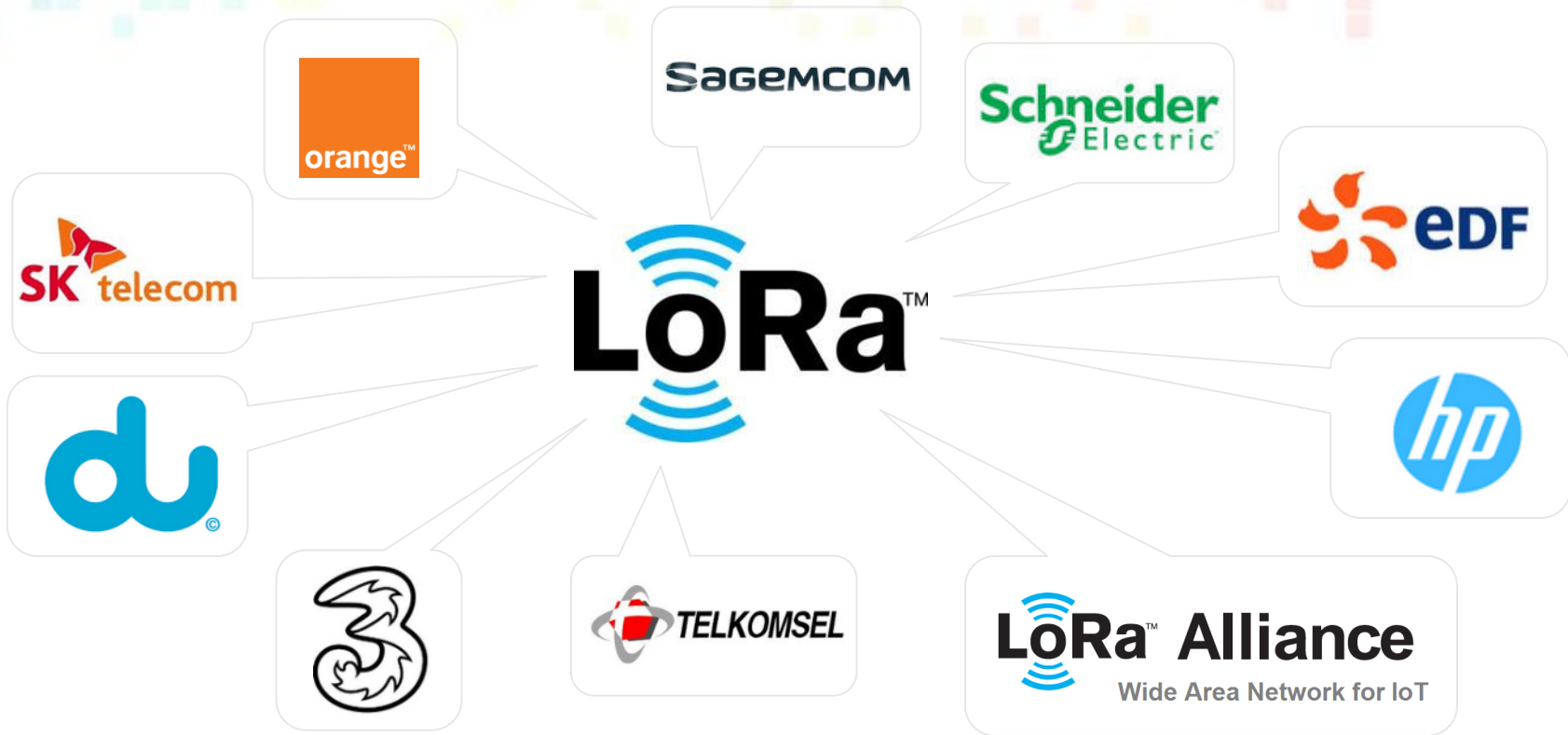




# LoRa®

The leading provider for carriergrade LPWA Network

# Latest news



**LoRa is rapidly becoming the defacto LPWAN standard**



# The Road To Low Power Wide Area

Multimedia & Voice



M2M



Internet of Things



5G

GB's/month

4G

MB's/month

3G

KB's/month

2G

bytes/month

LPWA





# Where Does LPWAN Fit



## Local Area Network

Short Range  
Communication

**40%**

Well established standards  
In building

Battery Live  
Provisioning  
Network cost & dependencies

Bluetooth  
4.0



WiFi

## Low Power Wide Area (LPWAN)

Internet of Things

**45%**

Low power consumption  
Low cost  
Positioning

High data rate  
Emerging standards

LoRa

## Cellular Network

Traditional  
M2M

**15%**

Existing coverage  
High data rate

Autonomy  
Total cost of ownership

GSM

3G+ / H+

4G

# 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



# 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





# LPWAN Market Size & Focus

## ❑ Machina, Strategy Analytics and Analysys Mason

- Excluding short range

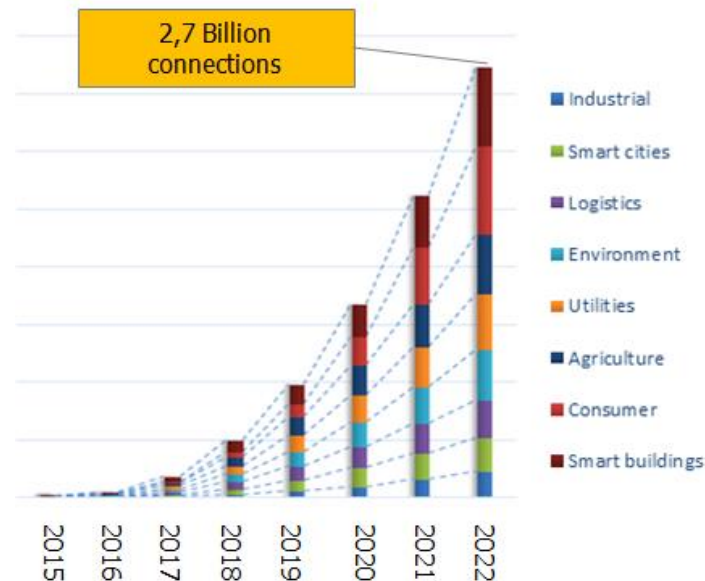
## ❑ Turning point 2018

## ❑ The top three application categories for this revenue forecast (2022)

- Agriculture and environment markets (25%)
- Consumer applications, which include pet, bicycle tracking and wearable's (21%)
- Smart buildings (18%)

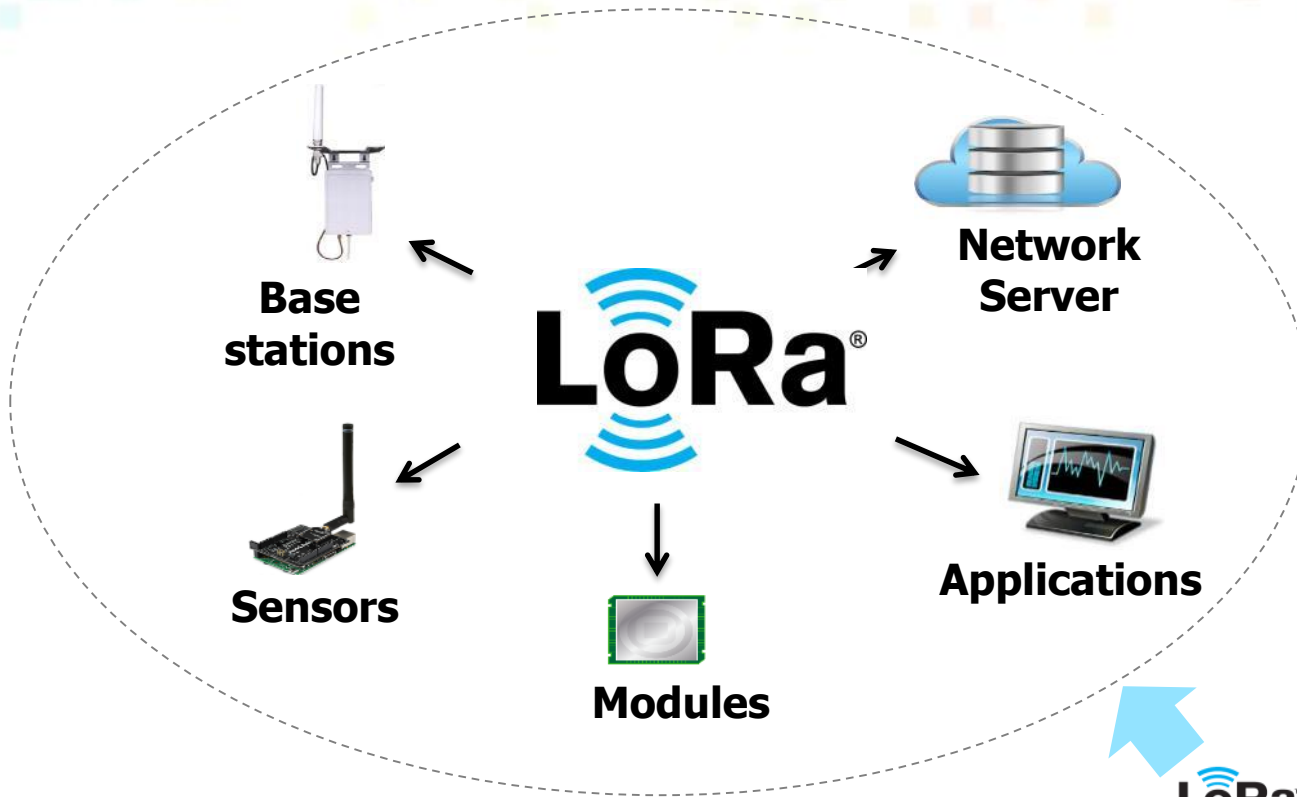


Source: Analysys Mason, April 2015





# Building Blocks





































# LoRaWAN Solutions



<p><b>1M2M</b> Tracking sensor</p>  <p>1M2M is a low-power, long-range, wide-area network (WAN) solution for tracking and monitoring. It is designed for applications such as asset tracking, fleet management, and location-based services. The network is highly scalable and can support millions of devices.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Low power consumption - Long range - High capacity - Scalable architecture</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> 1M2M 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.1m2m.com</p>	<p><b>Okidokeys</b> LoRaWAN® Smart lock and smart door</p>  <p>Okidokeys is a LoRaWAN-based smart lock and door solution. It allows users to control their locks remotely via a smartphone app. The system is highly secure and can be used in a variety of settings, from homes to businesses.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Remote lock/unlock - Access control - Real-time monitoring - Low power consumption</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Okidokeys 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.okidokeys.com</p>	<p><b>iSecur®</b> Intrusion alarm sensor</p>  <p>iSecur is a LoRaWAN-based intrusion alarm sensor. It is designed for use in homes and businesses to detect unauthorized access. The sensor is highly sensitive and can send real-time alerts to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time alerts - Remote monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> iSecur 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.isecur.com</p>	<p><b>iSecur®</b> LoRaWAN®</p>  <p>iSecur LoRaWAN module is a small, low-power module designed for integration into various IoT applications. It provides secure communication and is compatible with the LoRaWAN protocol.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Low power consumption - Long range - High capacity</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> iSecur 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.isecur.com</p>	<p><b>Homerider Systems</b> Wheat sensor</p>  <p>Homerider Systems is a LoRaWAN-based wheat sensor. It is used for monitoring soil moisture and crop health in agricultural settings. The sensor provides real-time data to farmers, allowing them to optimize their irrigation and harvesting practices.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Homerider Systems 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.homerider.com</p>	<p><b>iSecur®</b> Dish - Remote Diesel Detector</p>  <p>iSecur Dish is a LoRaWAN-based remote diesel detector. It is used to monitor diesel fuel levels and detect leaks in industrial settings. The detector provides real-time alerts and data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time alerts - Remote monitoring - Low power consumption</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> iSecur 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.isecur.com</p>	<p><b>Invenit</b> Parking sensor and UHF-WLAN module</p>  <p>Invenit is a LoRaWAN-based parking sensor and UHF-WLAN module. It is used for monitoring parking spaces and managing traffic flow. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Invenit 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.invenit.com</p>	<p><b>Flashnet</b> Outdoor lighting and LoRaWAN network</p>  <p>Flashnet is a LoRaWAN-based outdoor lighting and network solution. It is used for smart lighting applications in outdoor settings. The system allows for remote control and monitoring of lighting fixtures.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Remote control - Real-time monitoring - Low power consumption</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Flashnet 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.flashnet.com</p>	<p><b>NKE Wattec</b> LoRaWAN® TC sensor</p>  <p>NKE Wattec is a LoRaWAN-based temperature (TC) sensor. It is used for monitoring temperature in industrial and agricultural settings. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> NKE 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.nke.com</p>	<p><b>NKE Wattec</b> LoRaWAN® pH sensor</p>  <p>NKE Wattec is a LoRaWAN-based pH sensor. It is used for monitoring pH levels in industrial and agricultural settings. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> NKE 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.nke.com</p>
<p><b>NKE Wattec</b> LoRaWAN® Security Sensor</p>  <p>NKE Wattec is a LoRaWAN-based security sensor. It is used for monitoring security in industrial and agricultural settings. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> NKE 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.nke.com</p>	<p><b>Myfox</b> LoRaWAN® Smart Door</p>  <p>Myfox is a LoRaWAN-based smart door solution. It allows users to control their doors remotely via a smartphone app. The system is highly secure and can be used in a variety of settings.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Remote lock/unlock - Access control - Real-time monitoring</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Myfox 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.myfox.com</p>	<p><b>Intensens</b> LoRaWAN® Temp. measurement sensor</p>  <p>Intensens is a LoRaWAN-based temperature measurement sensor. It is used for monitoring temperature in industrial and agricultural settings. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Intensens 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.intensens.com</p>	<p><b>Ademco</b> LoRaWAN® Zulu Chime</p>  <p>Ademco is a LoRaWAN-based Zulu Chime. It is used for monitoring security in industrial and agricultural settings. The chime provides real-time alerts and data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time alerts - Remote monitoring - Low power consumption</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Ademco 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.ademco.com</p>	<p><b>IMST</b> LoRaWAN® CR1200</p>  <p>IMST is a LoRaWAN-based CR1200 module. It is a small, low-power module designed for integration into various IoT applications. It provides secure communication and is compatible with the LoRaWAN protocol.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Low power consumption - Long range - High capacity</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> IMST 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.imst.com</p>	<p><b>Abeway</b> LoRaWAN® Motor Tracker</p>  <p>Abeway is a LoRaWAN-based motor tracker. It is used for monitoring motor activity in industrial and agricultural settings. The tracker provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Abeway 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.abeway.com</p>	<p><b>NKE Wattec</b> LoRaWAN® pH Sensor</p>  <p>NKE Wattec is a LoRaWAN-based pH sensor. It is used for monitoring pH levels in industrial and agricultural settings. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> NKE 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.nke.com</p>	<p><b>Telog Instruments Inc</b> Water flow sensor</p>  <p>Telog Instruments Inc is a LoRaWAN-based water flow sensor. It is used for monitoring water flow in industrial and agricultural settings. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Telog Instruments Inc 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.telog.com</p>	<p><b>Mirakonta</b> Water sensor chip</p>  <p>Mirakonta is a LoRaWAN-based water sensor chip. It is used for monitoring water levels in industrial and agricultural settings. The chip provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Mirakonta 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.mirakonta.com</p>	<p><b>Enertac</b> LoRaWAN® Fuel Delivery Automation</p>  <p>Enertac is a LoRaWAN-based fuel delivery automation solution. It is used for monitoring fuel delivery in industrial and agricultural settings. The solution provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Enertac 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.enertac.com</p>
<p><b>Solvera Lynx</b> LoRaWAN® Temp. measurement sensor</p>  <p>Solvera Lynx is a LoRaWAN-based temperature measurement sensor. It is used for monitoring temperature in industrial and agricultural settings. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Solvera Lynx 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.solvera.com</p>	<p><b>Wiglabs</b> Low power edge device</p>  <p>Wiglabs is a LoRaWAN-based low power edge device. It is used for monitoring various parameters in industrial and agricultural settings. The device provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Wiglabs 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.wiglabs.com</p>	<p><b>Autotronic Enterprise</b> LoRaWAN®</p>  <p>Autotronic Enterprise is a LoRaWAN-based module. It is a small, low-power module designed for integration into various IoT applications. It provides secure communication and is compatible with the LoRaWAN protocol.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Low power consumption - Long range - High capacity</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Autotronic Enterprise 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.autotronic.com</p>	<p><b>Datalog 16</b> SingleTag</p>  <p>Datalog 16 is a LoRaWAN-based SingleTag module. It is a small, low-power module designed for integration into various IoT applications. It provides secure communication and is compatible with the LoRaWAN protocol.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Low power consumption - Long range - High capacity</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Datalog 16 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.datalog.com</p>	<p><b>Rising HF</b> SingleTag</p>  <p>Rising HF is a LoRaWAN-based SingleTag module. It is a small, low-power module designed for integration into various IoT applications. It provides secure communication and is compatible with the LoRaWAN protocol.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Low power consumption - Long range - High capacity</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Rising HF 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.rising.com</p>	<p><b>NKE Wattec</b> LoRaWAN® TC Sensor</p>  <p>NKE Wattec is a LoRaWAN-based temperature (TC) sensor. It is used for monitoring temperature in industrial and agricultural settings. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> NKE 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.nke.com</p>	<p><b>Intensens</b> LoRaWAN® Temp. measurement sensor</p>  <p>Intensens is a LoRaWAN-based temperature measurement sensor. It is used for monitoring temperature in industrial and agricultural settings. The sensor provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Intensens 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.intensens.com</p>	<p><b>Intensens</b> LoRaWAN® Temp. measurement sensor</p>  <p>Intensens is a LoRaWAN-based temperature measurement sensor. It is used for monitoring temperature in industrial and agricultural settings. 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The solution provides real-time data to a central monitoring station.</p> <p><b>LoRaWAN® Ready</b> Semtech 9200</p> <p><b>Public Regions</b> EU 863-868 MHz, US 902-920 MHz, AS 923-925 MHz</p> <p><b>Private Regions</b> 470-510 MHz, 863-868 MHz, 902-920 MHz, 923-925 MHz</p> <p><b>Feature Benefits</b> - Real-time monitoring - Low power consumption - Easy installation</p> <p><b>Resources</b> - User Manual - Application Notes - Reference Designs</p> <p><b>Company</b> Sensing Labs 15000 W. Alhambra Blvd., Suite 100 Alhambra, CA 91801 www.sensing.com</p>



# Examples

- Agriculture**
- Smart Building**
- Supply Chain**



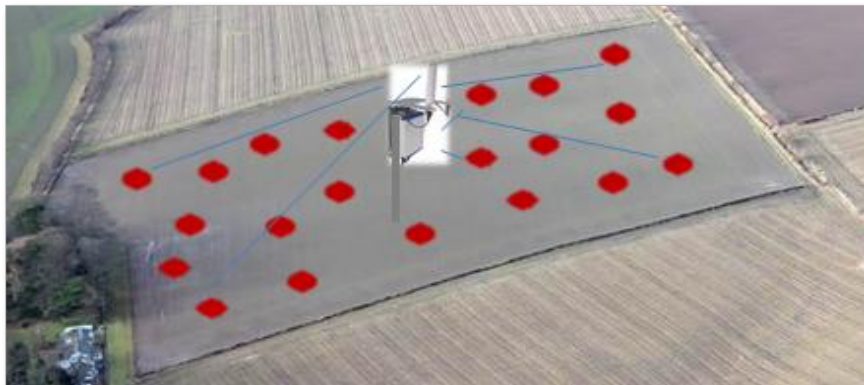
# Agriculture - Irrigation

## Current Solutions

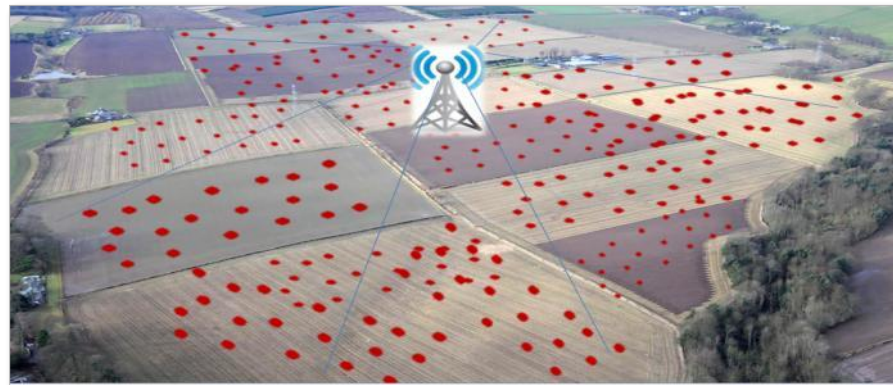
## LoRa®

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**





# Smarter Buildings

Bill each user separately



Clean after 5 hours of high CO2 level



Clean after 100 door openings



Send heart beats, battery status and alarms







# Supply Chain – Parcel delivery



Pick up: 4/21/15 (7:57 pm)



Driver goes to Port of Redwood City



**Nearest Tower:** 9 Miles / Skeggs Peak



75.2°



# Why carriers prefer LoRa®







# Carrier Grade Selection Criteria

**Security**



**Scalability**



**Standardization**





# LoRaWAN™



[www.lora-alliance.org](http://www.lora-alliance.org)





# Alliance Activities

## Explore

Membership Benefits

MEMBERSHIP RIGHTS	INDUSTRY (MEM)	CONTRACTORS (MEM)	ADAPTERS (MEM)	PUBLISHERS
The right to request Board of Director seat	•			
The right to submit Alliance Deliverables for final approval by the Board Of Director	•			
The right to access Alliance operational data	•			
The right to initiate, participate in, vote and chair Committees	•			
The right to initiate, participate in, vote and chair Work Groups	•	•		
The right to contribute to Draft Deliverables and access Final Deliverables	•	•		
The right to participate in press articles & interviews	•	•		
The right to certify Compliant Products	•	•	•	
The right to use Alliance and/or Certification Logo on certified products	•	•	•	
The right to access to members only website	•	•	•	
The right to participate in general or annual meetings	•	•	•	
The right to receive Alliance communications	•	•	•	
The access Final Deliverables	•	•	•	
Access to Released Deliverables	•	•	•	•



## Sign Up

To join the LoRa Alliance:

1. Complete the [Alliance Membership Agreement](#) in full and have it signed by an authorized employee of your company.
2. Complete the [Online Membership Application](#) below.
3. Email, fax or send the completed and signed membership agreement to the address below:

LoRa Alliance Membership Services  
2400 Camino Ramon, Suite 375  
San Ramon, CA 94583  
Fax: +1 925 275 6691  
[loral@loralliance.org](mailto:loral@loralliance.org)

Company or Institution Information

Company Name\*

Primary\*  Secondary

Ecosystem Category:  Select Industry   Select Industry

Address 1:

Address 2:

City\*:

Country\*:  Select

State\*:

Postal Code\*:

Preferred URL:

Next



## Get Exposure

Sponsor Members

- ❑ Become a member
- ❑ LoRa Alliance All Member Meeting: <https://www.lora-alliance.org/News-Events/Events>
- ❑ LoRa Alliance Challenge: <https://www.lora-alliance.org/News-Events/Global-IoT-Challenge>
- ❑ Participate in events: IoT World, European Utility Week, CES, MWC, ...



# Thank you

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# Back Up Slides





# Technical Positioning

Differentiator		LoRa	Sigfox	Ingenu	Short Range	LTEM	CiOT
Protocol		Open Standard	Proprietary	Proprietary RPMA	Zigbee BLE Wifi	Qualcom	Huawei Neul
Location		25 m	×	×	×	200 m	unclear
Power	Tx Rx Sleep	120 mA/20 Dbm 10 mA 0.001 mA	120 mA/20 Dbm 10 mA 0.001 mA	750 mA 300 mA 0.072 mA	35 mA / 8 Dbm 26 mA 0.003 mA	800 mA / 30 Dbm 50 mA 3.5 mA	Unclear
Range	Indoor Outdoor	3 Km 30 Km	3 Km 30 Km	3 Km 30 Km	150 m 30 m	1.7 Km 20 Km	Unclear
Link Budget		156 Db/290 Bps	156 Db/100 Bps	172 Db/240 Bps	108 Db	147 Db	
Sensitivity		-134 dBm	-126 dBm	-142 dBm	-100 dBm	-117 dBm	
Security		✓: 128 AES	×	✓	✓	✓	Unclear
Interference immunity		good	bad		bad	moderate	unclear





# Competitive Positioning

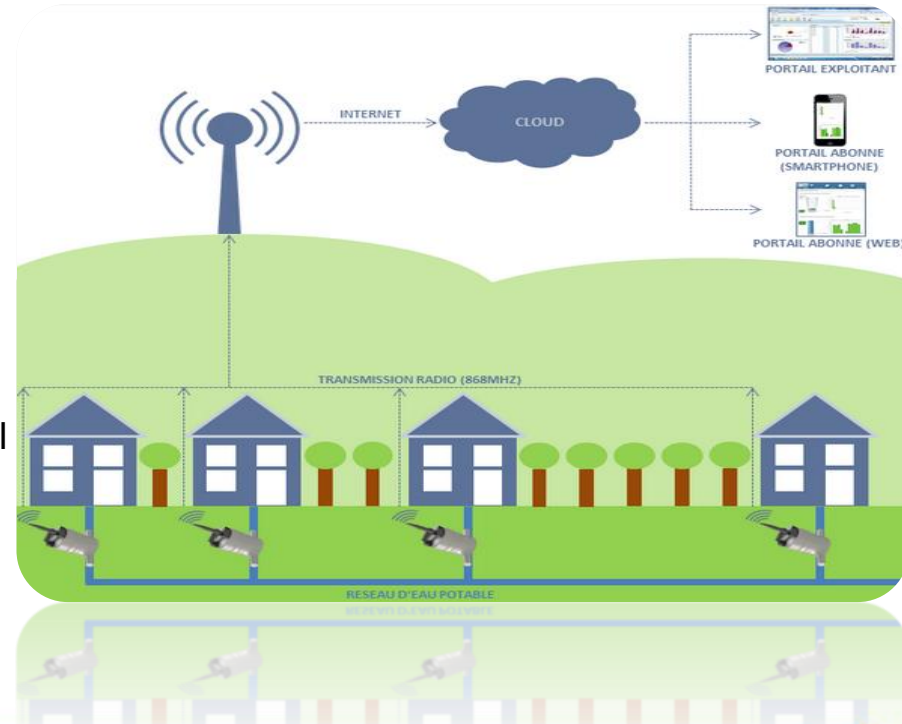


Differentiator		LoRa	Sigfox	Ingenu	Short Range	LTEM	CiOT
Moving objects		✓	✗	✗	✗	✓	unclear
Capacity		✓ : adaptive	1.3 M	< 500K	< 1000		Unclear
Hosting		In country	France	Custom	Custom	Custom	Unclear
Business model		Eco system	License 40% share	Custom	Custom	Carrier	Carrier
Installed base		> 5 million	< 200.000	< 500.000	> 200 M	0	0
Message size	Up Down	Up to 50 Kbs Up to 50 Kbs	12 Bytes 8 Bytes	Unknown			
Bi directional		✓	Very limited 20 Sec latency	✓ >3 sec latency	✓		
Broadcast		✓	✗	✓	✓		

# Typical LoRa Use Cases

# Smart Metering

- ❑ Type of application – Deep Indoor, Fixed objects
- ❑ Markets – Water, Gas, Electricity
- ❑ Critical business issues
  - ❑ Legislative compliance
  - ❑ Meter reading
  - ❑ Leak detection, also in network
  - ❑ Reduce flow to manage consumption
  - ❑ Shut down flow for safety and damage control
  - ❑ Manage disconnections/reconnections
  - ❑ Manage updates for pricing
  - ❑ Increase public awareness



# Industrial Asset Monitoring

- ❑ Type of application – indoor fixed objects
- ❑ Markets - maintenance and supervision of machine status
- ❑ Critical business issues
  - ❑ Warranty management
  - ❑ Predictive maintenance
  - ❑ Avoid outage
  - ❑ Respond to temperature or air quality alerts
  - ❑ Stop machine from control room
  - ❑ Accessibility to assets



# Logistics & Supplychain

- ❑ Type of application – outdoor mobile objects
- ❑ Markets – parcels, containers, pallets, valuable goods...
- ❑ Critical business issues
  - ❑ Reduce cost and optimize execution
  - ❑ Enhance customer service
  - ❑ Lost and found
  - ❑ Management and cost of return goods
  - ❑ Quality of goods during transportation



# Safety & Security

- ❑ Type of application – indoor/outdoor objects and people
- ❑ Markets – lone worker, smoke & intrusion detection  
access control
- ❑ Critical business issues
  - ❑ Health & Safety compliance
  - ❑ Building security
  - ❑ Time and attendance management
  - ❑ Home security
  - ❑ Jamming





# Fill rate monitoring

- Type of application – indoor & outdoor mobile objects
- Markets – gas tank, cylinders, waste containers, tyres
- Critical business issues
  - Customer service levels
  - Logistic cost
  - Complaints management
  - Predictive forecasting
  - Alerts management





# Smart Cities

- ❑ Type of application – indoor & outdoor fixed objects
- ❑ Markets – parking, streetlights, intelligent traffic mgt, air quality
- ❑ Critical business issues
  - ❑ Carbon footprint
  - ❑ Traffic management
  - ❑ Citizen satisfaction & safety
  - ❑ Reduced budgets
  - ❑ Assisted living





# The basics of LoRa





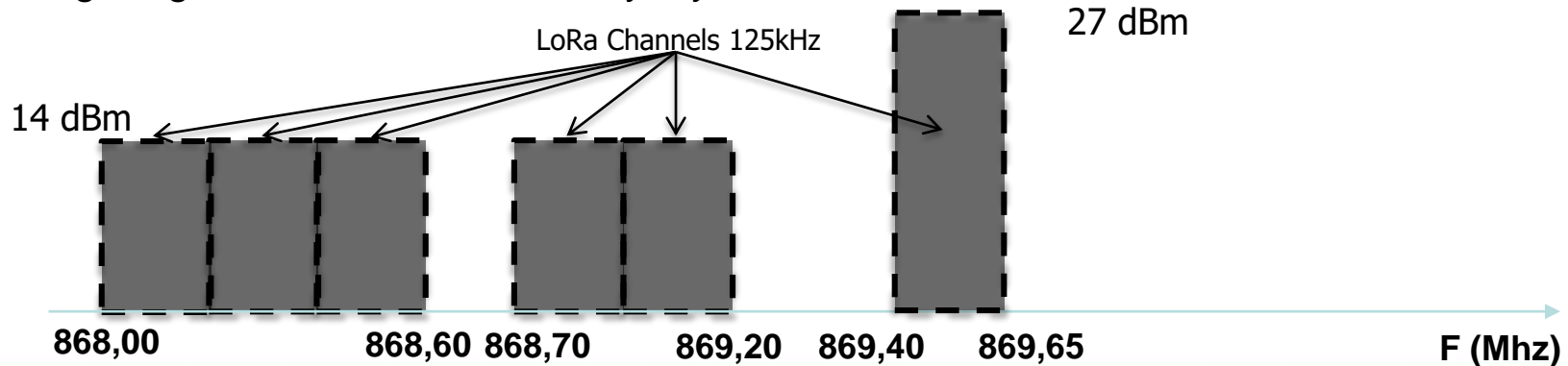
# What is an LPWAN network

- ❑ New enabling networks Low Power Wide Access Network
  - ❑ Low cost and small chipsets
  - ❑ Extreme low power consumption
  - ❑ Long range
  - ❑ Low throughput
- ❑ LoRa by Semtech
  - ❑ Technology available to MNO's and sensor/module manufacturers : radio technology based on Direct Spread Spectrum for secure, bidirectional and flexible payload messages
  - ❑ Growing feature footprint for example to enable location determination
- ❑ LoRa Alliance: Strategic non-profit partnership to drive optimal value creation
  - ❑ Define and manage the LoRaWAN specification
  - ❑ Ensure inter-operability and standardization
  - ❑ Drive the development of a global eco system and strategic partnerships



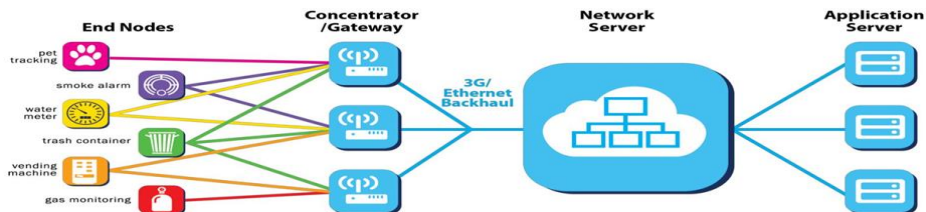
# Using License Free Bands

- ❑ ISM (Industry, Science, Medical) band, no licensing required
- ❑ Frequency band 863-870 Mhz in Europe
- ❑ However strict rules to adhere to:
  - UpLink : 25 mW (14 dBm), 1% duty cycle per hour (< 36 seconds transmission)
  - DownLink : 500 mW (27 dBm), 10% duty cycle per hour (< 360 seconds transmission)
- ❑ The 863-870 Mhz band will be available long term and will be extended to 863-875,6 Mhz increasing capacity
- ❑ Usage regulation is redefined every 4 years, next end of 2015

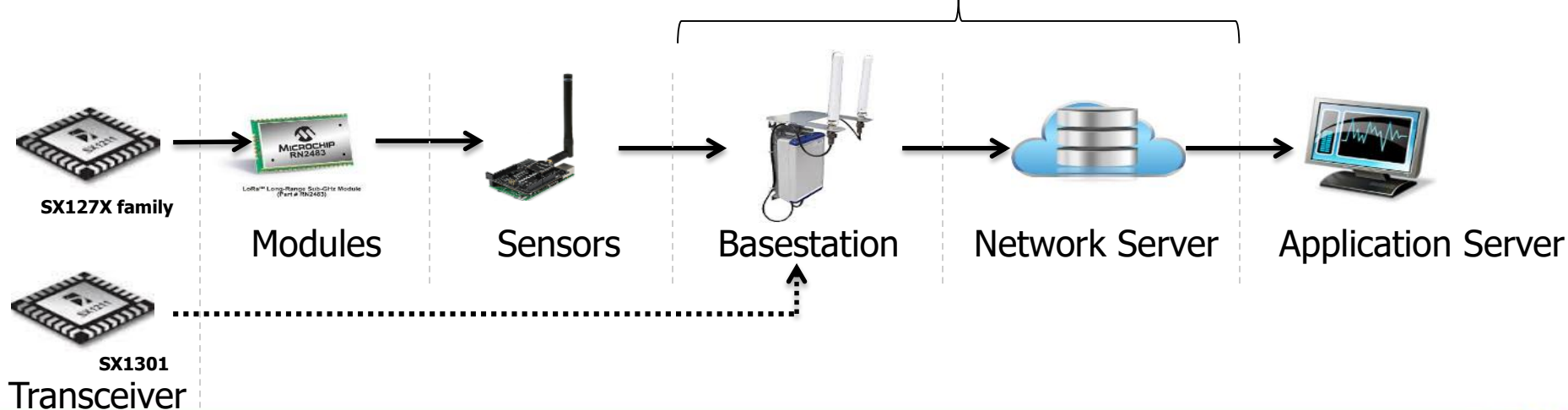


# LoRa Valuechain

- ❑ Module Manufacturers
- ❑ Sensor Manufacturers
- ❑ Base Station Manufacturers
- ❑ Network Server Providers



- Public Network Operator
- Private Network Operator

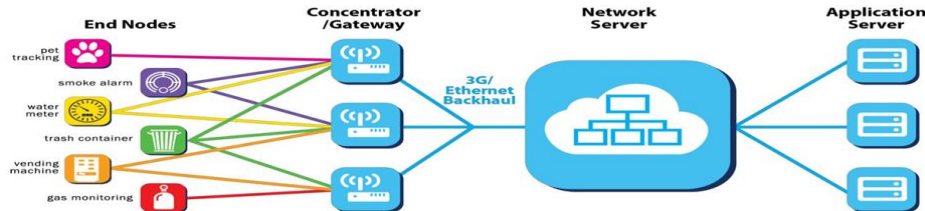






# LoRa Network Server

- ❑ Network Server : handles all data traffic:
  - ❑ Processes all traffic received from gateways
  - ❑ Manage radio configuration: Adaptive Data Rate (Spreading Factor)
  - ❑ Message management: authentication, authorization, accounting
  - ❑ Location determination (DTOA): license required
  - ❑ Manages acknowledgements (if required)
  - ❑ Manages downlink messages including multicast
  - ❑ Collects data for the Operations Support System (network management)
  - ❑ Interfacing towards application servers (API)





# Spectrum usage

## ❑ Basic Radio Transmission

- Messages are received by multiple base stations to deal with local interference resulting in optimal Quality of Service

## ❑ Spread Spectrum

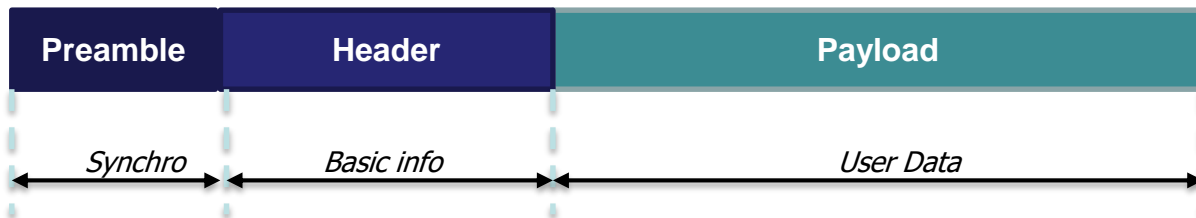
- Each string of bytes (a message) is increased with a redundant string for optimal Quality of Service. This ensures excellent demodulation of messages at the base stations even in an environment with high noise floors and other interferers

## ❑ Adaptive Data Rate

- A unique, and variable, spreading factor is used to increase the robustness of a message
- The Spreading Factor can vary between SF6 to SF12
  - The higher a spreading factor the better the robustness of a message as the distance between sensor and base station (range) can be longer
  - A lower spreading factor results in decreased robustness against interference, however due to faster transmission (Time on Air) one can send bigger messages resulting in lower power consumption
- The network manages these spreading factors automatically



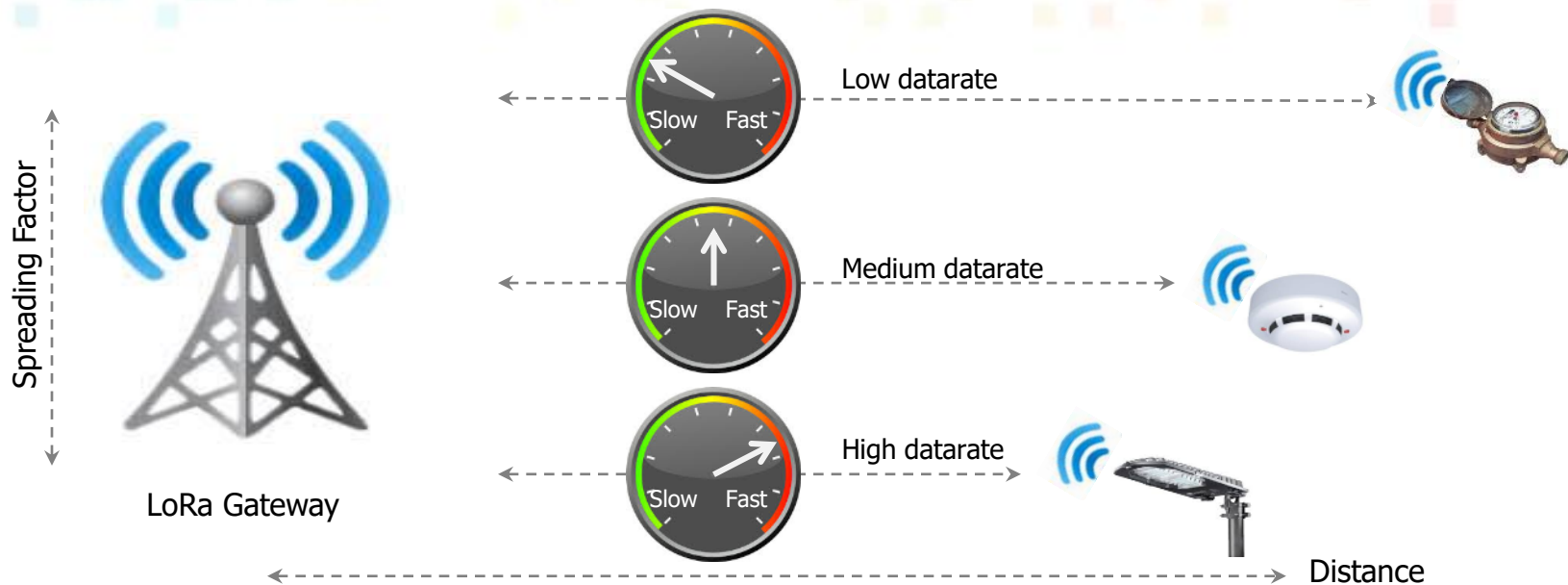
# Protocol and message structure



- ❑ Chirp (chirp) : synchronization preamble to allow for recognition of message
- ❑ Header : basic information for message size and error correction
- ❑ Payload (flexible) : user data ranging from 1 to 242 bytes



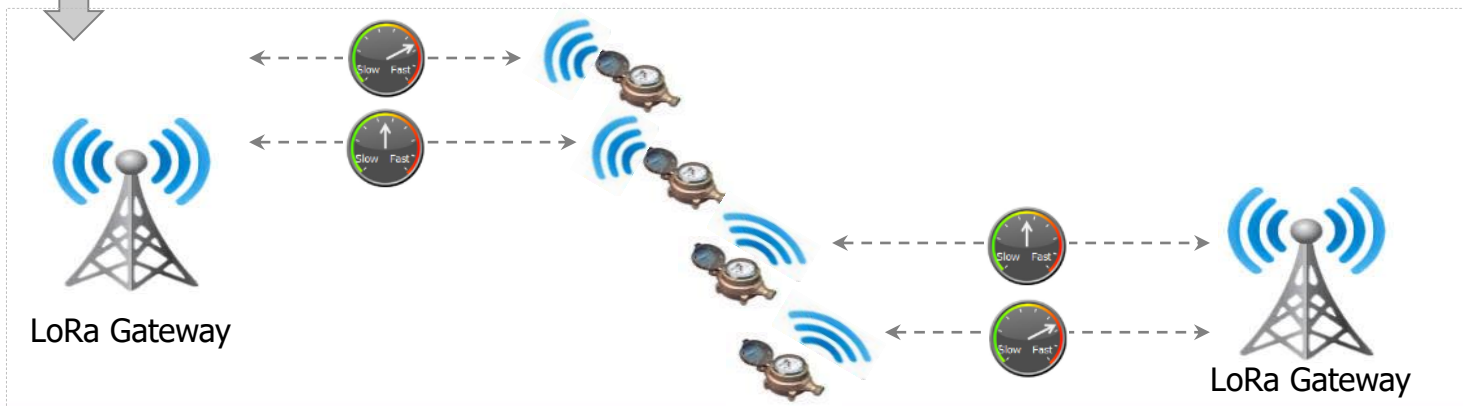
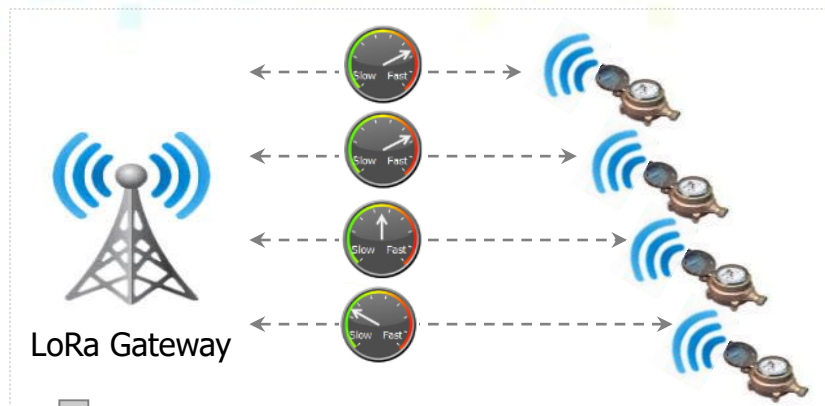
# A smart connexion for smart sensors



- ❑ Dynamic datarate to deal with outdoor, indoor and deep indoor
- ❑ Best datarate to reach gateway is set dynamically and automatically
- ❑ Power consumption is optimized automatically
- ❑ End result is the best mix between datarate, range, power



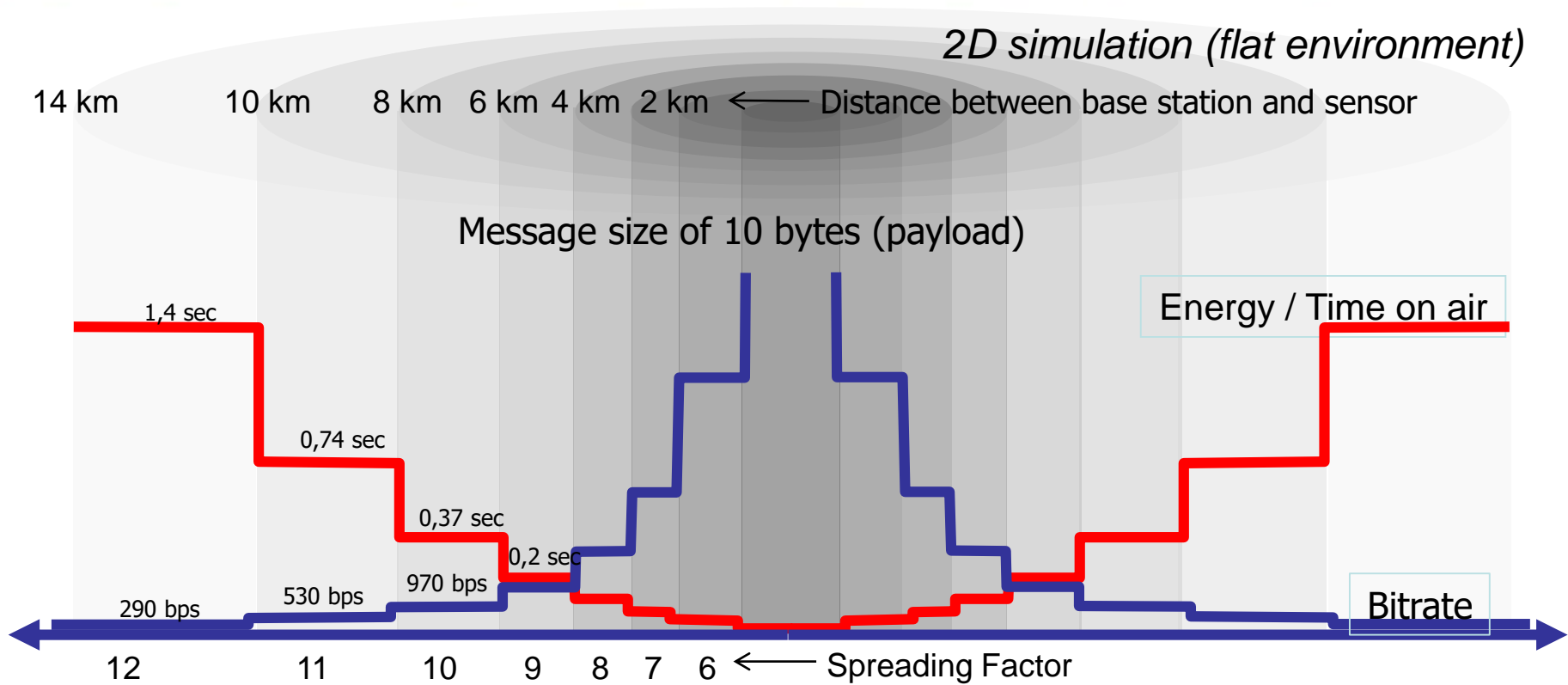
# Future proof scalability



- ❑ Datarate is set based on range, visibility, height whilst speed and time on air are optimised
- ❑ Best datarate to reach gateway is set dynamically and automatically
- ❑ Interference reduction
- ❑ End result is optimal deployment growing with market needs



# Unlimited growth enabled by ADR







# Adaptation to use case

Spreading factor	Time on Air	Data rate	Sensitivity
6	33 ms	9380 bps	-127.5dBm
7	56 ms	5469 bps	-130.0dBm
8	100 ms	3125 bps	-132.5dBm
9	200 ms	1758 bps	-135.0dBm
10	370 ms	977 bps	-137.5dBm
11	740 ms	537 bps	-140.0dBm
12	1400 ms	293 bps	-142.5dBm

*Values correspond with a payload of 10 bytes*

- All LoRa chipsets are compatible with a G(FSK) modulation allowing for data rates up to 50 kbit/s



# Huge advantages for growing demand

- ❑ Adding gateways scales capacity by 6-8X
- ❑ Optimizes channel usage
- ❑ Saves battery
- ❑ Increased Quality of Service
- ❑ Extremely robust for interference
- ❑ Optimized penetration for deep indoor and underground
- ❑ Increased payload
- ❑ Reduced time on air
- ❑ Ability to deal with existing or new agglomeration
- ❑ Allows for femto cell growth path

Higher Spreading Factor	Lower Spreading factor
Robustness against interference	Increased payload
Optimal link budget (Signal to Noise)	Lower time on air
Increased network range	Increased capacity



# Device Classes for any use case

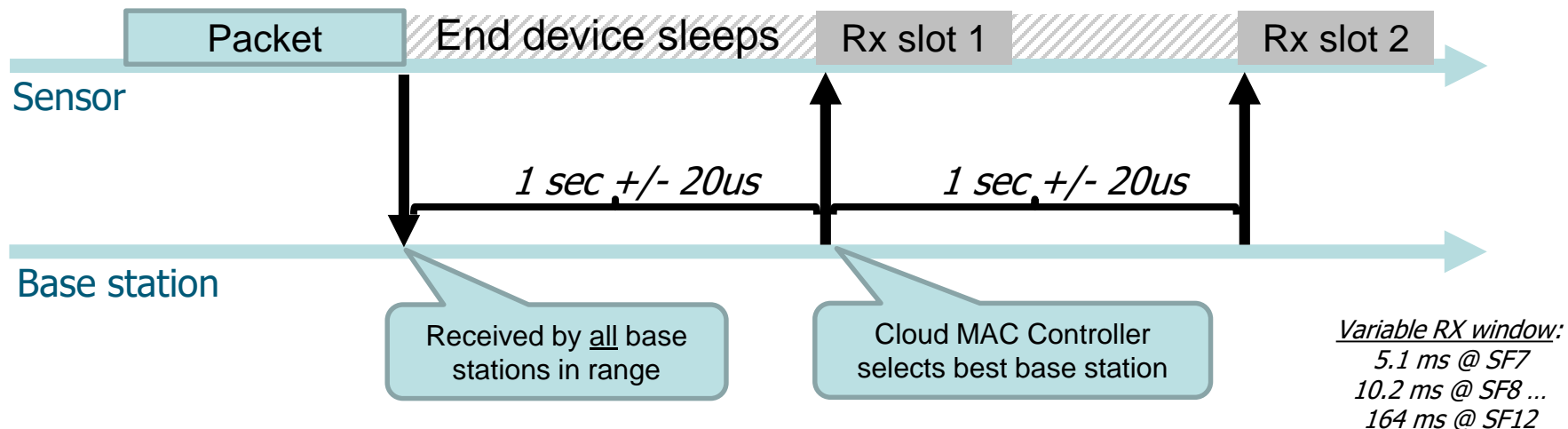
Class name	Intended usage
<b>A</b> (« all »)	Battery powered sensors <ul style="list-style-type: none"><li>• No latency constraint</li><li>• Most energy efficient communication class.</li><li>• Must be supported by all devices</li></ul>
<b>B</b> (« beacon »)	Battery powered actuators <ul style="list-style-type: none"><li>• Energy efficient communication class for latency controlled downlink</li><li>• Based on slotted communication synchronized with a network beacon</li></ul>
<b>C</b> (« continuous »)	Mains powered actuators <ul style="list-style-type: none"><li>• Devices which can afford to listen continuously.</li><li>• No latency for downlink communication</li></ul>





# Bidirectional communication, class A

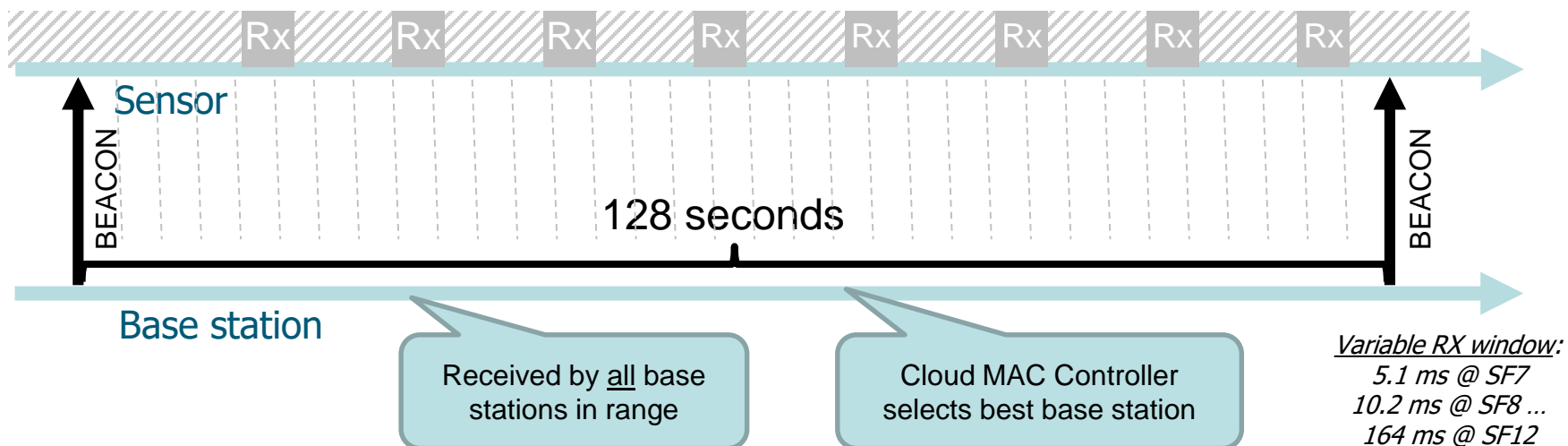
- ❑ Downlink messages are optional and initiated by an Uplink message
- ❑ Each Uplink message opens 2 windows Downlink
  - ❑ Acknowledgement, MAC commands, application commands





# Bidirectional communication, class B

- ❑ Downlink messages are optional
- ❑ Classe B: all sensors are synchronized with the gateways and have regular Downlink windows
- ❑ Coordinated Sampled Listening (CSL): Network may send downlink packet to node at any Rx slot





# Embedded Security

- ❑ Multi level encryption to ensure optimal protection
- ❑ Encryption using AES 128 algorithm, following 802.15.04 standard
- ❑ Three security keys
  - ❑ Primary security per sensor (objectId/@MAC-Id)
  - ❑ Dedicated network key per operator (MIC : network integrity)
  - ❑ Service provider key (not shared with operator) decryption in final application only
- ❑ Full protection against
  - ❑ Replay of messages through counters, both Uplink and Downlink
  - ❑ Identity of sender
  - ❑ Content of message





# Unique differentiators – for integrators

- ❑ Long range resulting in attractive subscription cost
  - ❑ 2 km in dense city environments
  - ❑ 15 km rural
- ❑ Low power consumption
  - ❑ Battery operated sensors with > 10 years lifespan
  - ❑ Extended battery life through reduced transmission time (ADR)
- ❑ Variable payload allows for adaptation to use case
- ❑ Bidirectional communication in three device classes
- ❑ Sensor management through unicast, multicast and broadcast
- ❑ Controlled Quality of service
- ❑ Low latency for downlink messages
- ❑ Robust against interference and noise
- ❑ Support mobile objects even at high speed
- ❑ Location determination
- ❑ Multi level security
- ❑ LoRa Alliance- open source LoRaWAN
  - ❑ Roaming, Interoperability and standardisation
  - ❑ Strong supporting eco system



# Unique differentiators – for operators

- ❑ Long range resulting in lower capex and opex
  - ❑ Attractive subscription models serving many use cases
  - ❑ Re-use of existing 2G antenna's lowering deployment cost
- ❑ Optimal Total Addressable market
  - ❑ Bidirectional communication in three device classes
  - ❑ Low latency for downlink messages
  - ❑ Robust against interference and noise
  - ❑ Support mobile objects even at high speed
  - ❑ Location determination
  - ❑ Multi level security
  - ❑ Variable payload to increases use case applicability
- ❑ Adaptive data rate
  - ❑ Lower time on air
  - ❑ Grow network coverage in sync with market demand
- ❑ Sensor management through unicast, multicast and broadcast
  - ❑ Required for subscription management
- ❑ Controlled Quality of service

# Location Determination



# Importance of Location

## Unique LPWAN feature

- Indoor/outdoor
- No battery impact, longer life span

## Applicable to majority of applications

- One off – determine installation location
- Recovery – regular heart beat and high SLA when needed
- Regular determination – all across supply chain and mobile assets in many market segments

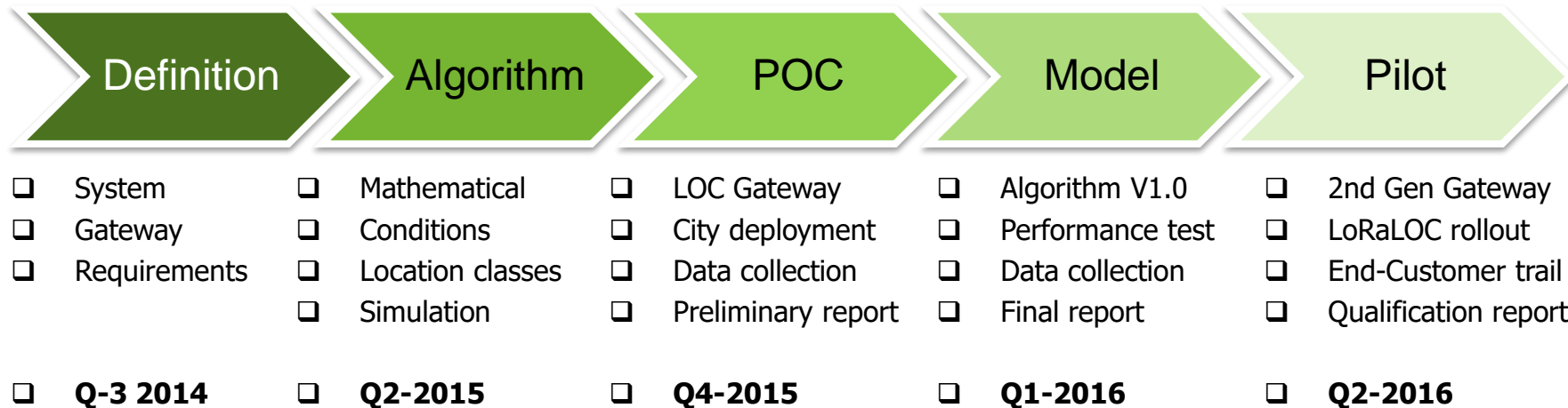
## High value add

## Replacing existing capabilities

- GPS – BOM and battery cost reduction (\$5-\$10)
- Wifi – mainly Google (\$0.50 USD / 1000 additional elements, up to 100,000 daily)

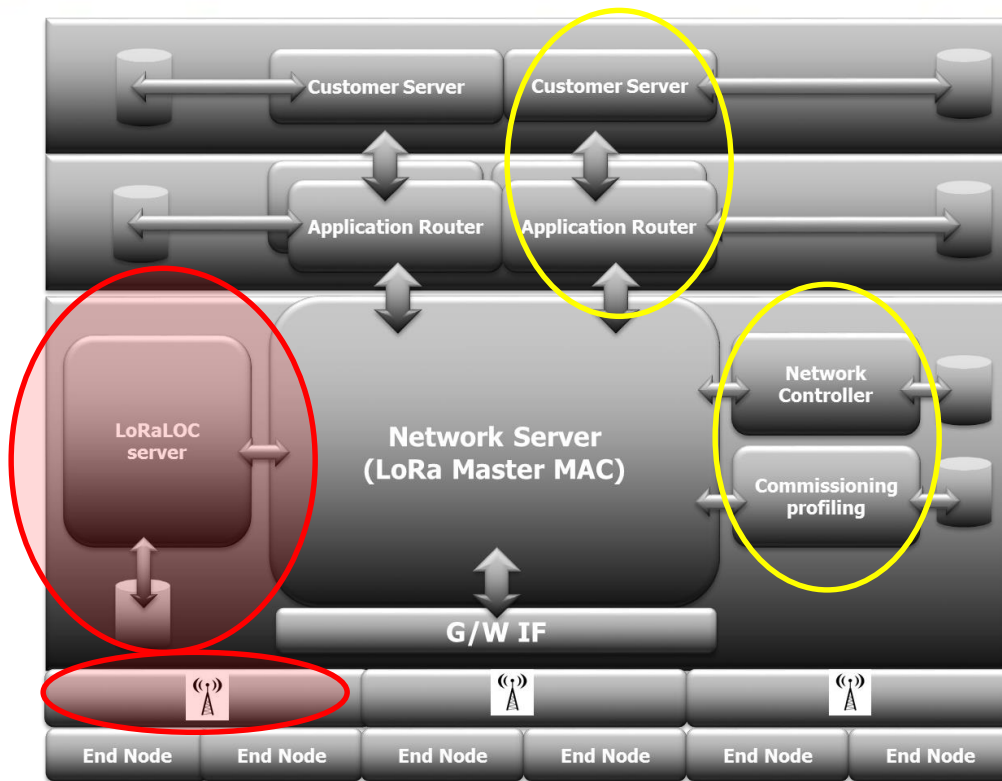


# Location Roadmap





# System design



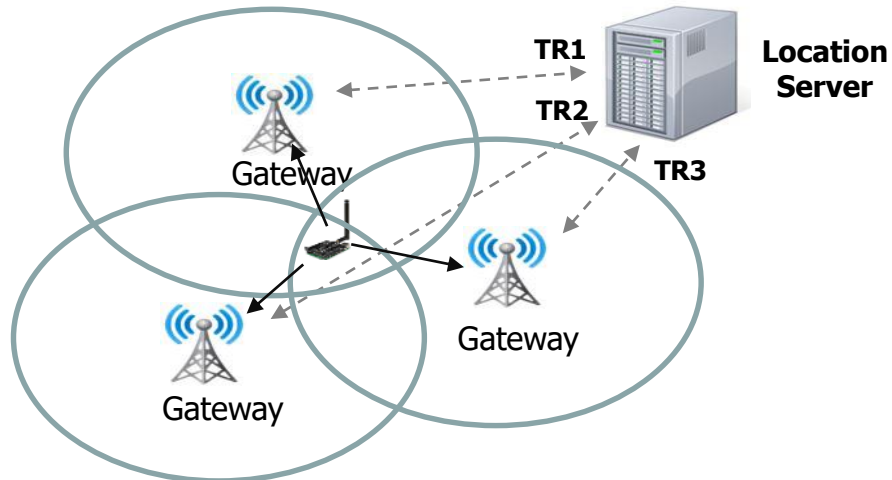
- ❑ Semtech LoRa Location License:
  - ❑ Semtech Location server
  - ❑ Reference design for localization gateway
- ❑ Network Server Provider:
  - ❑ Network Controller including Adaptive data rate management for localization
  - ❑ Commissioning including localization profile
- ❑ Network Operator
  - ❑ Application Router sending localization data to customer server
- ❑ Customer Server
  - ❑ Provide geo localization of devices through webservice and applications





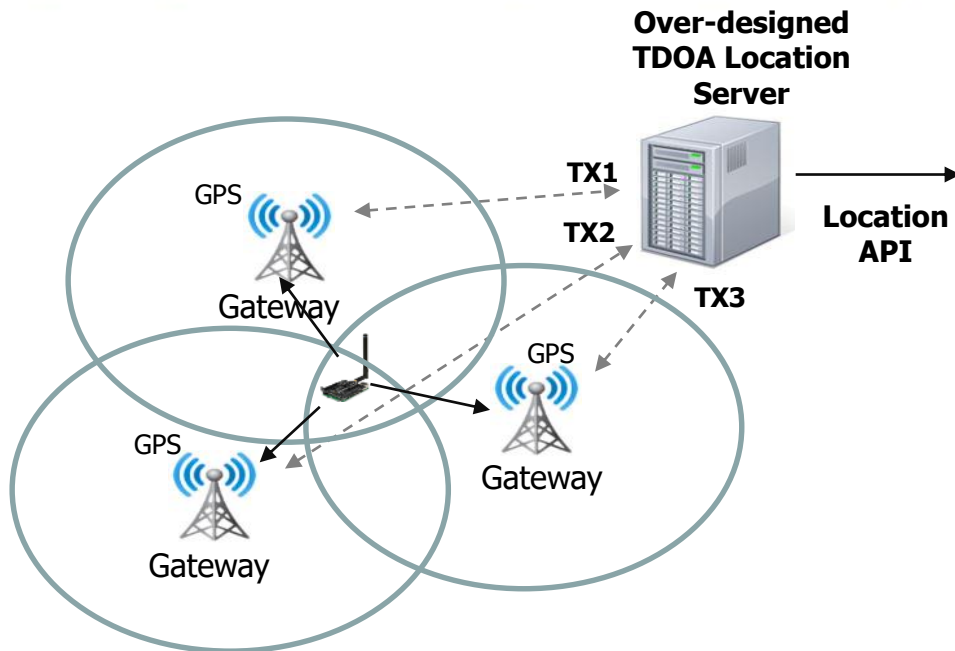
# Location ready without GPS

- ❑ LoRa uses Differential Time Of Arrival (DTOA) for location calculation
- ❑ Triangulation based location determination
  - ❑ Outdoor accuracy < 50 M
  - ❑ Indoor accuracy < 75 M
- ❑ Supports mobile sensors even when moving fast (fading/multipath)





# Network infrastructure



- ❑ Localization is performed on data transmissions from sensors
- ❑ Gateways are synchronized in time with GPS
- ❑ Accurate timestamps are added to received data, along RSSI, frequency error, pointing direction of antenna
- ❑ For each message to locate, a localization server collects the multiple receptions and solves for 2D position



# FAQ - LoRa

- How much data can be transmitted - What is the data throughput with LoRa
- What is the latency – how fast will data be delivered
- Capacity - how many sensors can be supported
- Capacity – what is the future strategy for ISM
- Capacity – how much data can LoRa handle
- Security – how is security and privacy managed
- Penetration – how deep indoor does LoRa work



# How much data can be transmitted

## Uplink :

	Overhead	Max Payload
LoRa	17 bytes	Up to 242 bytes

	Time on Air (for 12 bytes sent)	Data rate (for 12 bytes sent)
LoRa SF7	62 ms	1556 bits/s
LoRa SF12	1,48 sec	64,74 bits/s

## Downlink :

	Overhead	Max Payload
LoRa	15 bytes	Op to 242 bytes

	Time on Air (for 8 bytes sent)	Data rate (for 8 bytes sent)
LoRa SF7	56 ms	1142 bits/s
LoRa SF9	185 ms	346 bits/s

- The payload with LoRa is flexible using the adaptive data rate
  - Packet size ranging for 1 to 242 bytes
- Data throughput (data rate) is managed by network
- Time on air (data rate) is not fixed to optimize spectrum usage



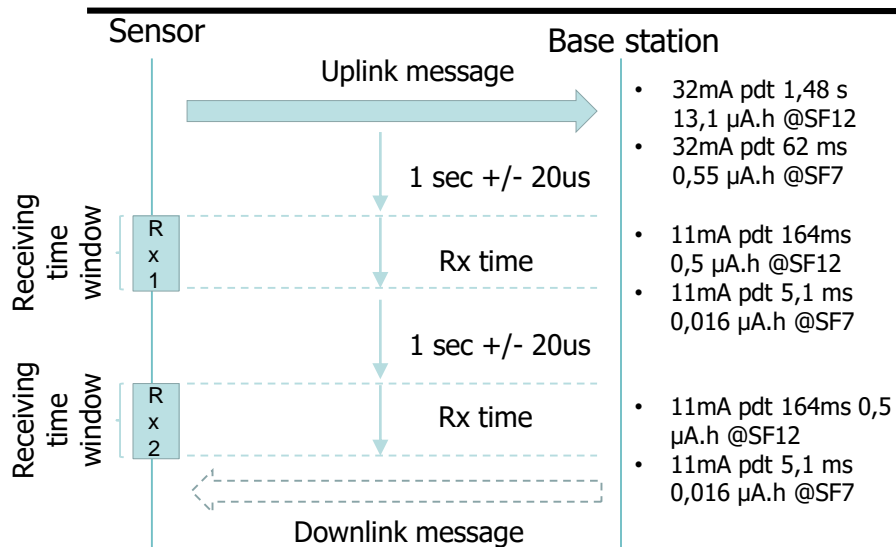


# Latency – how fast is data delivery

SEMTECH -



## LoRa (Classe A) – 12 bytes payload



- ❑ Uplink latency (sensor to network)
  - Adaptive data rate depending on signal quality
  - Time on air varies from 62ms to 1,48s
- ❑ Downlink latency (network to sensor)
  - Device class driven
  - Device class A – after an Uplink message the sensor listens 1 - 2,2 seconds for a downlink message
  - The network latency (backhaul) depends on operator, typically milli seconds



# Is there a capacity limit

- ❑ Radio networks have limited capacity
  - All radio channels in the same frequency band (868MHz) are occupied (6 channels of 125 KHz for LoRa)
  - When saturated the adaptive data rate does not allow further optimization (channel and spreading factor)
  - Theoretical capacity calculation
    - Gateways are not a limiting factor : 36 simultaneous demodulations (6 channels times 6 spreading factors)
    - Time on air (use of spectrum) depends on distance to base station
    - Highest concentration of sensors will be in urban areas
      - 70% of sensors on Spreading Factor 12 – longest range
      - 20% of sensors on Spreading factor 10
      - 10% of sensors on Spreading factor 8 – shortest time on air
    - Example for 10 bytes payload per message and 1 gateway every 1 Km
      - Maximum capacity per gateway per day 515 000 messages
      - Maximum capacity per Km<sup>2</sup> per day 164 000 messages
    - For use case with 4 messages per day per sensor : 41 000 sensors maximum per km<sup>2</sup>
- ❑ Example for Paris : population density is 21.347 per km<sup>2</sup>
  - Maximum number of messages of 10 bytes is (164.000/21.347) 8 messages per inhabitant per day
- ❑ Increased density of base stations will grow capacity rapidly and provides scalability for operators





# How much data can LoRa handle

- ❑ LoRa technology has been built from scratch to serve the IoT
- ❑ The adaptive data rate means change speed of transmission when there is a better quality of the radio signal
- ❑ The closer a sensor is to a base station the better the quality of the radio signal
- ❑ Outdoor sensors typically have better signal quality as indoor or underground placed sensors
- ❑ The faster the speed of the radio transmission, called data rate, the shorter the sensor consumes battery power
- ❑ Faster transmission increases the capacity of the band as more messages can be transmitted
- ❑ LoRa can handle from 300bps up to 9,4kbps
- ❑ The ADR is automatically managed by the network



# Optimal security management

- ❑ Network encryption is AES 128 (as per the 802.15.04 standard)
- ❑ Multi level security management
  - ❑ One security key per sensor
  - ❑ Network security key per operator (MIC : integrated key)
    - ❑ re-use of the standard encryption as per the 802.15.04 : CCM standard
    - ❑ encryption key only known to operator (always)
  - ❑ Solution provider security key different for each partner and only known to the partner
    - ❑ encryption of payload to ensure security up to the processing partner server
  - ❑ Message counter – protection against piracy and identity theft



# Underground or deep indoor

- ❑ Attenuation is higher when sensors are placed underground or deep indoor, up to the level that radio signals do not
- ❑ Signal strength is influenced by concrete walls, metal and even human bodies
- ❑ Each building has its own specific constraints
- ❑ If in doubt local measurements need to proof applicability
- ❑ Network coverage is mostly expressed in % coverage of territory and % coverage of population
- ❑ In difficult environments additional base stations will resolve coverage issues (keep in mind ADR is needed)
- ❑ The link budget of LoRa, defining the sensitivity of the network, is very close to the physical limit which leaves no room for competitors to be much better



# FAQ – LoRa Alliance

- Are there variations of LoRaWAN

Currently LoRaWAN R1.0 is published, enhancements of the standard is driven by the Technical Committee of the Alliance to which all members contribute

- What is the process for upgrades to LoRaWAN

The Technical committee drives the future of the LoRaWAN standard and publishes fixes and new releases when they become available

- How does roaming work with LoRaWAN
- Are there existing Quality of Service and SLA's for LoRaWAN
- How does hand-over work with LoRaWAN
- Why do carriers prefer LoRaWAN



# Roaming ready

- Roaming is driven by a working group in the Strategy Committee in the Alliance
- Roaming : a sensor joins another network as its Home Network
- Technical optimization – use additional base stations in other networks
  - Location determination
  - Faster transmission
  - Lower latency
  - Lower power consumption
- Roaming tariffs are not mandatory and bilateral, through the LoRa Alliance
- Network security keys enable proper management of roaming
- Message counters are available to allow for proper clearing
- Commercial offers including roaming are at each operators discretion



# Quality of Service

- All data communication is executed at best effort - technology needs to be robust
- Operate in different frequency bands
- Limit time on air to avoid collision through ADR
- Increase the link budget through higher spreading factor (up to + 20 dB)
- Reconstruction of messages even if only parts are received
- Automatic band hopping if needed
- Balanced link budget for UL and DL
- Several device classes to increase QoS when needed



# Service Level Agreements

- ❑ QoS and SLA are network operator responsibilities and defined by each operator as these depend on network deployment strategies and customer contracts
- ❑ Through deployment strategies LoRa Network Operators can deliver high service levels in terms of coverage
- ❑ LoRaWAN is open and standard protocol guaranteeing compliance throughout the value chain
- ❑ Certification guarantees legal compliance and device class for optimal connectivity and clear coverage maps
- ❑ Service Level Agreement
  - ❑ Interoperability and roaming
  - ❑ Strong encryption to protect data
  - ❑ Test house involved for certification of sensors
    - ❑ SRD 863-870 MHz : 300-220 (EMITECH)
    - ❑ LoRaWAN compliant
    - ❑ ETSI/FCC compliance





## How does handover work

- Handover like in GSM Networks does not exist with LoRa Networks
- Communication is not continuous, sensors transmit only when needed and receive responses accordingly
- Messages are received by one or more base stations and forwarded to a network server for further processing
- Message transmission time is very limited (< a few seconds)



# Why carriers prefer LoRaWAN

Benefits of scale and experience leading to reduced Capex & Opex

- ❑ MNO's have access to tower locations
- ❑ MNO's have experience in rolling out networks
- ❑ ADR enables to grow coverage with market demand

Optimized Quality of Service

- ❑ Experience in managing and maintaining data com networks
- ❑ ADR (adaptif data rate) allows for densification without capacity constraints
- ❑ For outdoor applications the majority of use cases can operate under SF 7 or SF 8, thus extreme low power consumption and high capacity