

Getting Started in LoRaWAN Hands On

Class 2: Introduction to LoRa and LoRaWAN

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Charles J. Lord, PE
President, Consultant, Trainer
Blue Ridge Advanced Design and Automation

This Week's Agenda

11/27 An Overview of Low-Power IoT Technologies

11/28 Introduction to LoRa and LoRaWAN

11/29 The design of a LoRaWAN node, hands-on

11/30 No Service? No Problem!

Building your own LoRaWAN server

12/1 Testing Our LoRaWAN design

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What Do IoT Users NEED?

Applications drive requirements

- Licensed versus unlicensed RF Bands
 - ISM 2.4 or 5 Ghz vs sub-Ghz
- Short versus long range
- Fixed or moving objects
- Powered or battery operated
- Bytes not MB's
- Private versus Public

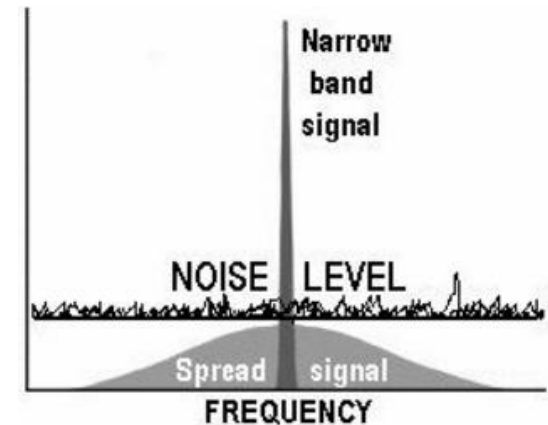
Question 1 - Are you working on battery-powered nodes?

What is LoRa[®]?

LoRa[™] is a spread spectrum modulation scheme that uses wideband linear frequency modulated pulses whose frequency increases or decreases over a certain amount of time to encode information.

Advantages:

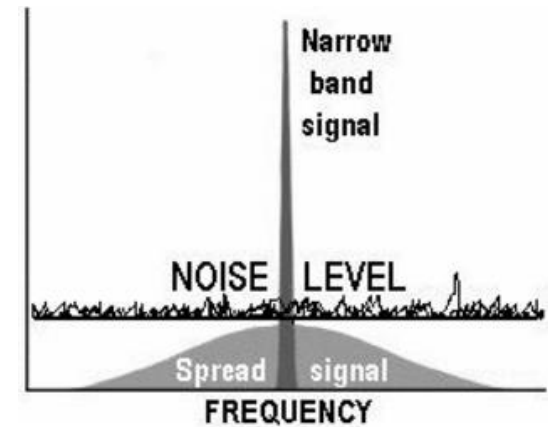
1. A substantial increase in receiver sensitivity due to the processing gain of the spread spectrum technique
2. A high tolerance to frequency misalignment between receiver and transmitter (narrowband disadvantage).



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LoRa[®] Advantages

1. Highly Robust - LoRa signal is very resistant to both in-band and out-of-band interference mechanisms due to a BT > 1 and fully asynchronous nature.
2. Multipath / fading Resistant, the chirp pulse is relatively broadband and thus LoRa offers immunity to multipath and fading, making it ideal for use in urban and suburban environments, where both mechanisms dominate.
3. Long Range Capability, for a fixed output power and throughput, the link budget of LoRa exceeds that of conventional FSK.
4. Doppler Resistant, Doppler shift introduces a negligible shift in the time axis of the baseband signal.
5. Enhanced Network Capacity, orthogonal spreading factors enables multiple transmissions at the same time and on the same channel.
6. Ranging / Localization, inherent property of LoRa is the ability to linearly discriminate between frequency and time errors
7. Constant Envelope Mod Scheme, same low-cost and low-power high-efficiency FSK PA stages can be re-used without modification.

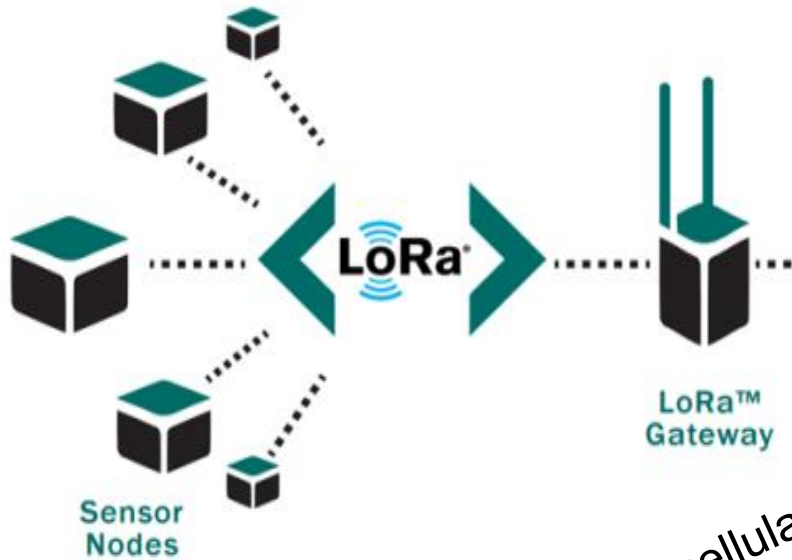


App

LoRaWAN

LoRa

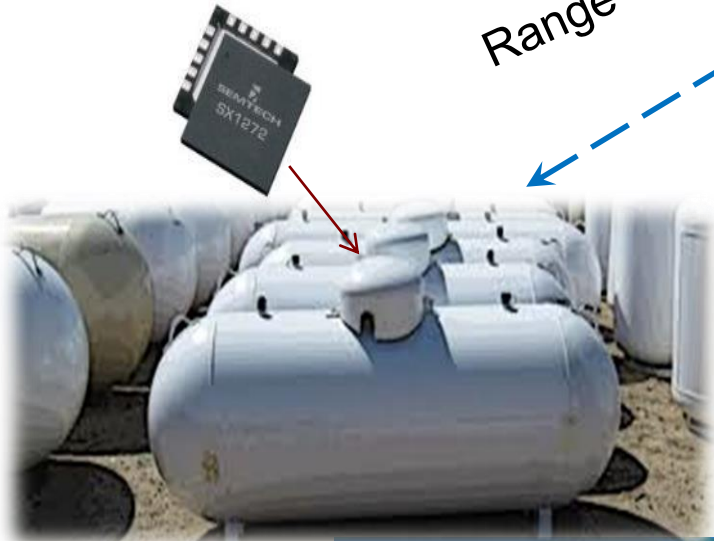
What is LoRaWAN?



LoRa Gateway



Range > cellular at fraction of power



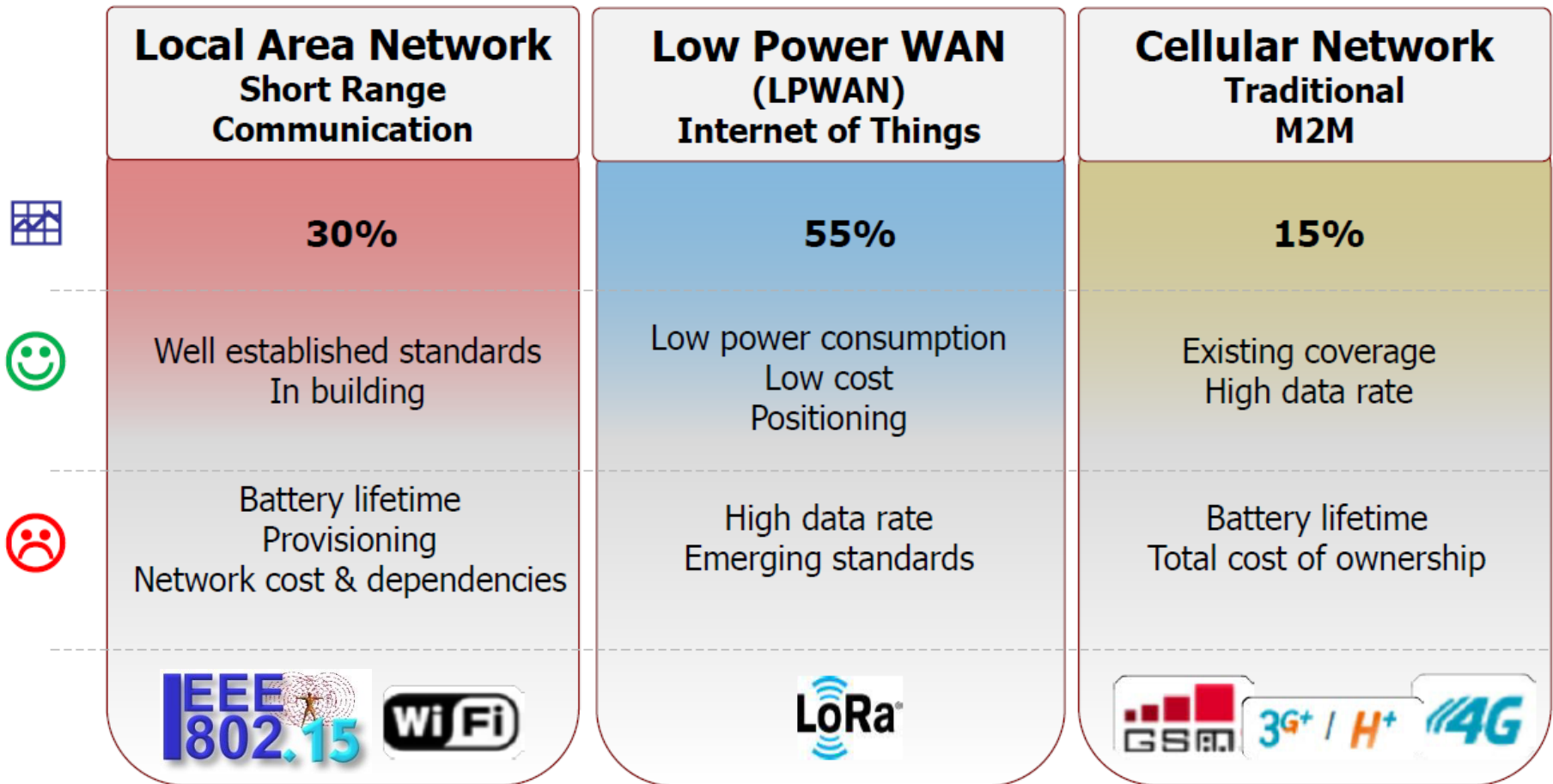
Application	App
MAC Protocol	LoRaWAN
PHY	LoRa

= 5-10 year battery life

= 5x lower sensor cost than cellular

Where does LPWAN Fit?

LPWAN = (Low Power Wide Area Network)



Example: Long Range Star - Silicon Valley Network

- Three LoRaWAN towers deployed in Silicon Valley
- Example coverage map from three towers



Tower 1:
Clay St, SFO



Tower 2:
Skeggs Peak



Tower 3:
North 1st, SJC

Silicon Valley Gateways
Provided by Senet



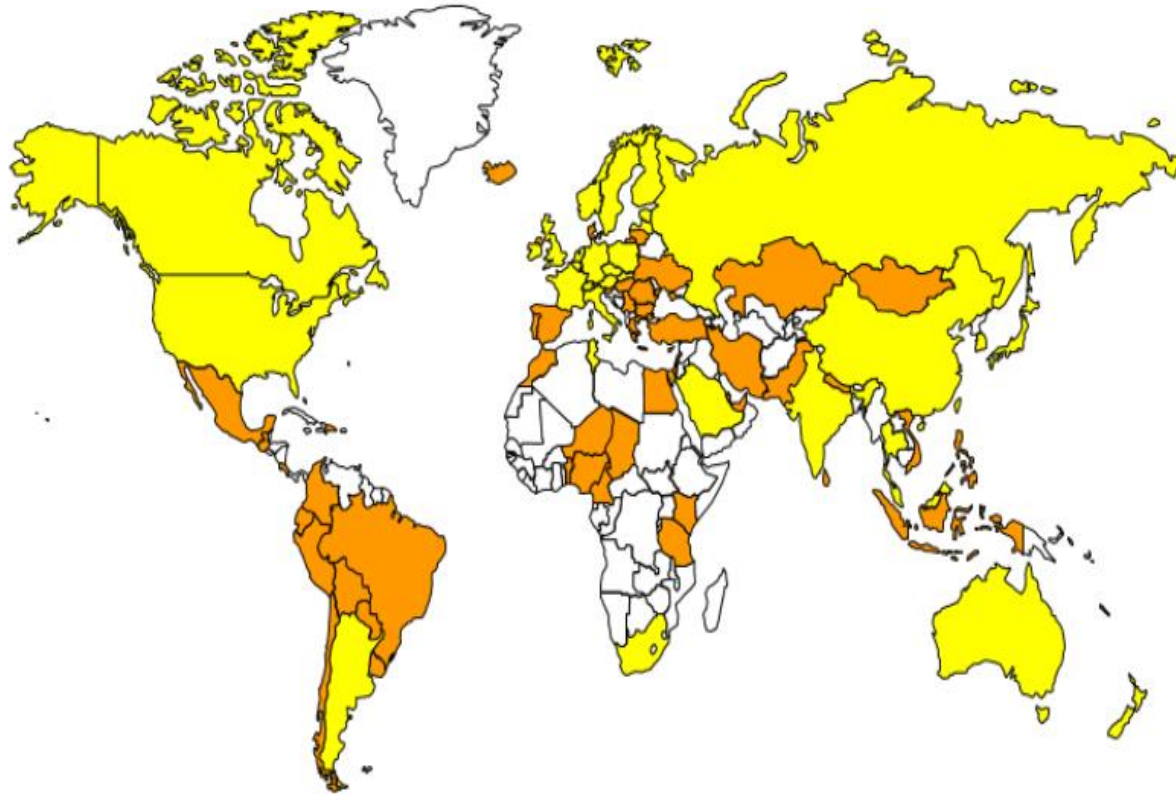
LoRa® - Brief history

- 2013 • Launch of first LoRa radio by Semtech
- 2014 • First mobile network operator trials
- 2015 • Launch of LoRa Alliance: 130 members in 6 months
 - Multiple sensors, gateways, modules available
 - Public, private, viral network deployments worldwide
- 2017 • Over 440 LoRa Alliance members today
 - Over 100 regions with deployments or trials
 - Low power geolocation available
 - Comcast announces US LoRaWAN network



Presented by:





- 46 Publicly Announced Operators
- 34 Alliance Member Operators
- 350+ on-going trials & city deployments
- 500+ members in the Alliance

Legend:

- Country with Publicly Announced Network
- Other LoRaWAN deployment



July 2017

All information contained herein is current at time of publishing – LoRa Alliance is not responsible for the accuracy of information presented

LoRa Open Networks

- POC's:
- Mainly driven by partners
 - > 35 ongoing

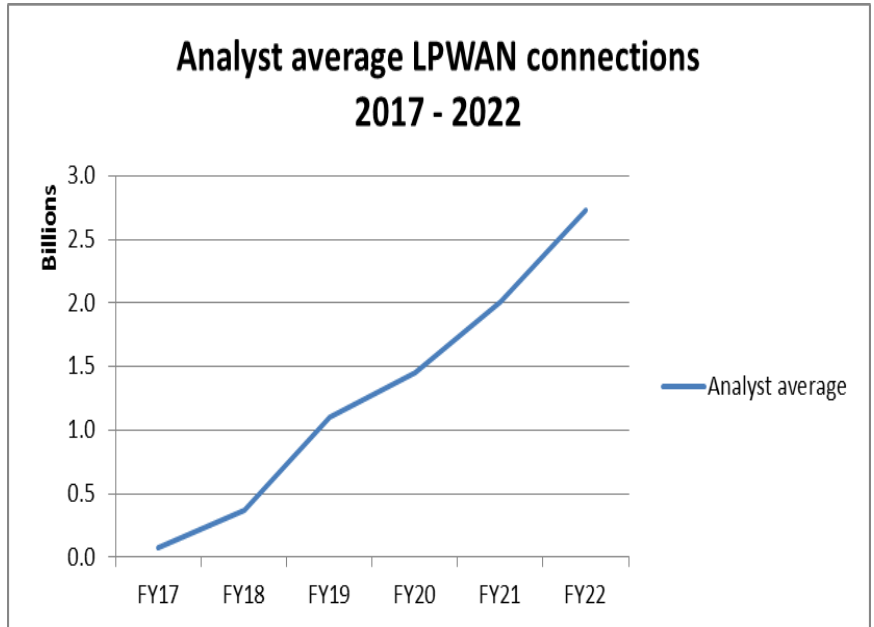


EMEA
21

AsiaPac
10

Americas
3

- Viral deployments:
- TTN in > 100 cities
 - Loriot in > 75 countries



Presented by:

IHS, Machina/Gartner, ABI, Strategy Analytics, Fraunhofer, Mason

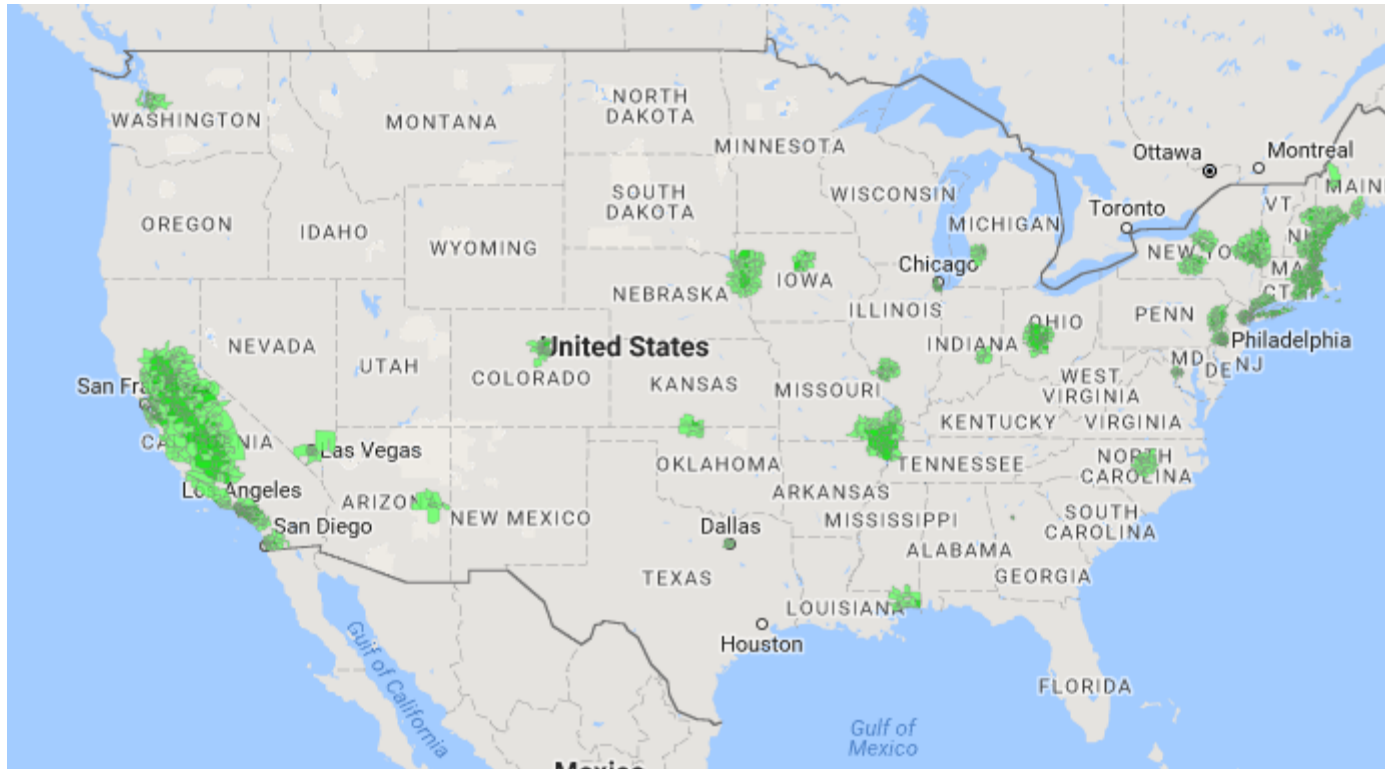
Comcast's machineQ expands LoRaWAN™ to 15 major US markets



Senet (senetco.com)

- A leading global provider of cloud-based software and services platforms to enable network connectivity build-out and management for the Internet of Things (IoT)
 - Senet owns and operates the largest public, carrier-grade LoRa™ network in North America
 - Senet builds, deploys and operates a Cloud-based LoRaWAN™ Network Operating System used to speed LPWAN commercialization world wide
 - A contributing member of the LoRa Alliance™, Senet is focused on accelerating the commercialization of LoRaWAN applications and devices through an open partner and developer ecosystem

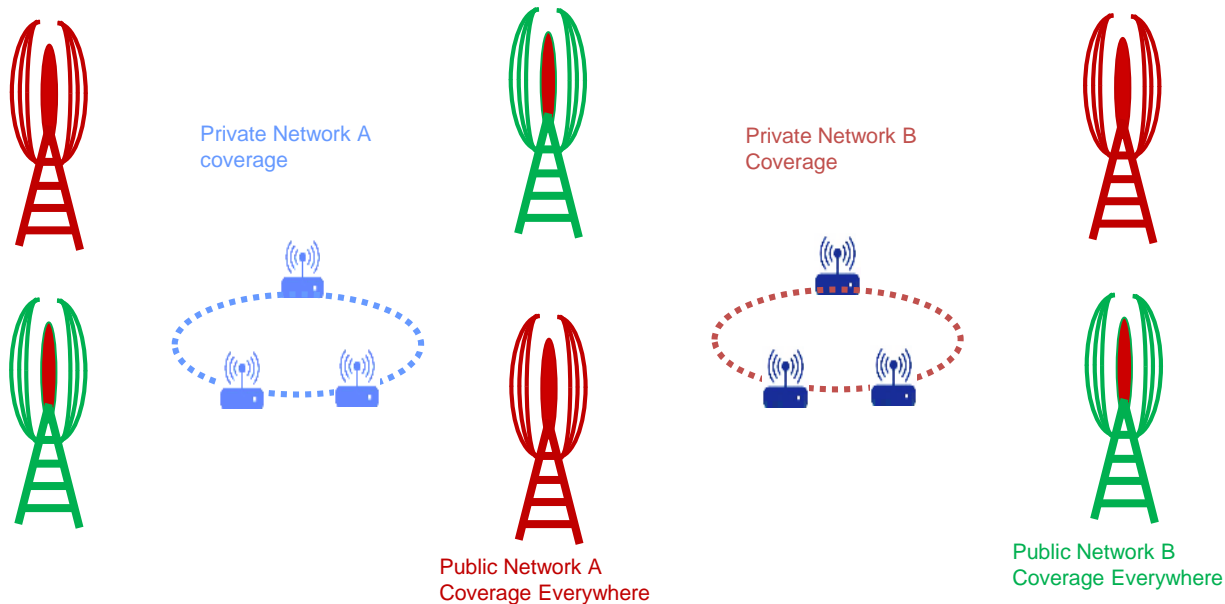
Current Senet Coverage



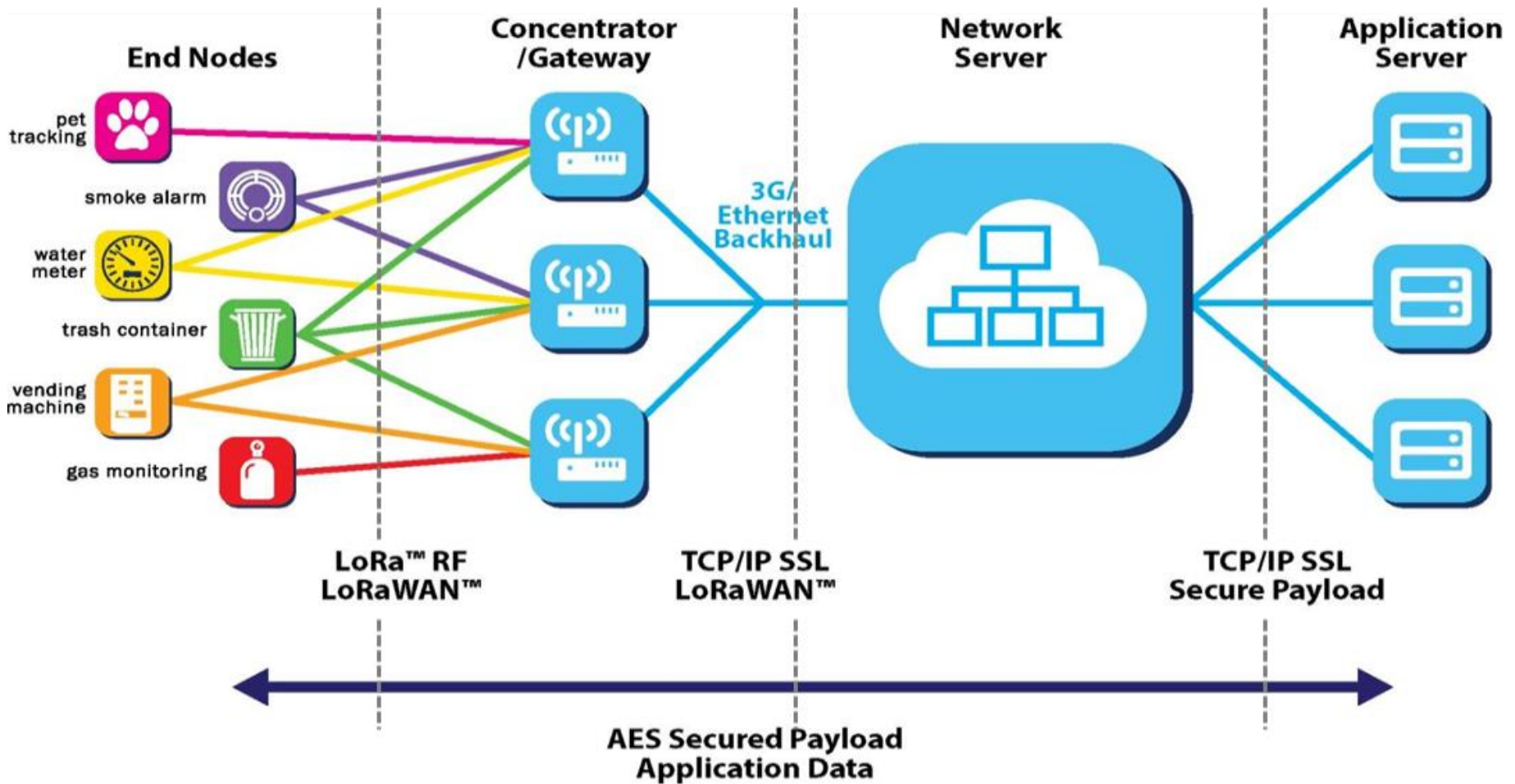
Question 2 - Are you (or customers) in one of the current coverage areas?

LoRaWAN supports all network options

- LoRaWAN supports all forms of network deployments Private, Managed and Public
 - Public – LPWAN fully deployed and operated by a network operator.
 - Managed – a network deployed for a specific customer, but fully or partially managed by a partner.
 - Private – a network fully deployed and managed by a private company or individual.
- Private, Managed and Public LoRaWAN Networks co-exist.



LoRa and LoRaWAN



Device Classes & Examples



Class B: Irrigation

Report moisture, a few times per day
Turn valves on or off
with a few minutes latency
Very low-energy,
which depends on latency



Class C: Smart Lighting

Maintenance and index info a few times per day
Constantly listens for network «ping»
For low-latency actuation



Class A: Smart City

Report status a few times per day
No planned actuation required
Extremely low energy

Presented by:

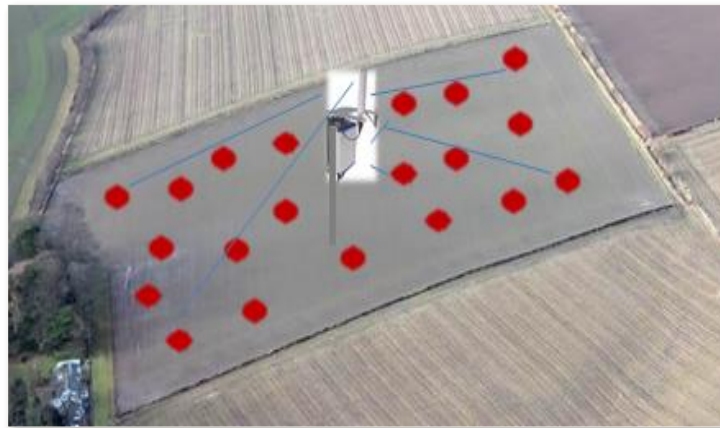
Agriculture - Irrigation

Current Solutions

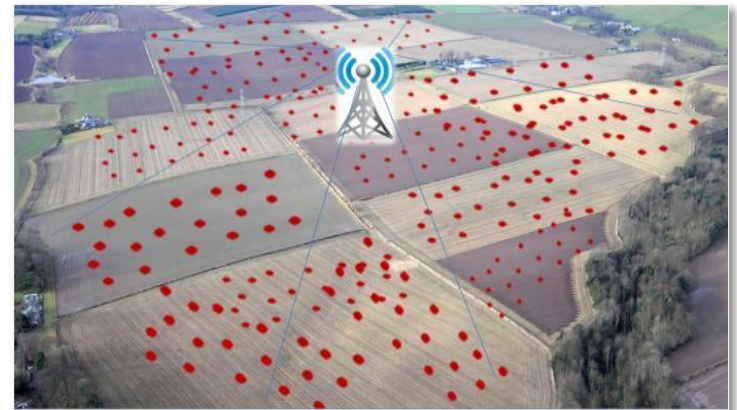
LoRa® & LoRaWAN

No. of fields	1	900
Coverage Area	0.5 mile radius / 0.75 Sq. miles	15 mile radius / 706 Sq. miles
Solution Cost	High	Low
Ease of use	Complex	Out of the box
Battery longevity	1-2 years	> 5 years

0.5 MILE Radius / 0.75 sq. miles /20 sensors



15 mile radius / 706 sq. miles /18k sensors



Multiple Sourcing On Every Level



SX127X family

LoRa™ Long-Range Sub-GHz Module (Part # RN2483)

Transceiver

Modules

Sensors

Gateway

Network Server

Application Server



LoRa® – Long Range Node IC's



Advanced metering infrastructure



Set top box to devices



Machine to machine



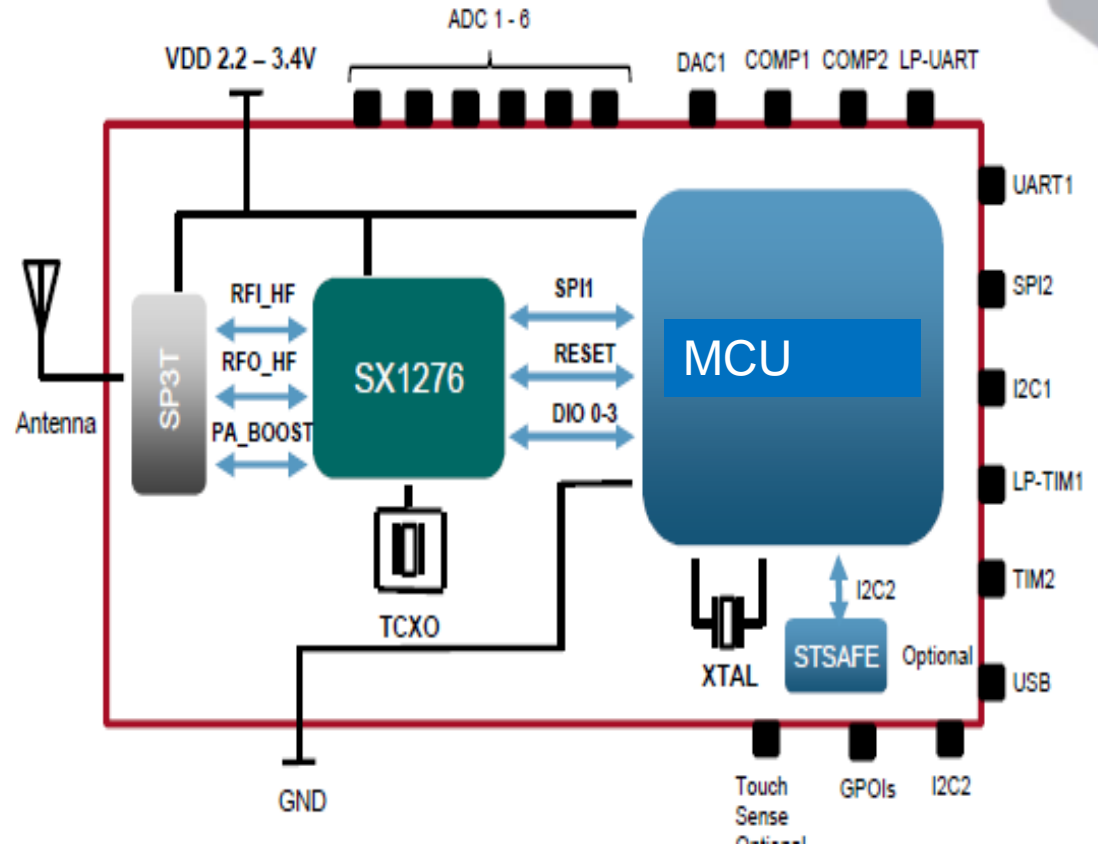
Internet of things (IoT)

LoRa® Transceivers

Part Number	Frequency Range (MHz)	Link Budget (dB)	Rx Current (mA)	FSK max DR (kbps)	LoRa DR (kbps)	Max Sensitivity (dBm)	Tx Power (dBm)
SX1272	860 – 1020	158	10	300	0.3 – 37.5	-137	+ 20
SX1273	860 – 1020	150	10	300	1.7 – 37.5	-130	+ 20
SX1276	137 – 1020	168	9.9	300	0.018 – 37.5	-148	+ 20
SX1277	137 – 1020	158	9.9	300	1.7 – 37.5	-139	+ 20
SX1278	137 – 525	168	9.9	300	0.018 – 37.5	-148	+ 20

LoRaWAN End Point / Module Example

- SX1272 or SX1276 Radio
- MCU
- TCXO
- RF Switch
- RF Matching components



(Example End point (LoRaWAN Module Shown))

Range of LoRaWAN Gateway Options

Picocell Gateway



Features

Price	\$50-100
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Backhaul	Ethernet only
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Options	minimal
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Industrial Gateway



Features

Price	\$250-400
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Backhaul	Eth, cellular, WiFi
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Options	configurable
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Tower-top Gateway



Features

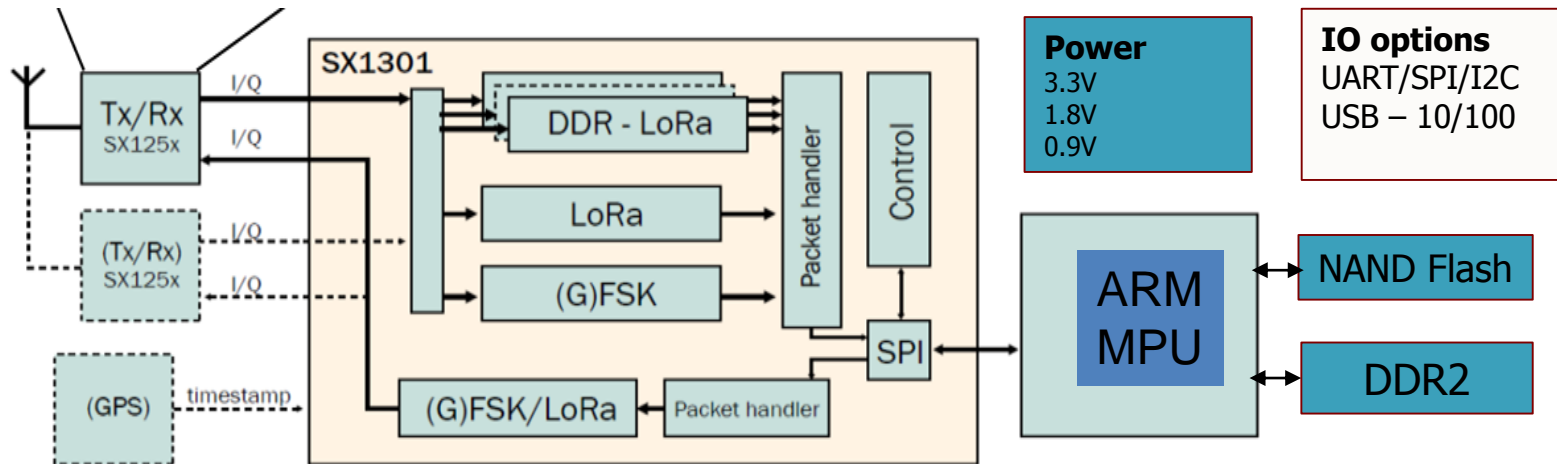
Price	\$1000-2000
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Backhaul	Eth, cell, sat, fiber
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Options	IP 67/68, lighting, batt
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Question 3 - Will you be building a gateway?

Linux LoRaWAN Gateway Example



SX130x LoRa Modem IC enables superior network solution vs. FHSS solutions

- Always listening on all 8 LoRaWAN channels simultaneously
- Simultaneously receives different datarates on the same channel
- Enables more robust and predictable battery life end points since they can truly be ALOHA
- Enables superior network capacity



LoRa[®] Network Features



Long Range

- ❑ Greater than cellular
- ❑ Deep indoor coverage
- ❑ Star topology



Max Lifetime

- ❑ Low power optimized
- ❑ 10-20yr lifetime
- ❑ >10x vs cellular M2M



Multi Usage

- ❑ High capacity
- ❑ Multi-tenant
- ❑ Public network



Low Cost

- ❑ Minimal infrastructure
- ❑ Low cost end-node
- ❑ Open SW

LoRaWAN - Differentiators & Benefits



True Location

- ❑ In/out door
- ❑ Accurate
- ❑ No Battery Impact



Bidirectional

- ❑ Acknowledge
- ❑ Scalable Capacity
- ❑ Broadcast



LoRaWAN

- ❑ Global Standard
- ❑ True Mobility
- ❑ Seamless
- ❑ Roaming



Security

- ❑ Unique ID
- ❑ Application
- ❑ Network

LoRa Website, Community and Microsite



What is LoRa? | LoRa Applications | Join Community

IoT Connects Our World. LoRa Makes It Smart.

Connect Data Intelligently

Connecting virtually all things—sensors, gateways, machines, devices, animals, people—LoRa Technology makes it possible to connect to the Cloud, enabling sound decisions and making people's lives better.



<http://www.semtech.com/wireless-rf/internet-of-things/>

<https://semtech.force.com/lora>

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Please stick around as I answer your questions!

- Please give me a moment to scroll back through the chat window to find your questions
- I will stay on chat as long as it takes to answer!
- I am available to answer simple questions or to consult (or offer in-house training for your company)

c.j.lord@ieee.org

<http://www.blueridgetechnc.com>

<http://www.linkedin.com/in/charleslord>

Twitter: @charleslord

<https://www.github.com/bradatrainning>