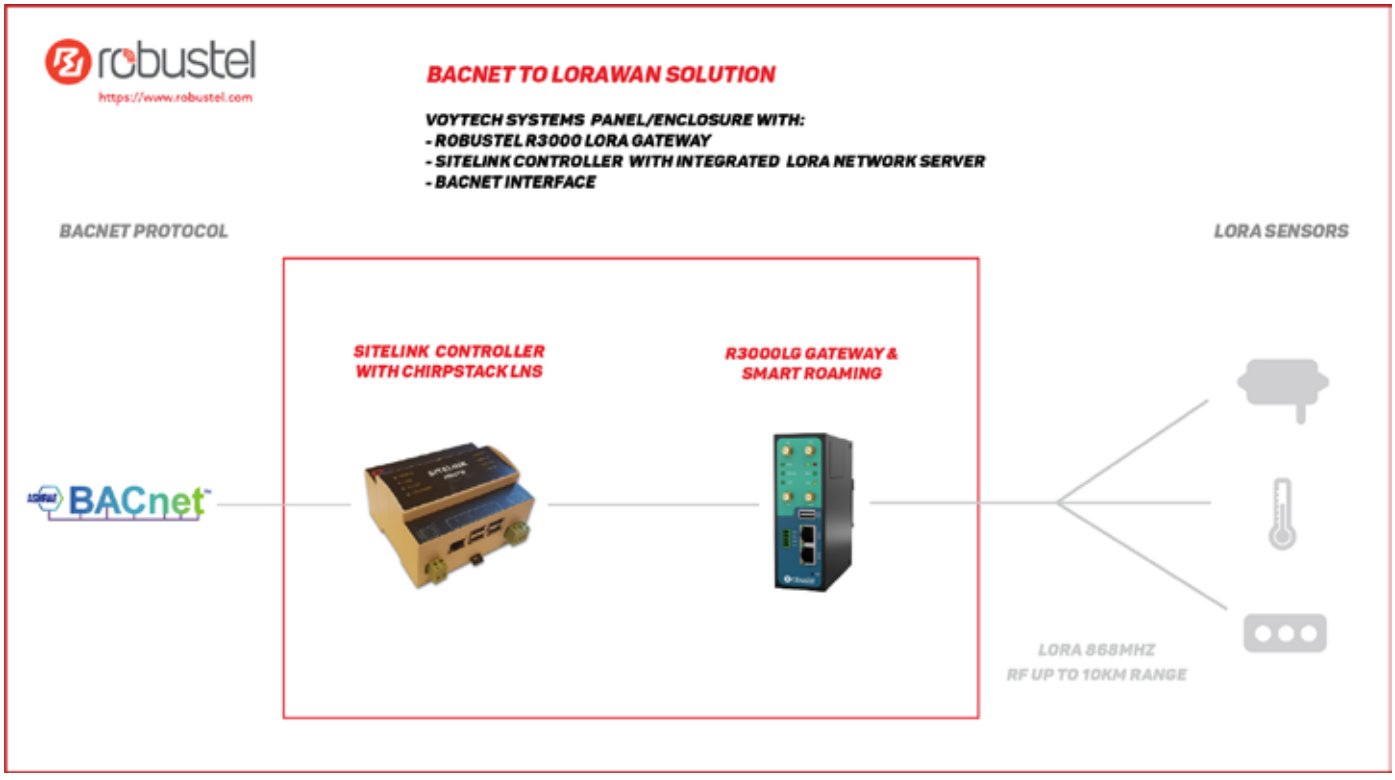

Figure 1.2 – Modular BACNET to LoRaWAN solution from Voytech Systems

With the vast majority of BMS systems able to handle BACNET, this instantly gives integrators access to the flexibility of LoRaWAN with none of the complex commissioning.

Voytech Systems has recently demonstrated an integrated BMS / LoRaWAN solution consisting of central HVAC control using a conventional BMS, and a distributed heating system consisting of 60 MClimate Vicki Smart Control Valves.

The integration was achieved using the Voytech Sitelink Controller which manages the LoRaWAN devices using a local LoRaWAN Network and Application server, and also runs a BACNet protocol implementation that allows demand and temperature information to be transmitted to the BMS, and to allow BMS control commands to be sent to the LoRaWAN devices.

All LoRaWAN devices were delivered to site pre-configured and were fitted by the electrical contractor, not a specialist commissioning engineer, further reducing installation costs.

The resultant solution achieves complete control of both central HVAC plant as well as integration of distributed room controls without the need for any wiring outside of the plant-room.

This results in significant installation cost savings while also reducing running costs by allowing more intelligent control of occupied spaces.

Mclimate's "Vicki" (Thermostatic Radiator Valve)

- Manual temperature adjustment
- 2-digits display
- Automatic temperature control algorithm
- Automatic temperature control algorithm with external temperature reading
- Manual valve openess control
- Open window detection
- Child lock

Vicki is a smart TRV LoRaWAN sensor targeted directly at the BMS/HVAC space – many units have already been installed by Voytech Systems

R3000-LG LoRaWAN Gateway

- 8 channel LoRaWAN interface
- Rugged and durable housing and connectors
- Free cloud management platform
- Smart Roaming for enhanced Roaming SIM management
- Fully programmable OS with an SDK
- Wide operating temperature range

About Robustel

Robustel are one of the world's leading manufacturers of industrial quality solutions for the IoT and M2M market. Robustel's portfolio of award-winning solutions are comprised of: Wireless Modems, Routers, Gateways, EDGE Computing, Cloud Software and End-to-End IoT solutions.

With a state-of-the-art production facility in Guangzhou, high quality products and services make up Robustel's corporate DNA. Maintaining an ISO9001:2015 Quality Management system and a sophisticated approach to quality control, planning, assurance and improvement has seen Robustel granted with numerous global certifications, including: CE, E-Mark, FCC, PTCRB, AT&T, Verizon, Anatel, IC, Rogers, GCF, TRA, RCM, iDA, NBTC, Postel, Sirim, CCC and Telec.

Today Robustel's solutions can be found in every corner of the 'Connected World' providing IoT solutions to industries as varied as: Security, Vending, Retail, Utilities, Oil & Gas, Industrial Production & Automation, Transportation, Environmental Services and Healthcare.

To learn more about how Robustel can help your business save money and improve efficiency through IoT, please visit www.robustel.com or email info@robustel.com for more information

Appendix A – LoRa vs LoRaWAN

LoRa vs LoRaWAN

It is very important to differentiate LoRa from LoRaWAN for a complete understanding of this subject. What follows is an overview / comparison of the two technologies.

LoRa is a proprietary low-power wide-area network modulation technique. [1] It is based on spread spectrum modulation techniques derived from chirp spread spectrum (CSS) technology. [2]

It was developed by Cycleo of Grenoble, France, then acquired by Semtech, the founding member of the LoRa Alliance. LoRa Technology is patented.

In essence, LoRa only defines how the radio works and it is typically deployed on 868MHz (EU) and 915MHz (North America).

Other implementations such as the 470MHz used in China also exist.

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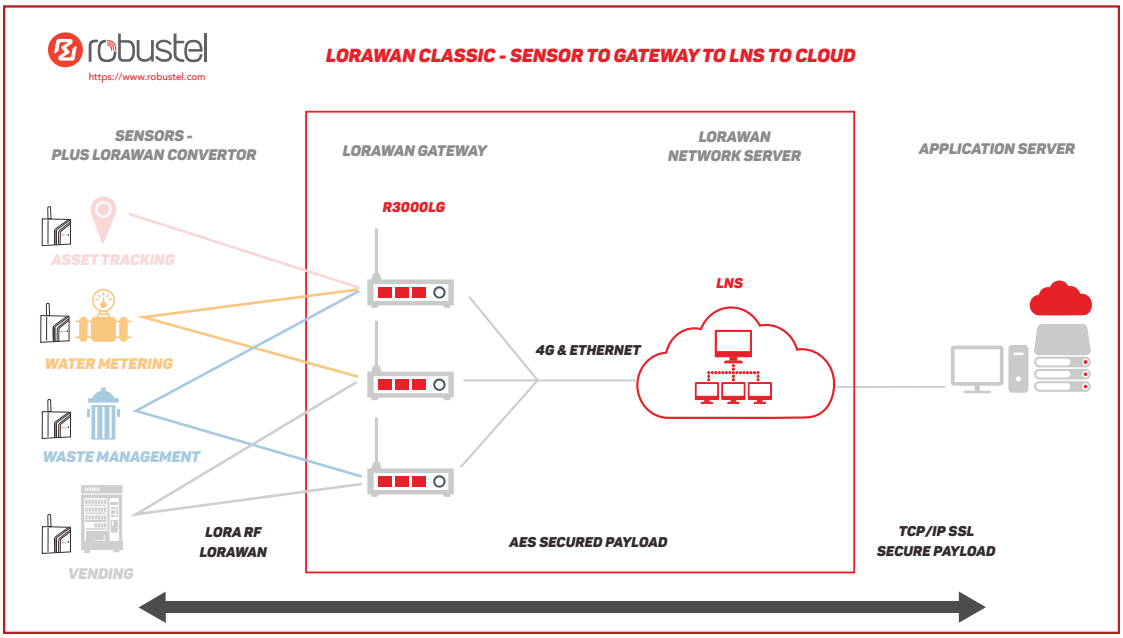

Figure A.1 – LoRaWAN solution stack

The component parts of a LoRaWAN stack are laid out in Figure A.1. Descriptions below:

Sensors - it is the richness of the LoRaWAN ecosystem that makes LoRaWAN such a good choice for BMS. Just about all sensor types that are required are available from a multitude of sources.

Gateway - Multiple Gateways can be deployed in the same area to create – "one continuous distributed antenna". It is this concept that makes in-fill of patchy networks so easily achieved.

Network Server – this is the component that causes the most confusion in the LoRaWAN stack.

A LoRaWAN Network Server (LNS) is always required. Whereas the Gateways can be considered "dumb", simply forwarding on any 'chirps' received from sensors, the LNS is the brains of the network, responsible for orchestrating the antennas (Gateways) to transmit and receive data from sensors in an optimal fashion.

A more detailed overview of the LNS function can be found here:
https://www.rs-online.com/designspark/lorawan-network-server-integrated-or-cloud-hosted-1

Application Server – every Network Server is associated with an Application Server which is the final destination of all Sensor data. Decryption of the data does not take place until this point and this is how LoRaWAN achieves end to end security. At this point, the sensor data can be extracted and employed in whichever way the overall application dictates. (Please note that Voytech's Sitelink controller contains both the Network Server and the Application Server to keep monitoring and control functions site-local. The ability to then express sensor data as a BACNET object is a key reason why the Sitelink controller is an invaluable tool for BMS integrators)

A complete definition of LoRaWAN is available at:
https://lora-alliance.org/about-lorawan/