– WiFi HaLow 802.11ah  
– Bluetooth 5.0 + mesh  
– SigFox  
– LoRaWAN  
– Thread  
– LTE V2X  
– LTE NB IOT  
– ZigBee  
– Z-wave  
– Weightless  
– EnOcean

**LoRaWAN**

● Operation principles  
● Required certifications  
● Geographical coverage World / Finland  
● Radio range  
● Bandwidth, data limitations  
● Latency up/down  
● Power consumption / Battery life  
● Network Topology (star/mesh/other)  
● Chip vendors, sample chip cost  
● Development tool availability

*Data rate is the amount of data in bits per second of footage, measured per second and expressed as bits per second. (*The speed at which data is transferred within the computer or between a peripheral device and the computer, measured in bytes per second*)*

LoRaWAN data rates range from 0.3 kbps to 50 kbps.

● Operation principles

star-of-stars topology in which **gateways**is a transparent bridge relaying messages between **end-devices** and a central **network server** in the backend

Communication between end-devices and gateways is spread out on different **frequency channels** and **data rates**

**adaptive data rate** (ADR) scheme

**Bi-directional end-devices (Class A)**

**Bi-directional end-devices with scheduled receive slots (Class B)**

**Bi-directional end-devices with maximal receive slots (Class C):**

these low frequencies provide great penetration in possible materials (brick walls, trees, concrete), so these bands get less loss in the presence of obstacles than higher band.

● Required certifications

* **LoRa Alliance European EU 863-870MHz Region End Device Certification Requirements document\***
* LoRa Alliance US + Canada US902-928MHz Region End Device Certification Requirements document\*
* LoRa Alliance Asia AS 923MHz Region End Device Certification Requirements document\*
* LoRa Alliance South Korea 920-923MHz Region End Device Certification Requirements document\*

● Radio range

Frequencies: 867-869 MHz

LoRaWAN can achieve a 15 km in suburban settings and more than 2 km in dense urban environments.

● Bandwidth, data limitations

Device can send up to 250 Bytes / packet  
§ (max value depends on the selected DataRate)

● Latency up/down

● Power consumption / Battery life  
● Network Topology (star/mesh/other)  
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<https://www.digikey.com/en/articles/techzone/2016/nov/lorawan-part-1-15-km-wireless-10-year-battery-life-iot>