LoRA wireless networking standard opens up the smart city

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This article describes the advantages of the long range LoRa network for creating IoT applications, not only in cities but also spreading into the rural environment.

The Internet of Things (IoT) is a revolution in the way technology enables countless different systems to work together. It uses the free flow of data to democratise technology and let new types of business evolve and disrupt traditional suppliers by reducing costs and improving service. Like the IoT that it serves, the LoRa wireless networking standard is showing that it can harness the same driving forces and help unleash greater technological creativity.

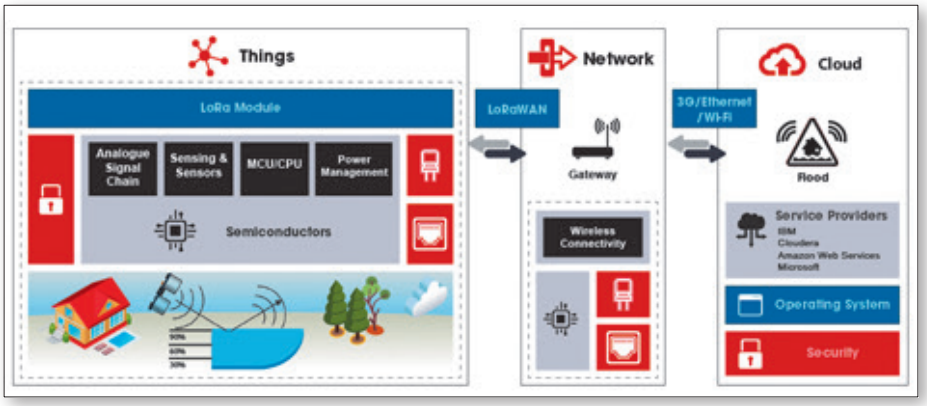
Rather than wait for telecommunications companies to build an IoT network, The Things Network encouraged organisations and inhabitants spread around Amsterdam to create their own in the space of just six weeks using the LoRa technology. Thanks to its long range, the group was able to cover much of the city with just ten gateway routers. Now the group has turned its attention to other cities around the world, helping them to build a wireless infrastructure for the IoT that will be free of the subscription charges used by operators for conventional networks based on cellular radio.

The LoRa protocol was originally developed by the integrated-circuit (IC) supplier Semtech to operate on unlicensed RF bands such as the widely supported 868 MHz band in Europe. To help spread use of the technology, Semtech has licensed the technology to IC manufacturers Microchip and STMicroelectronics. The protocol uses a spread-spectrum modulation scheme that ensures communications between gateways and devices do not interfere with each other. Spread-spectrum coding creates a set of virtual channels that increase the communications capacity of each gateway. The possible and probable emergence of multiple network operators is not an issue for LoRa thanks to its use of spread-spectrum to separate not just individual packets but communications to and from different gateways within the same area.

The coding scheme lets devices choose the most appropriate data rate for them without affecting devices using other virtual channels. This helps optimise not just network capacity but maximises the battery life of sensor-node devices. The data rate of a LoRa link can range from 0.3kbit/s to 50kbit/s using a protocol that dynamically adapts the transmission rate. Devices can sit at distances of at least 15km from a gateway for line-of-sight communications or up to 5km where line-of-sight is not available, such as in dense urban environments. Several layers of encryption are available to protect data and ensure that messages to and from critical infrastructure can be transmitted securely across open, multi-tenant networks. Different key pairs operate at the network level, the application and device level, to allow security needs to be fine-tuned. In contrast to cellular technology where the operator must carefully manage cell overlap, with LoRa a message transmitted by an end device can be received by one or more gateways. Every gateway that receives the message will forward it to the network – servers deal with any duplication and ensure that replies are delivered to the target application in the cloud. Servers in the cloud can use not just point-to-point communication to talk to end devices but can also take advantage of multicast packets to send commands to groups of devices efficiently, allowing for a wide range of application use cases.

One of the first use cases developed for the Amsterdam network was a service to prevent boats sinking in one of the many canals of the city. The core of the idea is a water detector installed on the floor of the boat. If the boat starts to fill with water, it can send a message to a server that then alerts the owner by a text message to their phone. Replying "clear my boat" would then send a service to check and repair the boat before the water level causes it to sink under the surface.

The severe flooding that Calderdale — an area in the North of England — suffered in recent years, provided the motivation for setting up a Things Network community to build a LoRa



Structure of a typical LoRa network for IoT applications

WAN network for the area. The long-range technology allowed for many more flood network sensors than a simpler wireless technology with a far shorter range, or sensors that made use of commercial cellular networks for backhaul.

The Things Network is planning to run other proofs of concept that range from crowdfunded solar electricity generation to keeping track of garden tools. The peer-to-peer lending service Peerby, for example, wants to run a trial on the Amsterdam network that will let users check where implements they have lent to other service users are being used or stored. WeShareSolar wants to connect the solar panels it installs to the network to let users monitor the electricity production of them all in real time. And QwikSense aims to use sensors to monitor temperature, humidity and carbon dioxide levels in buildings to help reduce sick leave. In the UK, Reading is one of the cities also set to benefit from the ability of communities to come together to provide wireless network services. TTN Reading has performed end-to-end tests of the network and early adopters have initiated projects such as performing on-the-fly signal strength measurements around the city, as well as one to attach tiny transceivers to hedgehogs to provide researchers with information on their movement and development. Another idea is to use the LoRa network to support smarter car alarms. Instead of unnecessarily waking up neighbours when the car detects a possible intruder, a device in the car attached to the alarm could send text alerts direct to the owner instead.

The openness of the LoRa means there will be many more options for IoT wireless wide-area networks. Early in 2016, German start-up Digimondo, working together with Semtech, organised a demonstration of LoRa-enabled IoT applications at the influential Embedded World exhibition in Nuremberg. The south German city became the latest in a list of rollouts that started with Hamburg and Berlin and will later extend to rural coverage of the country. In the demonstration, LoRa gateway received messages from vehicles driving around Nuremberg, letting visitors track their locations in real time on monitors installed on the Semtech and Microchip booths. One of the key reasons for Digimondo electing to base its IoT network on LoRa was to help improve communication with its initial focus on smart meters, many of which are often installed inside buildings and may also be underground. The LoRa signal is able to penetrate far enough below ground to communicate with buried devices such as water meters. Magnetic parking sensors are also likely to benefit from the reach of the LoRa protocol.

In Italy, utility company Enevo chose LoRa earlier this year to help drive its business of providing waste disposal bins with greater levels of intelligence. Sensors in the bins measure waste levels so that near-empty bins are not collected unnecessarily and that those with high levels are served before they overspill.

As LoRa extends from cities into the rural environment, farmers may choose to add their own gateways to the network. Agriculture is one of the many activities that can benefit from the widespread use of sensors. Sensors that monitor the temperature of soil or crops as well as environmental conditions such as pH can help farmers determine where and when to irrigate and to identify areas where pesticide or herbicide applications need to be focused. The long reach of LoRa signals will allow even big farms to gain coverage using only a few gateways on even large tracts of land. At the same time, they can provide wireless IoT infrastructure to their neighbours in villages that otherwise would not have an affordable connection.

Thanks to its open nature in which communities can become operators of their own infrastructure, LoRa is enabling the IoT to deliver on its promise to supply applications that can create smart cities. And, thanks to the long range of LoRa, that smartness can easily spread into the rural environment. ■