

# The Internet of Things (IoT) with LoRaWAN



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## The Internet of Things

The Internet of Things or 'IoT' is where we have objects or 'things' connected to the internet that sense something, create some data from what they have sensed and then do something with that data. The purpose of this document is to introduce you to how IoT applications are made using LoRaWAN and enable you to explore how they may be useful in the context of farming.

## LoRa and LoRaWAN

There are lots of different types of devices that can be used for IoT, and they can be thought of as belonging to different families that can work together. LoRa is a wireless technology and LoRaWAN is a way of linking sensor devices and applications together. LoRa is a low-power technology and transmits at a very low power compared to mobile phones, WiFi etc.

LoRa stands for 'Long Range' and LoRa devices are indeed able to transmit and receive data over large distances. WAN stands for 'Wide-Area Network'. A LoRaWAN sensor device is a thing that combines:

- One or more sensors to measure or detect things of interest
- A LoRa radio transmitter and antenna
- A small microcontroller that is programmed to perform the sensing, join on to the LoRaWAN network and send the data (possibly receiving some data and performing some other tasks)
- And, usually, a battery power supply

## Using Sensor Data

In a LoRaWAN network, a sensor device transmits its data to be received by one or more gateways. In turn, the data is sent on to the Internet. We can then connect other applications and systems together to make use of the data. Some broad categories of applications are:

- Data archiving and auditing to automate record keeping
- Live data on a website using graphs, charts and gauges to inspect, monitor and analyse for decision making
- Performing actions depending on the data, for example, if a temperature sensor goes beyond a certain range, we can send someone a warning text message or email

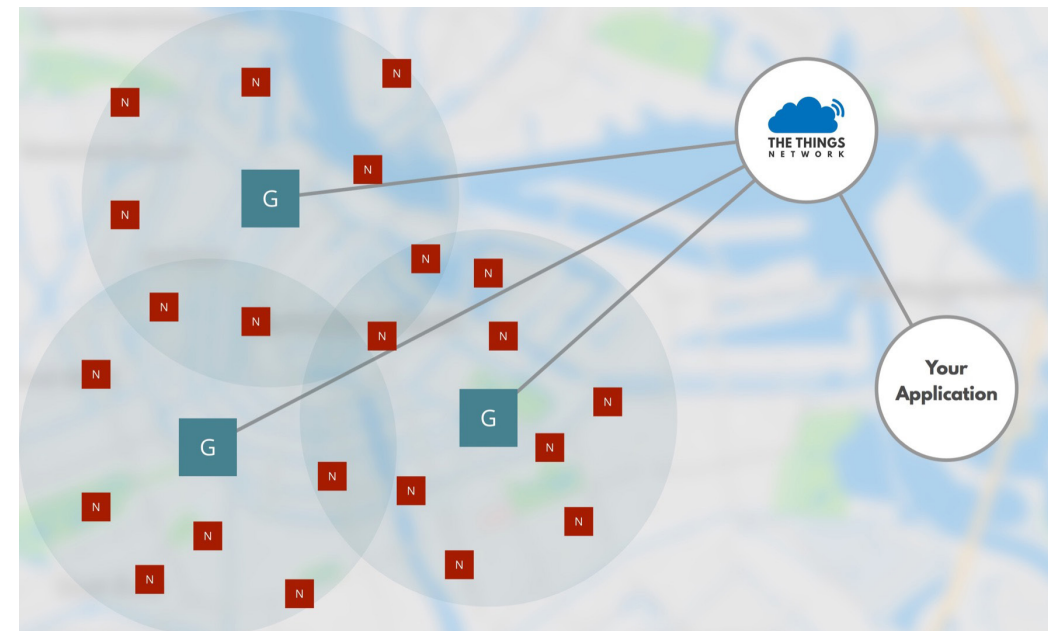


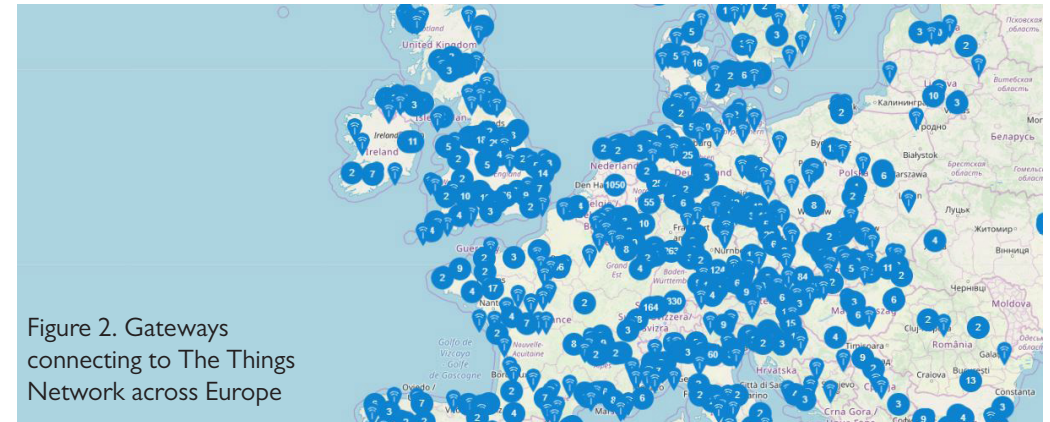
Figure 1. Overview showing sensor devices (N) and gateways (G) linking to The Things Network [Ref]

## Why LoRaWAN?

LoRaWAN devices have numerous advantages and a few disadvantages. Some considerations are:

- **Long range.** We can place devices a long way from the receiving gateways - up to 10km in situations where we have good line of sight between the sensor device and the gateway.
- **Battery life.** Whilst current mobile phones may require a battery charge every day, it is common for LoRaWAN devices to have batteries that last for many months and perhaps even up to 10 years before requiring a recharge or replacement. It's also possible to use solar charging to extend this indefinitely.
- **Data rates.** In order for LoRaWAN to be able to perform so well in terms of range and low power consumption, the trade-off is the amount of data that can be sent and how often. Data rates are slow and small, and it is enough for many use cases. However, a LoRaWAN device can easily send frequent environmental measurements, but there is not enough capacity to send a CCTV image, for example.
- **Scalable and affordable.** LoRaWAN devices are becoming more affordable and as such, large numbers of devices (each with multiple sensors) can be used to provide sensing over a wide area or for more fine-grained local measurement.
- **Gateways are becoming more widespread.** Gateways can handle a lot of sensor devices and pick up signals over a wide area. With the network that is commonly selected for innovation (described later), you don't need to own a gateway to get started if you are in range of somebody else's. Adding more gateways into an area improves the resilience of the application and spreads the network further.
- **Security.** Your data from the sensor is never available by eavesdropping on the radio waves and is secure.
- Devices can send **self-monitoring** data or 'telemetry' as well as the sensor data as part of their payload. For example, they can send their own power supply levels to give an indication of when they may need batteries replacing or recharging.

## A Network of Gateways: The Things Network



The gateways that will be used on the Demo Sites will be connected to a service called 'The Things Network' which is a platform for LoRaWAN gateways across the world. In the above image we can see the number of gateways across Wales, UK and Europe.

The Things Network is a crowdsourced project where people add gateways that anyone can connect to.

Allowing public usage of gateways means that the platform grows more readily (meaning it is more likely to be supported into the future). As a popular growing platform, it means more people are developing sensors for LoRaWAN, creating more hardware and more software in the marketplace. As the network of gateways increases, it also adds capacity and resilience where regions may be covered by multiple gateways. This means that if our own gateway fails, we might still get our data via another gateway in range. Gateways can handle thousands of sensor devices being connected, so in a rural application, we are very unlikely to run out of capacity by sharing with others.

## Types of Sensors

There are countless types of sensors out there that could be connected to LoRaWAN transmitters; these include:

- **Buttons and switches** can detect if something is pressed or if, for example, a door or gate is open or closed. A sensor device could also count how many times something is opened, closed or pressed in a given time period. An example we have looked into is mink traps which require attention within a reasonable time frame if they have captured a mink; a LoRaWAN enabled trap can be configured to send the person a text message with information as to which trap has been 'fired' to illicit a timely response. This works simply by adding a switch that is triggered if the trap fires.
- **Rotary sensors** can sense how many times or how far they have been turned. For example, if embedded in something, you could tell how often that object was turned or indeed which direction it was pointing.
- **Ultrasonic sensors** transmit an inaudible signal and detect how long it takes for that signal to bounce off a surface and return. From this data we can work out the distance, for example, the level of a slurry pit or the level of a river.
- **Light sensors** detect presence of light and/or the level of light. As such, they can be used to tell if something is covered or uncovered. For example, we might be able to tell or receive notification if a vehicle bay is occupied as the light level decreases when a vehicle is parked over it.
- **Motion detectors/PIR (Passive Infrared) sensors** are the type of technology used in motion detectors in buildings.
- **Soil** moisture, nutrient and temperature sensors.
- **GPS devices** installed on a LoRaWAN device can be used to transmit where an object is, but also could be set up so that it alerts someone if the item moves out of a certain area. For example, a device could be created that detects a quad bike going off the farm boundaries after a pre-defined time, say 8pm, and trigger an alert.
- **Temperature and humidity** sensors can be used widely. For example, an occupied animal pen is warmer than unoccupied; a fridge containing vaccines will rapidly rise in temperature if the door is left open.
- **Rain** sensors, **wind** sensors and other **weather**-related conditions.
- **Speciality sensors** - there are a huge range of sensors that can detect all manner of things from presence of specific gases, types of liquids, pollutants and much more.



## CREATING A SOLUTION

### Devices

A sensor is selected and attached to a LoRaWAN wireless transmitter and controller. This unit is programmed to determine how often to read the sensor, how to package the data it has taken from the sensor and when to transmit the data.

LoRaWAN sensor manufacturers will deal with all of these aspects and make off-the-shelf sensor devices to do a particular thing. There are hundreds of types and models to choose from and the choice is growing rapidly. For the adventurous, it is possible to create entirely bespoke LoRaWAN sensor devices, and sometimes you can accommodate simple sensors with general purpose LoRaWAN transmitters to create new solutions quickly.

### Setup

Gateway hardware must be configured for the right frequencies etc. The gateway requires mains power and internet connectivity (ethernet cable or mobile phone coverage). To maximise coverage for the sensors, gateways are typically installed on a tall building with a clear view of the area in which the sensor devices are being placed. The gateway needs to be securely and robustly attached with some lightning protection.

Each LoRaWAN sensor device must be configured before placement to allow it to register itself on the network.

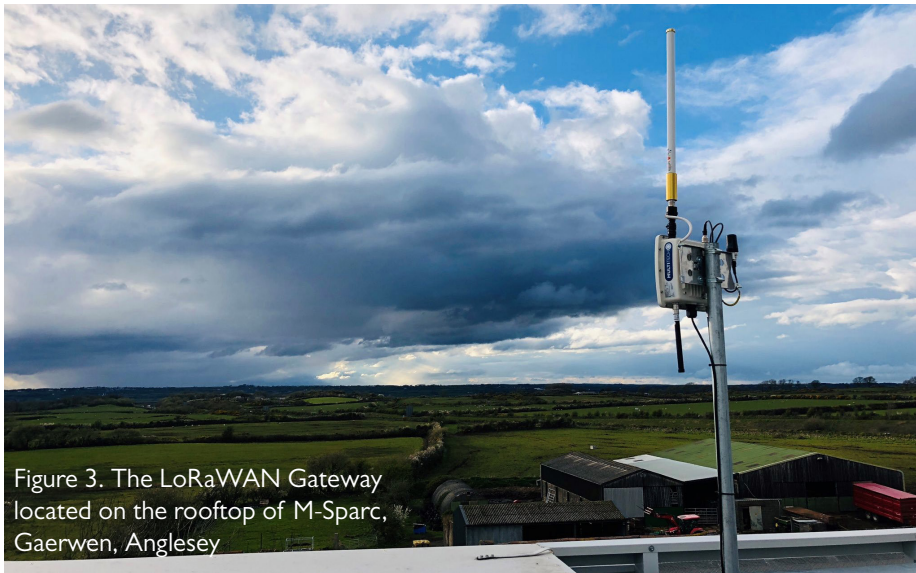


Figure 3. The LoRaWAN Gateway located on the rooftop of M-Sparc, Gaerwen, Anglesey

## DATA PROCESSING

### Decoding

Software needs to be created to decode or 'unpack' the data that is relayed from the gateway into the network. Decoding software is unique to each type of device and sensor manufacturer and converts raw sensor data into readings (numbers, values, signals) that mean something to humans.

### Dashboards and Actions

Data points are sent to other services which help bring value from the readings by helping to make decisions or take actions.

Some examples:

- Using a spreadsheet to collate data
- Sending to a smartphone application
- Relaying to a service that sends emails or SMS messages for immediate notification
- Displaying live information on an online dashboard.

The timing of actions can also be considered. We might need to know immediately if the temperature starts to rise in a vaccine fridge or bulk tank, but other things might only need to alert us periodically or during working hours. Data from our sensor devices may be combined from other sources of information before a decision is made. For example, we may be able to use information from a weather forecast to decide if alerts and notifications are needed by considering the forecasted conditions and how that might impact what we are measuring.

### Actuators

An actuator is a term given to a device that can perform an action, usually mechanical or electronic, when it receives a signal.

By combining a LoRaWAN device with an actuator, we can then control things remotely over long distances, for example, opening valves or vents or sounding audible alarms or buzzers or indicator lamps.

We can combine sensors (input) with the applications on the internet (logic, control) to get some output. These may all be spread out over a very long range.

## For more information:

- The LoRa Alliance is a not-for-profit association established in 2015 to support and promote the adoption of the LoRaWAN standard.  
See <https://lora-alliance.org>
- 'The Things Network' provides open tools and an open world network to support individuals and businesses to design an IoT package. It operates thousands of gateways to provide a service to millions of people.  
See <https://thethingsnetwork.org>
- Search 'Cyflwyniad i Rhyngwyd y Pethau / Introduction to the Internet of Things' on *YouTube* to learn more about installing a LoRaWAN portal at Glynllifon Agricultural College.

## References

Figure 1: Courtesy - The Things Network - CC BY-SA 4.0

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