LoRa and LoRaWAN Timing

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LoRaWAN (**Lo**ng-**Ra**nge **W**ide **A**rea **N**etwork) is a type of data communication for wide area wireless networks. It is designed to allow long-range data acquisition at a low bit rate between connected sensors that monitor and relay back data. LoRa can transmit data over large distances with low power. This is based on the laws of physics, which dictate that, to transmit over a long distance; you either need to increase the power or reduce the bandwidth.

There are several other types of similar networks. Like LPWAN **(**low-power wide-area network), LPWA **(**low-power wide-area) or LPN **(**low-power network).

What is LoRa and LoRaWAN

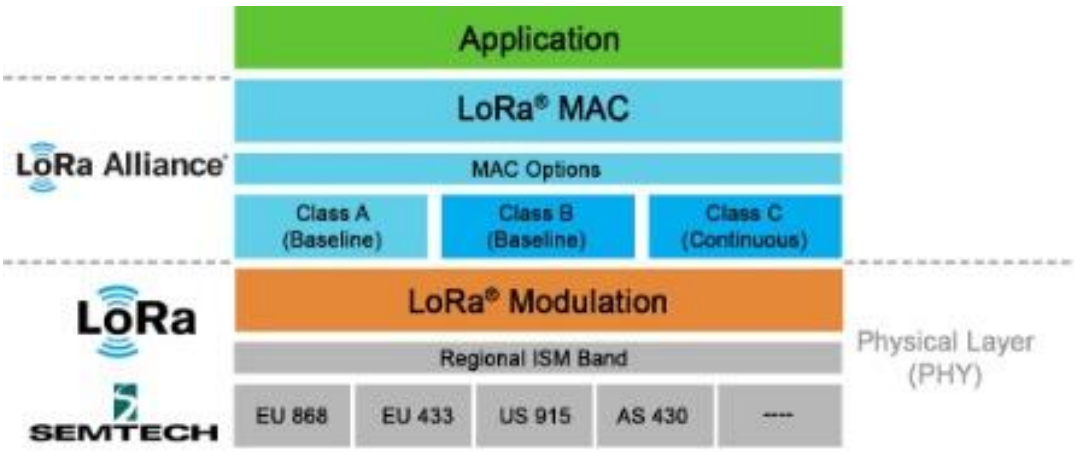
LoRa (Long-range) is a patented digital wireless data communication IoT technology developed by Cycleo of Grenoble, France. Cycleo was acquired by Semtech in 2012. Semtech holds the IP for LoRa transmission methodology. The LoRa advantage is in the technology's long-range capabilities. A single gateway or base station can cover entire cities or hundreds of miles.

LoRa transmits over license-free megahertz radio frequency bands like 169 MHz, 433 MHz (Asia), 868 MHz (Europe) and 915 MHz (North America). LoRa enables very-long-range transmissions (more than up to 10 miles in rural areas) with low power consumption. LoRa communications can be made at ranges of ten miles or more in rural areas, using low power. LoRa can achieve this by narrowing the bandwidth. The laws of physics dictate that to transmit over a longer distance, you either need to increase the power or reduce the bandwidth.

The technology is presented in two parts — LoRa, the physical layer, and the communication protocol built upon the underlying LoRa physical layer. The communication layer will be WAN (Wide Area Network), an open-source communication protocol defined by the LoRa Alliance consortium.

Thus, LoRaWAN defines the communication protocol and system architecture for the network, while the LoRa physical layer enables the long-range communication link. LoRaWAN communication protocol ensures reliable communication and secure communication.

Physical and communication layers of a LoRaWAN network

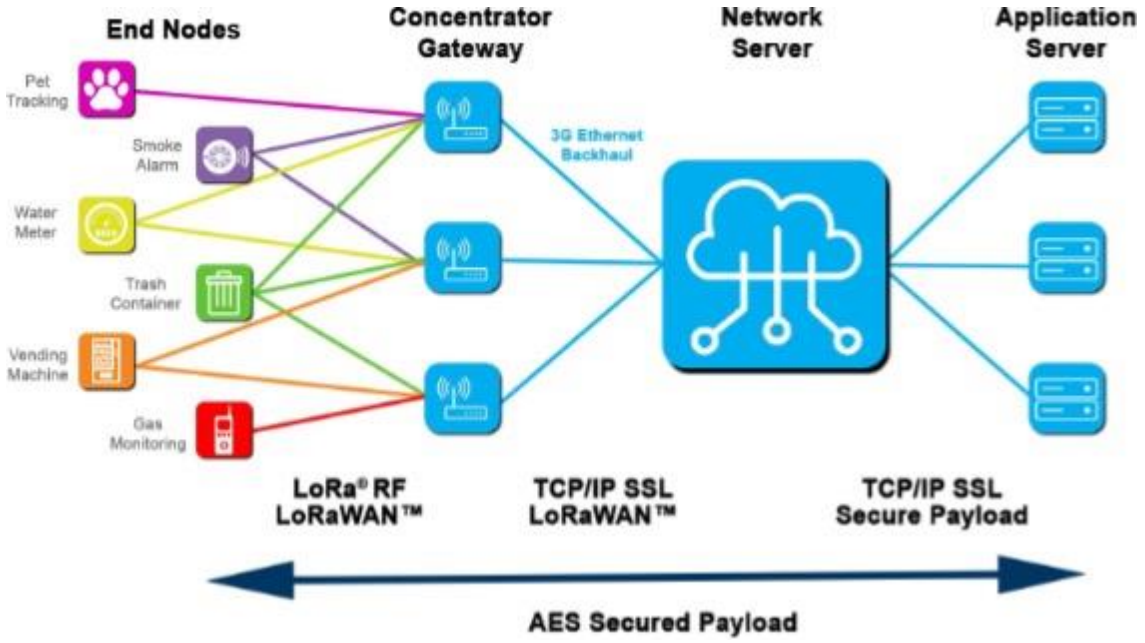


LoRa and LoRaWAN Network Topology

LoRaWAN network architecture is deployed in a star-of-stars topology. This allows base stations to relay the data between the sensor nodes and the network server.

Communication between the sensor nodes and the base stations goes over the wireless channel utilizing the LoRa physical layer, whilst the connection between the gateways and the central server are handled over a backbone IP-based network.

- **End Nodes** transmit directly to all gateways within range, using LoRa.
- **Gateways** relay messages between end devices and a central network server using IP.



End Nodes

The End Nodes are LoRa embedded sensors. Class A nodes typically have:

- **Sensors** used to detect the changing parameter. Example: temperature, humidity, accelerometer, GPS
- **LoRa transponder** to transmit signals over LoRa patented radio transmission method and optionally a **micro-controller (with onboard memory).**

The LoRaWAN end nodes are typically battery powered (Class A and Class B) sensors. Battery life for a node can typically last two to five years. The LoRa sensors use line of sight communications. Their distances can vary from one to ten miles.

Node Types

Class Type A	Class Type B	Class Type C
Battery powered	Low latency	No latency
Bidirectional with 1 UL+2DL Slot	Bidirectional with scheduled downlink slots	Bidirectional with most of the time listening mode
Unicast messages	Unicast and multicast messages	Unicast and multicast messages
• Small payloads • Long intervals	• Small payloads • Long intervals • Periodic beacon from gateway	• Small payloads
End device initiates communication (uplink)	Extra receive window	Server can initiate transmission at any time
Server communicates with end-device (downlink) during predetermined response windows	Server can initiate transmission at fixed intervals	End-device is constantly receiving

Gateways

The LoRa sensors transmit data to the LoRa gateways. The LoRa gateways connect to the internet via the standard IP protocol and transmit the data received from the LoRa embedded sensors to the Internet i.e. a network, server, or cloud.

The gateway devices are always connected to a power source. The gateways connection acts as a transparent bridge simply converting RF packets to IP packets and vice versa.

Advantages and disadvantages of LoRaWAN

Advantages of LoRaWAN

- Low powered sensors that can cover a wide area measured in miles
- Operates in the industrial, scientific and medical (ISM) radio bands. These are free (unlicensed) frequencies, having no upfront licensing cost to use the technology
- Low power means long battery life for devices. Sensor batteries can last for 2 – 5 years (Class A and Class B)
- Single LoRa gateway device is designed to take care of thousands of end devices or nodes
- Perfect for monitoring field deployed assets
- Widely used for M2M and IoT applications
- LoRaWAN is governed by an alliance
- Long-range functionality enables smart solutions, such as smart city applications
- Wireless, easy to set up and fast deployment
- Security: a layer of security for the network and one for the application with AES encryption
- Fully bi-directional communication

Disadvantages of LoRaWAN

- Not for large data payloads, payload limited to 0.3 ~ 5.5 kBps
- Has no support for audio or video
- Limited to line of sight (LoS) communication
- Not for continuous monitoring (except Class C devices)

- Not ideal candidate for real time applications requiring lower latency and bounded jitter requirements
- LoRa operates on frequencies that are open and do not need a state license. That means that you may get interference on that frequency and the data rate may be lowered. Also, because open frequencies are different from country to country the performance may vary

LoRaWAN is a wireless data collection protocol. Specifically designed for gathering low bandwidth sensors over long distances. It's use as a portal for industrial, medical and municipal data gathering will help simplify time consuming tasks and drive a connected world.

Contingent on the configuration of your LoRa radios and how many nodes and gateways you will use, you will need one or more clocks at different frequencies and stabilities. ECS Inc. has many products specifically engineered to meet these requirements. Listed below are some of the more commonly used clocks in LoRa and LoRaWAN applications.

Crystals and oscillators for LoRa and LoRaWAN applications

32.769 kHz Tuning Forks

Part Number	Frequency	Package Size	Load Capacitance
ECS-.327-12.5-1210-TR	32.768 kHz	1.2 mm x 1.0 mm	12.5 pF
ECS-.327-12.5-16-TR	32.768 kHz	1.6 mm x 1.0 mm	12.5 pF
ECS-.327-12.5-12-TR	32.768 kHz	2.0 mm x 1.2 mm	12.5 pF
ECS-.327-12.5-34B-TR	32.768 kHz	3.2 mm x 1.5 mm	12.5 pF

32 MHz Tuning Forks

Part Number	Frequency	Package Size	Load Capacitance
ECS-320-10-48-CKY-TR	32 MHz	1.2 mm x 1.0 mm	10 pF
ECS-320-8-47-CKM-TR	32 MHz	1.6 mm x 1.2 mm	8 pF
ECS-320-8-37CKM-TR	32 MHz	2.0 mm x 1.6 mm	8 pF
ECS-320-10-36-CTN-TR	32 MHz	2.5 mm x 2.0 mm	10 pF
ECS-320-8-33-RWM-TR	32 MHz	3.2 mm x 2.5 mm	8 pF

32.769 kHz Oscillators

Part Number	Frequency	Package Size	Tolerance	Voltage
ECS-327MV-CN-TR	32.768 kHz	1.2 mm x 1.0 mm	±25 ppm	1.6V ~ 3.6V

MHz Oscillators

Part Number	Frequency	Package Size	Tolerance	Voltage
ECS-1612MV-320-CN-TR	32 MHz	1.6 mm x 1.2 mm	±25 ppm	1.6V ~ 3.6V
ECS-2016MV-320-CN-TR	32 MHz	2.0 mm x 1.6 mm	±25 ppm	1.6V ~ 3.6V
ECS-2520MV-320-BN-TR	32 MHz	2.5 mm x 2.0 mm	±25 ppm	1.6V ~ 3.6V
ECS-3225MV-320-BN-TR	32 MHz	3.2 mm x 2.5 mm	±25 ppm	1.6V ~ 3.6V
ECS-1612MV-520-CN-TR	52 MHz	1.6 mm x 1.2 mm	±25 ppm	1.6V ~ 3.6V
ECS-2016MV-520-CN-TR	52 MHz	2.0 mm x 1.6 mm	±25 ppm	1.6V ~ 3.6V
ECS-2520MV-520-BN-TR	52 MHz	2.5 mm x 2.0 mm	±25 ppm	1.6V ~ 3.6V
ECS-3225MV-520-BN-TR	52 MHz	3.2 mm x 2.5 mm	±25 ppm	1.6V ~ 3.6V

TCXOs

Part Number	Frequency	Package Size	Tolerance
ECS-327TXO-33-TR	32.768 kHz	3.2 mm x 2.5 mm	±1.5 ppm
ECS-TXO-2016-33-320-TR	32 MHz	2.0 mm x 1.6 mm	±2.5 ppm
ECS-TXO-2520-33-320-AN-TR	32 MHz	2.5 mm x 2.0 mm	±2.5 ppm
ECS-TXO-2016-33-520-TR	52 MHz	2.0 mm x 1.6 mm	±2.5 ppm
ECS-TXO-2520-33-520-AN-TR	52 MHz	2.5 mm x 2.0 mm	±2.5 ppm

ECS Inc. is committed to supplying high end electronic components to help you engineer the IoT connected world. For more information on ECS Inc. products click here.