LoRaWAN from LoRa Alliance

1 LoRa Alliance™ Technology

LoRaWAN™ is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery operated Things in a regional, national or global network. LoRaWAN targets key requirements of Internet of Things such as secure bi-directional communication, mobility and localization services. The LoRaWAN specification provides seamless interoperability among smart Things without the need of complex local installations and gives back the freedom to the user, developer, businesses enabling the roll out of Internet of Things.

LoRaWAN network architecture is typically laid out in a star-of-stars topology in which gateways is a transparent bridge relaying messages between end-devices and a central network server in the backend. Gateways are connected to the network server via standard IP connections while end-devices use single-hop wireless communication to one or many gateways. All end-point communication is generally bi-directional, but also supports operation such as multicast enabling software upgrade over the air or other mass distribution messages to reduce the on air communication time.

Communication between end-devices and gateways is spread out on different frequency channels and data rates. The selection of the data rate is a trade-off between communication range and message duration. Due to the spread spectrum technology, communications with different data rates do not interfere with each other and create a set of "virtual" channels increasing the capacity of the gateway. LoRaWAN data rates range from 0.3 kbps to 50 kbps. To maximize both battery life of the end-devices and overall network capacity, the LoRaWAN network server is managing the data rate and RF output for each

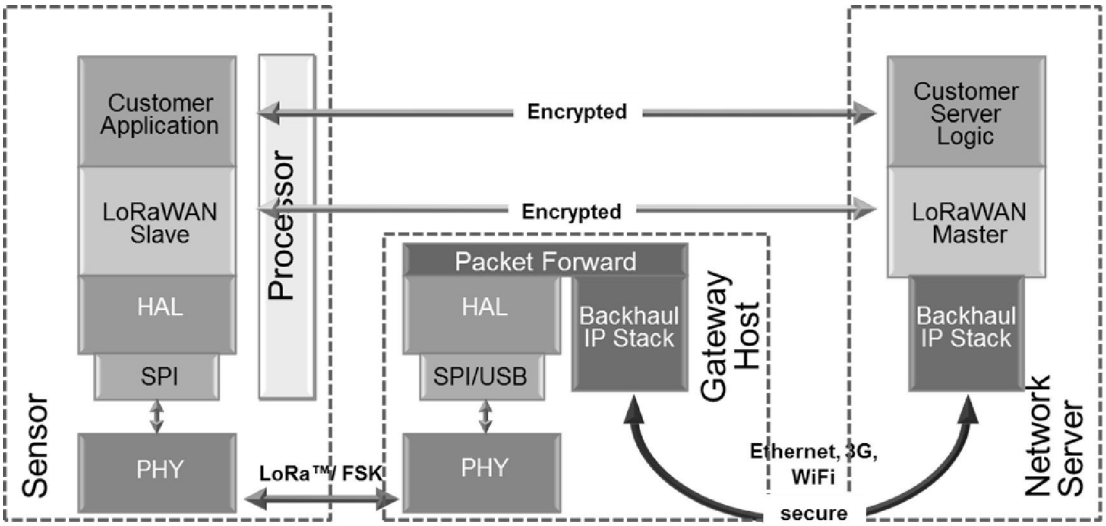
end-device individually by means of an adaptive data rate (ADR) scheme.

National wide networks targeting internet of things such as critical infrastructure, confidential personal data or critical functions for the society has a special need for secure communication. This has been solved by several layer of encryption:

- Unique Network key (EUI64) and ensure security on network level
- Unique Application key (EUI64) ensure end to end security on application level
- Device specific key (EUI128)

LoRaWAN has several different classes of end-point devices to address the different needs reflected in the wide range of applications:

- Bi-directional end-devices (Class A): End-devices of Class A allow for bi-directional communications whereby each end-device's uplink transmission is followed by two short downlink receive windows. The transmission slot scheduled by the end-device is based on its own communication needs with a small variation based on a random time basis (ALOHA-type of protocol). This Class A operation is the lowest power end-device system for applications that only require downlink communication from the server shortly after the end-device has sent an uplink transmission. Downlink communications from the server at any other time will have to wait until the next scheduled uplink.
- Bi-directional end-devices with scheduled receive slots (Class B): In addition to the Class A random receive windows, Class B devices open extra receive windows at scheduled times. In order for the End-device to open its receive window at the scheduled time it receives a time synchronized Beacon from the gateway. This allows the server to know when the end-device is listening.
- Bi-directional end-devices with maximal receive slots (Class C): End-devices of Class C have nearly continuously open receive windows, only closed when transmitting. Class C


Customer Application
LoRaWAN Slave
HAL
SPI
PHY
Sensor
Processor
LoRa™/ FSK
Encrypted
Encrypted
Packet Forward
HAL
SPI/USB
PHY
Backhaul IP Stack
Gateway Host
Ethernet, 3G, WiFi
secure
Customer Server Logic
LoRaWAN Master
Backhaul IP Stack
Network Server

2 LoRaWAN™ For Developers

LoRaWAN is a Low Power Wide Area Network with features that support low-cost, mobile, and secure bi-directional communication for Internet of Things (IoT), machine-to-machine (M2M), and smart city, and industrial applications. LoRaWAN is optimized for low power consumption and is designed to support large networks with millions and millions of devices. Innovative features of LoRaWAN include support for redundant operation, geolocation, low-cost, and low-power - devices can even run on energy harvesting technologies enabling the mobility and ease of use of Internet of Things.

Specification and Regional Parameters

LoRaWAN Specification

The LoRaWAN Specification document describes the LoRaWAN™ network protocol including MAC layer commands, frame content, security, flexible network frequency management, device EIRP and TX dwell time, power control, relay protection and more.

LoRaWAN Regional Parameters V1.0

The LoRaWAN Regional Parameters document contains the channel frequency plans for various global regions. These details are managed separately from the LoRaWAN Specification to enable the Alliance to quickly address regional regulatory support requirements.

Complete this form to request the LoRaWAN 1.0.2 Specification and LoRaWAN Regional Parameters 1.0.

Certification

The LoRa Alliance™ is committed to interoperability, quality of the network as well as the end-points. LoRa Alliance™ member products are available throughout the eco-system. The LoRa Alliance Certified ™ program leverages the expertise of industries and certification groups around the world to maintain the vision of the LoRa Alliance.

Members benefits of the LoRa Alliance Certified™ program:

- Certified Product
- Interoperability testing
- Use of LoRa Alliance Certified ™ logo
- Product listing on the Alliance website
- Product promotion in Alliance collateral
- Inclusion in Alliance product demonstrations

Types of Certification

LoRa Alliance Certified ™ product program ensures that products meet national frequency regulations as well as the LoRaWAN features required to ensure interoperability and compliance.

The LoRa Alliance Certified ™ product program also ensures LoRaWAN interoperability and compliance of network infrastructure, components and offerings according to national frequency regulations and the Alliance specification.

Authorized Test Service Providers and certification process

Only LoRa Alliance™ authorized test houses may perform testing for the LoRa Alliance Certified ™ product program. Applicable national conformity test reports and registrations are supplied together with the LoRa Alliance™ conformity report to the Alliance Certification body before receiving the right of Certified product or Certified platform.

3 LoRa Alliance™ FAQ

What is the LoRa Alliance?

The members of the LoRa Alliance believe that the time of the Internet of Things is here and that standardization and a strong, growing ecosystem is the only way drive volume deployments for low power wide area networks.(LPWAN) These LPWAN's are projected to connect 50% of the predicted IoT volumes. The LoRa Alliance is standardizing LPWAN with the LoRaWAN™ specification and has created a certification and compliance program to ensure interoperability. LoRaWAN™ end-devices will be able to be deployed in multiple networks and roam from one network to another irrespective of network infrastructure or operator.

The LoRa Alliance is the fastest growing technology Alliance; we already have over 190 members and have been operational since the end of March 2015. The members include technology leaders such as IBM, Cisco, HP, Foxconn, Semtech and Sagemcom as well as the leading product companies such as Schneider, Bosch, Diehl, and Mueller as well as many SME's and Startup companies all adding significant value to the fast growing LoRaWAN™ ecosystem. Our members also include some of the largest mobile network operators who are deploying networks using the technology.

What is the goal of the LoRa Alliance?

The primary goal of the LoRa Alliance is to standardize LPWAN and through standardization enable large scale volume IoT deployments. The LoRaWAN™ ecosystem will enable product availability, the LoRaWAN™ Certification Program will ensure interoperability and both are due to our members collaborating together on the LoRaWAN™ standard.

Is there really a need for LPWAN?

Every network operator agrees that they can only connect 10-15% of the

predicted volume of IoT devices with cellular. WiFi and BTLE serve some applications well, but clearly you are not going to connect moisture sensors for agriculture with WiFi, LPWA, with the inherent long range and low power characteristics will be the 'goto' technology for IoT applications where remote locations, easy deployment, thousands of connections per gateway and long battery life are required.

Most analysts predict that 45-55% of predicted IoT volumes will be in the LPWAN space, see also the comparative volumes below as per SNS Research.

Global Wide Area M2M Connections by Technology: 2015 - 2030 (Millions)										
Technology	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2030**
2G & 3G Cellular	268	316	373	440	520	613	723	716	709	654
LTE & 5G Cellular	7	14	27	52	101	197	385	423	466	998
Satellite	4	5	6	7	9	10	11	13	14	33
LPWA	13	57	129	222	387	602	878	1'321	1'844	7'192
Wireline	122	131	141	151	163	175	186	193	199	263
Others	101	103	104	105	106	108	109	110	111	123
Total	**516**	**625**	**780**	**978**	**1'286**	**1'705**	**2'293**	**2'776**	**3'344**	**9'262**

SNS Research - October 2015

What are the target applications?

The main IoT applications for LPWA technology need a long battery life to enable 'fit and forget' or disposable end devices, a low cost sensor or end-device BOM, and long range connectivity.

The applications where LPWAN's are applicable is endless, but if you look at the main applications driving the current network deployments it is intelligent building, supply chain, Smart City and agriculture. In intelligent building the main value driver is in insurance premiums and servicing. In cold regions a broken water pipe has an approximate insurance claim of $50K so insurance companies offer a premium discount if a building management solution is utilized. Having sensors know if the building or room was used can have significant reductions in service management and related expenses. In supply chain any application that has a delivery or pick-up with associated inventory can have huge savings in inventory management and delivery route

optimization. A smart trash monitoring solution reduces pick-ups by 40%. In agriculture the needs are driven by growing food demands whereas 80% percent of water usage is by agriculture and the value of crops is extremely high so having sensors to determine water usage, health of soil/crop, etc. Accurate irrigation and soil monitoring translates into significant cost savings in resource usage and improved profit with improved yields.
See our guides to LoRaWAN™ and LPWA.

Why is LoRaWAN™ becoming the 'goto' LPWA standard?
There are some technical differences between LoRaWAN™ and alternative LPWAN technologies which enable a much broader set of applications to be addressed from a bi-directional connectivity, adaptive datarate and end point class perspective but the key differentiator is the ecosystem, the Certification Program and standardization. If you look at successful technology adoption over the past 10 years all have followed this model. Having different business models, competition, and a diverse ecosystem with industry leaders is the only way to scale volume and deployments. An open standard is also a proven strategy to get acceptance and wide deployment versus proprietary technology, the choice of the various network components; gateways, end devices, cloud network servers along with chips, development kits and end products from many different suppliers offers a low risk strategy for potential operators or end users.
Last but not least LoRaWAN™ protects data and privacy like no other LPWAN, it is the most secure solution available in the market with 128AES encryption on multiple levels for all data from sensor to application server and back.

Won't CIoT or other LTEM variants in 3GPP eventually replace LoRa?
LoRaWAN™ is a compliment to the LTE variations and serves different application segments. They are not competing for the same applications.

Operators are deploying networks now in the unlicensed band because they have the business cases to support and standardization through 3GPP is still a few years away. If you look five years down the road there will be LPWAN solutions in the licensed and unlicensed bands. The operators will offer services in cellular M2M, licensed band LPWAN, and unlicensed band LPWAN and price segment the different categories with the quality of service (QoS) to maximize revenue and licensed band usage.

What is the rollout plan for network deployments?

KPN, Proximus, Swisscom, Orange, Bouygues, Lace, Senet, Fastnet, Three, SKT, Telstra, Tata, and ?eské Radiokomunikace have all announcement intentions for nationwide deployments. Most plan to complete their deployment in 2016 but the individual schedules should be confirmed with the local operators. There are many more not yet publically announced.

What is the pricing for location and geolocation services?

The LoRa Alliance does not discuss pricing; this should be discussed directly with the LoRa Alliance Members or the solutions providers.

Is LoRaWAN targeting license bands?

There is no technical challenge to operating a LoRaWAN™ private solution in a licensed band but to be included as part of the Alliance it would need to be proposed and accepted in the Alliance Committees.

Is the alliance really a true open standard if Semtech is the only supplier of the RF chips?

From an Alliance perspective we want to see as many LoRa chip suppliers as possible. Microchip is in development today of an integrated micro+RF solution to be a second source silicon provider of the technology and ST

Microelectronics have now announced that they will also be manufacturing LoRa chips. There will also likely be other semiconductor companies offering solutions in the near future.