A Detailed Breakdown of LPWAN Technologies and Providers

Analyst Insight | by Isaac Brown

The Internet of Things (IoT) has fundamentally shifted the nature of connected devices, creating massive opportunities for low-power wide area network (LPWAN) technologies. LPWAN solutions are ideal for devices that need to send smaller amounts of data over long ranges, with particular constraints around power consumption and computational horsepower. Many of the LPWAN solutions perform well in obstructed environments – like in cities and rugged outdoor environments. There are developments in traditional cellular networks that are improving their suitability for IoT applications – these include the array of low-power, low-bandwidth LTE developments like LTE-MTC, NB-LTE-M, and NB-IoT (now known as CAT-M1 and CAT-M2). These solutions however are largely unavailable at the present time; traditional cellular (2G, 3G, and 4G LTE) is still best suited for higher-bandwidth applications and is not as cost effective as LPWAN for a myriad of IoT use cases.

Given the immediate need for LPWAN in IoT deployments, multiple solutions have emerged offering the right balance of bandwidth, power consumption, and distance range – and at the right cost. Some of these initiatives are coordinated by membership-based standards alliances, while others or facilitated by private companies with proprietary solutions. In this brief, we will explore several of the leading LPWAN offerings and analyze their underlying technologies, business models, and ecosystem drivers. Some household names – like Bluetooth and ZigBee – will be left out of this discussion; while these technologies often solve similar problems, they are not LPWAN technologies.

Sigfox

One of the biggest names in the game is the startup company Sigfox. Sigfox has been blanketing large swaths of the planet (notably in Europe) with its proprietary LPWAN solution since 2009, making it one of the older players in IoT LPWAN. The firm completed a $115 million Series D raise in February 2015, bringing its total venture funding to date up to $151 million. Sigofx sets up base station antennas on towers and often works with local mobile network operators (MNOs) to do so. It controls the backhaul communications infrastructure and backend cloud management platform, so any customer that wants to use Sigfox has to leverage its communications infrastructure and cloud platform – and of course pay the associated recurring fees. Radios and modules for endpoints are widely available from manufacturers like Texas Instruments, Atmel, and Telit.

The technology is based on ultra-narrow band (UNB) binary phase-shift keying (BPSK) transmitted in the 868 or 902 MHz bands, depending on the region and the regulations – the nature of UNB is that the energy density of noise tends to be spread across spectrum, thus the Sigfox signal in any narrow portion of the spectrum is more likely to be above the noise floor. The flip side is that noise spikes in narrow portions of the spectrum can interfere with a UNB type signal. Sigfox is well-suited for low-bandwidth (less than 300 bits per second / up to 12 total bytes per payload) and low-frequency (up to 140 messages per day) applications. Sigfox is effective for communications from endpoints to base stations (uploads), but it is not particularly effective from base stations to endpoints (downloads).

LoRa

The LoRa Alliance is a membership-based alliance dedicated to promoting and developing the LoRaWAN protocol. LoRa is an open alliance in the sense that any organization can purchase LoRa hardware and deploy its own networks without going through (and having to pay fees to) any centralized authority. Like Sigfox, the LoRa alliance is working with MNOs to help deploy its solution and drive adoption. While LoRa is a more open model than Sigfox, there is one closed aspect of the ecosystem: the only vendor that is licensed to manufacturer radio chipsets is Semtech; the alliance has however announced agreements with STMicroelectronics and Microchip, both of which should be shipping radios in the near future. As of now, all module and gateway manufacturers (like MultiTech Systems) source radios from Semtech.

LoRa is a chirp-based spread-spectrum technology with a wider bandwidth than Sigfox – that itself looks like noise. Due to the modulation technique and built-in forward error correcting capability, the LoRa signal can transmit data with signal strengths well below the noise floor – LoRa proponents claim that LoRa is the only commercially available technology that can transmit so far below the noise floor.

From a bandwidth perspective, LoRa sits above Sigfox in terms of throughput and is ideal for data transfer rates of between 300 bits per second and 5,000 bits per second. Another important consideration is that LoRa offers effective bidirectional functionality – so it is good for receiving messages from endpoints, but also for sending messages from base stations to endpoints (like for command and control applications). LoRa operates in similar portion of the sub-GHz spectrum to Sigfox.

Ingenu (formerly On-Ramp Wireless)

Ingenu was founded in 2008 and originally focused on utilities and oil and gas applications; it has however expanded into other IoT applications including urban and agricultural environments. Ingenu has raised $119 million in venture funding to date and is the driving LPWAN solution behind a number of major smart meter and digital oilfield deployments. The firm's solution is proprietary in the sense that it is the sole developer and manufacturer of the hardware. Its major business model in the past was to sell hardware components to enterprises that built and controlled their own networks; recently however the firm has constructed several public networks, for which it sells radio modules and recurring data subscriptions – many customers for this model are machine-to-machine (M2M) solutions providers.

The proprietary Ingenu solution is based on random phase multiple access (RPMA) technology, which enables higher data throughput rates than Sigfox and LoRa – Ingenu typically transmits at rates in the hundreds of thousands of bits per second, at the cost of higher power consumption than Sigfox and LoRa. Ingenu operates in the 2.4 GHz band, which gives it a shorter range than Sigfox and LoRa, and also encounters more propagation loss from obstructions, like water or packed earth. The Ingenu protocol itself enables precise tracking, while Sigfox and LoRa do not provide similar levels of tracking precision and require a separate global navigation satellite system (GNSS) module for tracking applications. Like LoRa, Ingenu is capable of effective bidirectional transmission; Sigfox and LoRa can typically achieve a greater amount of endpoints per base station than Ingenu.

Other LPWAN Protocols

The three protocols mentioned above – Sigfox, LoRaWAN, and Ingenu – are the three most established, with multiple large-scale deployments generating value across industries. There are however several other LPWAN solutions vying for their slices of the pie, some of which overlap directly with the target applications of the above protocols, and some that diversify and target different specifications. One of the next in line is the Weightless standard, which is developed and maintained by the Weightless Specialty Interest Group (SIG). There are several implementations of the Weightless standard (Weightless-W, -N, and -P) that leverage different underlying technologies and target different bandwidth applications. The company Nwave is one of the major proponents commercializing Weightless technology. Other prominent LPWAN standards include Dash7 (maintained by the Dash7 Alliance) and ThingPark Wireless (commercialized by Actility, based on LoRaWAN).

Table of the major LPWAN solutions

Solution	Model	Frequency	Range	Data transfer rate	Packet Size	Stage
Sigfox	Proprietary	868 / 902 MHz	rural: 30-50 km urban: 3-10 km	upload: <300 bps download: 8 bits per day	12 bits	scale
LoRaWAN	Alliance	433 / 868 / 780 / 915 MHz	rural: 15 km urban: 2-5 km	upload: 300 bps – 50 kbps download: 300 bps – 50 kbps	user-defined	scale
Ingenu	Proprietary	2.4 GHz	rural: 5-10 km urban: 1-3 km	upload: 624 kbps download: 156kbps	6 bits – 10 kbits	scale
Weightless-W	Alliance	400-800 MHz	5 km	upload: 1 kbps – 10 Mbps download: 1 kbps – 10 Mbps	>10 bits	introduction
Weightless-N	Alliance	<1 GHz	3 km	upload: 100 bps download: 100 bps	<20 bits	introduction
Weightless-P	Alliance	<1 GHz	2 km	upload: 200 bps – 100 kbps download: 200 bps – 100 kbps	>10 bits	under development
Dash7	Alliance	433 / 868 / 915 MHz	<5 km	upload: 10, 56, or 167 kbps download: 10, 56, or 167 kbps	<256 bits	introduction

Analysis

A major consideration when selecting an LPWAN solution for implementation is the ownership and business model of the standard. The three major scale developers offer a broad spectrum in terms of ownership: of the three, Sigfox is the most "closed", in that all traffic through a Sigfox deployment must be routed through the Sigfox cloud platform, which requires users to sign with Sigfox and continuing paying the firm to keep up the deployment. An open element however is that users can buy Sigfox hardware from a wide variety of vendors. LoRa is much more "open" in that users can source LoRa modules and gateways from hardware vendors, then deploy their own networks and manage them privately. The closed element in LoRa is that Semtech is the only organization currently manufacturing the radio chips themselves, but this does not pose a strict restriction as multiple vendors farther downstream sell the required communications hardware. Ingenu offers both models: users can buy hardware directly from Ingenu, then deploy and manage their own solutions, while Ingenu also sells data plans to public networks that the firm manages itself.

Application-specific performance is an essential factor for successful LPWAN deployments. Depending on the requirements of a solution in terms of data transfer rate, packet size, power consumption, bidirectionality, and distance range, there is a wide variety of standards to meet these needs. An alarm that is seldom triggered and sends a simple on / off signal from the endpoint to the cloud might be best addressed by a Sigfox deployment, while a higher-bandwidth system for a pump controller that requires real-time, bidirectional communication would be better addressed by Ingenu. It should also be noted that all of these standards experience difficulties when expanding into new regions with different spectrum licensing landscapes – LoRa and Sigfox both achieved significant adoption in Europe before pushing into North America, at which point both experienced delays in deployments due to adjusting to different frequency spectrums and local regulatory requirements.

The future for LPWAN solutions will likely involve multiple standards being deployed in parallel in their target niches, while battling each other at the borders between their optimal performance parameters. Unlike the IoT platform space announcements of new LPWAN standards tapered off a while ago and appear to have plateaued with the standards mentioned above, although the occasional new LPWAN standard does pop up occasionally (like Wi-Fi HaLow, announced in January 2016). Sigfox and Ingenu have achieved sustained growth and funding, and both have the potential to become global IoT MNOs – offering region-wide IoT data plans much the way Verizon and Vodafone provide phone plans. Sigfox and Ingenu are also both great acquisition targets for MNOs looking to become major M2M enablers. Clients interested in deploying LPWAN solutions should perform a comprehensive assessment of target deployment performance parameters, and align with the ownership model that makes the most sense for their long-term deployment goals.