

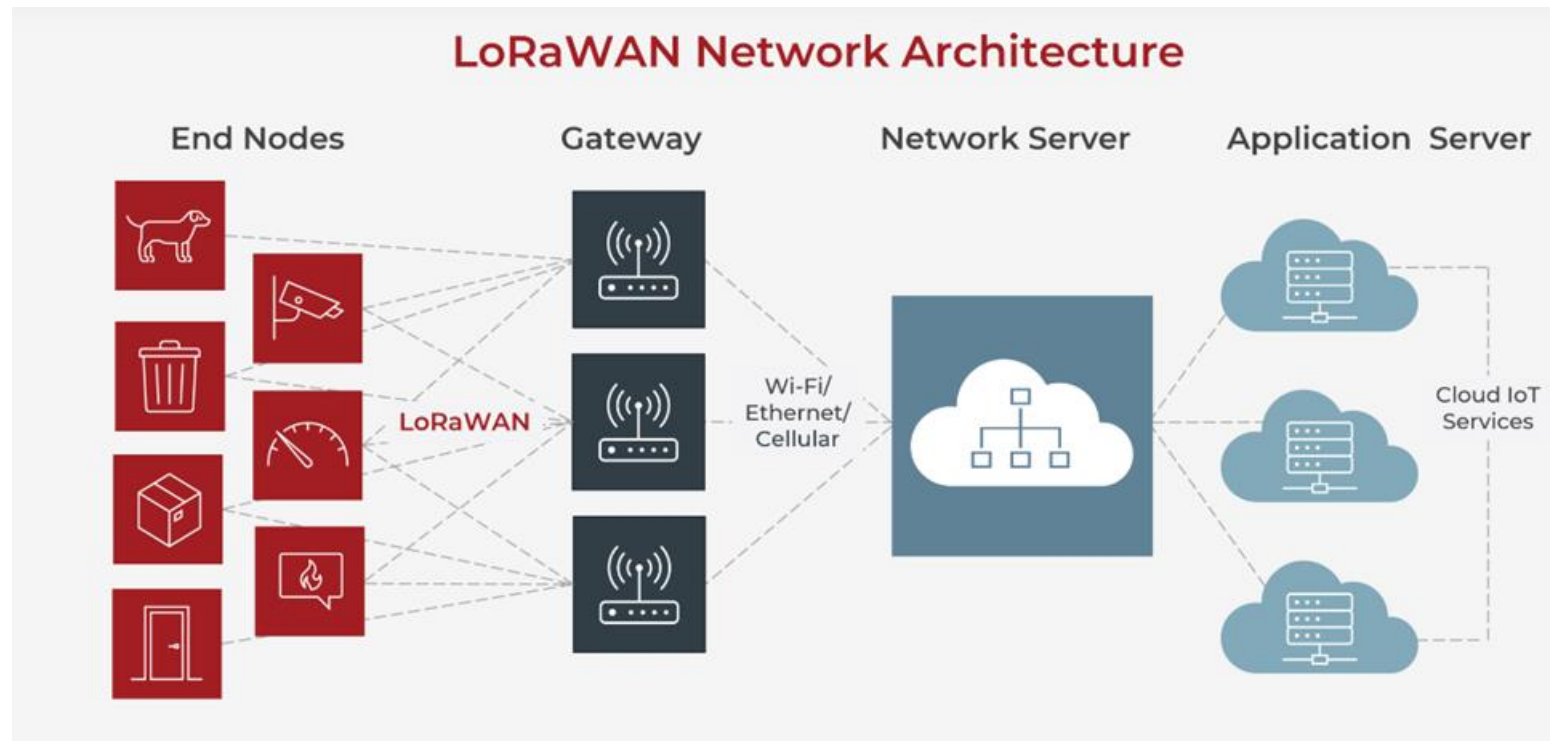
LoRaWAN Research

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Expectations of Working Conditions

- ▶ In significant movement of sensors and gateway
- ▶ Minimal competition from unknown LoRa networks
- ▶ Minimal interference from gateways in the same network
- ▶ Not overwhelming number of nodes

Basic Structure of LoRaWAN Network



Specifics of LoRaWAN Protocol

- ▶ Adaptive Data Rate
- ▶ Multichannel multi-modem
- ▶ Devices follow chain of command

Device Classes

Class	Description of behavior
A	<ul style="list-style-type: none">• ALOHA contact method/asynchronous• talks when it has power• one uplink transmission slot two downlink transmission slots
B	<ul style="list-style-type: none">• additional scheduled receive slots in addition to what A has
C	<ul style="list-style-type: none">• receive slots always open

LoRa Range

- ▶ LoRa has a large Link budget → increased range
 - ▶ Link budget is an accounting of all the gains and losses in a transmission system.
- ▶ LoRa communications range is likely limited to 1 km or less in forested areas
- ▶ At higher range, nets of sensors run into problems with collision

Types of Authentication

Over The Air Activation

- ▶ Better for roaming
- ▶ Easy gateway change
- ▶ Exchange of authorization packages

Activation By Personalization

- ▶ Connection details preset
- ▶ Connected to only one gateway

Sensor Energy Usage

- ▶ The average battery lifetime is calculated to be 1-5 years for sensing interval of 1-5 min, respectively.
- ▶ If energy harvesting from renewable energy sources is used, battery lifetime can go from 4 to 12 years for the same sensing interval range.

Co-existence with Other Networks

- ▶ Frequency and bandwidth restrictions
- ▶ Semtech control-> standardized hardware
- ▶ Gateways competing over nodes
- ▶ In many areas LoRa networks exist alongside traditional networks
- ▶ Majority of tests were done in busy cities

Works Cited

- ▶ https://content.u-blox.com/sites/default/files/ZOE-M8_DataSheet_UBX-16008094.pdf
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- ▶ <https://www.mdpi.com/1424-8220/18/11/3995/htm>
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- ▶ Hartman, Reliability of LoRaWAN Communications in Rugged Terrain