



Semtech LoRa® Overview

Rohde & Schwarz France

Journée IoT Test Day - March 2018

About ChipSelect...

NORTH AMERICA

- United States
 - California (4)
 - North Carolina (1)
 - Texas (1)
- Canada (4)
- Mexico (2)

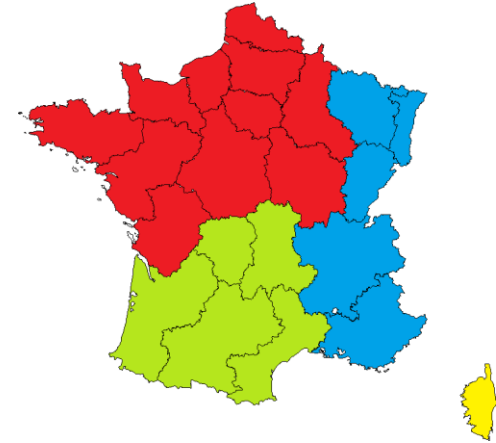
EUROPE

- England (3)
- France (2)
- Germany (1)
- Lithuania (1)
- Switzerland (2)

ASIA

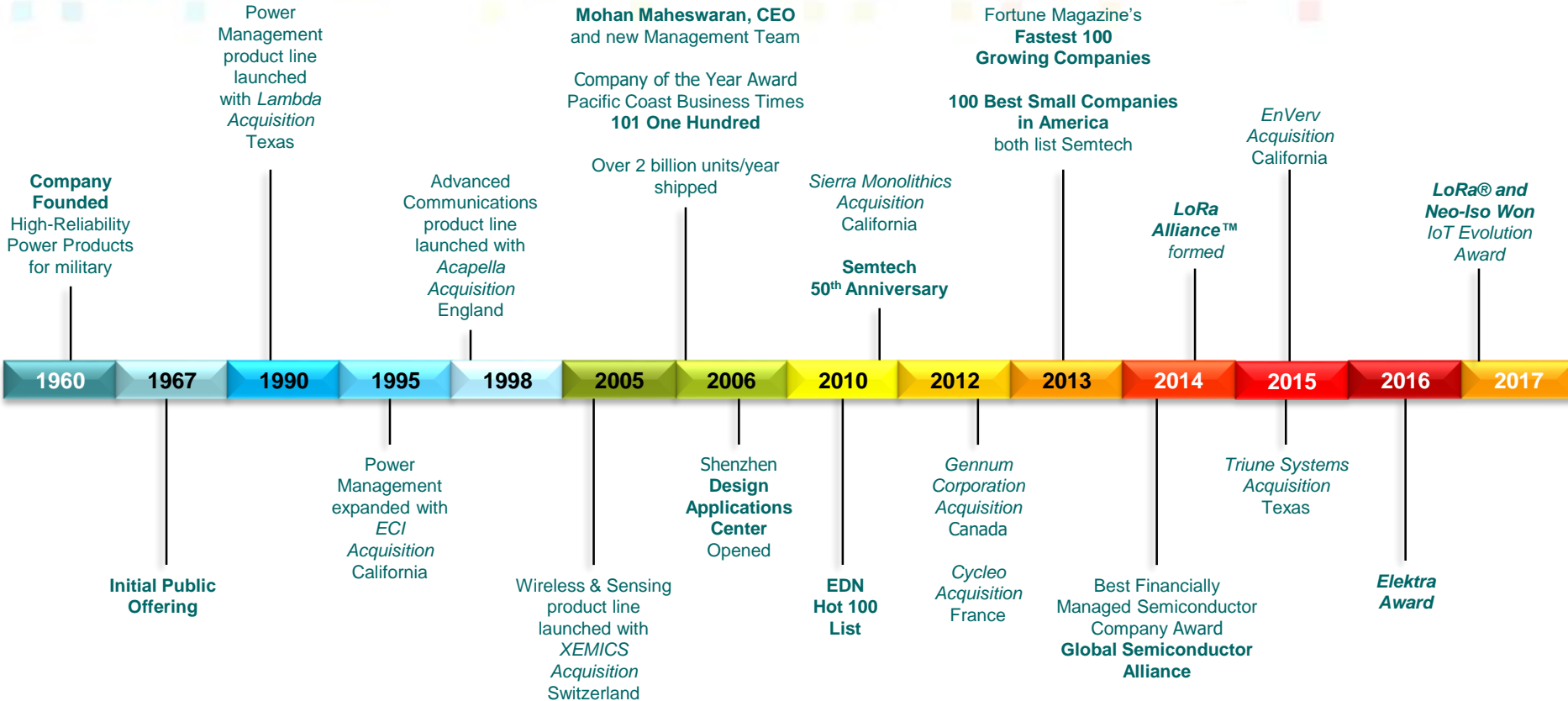
- China (3)
- India (1)
- Japan (2)
- Korea (1)
- Malaysia (2)
- Philippines (1)
- Taiwan (1)

ChipSelect
Vision for Expert



... Sales REP for Semtech since 2010

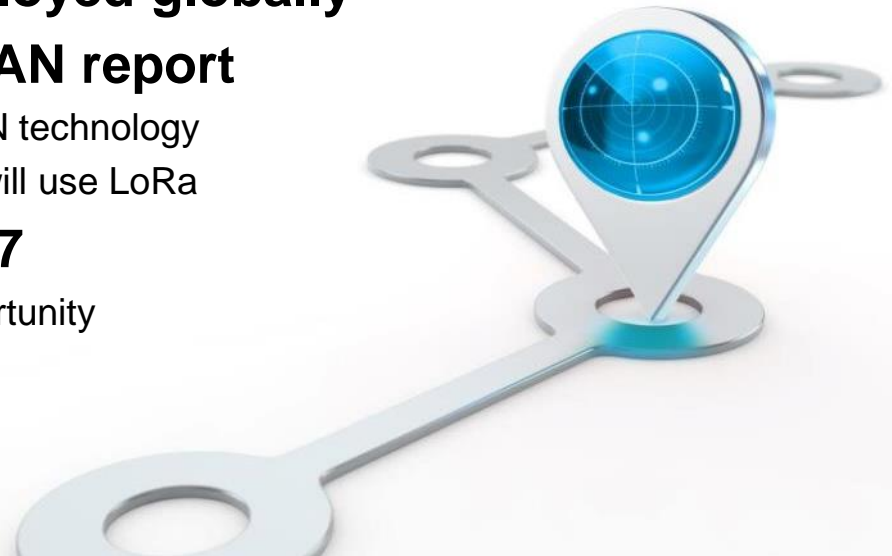
Semtech History & Recognition



Semtech: Creator of LoRa Technology



- ❑ **60+ years of low-power mixed signal design**
- ❑ **Creator of LoRa Technology**
- ❑ **Founding member of the LoRa Alliance™**
- ❑ **Millions of LoRa® radios deployed globally**
- ❑ **IHS Technology – 2017 LPWAN report**
 - LoRa expected to be dominant LPWAN technology
 - Over 40% of all LPWAN connections will use LoRa
- ❑ **Gartner – Market Trends 2017**
 - LoRa offers low risk, high reward opportunity



Low Power, Low Data Communication

Then: People sending messages



Now: Machine driven wireless



**Unlike cellular, Wi-Fi or Bluetooth,
LoRa[®] is designed specifically for LPWAN applications**

LoRa Addresses Technology Gap



Traditional Cellular

Low battery life
High Cost
MNO controlled



NB-IoT

Sigfox

LPWAN

Long Range
Low data rates
Long battery life



802.15.4

Local Area Network

Short Range
Low battery life

Short range
Medium battery life



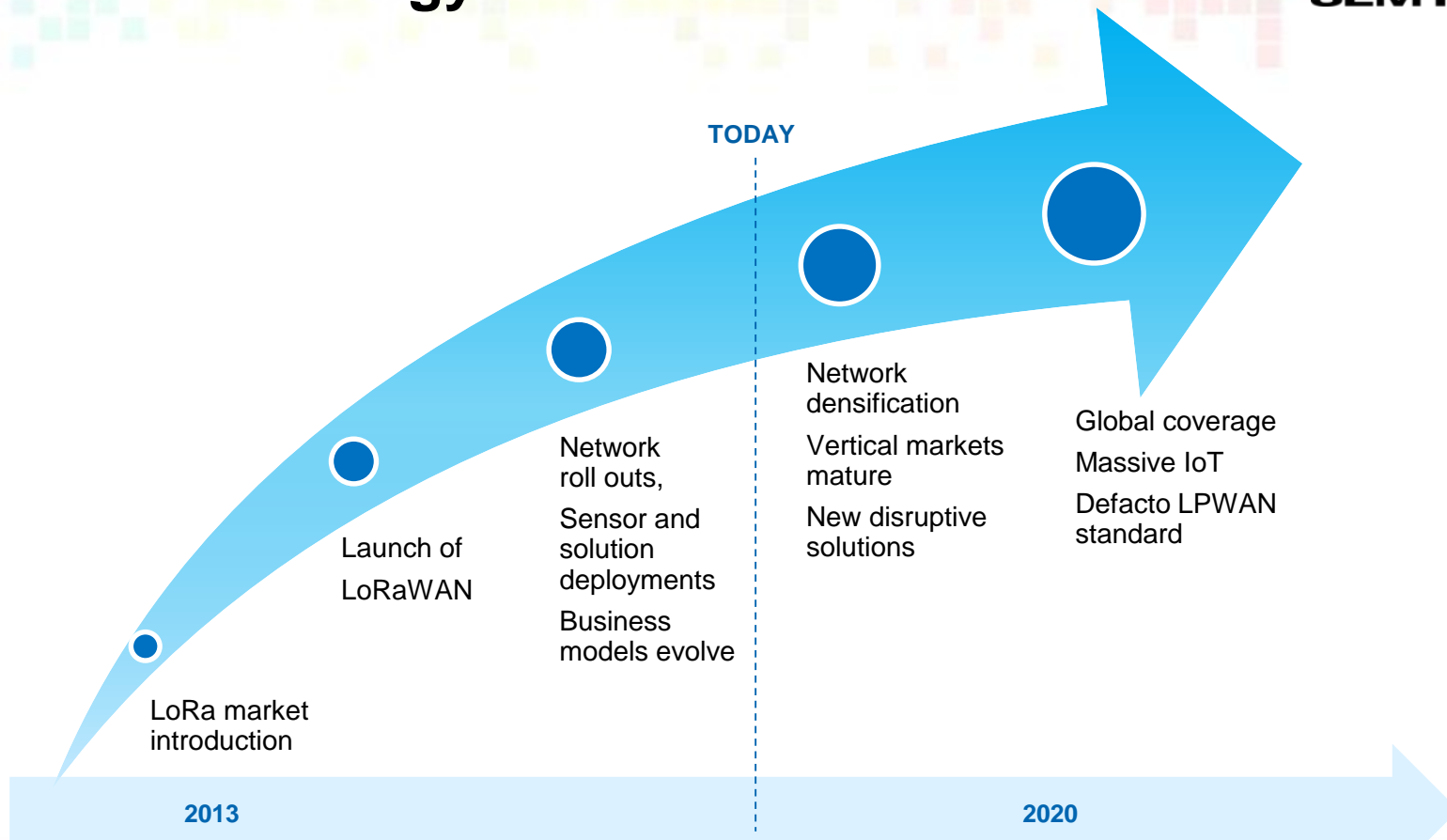
Bluetooth

Personal Area Network

Short Range
Medium battery life

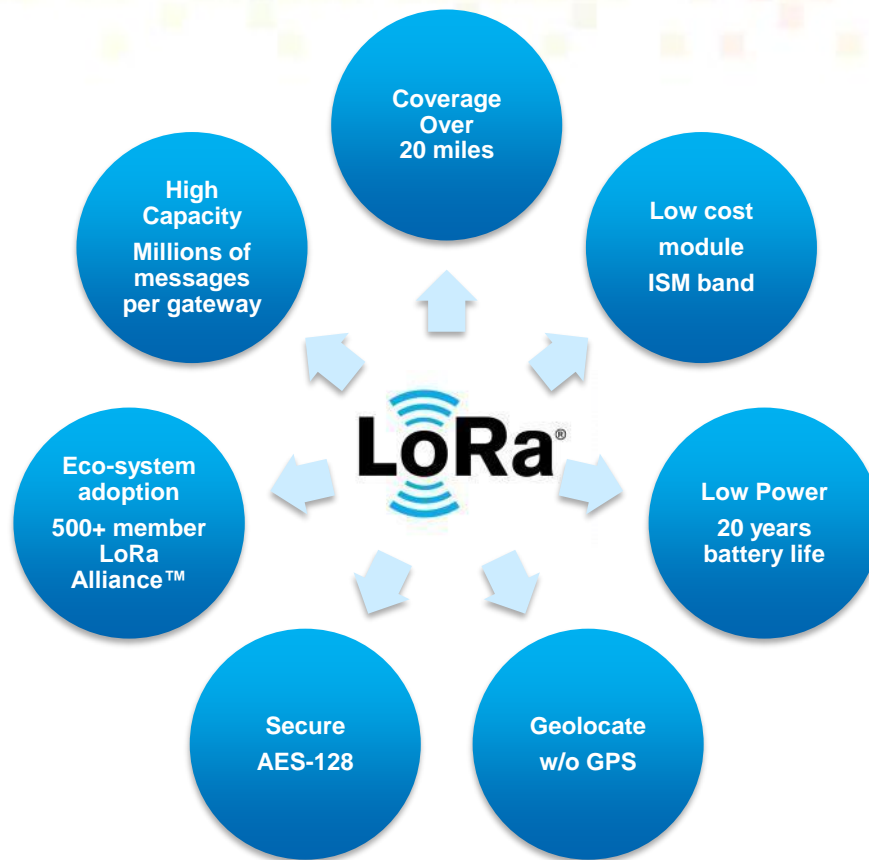


LoRa Technology Enables Massive IoT

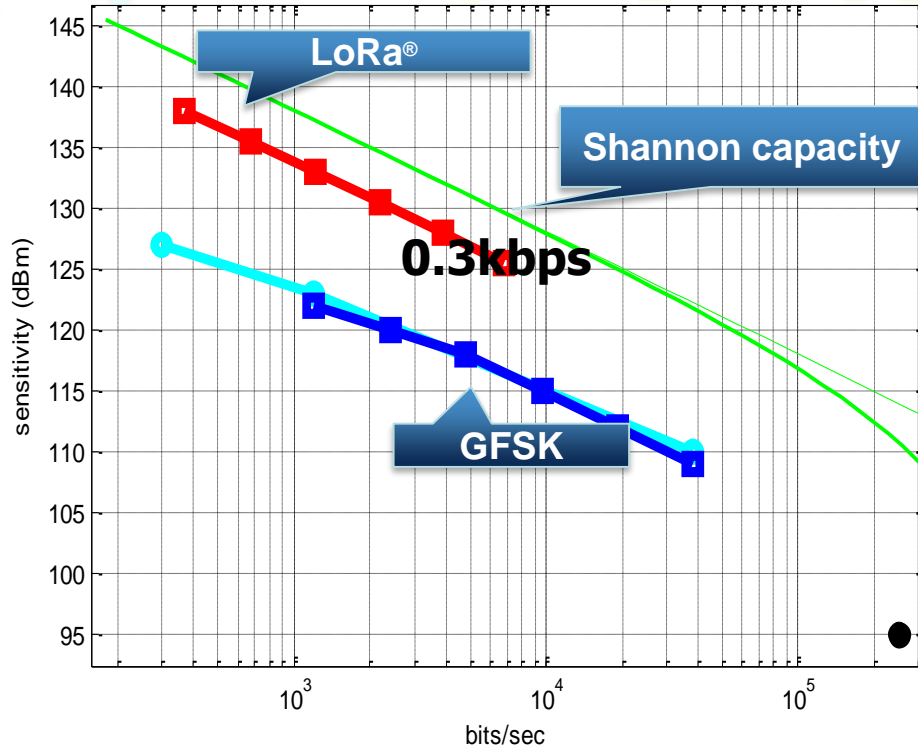




LoRa Technology Value Proposition

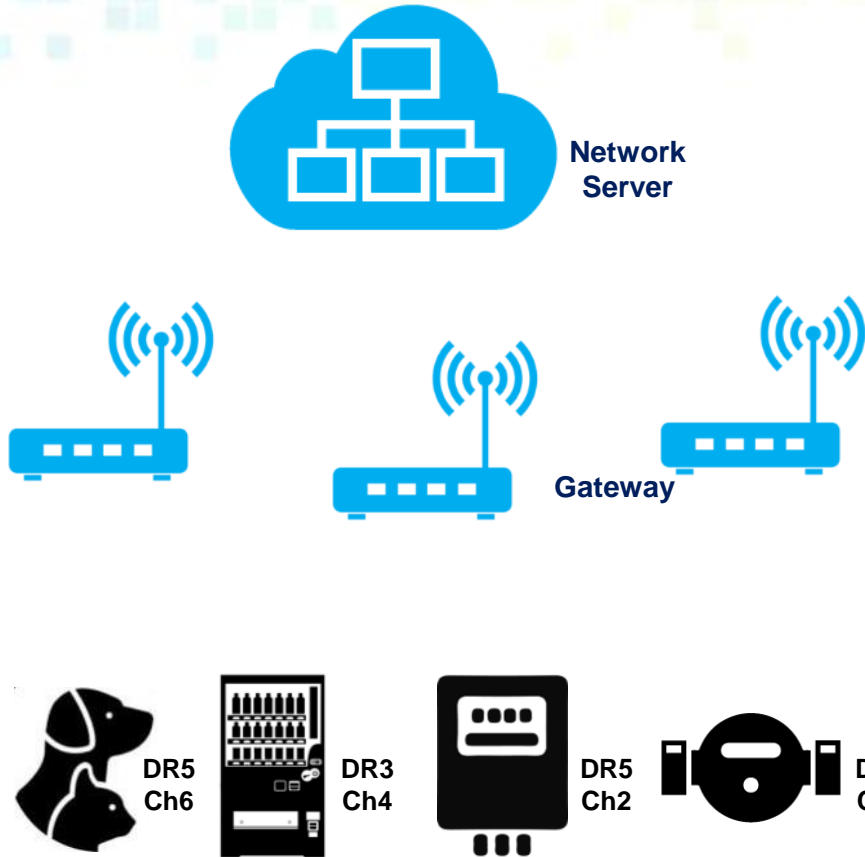


LoRa: Disruptive Technology



~30 miles field results

LoRaWAN™ Network



❑ Multi-channel gateways

- Simultaneous reception of messages
- Scalable capacity
- Indoor or outdoor
- Adaptive data rate
- Supports geo-location

❑ LoRaWAN sensors

- Smart Building
- Smart City
- Agriculture
- Supply chain
- Smart Energy
- Insurance
- Smart Health

LoRa - Brief history



2013 • Launch of first LoRa radio by Semtech

2014 • First mobile network operator trials

- Launch of LoRa Alliance

2015 • Multiple sensors, gateways, modules available
• Public, private, hybrid network deployments

Today • Over 500 LoRa Alliance members
• LoRaWAN spec downloads over 20K
• Low power geolocation introduced
• Multi source value chain



Ecosystem – Multi-Source Value Chain



Chipset



Module



Device



Base Station



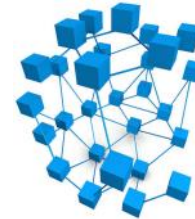
Network Server



Application Server



Network Operator

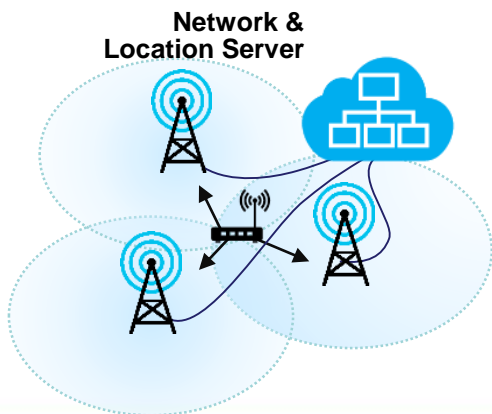
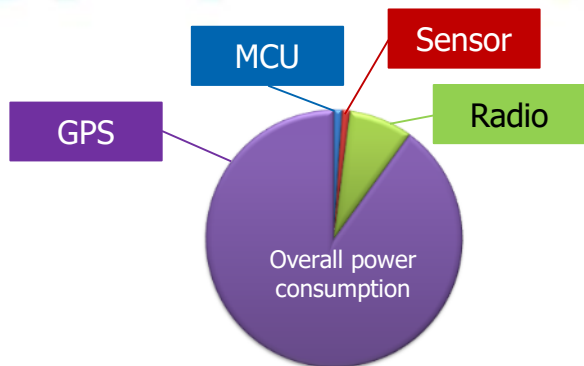


Solution Provider



Silicon to Solutions

LoRaWAN™ Geolocation Feature



**Low
Power**



**GPS-free
location**



**Optimize
operations**

LoRaWAN Vertical Successes: Examples



IN-GROUND

Parking sensor



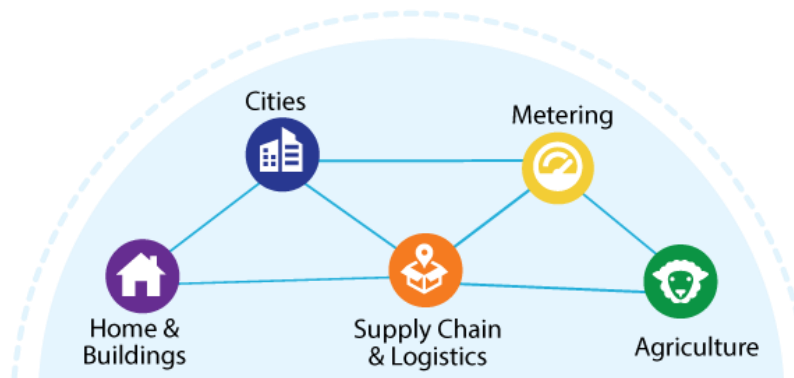
Asset tracker



Smart meter



Leak detection



- 1 LoRaWAN Transceiver
- 2 Embedded battery
- 3 Solar panel
- 4 Waterproof casing

Cattle monitor



Semtech LoRa® Sub-GHz solution

Semtech LoRa[®] IC Products



Sensor Radio IC




Gen 1


SX1276 (Global)
Sub-GHz LoRa, FSK,
10mA Rx, 20dBm

SX1272 (NA and EU)
Sub-GHz LoRa, FSK,
10mA Rx, 20dBm

SX1278 (China only)
Sub-GHz LoRa, FSK,
10mA Rx, 20dBm

Gen 2

SX1261 (Global) 
Sub-GHz LoRa, FSK,
GMSK, 5mA Rx, **15dBm**

SX1262 (Global) 
Sub-GHz LoRa, FSK,
GMSK, 5mA Rx, **22dBm**

SX1268 (China only) 
Sub-GHz LoRa, FSK,
GMSK, 5mA Rx, **22dBm**

Gateway ICs



SX1301

Macro Cell Gateway
Baseband demodulator
-142 dBm, -40 to 70C

SX1308 

Pico cell Gateway
Baseband demodulator
-139 dBm, 0 to 70C

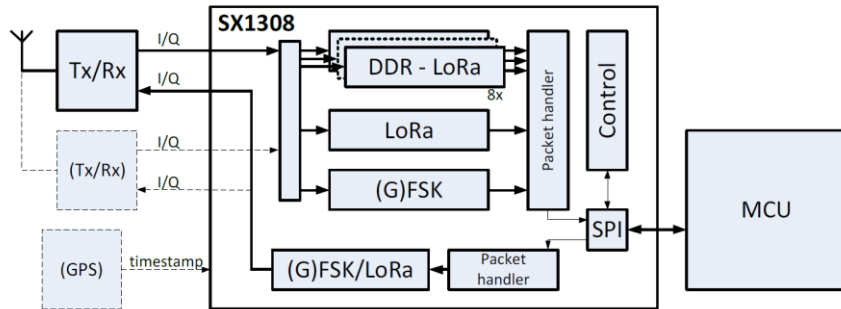
SX1255/7

Gateway Radio (RF to IQ)

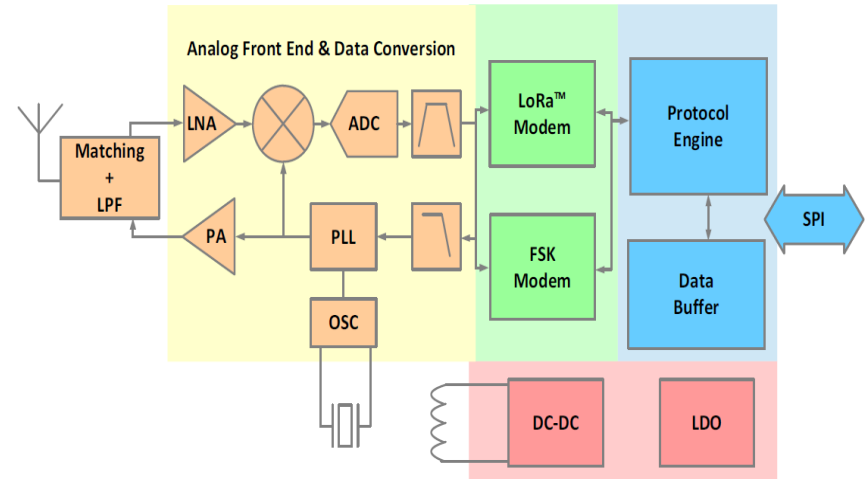
LoRa Alliance[™] members offer complete LoRaWAN based products and solutions today

Functional Block Diagram



GATEWAY



END NODE



End Node Reference Designs

Part	Design	Band	Region	P _{OUT}	Platform
 SX1261	SX1261DVK1BAS	868MHz (XTAL)	Europe	14dBm	Mbed
 SX1262	SX1262DVK1CAS	915MHz (XTAL)	USA, Canada	22dBm	Mbed
	SX1262DVK1DAS	866MHz (TCXO)	India	22dBm	Mbed
SX1272	SX1272MB1DCS	868MHz	EU	14dBm	Mbed
	SX1272MB2DAS	868MHz/915MHz	EU/US	14dBm	Mbed
	SX1272RF1xAS	868MHz/915MHz	EU/US	20dBm	Eiger, Prototype
SX1276	SX1276MB1JCS	433MHz/868MHz	EU/US	14dBm	Mbed
	SX1276MB1MAS	433MHz/868MHz	EU/US	14dBm	Mbed
	SX1276MB1LAS	433MHz/915MHz	US	14dBm/20dBm	Mbed
	SX1276RF1IAS	169MHz/868MHz	EU	20dBm/14dBm	Eiger, Prototype
	SX1276RF1JAS	433/868/915MHz	EU/US	14dBm/20dBm	Eiger, Prototype
	SX1276RF1KAS	490MHz/915MHz	China/US	20dBm/14dBm	Eiger, Prototype

Design Files are available under Docs & Resources of Semtech's LoRa Product Page

LoRaWAN™ for sensor nodes

- ❑ LoRaWAN specification defined by the LoRa Alliance
- ❑ Open source stack for ARM Cortex-M MCUs
- ❑ Portable to other MCU or CPU architectures

- ❑ Option 1: GitHub
 - <https://github.com/Lora-net/LoRaMac-node> (*Master & develop branches*)
 - <http://stackforce.github.io/LoRaMac-doc/> (*Documentation*)

- ❑ Option 2: ARM mbed
 - <https://developer.mbed.org/teams/Semtech/code/>
 - Many sample applications on mbed™ platform





LoRa Gateway Reference Designs

LoRa Gateway Reference Designs

	DATA ONLY (V1.X) MACRO & PICO	DATA + GEOLOCATION (V2.X)
Baseband IC	SX1301 / SX1308	SX1301
TX Channels	1	2
RX Channels	8	16 to 64
Antennas	1	2
Duplex	Half	Half / Full
Power Output	up to 23dbm	up to 30dbm
ARCHITECTURE		
Modems	1	2 to 8
DSPs	0	2
FPGA	-	1
Radio FE	Yes	Yes

- LoRaWAN gateway products available from multiple suppliers
- Reference design and SW available from Semtech
- Macro cell for outdoor, data and geolocation
- Pico cell design intended for indoor environments



**Base-band extender for GW v2.1*

Gateway hardware reference design	Pico 1.0	V1.0	V1.5	V2.1
License agreement	No	No	No	Yes
Environment	Indoor	Indoor / outdoor	Indoor / outdoor	Outdoor
RX Channels	8	8	8	16-64 (No Diversity) 8-32 (with Diversity)
Region	All except JP and Korea	All except JP and Korea	JP , Korea EU (above 20 dBm) (LBT required)	All
Packet Forwarder	No	No	No	No
HAL	No	No	No	No
Interface	USB / UART	SPI	SPI	SPI
TX power	20dBm	27dBm	27dBm	27dBm
RX Sensitivity	Down to -140dBm	Down to -140dBm	Down to -140dBm	Down to -140dBm
RF Frequency	<1GHz ISM Bands 470-928MHz	<1GHz ISM Bands 470-928MHz	<1GHz ISM Bands 470-928MHz	<1GHz ISM Bands 470-928MHz
LoRa GeoLoc Capable	No	No	No	Yes
MCU/FPGA Function	MCU (USB-SPI, Power Consumption)	No	FPGA (TX filtering for EU, LBT for JP / KR)	FPGA + DSP (fine time stamping, freq conversion, Tx filtering)
Full Duplex	No	No	No	Yes

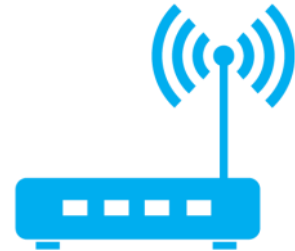
Additional Resources

❑ Pico Cell gateway information

- <http://www.semtech.com/wireless-rf/rf-transceivers/sx1308/>
- SX1308 datasheet
- SX1257/55 datasheet
- Picocell gateway ref design user guide
- Ref design files (schematic, layout, BOM)
- HAL and packet forwarder are on github

❑ All other gateway reference designs

- HAL and packet forwarder for v1.x are on github
- <https://github.com/Lora-net>
- Contact Semtech for GW v2.1



LoRaWAN Roadmap

TODAY

LoRaWAN 1.0.0
Initial Spec Release
Released

LoRaWAN 1.0.2
APAC Updated
Regional Requirements
Available to Alliance Members
Released

2017

LoRaWAN 1.1
Roaming, Join Server ,
Class Switching
In IPR review

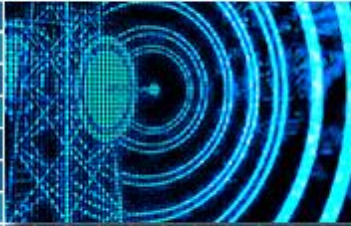


LoRa Community

- ❑ **One stop resource for suppliers and customers**
- ❑ **Promote your products and find products**
 - Over 200 LoRa based products and solutions
 - Eco-system partners and alliance members are active users
- ❑ **Learn what the market needs**
 - New use case announcements from the eco-system
 - Idea exchanges and support forums tell you what your customers experience on the ground
- ❑ **Get support**
 - Experts in the community including Semtech provide technical support
- ❑ **Education**
 - Many videos, training material, application briefs, white papers available



<http://www.semtech.com/iot>



SX126x overview

SX126x – Key benefits

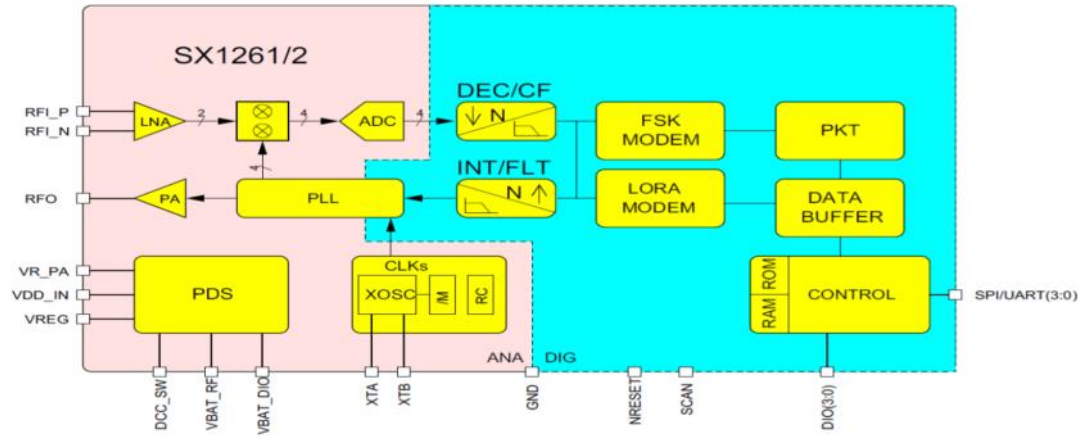
Spec Comparison with SX127x

- ❑ 50% less power in RX
- ❑ 25% less power in TX
- ❑ 45% reduction in size

New Features

- ❑ Higher TX power (22dBm)
- ❑ Global continuous frequency coverage (150-960MHz)
- ❑ New spreading factor SF5
- ❑ Simplified user interface with implementation of Commands

SX126x – LoRa / FSK Transceiver



Overview

- 150 - 960 MHz continuous frequency range self calibrated, SD freq. synthesizer 1 Hz res.
- 14 dBm max. Tx Power for the SX1261
- 22 dBm max. TX power for the SX1262
- TCXO support (integrated LDO with embedded control)
- 32 MHz crystal reference

SX126x Key Specs

❑ Supported modulations

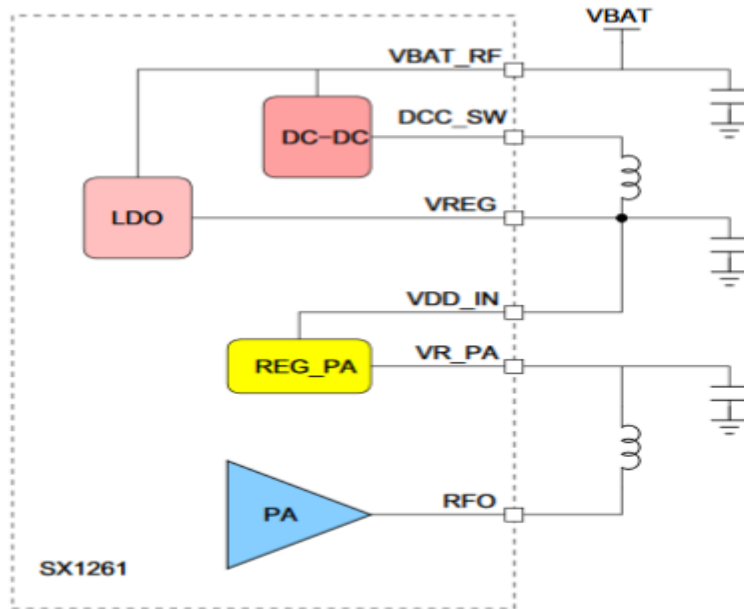
- LoRa RX/TX 7.8 – 500 kHz BW, SF 5 – 12
- (G)FSK RX/TX 0.6 – 300 kb/s

Specification	Typ	Unit
IDD OFF (deep sleep)	150	nA
IDDSL (sleep + regs)	500	nA
IDDSBx (STBY)	1	mA
IDDFS (DC-DC)	2.8	mA
IDDRX (DC-DC)	5	mA
IDDTX (14 dBm DC-DC)	30	mA
(20 dBm)	80	mA
(22 dBm)	120	mA

SX126x TX Power Options

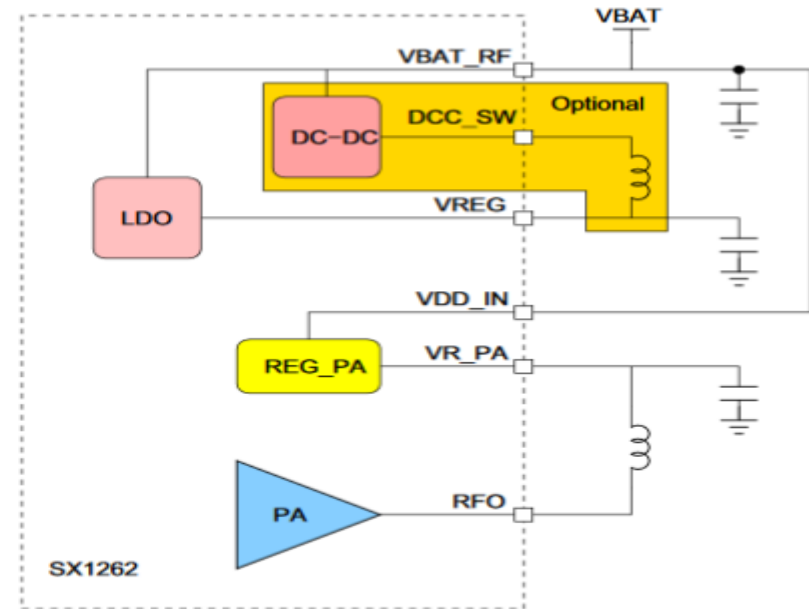
□ SX1261 – 14 dBm PA

- < 3 dB typ. power drop over battery



□ SX1262 – 22 dBm PA

- 8 dB typ. power drop over battery



SX126x New Command Interface

- ❑ The control of the SX126x is done through “OpCode”, similar to AT commands
- ❑ This simplifies the use of the device and shortens development cycle
- ❑ No register table to understand
- ❑ Only 10 lines of code to transmit or receive a packet
- ❑ 15us resolution in-device timer, most of the timing handling can be done in the SX126x



Introduction to SX128x

Semtech LoRa[®] 2.4 GHz solution

SX1280/1



➤ [SX1280/1 on the web](#)

2.4GHz Wireless RF Solution

Low Power, Long Range Communication
with Scalable Data Rate and Ranging Capability

SX1280 Overview

» LoRa 2.4 GHz

Long Range communication for low data rate in 2.4 GHz

» FLRC 2.4 GHz

A robust long range modem for high data rate communication

» GFSK 2.4 GHz

Compatibility asset for migration to FLRC or standard FSK use

» BLE PHY

Physical layer compatibility for BLE (PHY layer only)

» Ranging Engine

RF link Security, P2P ranging and positioning solutions

- ✓ Smart Home
- ✓ Alarm / Security
- ✓ Drone control

- ✓ Video streaming
- ✓ Audio streaming

- ✓ Traditional application
- ✓ Backwards compatibility

- ✓ Sensor provisioning
- ✓ Wearables
- ✓ Beacons

- ✓ Keyless entry
- ✓ Asset tracking
- ✓ Industry 4.0



Key Features Overview

❑ Long Range

- High sensitivity down to -132 dBm
- +12.5 dBm output power with high efficiency PA
- 144.5 dB maximum link budget

❑ Low Current

- <5.5 mA RX current (LoRa), 4.8 mA (FSK)
- 24 mA TX @ +12.5dBm
- 215 nA sleep mode

❑ Supported Modulation

- LoRa – 476 bps up to 200 kbps (Long Range)
- FLRC – 260 kbps up to 1.3 Mbps (Fast Long Range Communication)
- (G)FSK/MSK – up to 2 Mbps
- BLE PHY Layer compatibility

❑ Ranging Engine

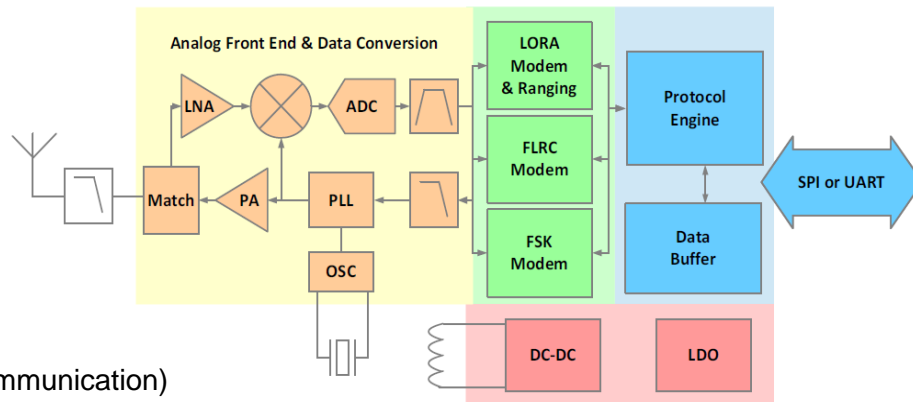
- Time-of-flight functionality, 1 meter accuracy (LoS)
- Build-in ranging data filtering

❑ Low System Cost

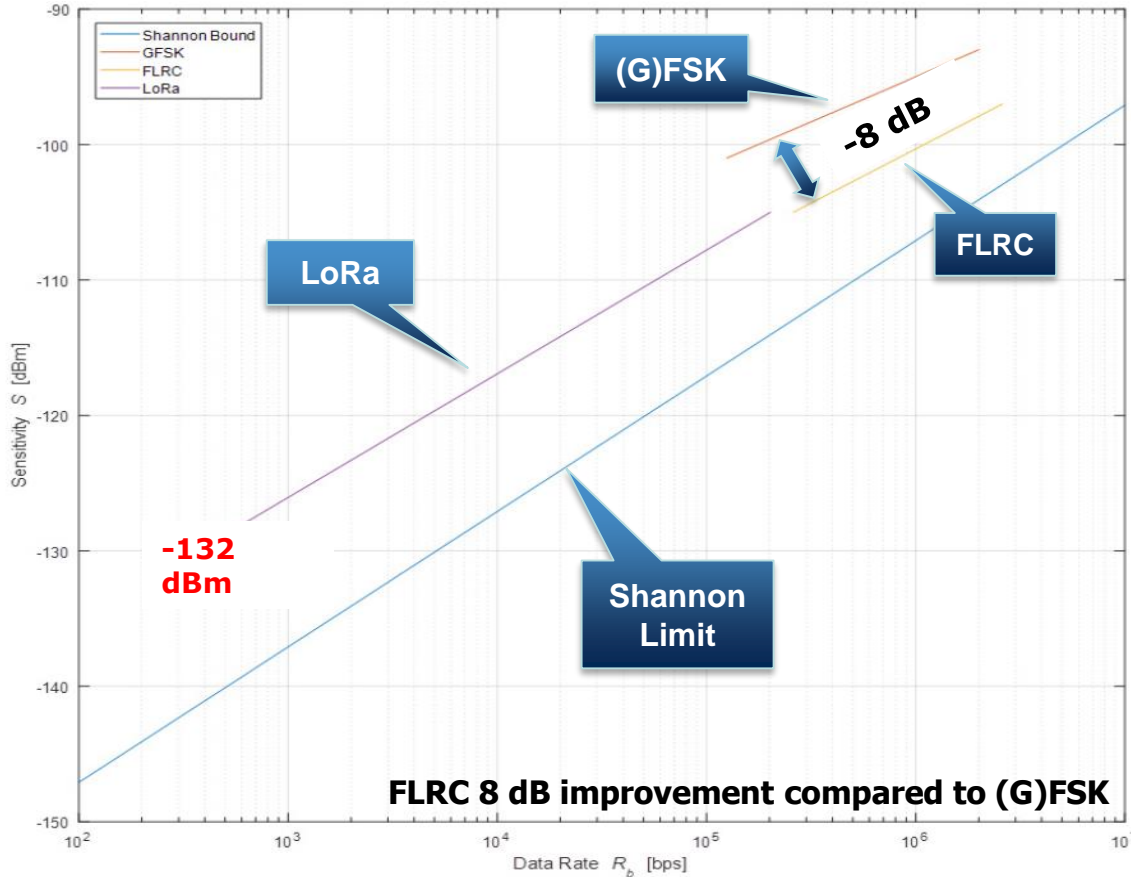
- Minimal external BOM/matching
- Package low foot print, 24-pin 4x4

❑ Compliant with 2.4 GHz regulations

- ETSI EN 300 440, FCC CFR 47 Part 15, ARIB STD-T66



High Sensitivity Modems



High Link Budget

In the 2.4 GHz Band



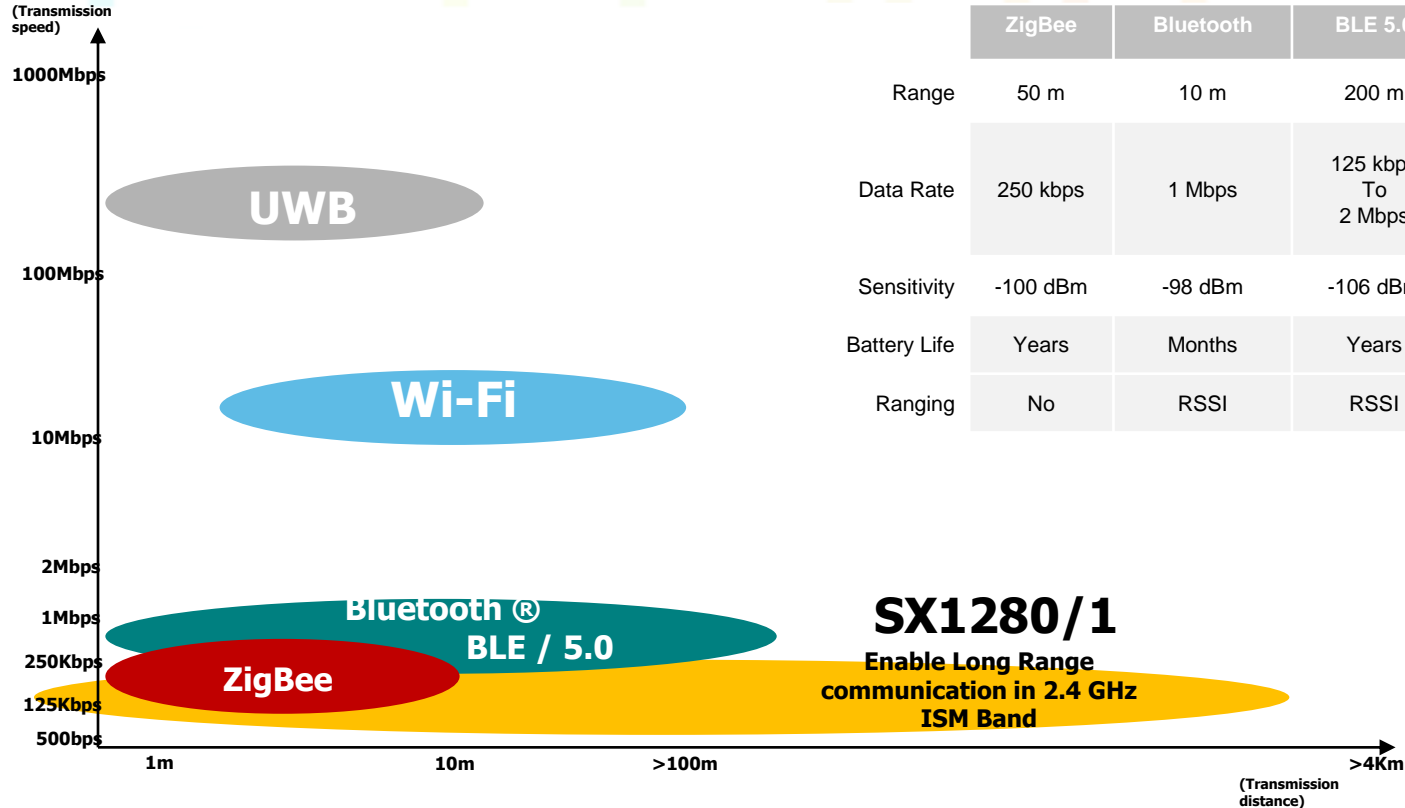
Low Energy Radio



- Designed for Coin Cells Battery**
- Sub-30 mA Current consumption at full Tx Power**
- 4.8 mA Continuous Rx current FSK**
- 200 nA Sleep Current**



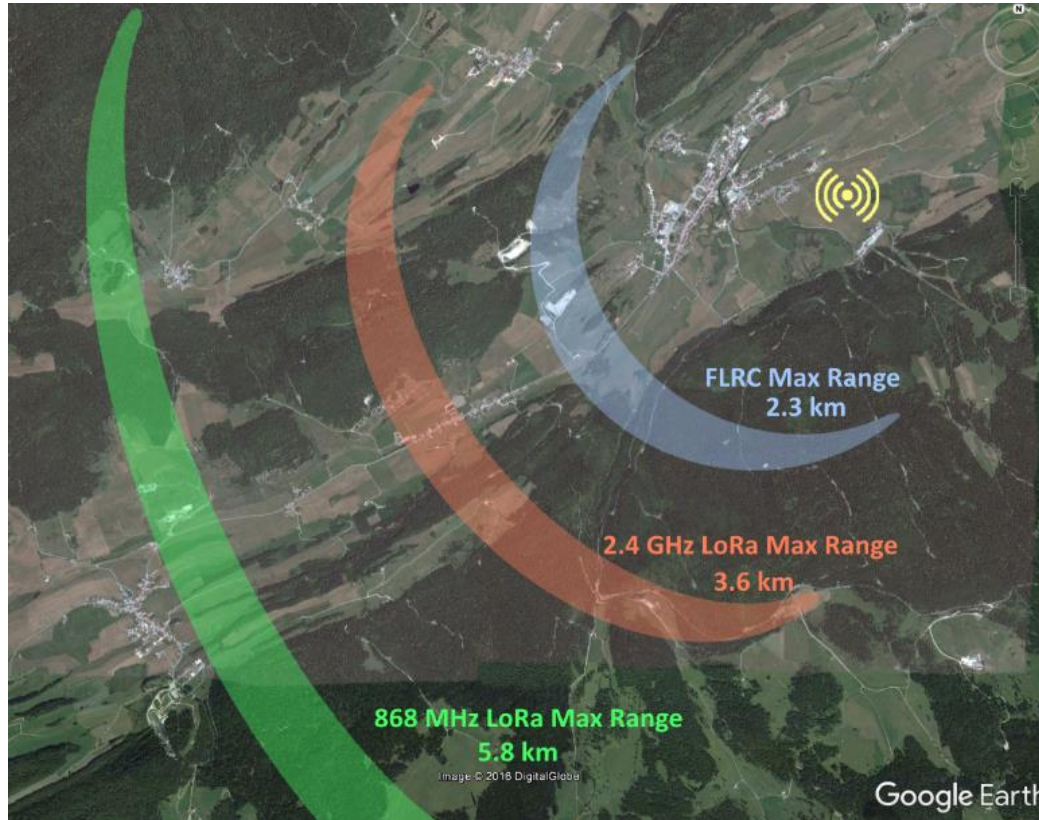
2.4 GHz Technology Landscape



	ZigBee	Bluetooth	BLE 5.0	Wi-Fi	SX1280
Range	50 m	10 m	200 m	100 m	>4 Km
Data Rate	250 kbps	1 Mbps	125 kbps To 2 Mbps	10 Mbps to 1000 Mbps	500 bps to 2 Mbps
Sensitivity	-100 dBm	-98 dBm	-106 dBm	-95 dBm	-132 dBm
Battery Life	Years	Months	Years	Days	Years
Ranging	No	RSSI	RSSI	RSSI	ToF + RSSI

LoRa 2.4 GHz & FLRC Outdoor

❑ Field Distance Testing (SX1280 output power 12.5 dBm)



- **FLRC – 2.3 km** (SX1280/1)
 - Line-of-Sight
 - 260 kbps
- **LoRa 2.4 GHz – 3.6 km** (SX1280/1)
 - non Line-of-Sight
 - 476 bps (SF12)
- **LoRa 868 MHz – >5.8 km** (SX1272)
 - non Line-of-Sight
 - 292 bps (SF12 135 khz)



Thank You