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IoT – Internet de las cosas

17 de Noviembre de 2016

Artimar Linecard

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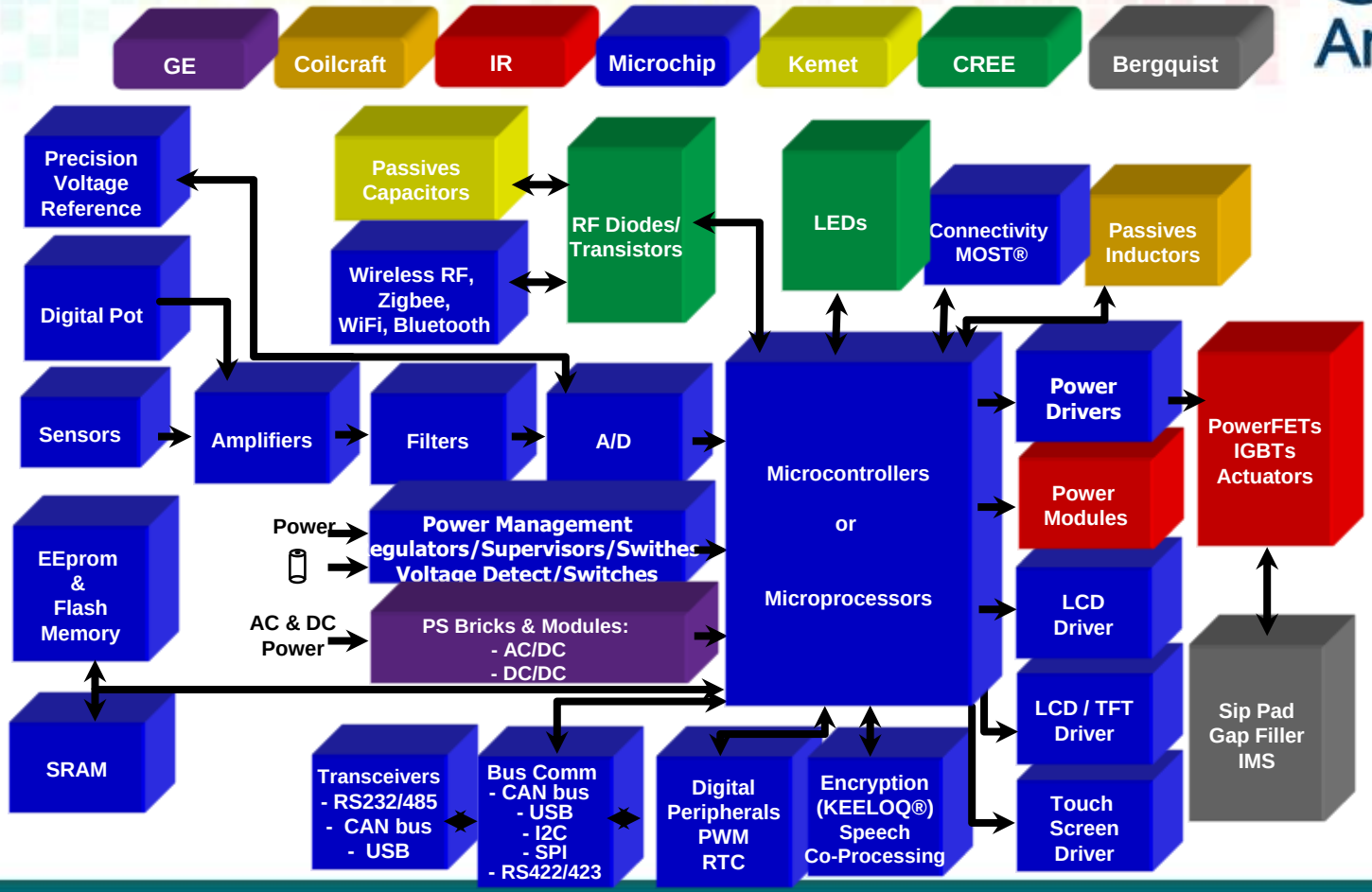
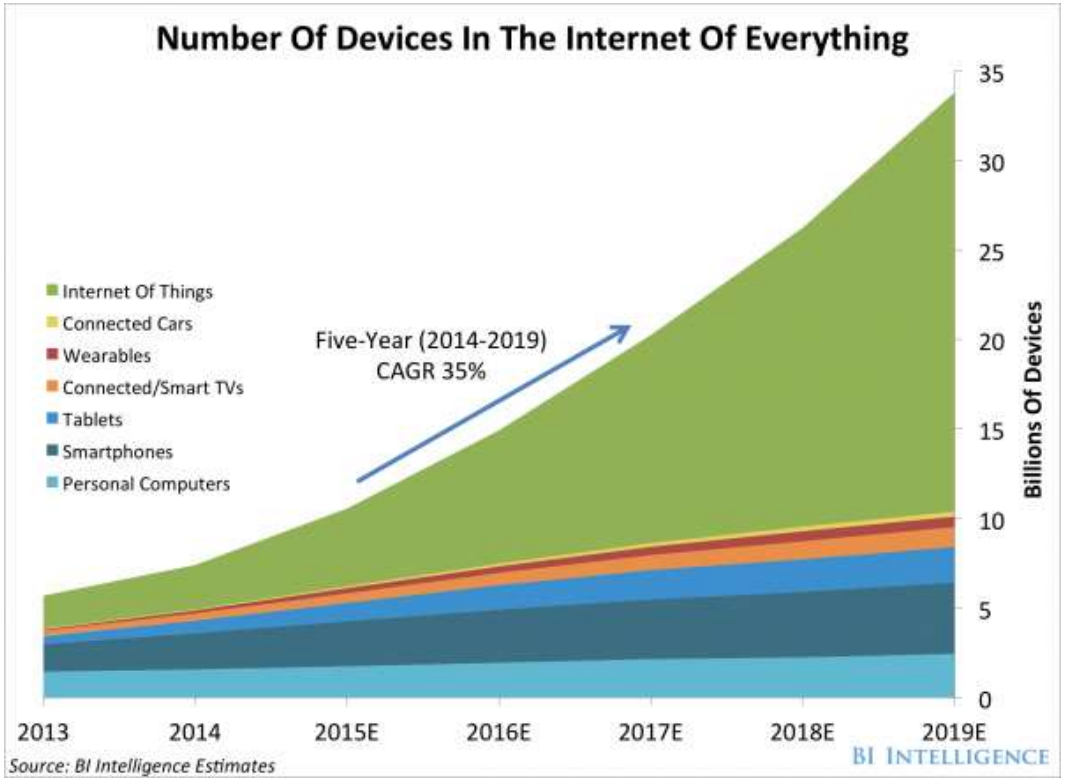
Artimar Total Value Proposition CY16



Agenda

- Qué es IoT y porqué debería importarme?
- Oportunidades de negocio
- Tecnologías de IoT

IoT y el futuro



Low Power WAN: Mercado disponible

SMART ENVIRONMENT & INDUSTRIAL

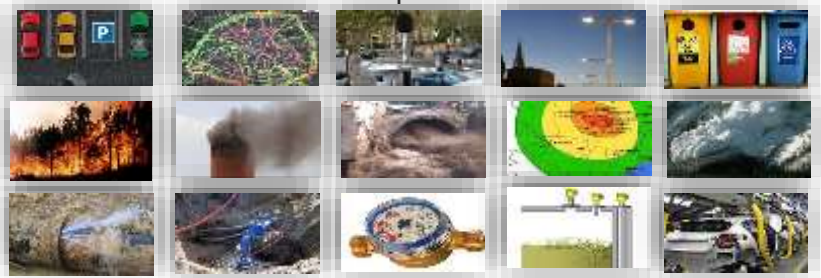
75M

- Forest fires
- Air pollution
- Earthquake sensors
- Avalanche and flooding
- Heating and AC
- Equipment status
- Factory control

SMART METERING

450M

- Electric
- Water
- Gas
- Infrastructure & production



SMART CITY

200M

- Smart parking
- Traffic sensors & control
- Street lighting
- Infrastructure monitoring
- Trash and waste containers
- Public events –location services
- Advertising displays

TRACKING

250M

- Motor bikes
- Cars
- Bicycles
- Kids
- Pets
- Insurance – valuable assets
- Find My Stuff

AGRICULTURE

25M

- Irrigation control
- Environment sensing
- Animal tracking
- Animal sensing – ovulation, birth

SECURITY/SMART HOME

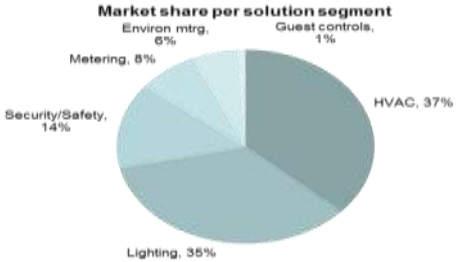
250M

- Smoke detectors
- Security systems
- Smart appliances
- Heating control / monitoring

Mercados verticales y aplicaciones

Edificios inteligentes

- En el TOP3 de todos los MNO (operadores celulares)
- 75% de reducción de costos capex y opex
- TAM - 465M de sensores, 45% de mercado en 2022 = 191M sensores
- Relacionado con la reducción de primas de seguros
- Reducción de costos operativos
- Sub-segmentos de este mercado
  - HVAC, security/safety, lighting, metering, environmental monitoring, control



Established companies	New entrants
Johnson Controls	Ecobee
Schneider	Entouch Controls
Siemens	Golden Power
Ingersoll Rand	Millennial Net
Invensys	Nest
Honeywell	RCS
	TCS Basys
	Thermokon
	Viconics
	Vigilent

Edificios mas inteligentes

Facturar a cada usuario por separado

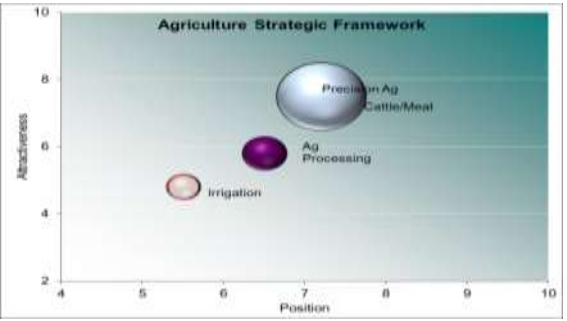
Clean after 5 hours of high CO2 level

Clean after 100 door openings

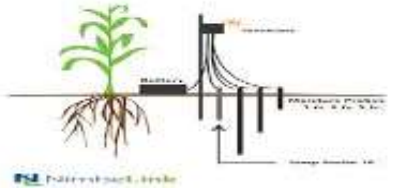
Mandar estado de vida, alamas y batería

Agricultura y ganadería

- Falta de cobertura celular
- La duración de la batería y el alcance son importantes
- Activos de gran valor, sensores de bajo costo = mas sensores
- Gran éxito con líderes del mercado
- Sub segmentos de agricultura
  - Agricultura de precisión
  - Riego artificial
  - Ganado
  - Procesamiento de agricultura (temperatura, humedad, etc)

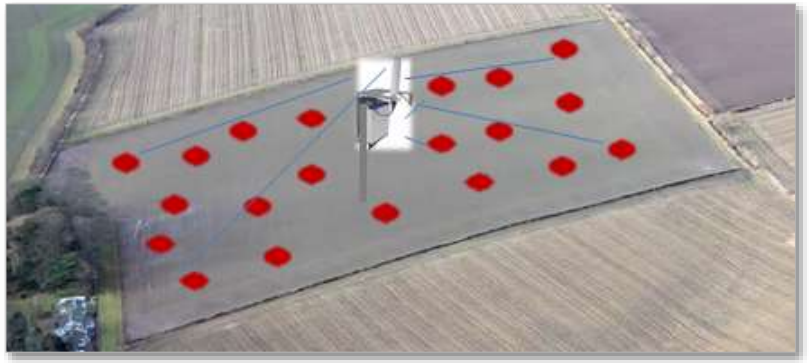


US Ag Market Segments	US Market Size
Irrigation and precision farming	TAM = 100M, SAM = 20M
Ag processing	TAM = 50M, SAM = 10M
Cattle & meat prod	TAM = 190M, SAM = 40M
Total	**TAM = 340M, SAM = 70M**

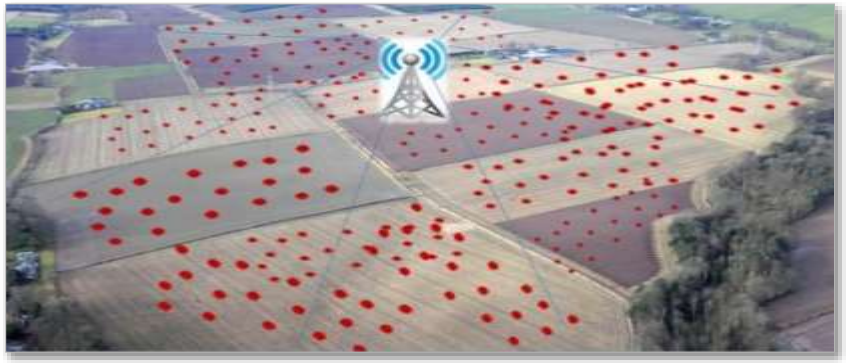


Agricultura - Riego

	Solución actual	LoRa®
# de Hectáreas	200	180.000
Area de cobertura	1 km radio / 2 km²	24 km de radio / 1800 km²
Costo de la solución	Alto	Bajo
Simplicidad	Compleja	Muy fácil
Duración de batería	1-2 años	> 5 años



0.5 MILE Radius / 0.75 sq. miles /20 sensors



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

Cadena de suministros – Logística

Supply Chain - Trash

Partner

- Enevo - Sensors and analytics for trash and recycling pickup optimization

Benefit

- 40% reduction in collection costs
- 50% reduction in collection
- Aesthetic city benefits to ensure pickup if containers are full ahead of schedule

Supply Chain - Delivery

Partner

- Insigma - Sensors and analytics for coolers

Benefit

- $B lost to beverage supplier yearly due to out of stock
- $50 'expense' if truck stops at store which doesn't need stocking
- Coolers or compressors stolen in some countries

Low Power WAN: Use Case
Smart Water Meter

LP WAN Value:

- 10 YR Battery life
- Endpoint cost
- Reduced access cost

There are 3 options for achieving long range for water meter star networks.

1. Cellular: Recurring cost + hardware cost prohibits mass adoption
2. Tier 1 market leader uses high power licensed spectrum – only one doing this
3. LP WAN: Best solution for cost and battery life requirements

Proof of concept showed elimination of 600 repeaters using LP WAN

Elimination of costs associated with “drive-by” reading

North America deploys 6-8M smart water meters annually

Low Power WAN: Use Case
Distribution Leak Detection

LP WAN Value:

- 10 YR battery life
- Endpoint cost
- Reduces access cost
- Wide Area needed

35% of all water leakage is lost thru distribution

Municipalities spend billions of dollars annually repairing leaks

- Most leak detection today is only 50% accurate
- Results in additional expense because of the inability to accurately locate leaks

Pipe aging is accelerating by 2% annually in NA

Low cost sensors are needed due to the shear volumes of sensors for a comprehensive network

Technology leader is developing system that will be 90% accurate

Low Power WAN: Use Case
Oxygen Tank Monitoring

LP WAN Value:

- 5 YR Battery life
- Endpoint cost
- Recurring charge cost

Huge efficiency gains are realized by tank monitoring

Tanks are replaced at predetermined intervals regardless of need

Sensor batteries need 5 years = same as tank life

- Cellular unsuitable

Low Power WAN makes business case

- Recurring charges ¼ of cellular

Bouygues Telecom contracted for 5M tanks in France using Low Power WAN Network

Low Power WAN: Use Case
Propane Tank Monitoring

LP WAN Value:

- 10 YR Battery life
- Endpoint Cost
- Reduces access cost
- Wide Area needed

One of the nation's largest propane dealers w/over 2M tanks on the east coast of NA

2014 propane demand cause shortages and delivery delays of up to 3 weeks

Current system for estimating tank levels results in an average of 50% tank levels across the board

W/real time monitoring, tank levels would rise to 75% and connection to SAP would avoid shortages

Currently monitoring is done only in extreme cases due to cost

ROI is realized thru inventory cost reduction, avoiding shortages, and reduced waste in labor allocation.

Low Power WAN: Use Case
Localization / Asset Tracking

LP WAN Value:

- 10 YR Battery life
- Endpoint cost
- Reduces access cost
- Wide Area needed

Ability to track and locate industrial assets

Trimble / RF Code deploying more than 6M sensors annually

Agriculture:

- Large yards: Tools and equipment
- Variable assets: Fertilizer, Cotton bales
- Powered assets: Tractors, vehicles
- Flower growers: Tracking production thru POS

Environmental:

- Landfill: Regulated. Waste disposal tracking
- Kodak: Chemical container mgmt.
- Waste: Container mgmt.
- Railway: Container mgmt.
- Shipping Container mgmt

Low Power WAN: Use Case
Smart Vending

LP WAN Value:

- 5 YR Battery life
- Endpoint cost
- Wide Area needed

Vending in process of being automated and monitored remotely

Monitoring provides visibility and accountability resulting in increased profits

- Efficient restocking
- JIT inventory management
- Preventive maintenance
- Location (theft prevention)

ROI includes labor and fuel efficiencies

Remote vending leader(s) have multiple pilot projects

Low Power WAN: Use Case
Irrigation

LP WAN Value:

- 5 YR Battery life
- Wide Area / height
- Low cost sensors

Current system valve controllers have limited range and are hard wired

Cost and maintenance of hard wired systems are extremely high

All 3 leaders are designing wireless systems to monitor soil condition

There are over 15k golf courses in the US

LP WAN makes a business case by eliminating repeaters as control panels are not elevated

Low Power WAN: Use Case
Pet/People Tracking

LP WAN Value:

- 2 YR Battery life
- Wide Area
- Low cost sensors

Walt Disney spent $1B for crowd control, data collection, and wearable technology

- One industry leader provides >2M tracking devices for theme park and event tracking

LoRa with location provides a cost effective, long life way to track pets and/or people

Low Power WAN: Use Case
Oil / Gas Exploration

LP WAN Value:

- Solar powered GW repeater
- Wide Area
- Long range

In some cases cellular access is unavailable for remote oil / gas exploration sites

LP WAN allows for solar powered gateway repeaters to act as an interconnect to the cellular backhaul

Low cost, long range sensors can act to fill the void of rural connectivity

LP WAN repeaters can be placed on a pole using unlicensed RF bands – extremely low cost

Technology available today without touching base stations – range extension w/cellular backhaul

Low Power WAN: Use Case
Smart Parking

LP WAN Value:

- Battery life
- Low node cost
- Wide Area

Enables street level sensors and mobile apps to effectively manage complex parking in cities

- Better user experience via parking finder apps
- More revenue for cities

The average American spends $1300/yr on parking

Data driven decisions are made by cities / over 50 cities deploying smart parking systems

“Parking” is an increasing urban issue to solve thru data and analytics

IoT necesita un standard abierto

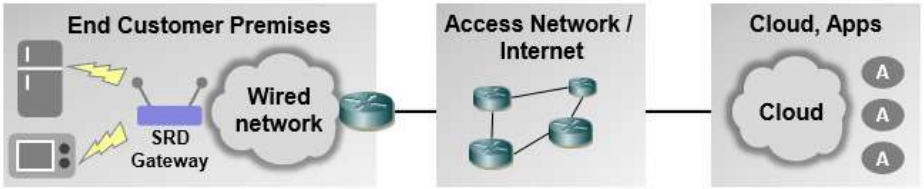
- Licenciado vs no licenciado
- Propietario o standard abierto
- Largo o corto alcance
- Objetos móviles o fijos
- Alimentación con batería o red
- Bytes vs MBs

Dónde encaja LPWAN?

	Local Area Network Short Range Communication	**Low Power Wide Area** (LPWAN) Internet of Things	**Cellular Network** Traditional M2M
%	**40%**	**45%**	**15%**
☺	Well established standards In building	Low power consumption Low cost Positioning	Existing coverage High data rate
☹	Battery lifetime Provisioning Network cost & dependencies	High data rate Emerging standards	Battery lifetime Total cost of ownership
	4.0 Bluetooth™ Wi Fi™	LoRa®	GSM 3G+ H+ 4G

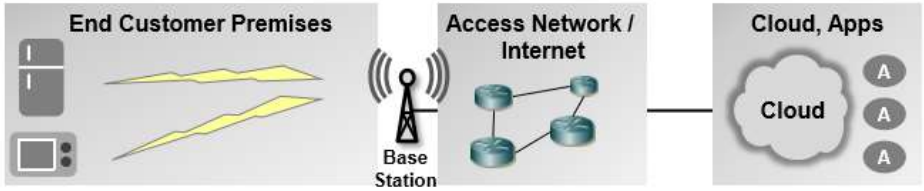
Short Range vs LPWAN

Short range radio connectivity for IoT devices:



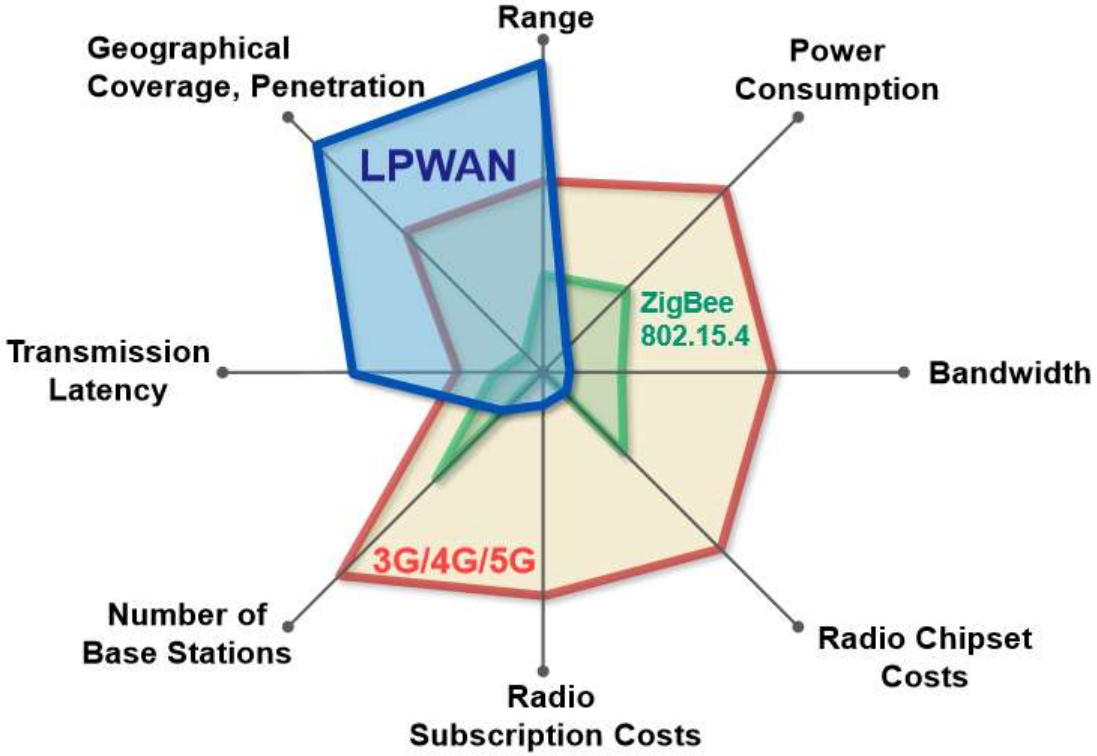
- Short range radio devices (SRD) such as ZigBee require using a gateway for long-range backhaul.
- The gateway is typically hooked up to some on-site wired network which is not under control of the IoT provider.

Direct long range connectivity (LPWAN) for IoT devices:



- Long range connectivity allows direct access to the devices in the field.
- The base station typically serves a large number of devices thus greatly reducing costs.

Ventajas y desventajas de las tecnologías



IoT necesita un standard abierto

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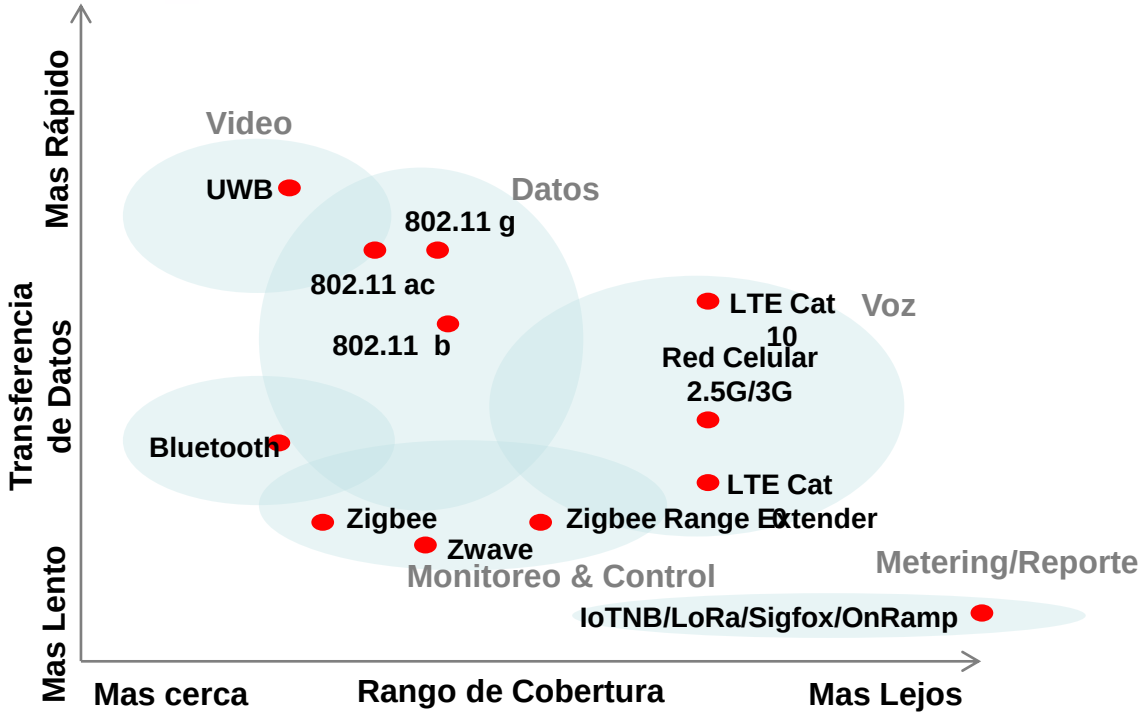
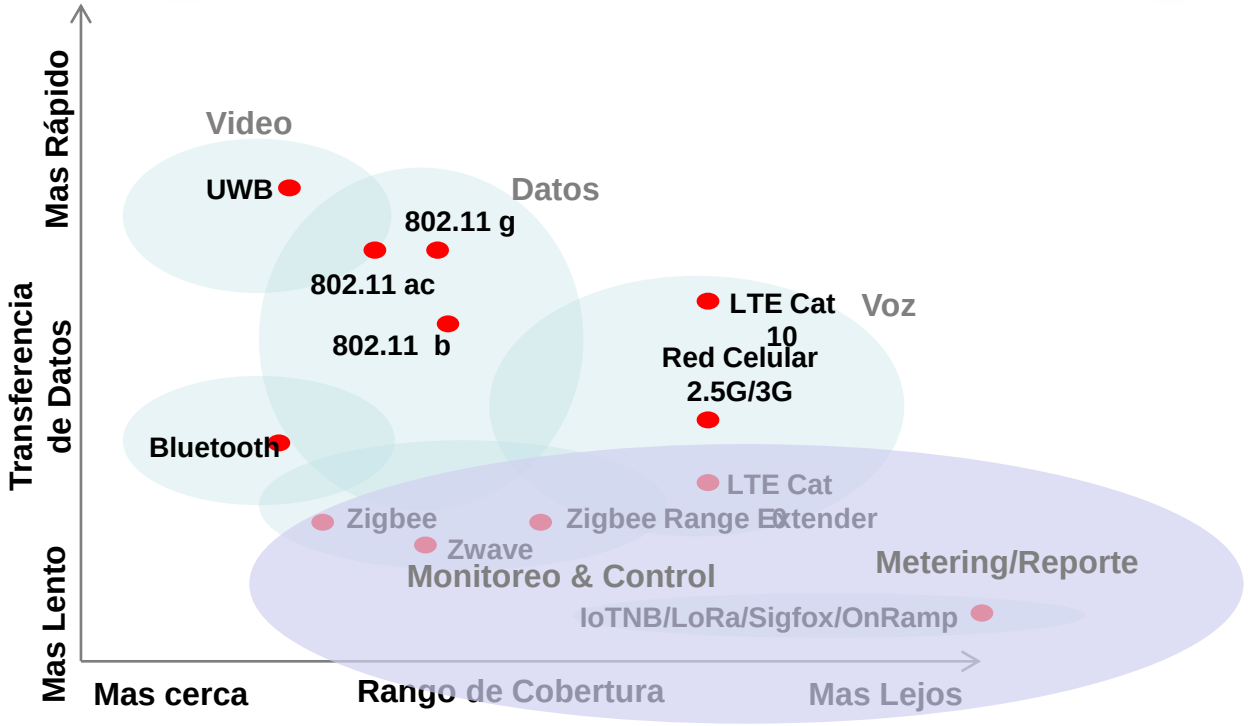
Mapa de Tecnologías Inalámbricas



UWB = Ultra Wide Band = <500MHz – 400Mbits/s

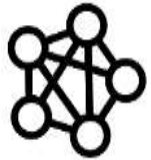
Mapa de Tecnologías Inalámbricas



UWB = Ultra Wide Band = <500MHz – 400Mbits/s

¿Zigbee?

- Soporte redes de mesh.
- Batería de larga duración.
- Baja latencia.
- Hasta 65.000 nodos por red.
- 128-bit AES de cifrado para las conexiones de datos seguras
- Solución de bajo coste.
- Estándar abierto para facilitar la interconectividad



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- Solución de bajo coste.
- Estándar abierto para facilitar la interconectividad

Muy Importante

Esto sigfica intercompatibilidad entre marcas…

WH-204	Themostat Control Unit HVAC (Zigbee)	
WH-206	Thermostat HVAC - 24VAC	
WH-222	Thermostat HVAC - 24VAC	
WH-254	Thermostat HVAC - 24VAC & Milivolts	
WH-211	Inwall ON/OFF Switch - 10 Amp High Power (220VAC)	
WH-212	Inwall Dimmer Switch for LED (220VAC)	
WH-213	Inwall Switch for Curtains and Roller Shutters (220VAC)	
WH-214	Open Close Sensor	

WH-215	Motion and Temperature Sensor	
WH-216	Temperature and Humidity Sensor	
WH-217	Water Leak Sensor	
WH-218	Electric Current Sensor (Up to 50 Amp with 3 Clamps	
WH-219	YRL Deadbolt Touchscreen	
WH-220	YRL Leaver Touchscreen	
WH-221	LED A19 Monochromatic Zigbee ZLL - 220VAC	
WH-222	LED Light A19 RGB Zigbee ZLL - 220VAC	

WH-223	LED PAR16 RGB Zigbee ZLL - 220VAC	
WH-224	LED Power Strip 3mts Zigbee ZLL - 220VAC	
WH-243	Light Bulb A19	
WH-226	Power Plug ON OFF	
WH-225	Power Plug Dimmer	
WH-228	Power Plug ON OFF Switch with Metering	
WH-229	Power Meter Relay Switch	
WH-232	Battery-Powered Light Switch	

Sin dependencia tecnologica…

WH-233	AC-Powered Light Switch	
WH-234	Roller Shutter Control (Motor Control)	
WH-235	Roller Shutter Control (for Shutters with Control Units)	
WH-228	Power Relay Switch	
WH-229	Power Meter Relay Switch	
WH-230	Power Dimmer Switch Series	
WH-231	Power Metering Dimmer Switch	
WH-208	Presence Tag (15mts)	

WH-236	Temperature and Humidity Sensor	
WH-237	Door Contact	
WH-238	Door Contact with Vibration Sensor	
WH-239	Motion Sensor	
WH-240	Smoke Detector	
WH-241	Carbon Monoxide Detector	
WH-244	Lamp Module Plug	
WH-245	Appliance Module Plug	

WH-242	AC-Powered Indoor Siren	
WH-253	Battery-Powered Indoor Sierne	
WH-249	Relay Controller 5V	
WH-250	Relay Controller 12-24V	
WH-251	ZigBee Relay Controller 110-230VAC	
WH-252	Outdoor Bell Box	
WH-246	DIN Rail Power Meter Switch	
WH-210	Infrared Emmiter (IR)	

Ni desarrollo de parches o modificaciones de Software para soporte de nuevos productos…

WH-247	Thermostatic Radiator Valve	
WH-248	Light Switch-3Way Switch (US)	
WH-249	Circular Lamp	
WH-250	White Garden Lights (nine IP66 bulbs)	
WH-251	RGB Garden Lights (nine IP66 bulbs)	
WH-252	Spot White	
WH-253	Surface Spot	
WH-254	RGBW Flex	

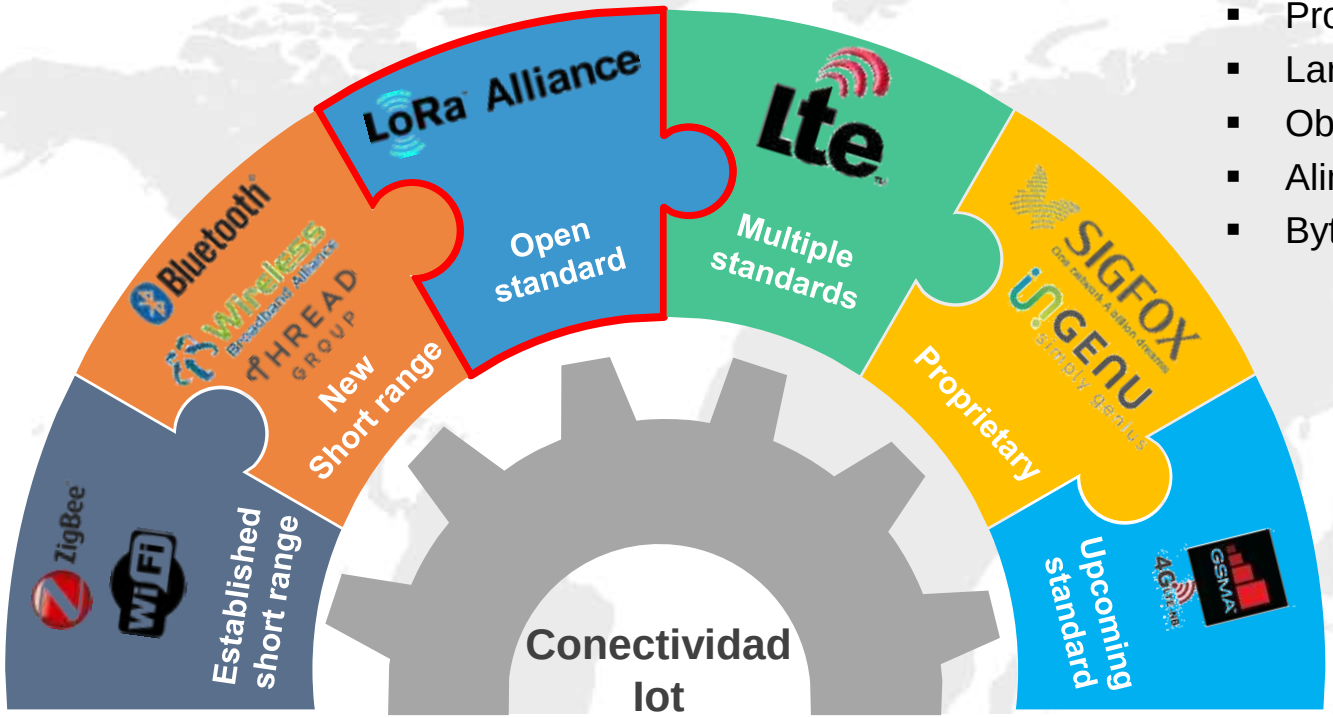
WH-255	Classic A White	
WH-256	Classic A RGB	
WH-257	Classic A 60	
WH-258	Classic B	
WH-259	PAR White	
WH-260	PAR RGBW	
WH-258	Boton a Baterias	
WH-259	Switch Mecanico	

WH-255	Sensor de Apertura y Cierre Compacto	
WH-256	Sensor de Movimiento Compacto	
WH-257	Luz de Noche y Router con Bateria (Enchufe tipo Americano)	
WH-258	Apertura y cierre de Garage	
WH-259	Tecla Pared Inalambrica	

Products with WiFi & Zigbee PRO HA Connectivity

WH-102	WeHaus Hub - Zigbee PRO HA 1.2 - Wifi b/g/n - Plastic Case	
WH-103	WeHaus Hub - Zigbee PRO HA 1.2 - Wifi b/g/n (2) - Aluminium Case	

IoT necesita un standard abierto



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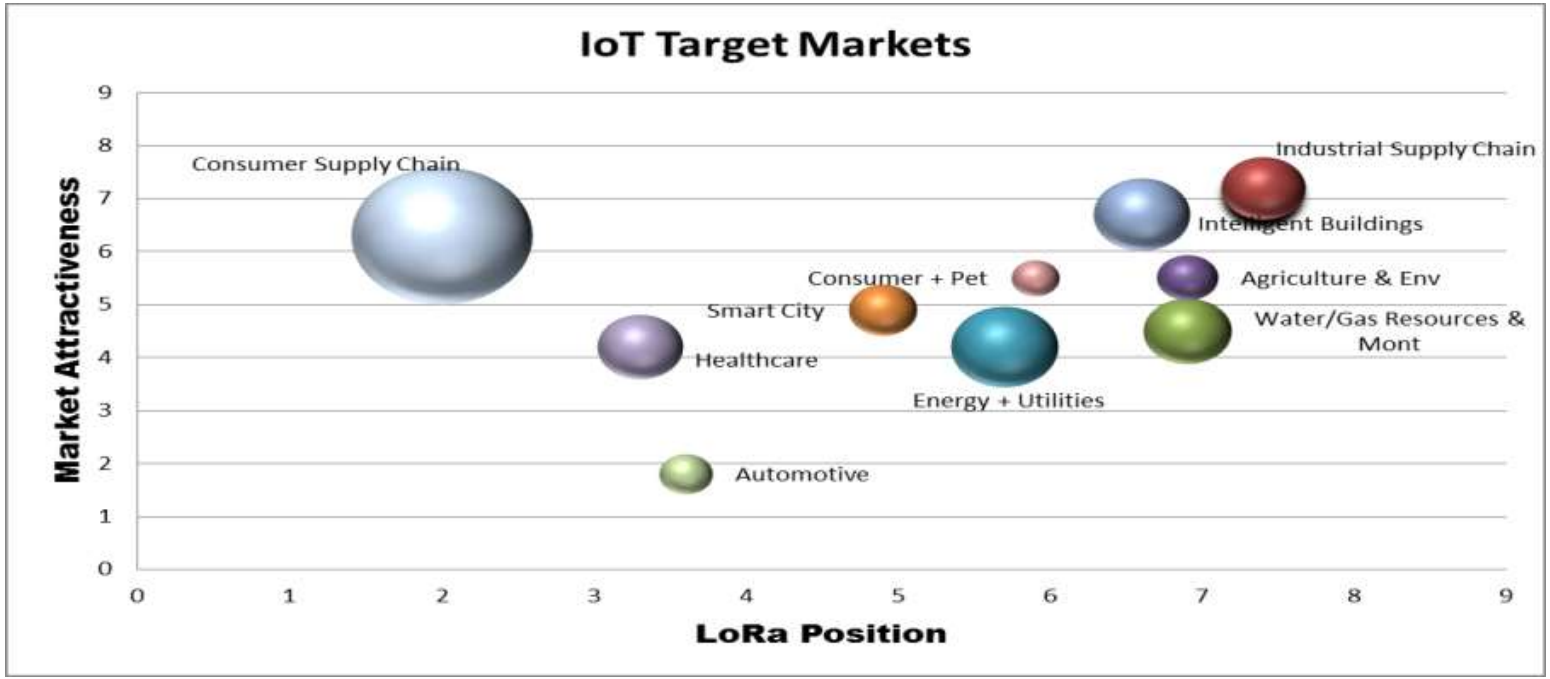
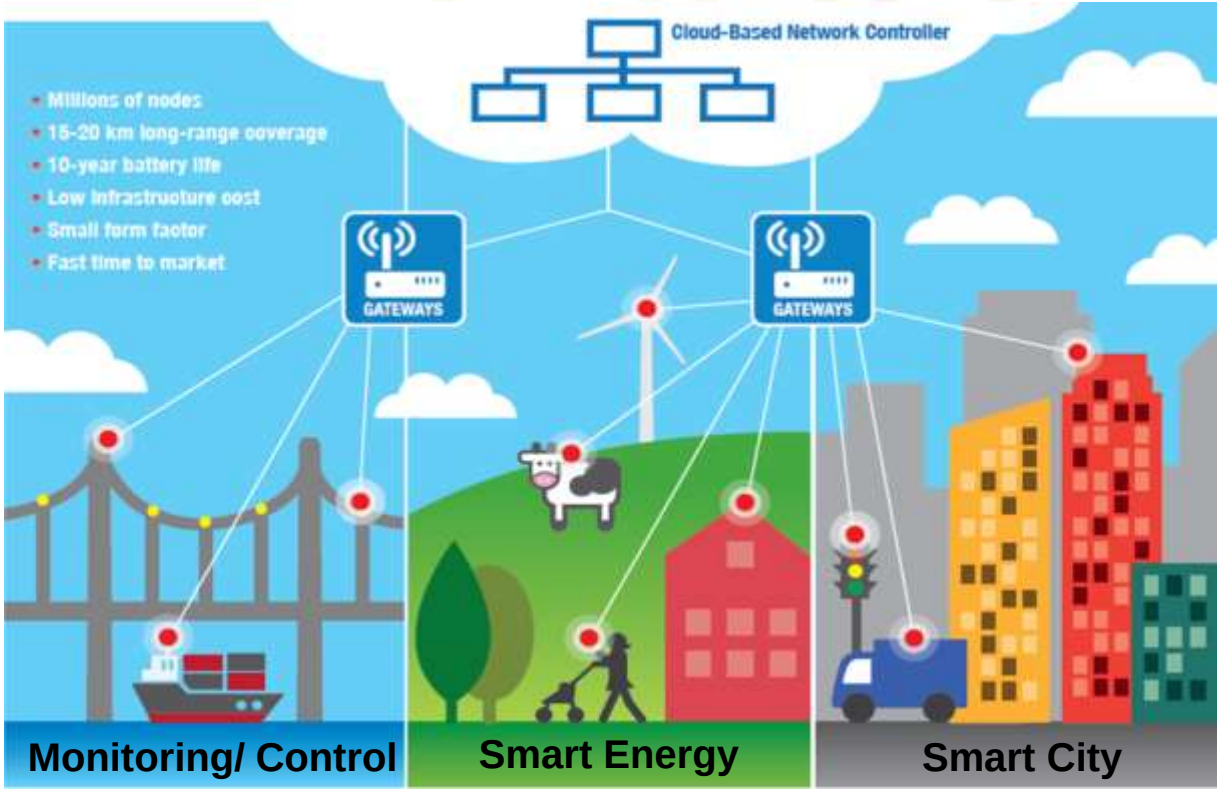
Vertical Positioning

- Size of bubble indicates size of market

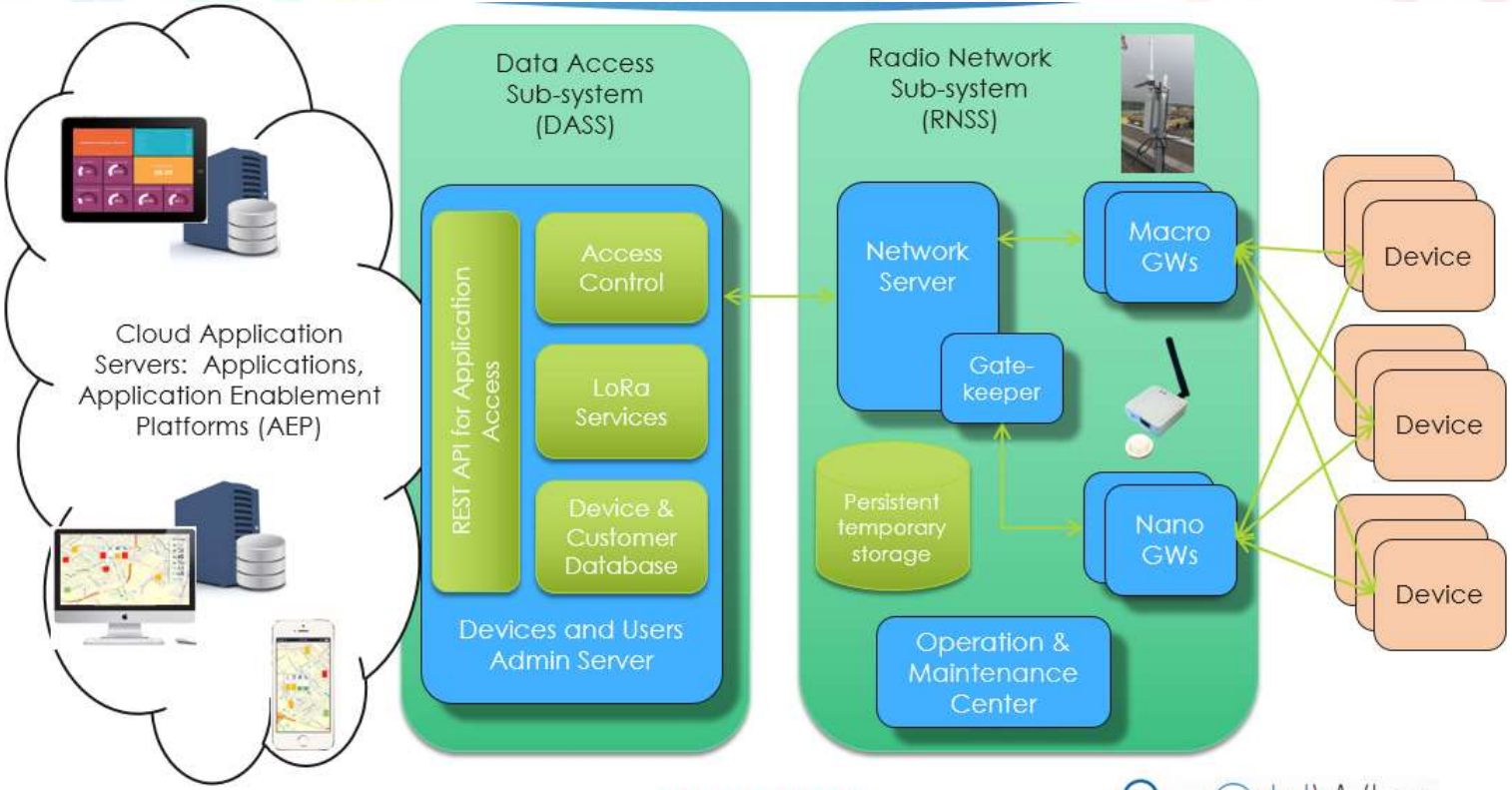


Microchip LoRa ™ Technology IoT



Light Control **Smart Agriculture** Smart Home and Security

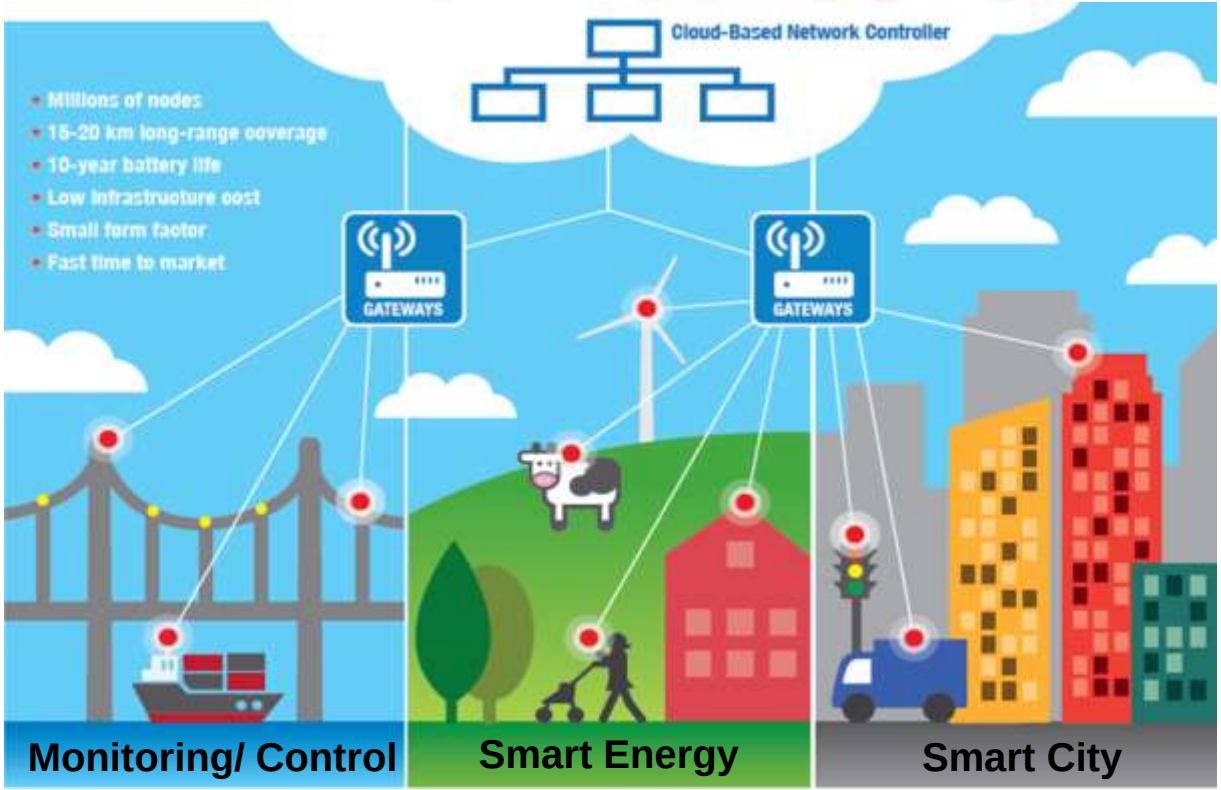
El Network Server



CONFIDENTIAL

OrbiWise

Microchip LoRa ™ Technology IoT



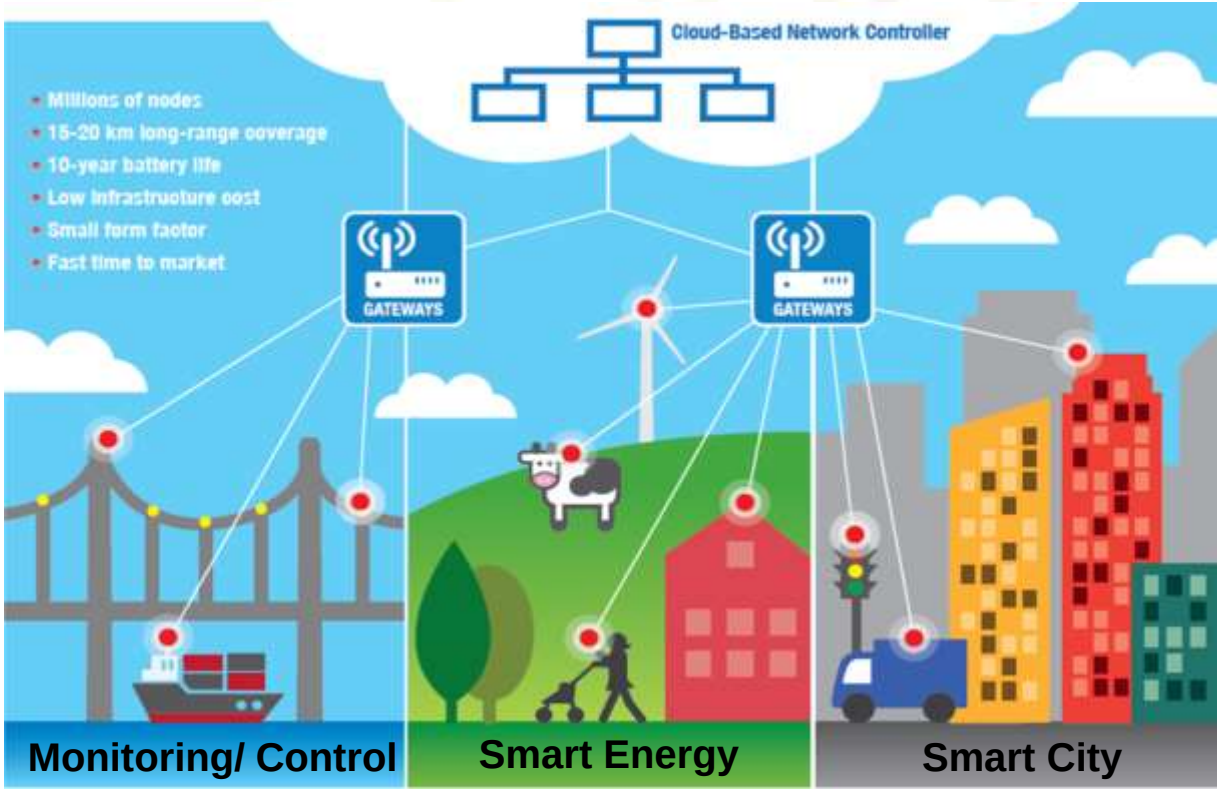
Light Control **Smart Agriculture** Smart Home and Security

El Gateway

Wirnet Station

- ➔ **Pioneer. First LoRa™ Gateway in the market.**
  - Industrialized since February 2014
  - More than 5000 units produced.
- ➔ **Exclusive features**
  - Specific saw filters in order to limit impact of LTE
  - Real time radio scanning
  - ERP up to 27dBm for EU, 30dBm for US & Asia
  - Natively rugged & outdoor
- ➔ **4 versions : 433/868/915/923 MHz**
  - certified CE/FCC/IC/KC (and a lot of CB schemes)
- ➔ **Compatible with all Core Network providers :**
  - Actility, IBM, Loriot, Orbiwise, Stream Technologies, The Things Network, …

Microchip LoRa ™ Technology IoT



Light Control **Smart Agriculture** Smart Home and Security

El End Device

IR868LR

PB868LR

CM868LR

CO868LR

What is LoRa™ Technology?

A combination of two major concepts:

- **LoRa™ spread spectrum modulation**
  - Provides the core long range capability
    Up to 5km range in urban environment, **up to 15km suburban**
  - Developed by Semtech, built in to SX127x transceivers
  - SX1301 gateway baseband allows multiple receive channels
- **LoRaWAN™ network protocol stack**
  - Provides the cellular network (aka large-star topology)
  - Defined by IBM & Actility, made open by the LoRa™ Alliance
  - Promotes a subscription-based business model
  - Microchip developed/owns/maintains LoRaWAN for our end-node and aims to become the “golden” node

What is LoRa™ Technology?

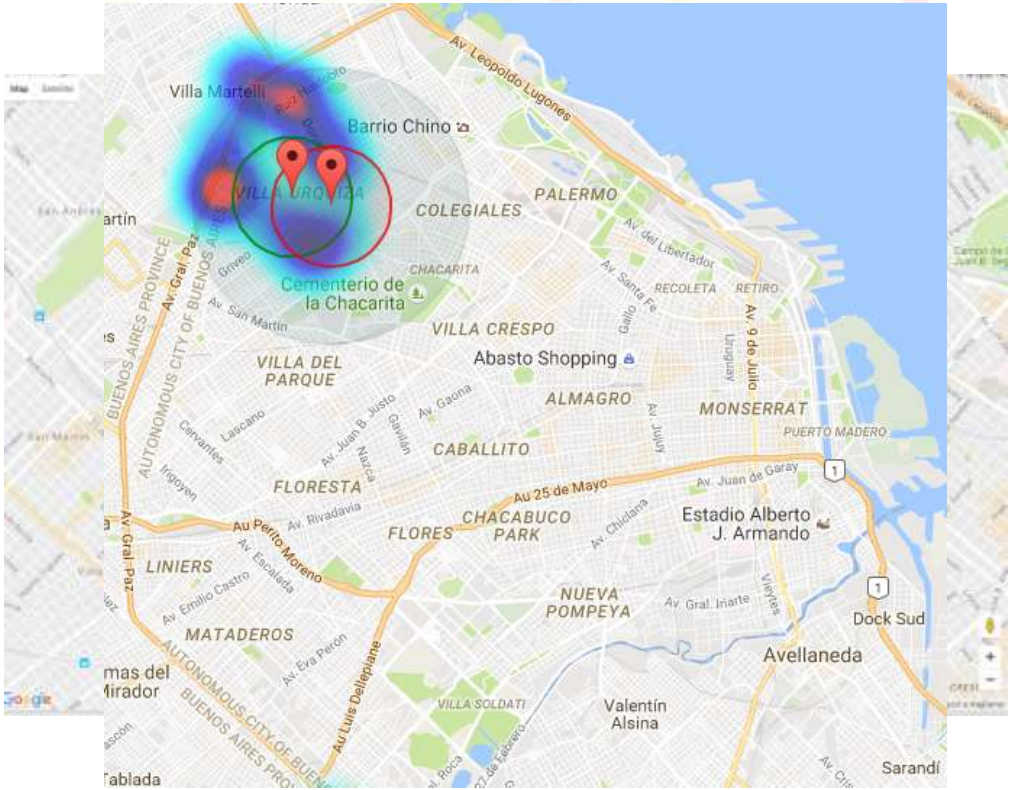
- **A long-range and low-power sub-GHz modulation**
  At +14dbm output power, 868MHz:
  - **Up to 5km range in urban environment, up to 15km suburban**
  - **>10 year battery life capability**
- **Provides robust communication links**
  - **Not susceptible to interference from Wi-Fi, Bluetooth, GSM, LTE, etc**
- **Spread Spectrum gives improved capacity**
  - **Connect more nodes, 100k to 300k nodes**
- **High accuracy localization and ranging capability (future feature)**
  - **Modulation format permits high accuracy localization**
  - **Not RSSI based and accounts for multi-path and fading**
  - **Permits high value additional features**

LoRa™ Coverage Test

Longest Range Coverage !

- ❑ Coverage map from a single gateway/concentrator located on Cisco Webex building in San Jose
- ❑ >20miles to San Bruno
- ❑ A conservative 1 mile radius allows for in-building penetration even at the edges
- ❑ 7 Gateways cover all of lower Manhattan

Medicion en CABA



What is LoRaWAN™ Protocol?

(WAN = Wide Area Network)

- A Bi-directional, Secured, Cellular Network
- Designed for low data-rate (~100bps), low duty-cycle (~10mins), high capacity (~100k nodes) & long battery life (~10yrs)
- Developed, maintained and promoted by the LoRa™ Alliance
- Microchip is a founder member and sits on Strategic, Marketing & Technical committees
- Microchip developed own end-node implementation

True Location

- In/out door
- Accurate

Bidirectional

- Bidirectional
- Scalable Capacity
- Broadcast

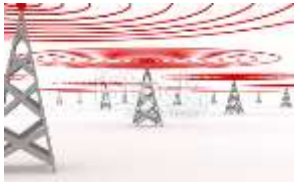
Global Mobility

- True Mobility
- Seamless
- Roaming

Security

- Unique ID
- Application Key
- Network Key

LoRaWAN™ Network Features



Long Range

- ✓ Greater than cellular
- ✓ Deep indoor coverage
- ✓ Star architecture

Max Lifetime

- ✓ Low power optimized
- ✓ 10-20yr lifetime
- ✓ 10x vs cellular

Multi-usage

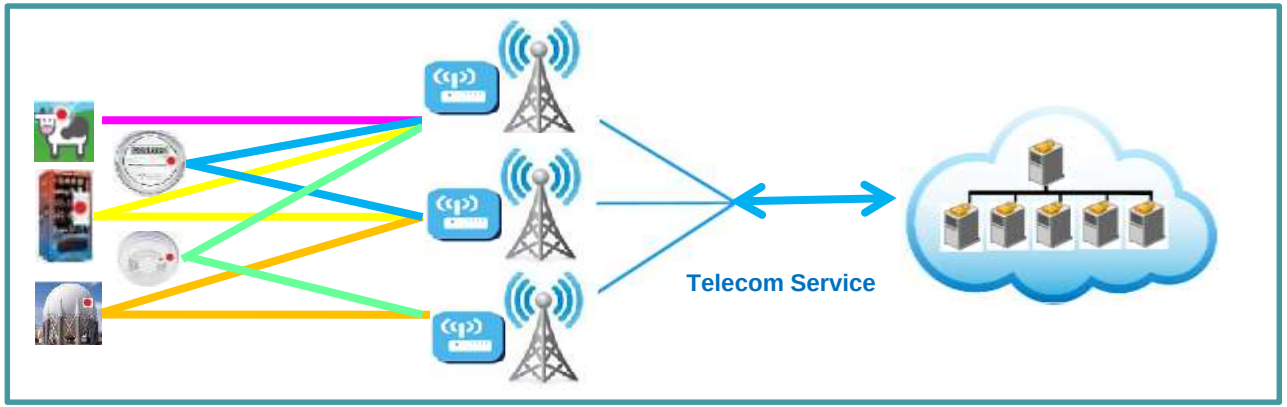
- ✓ High capacity
- ✓ Public network

Low Cost

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

LoRaWAN™ Infrastructure

- **Private network**
  - **Individually managed networks**



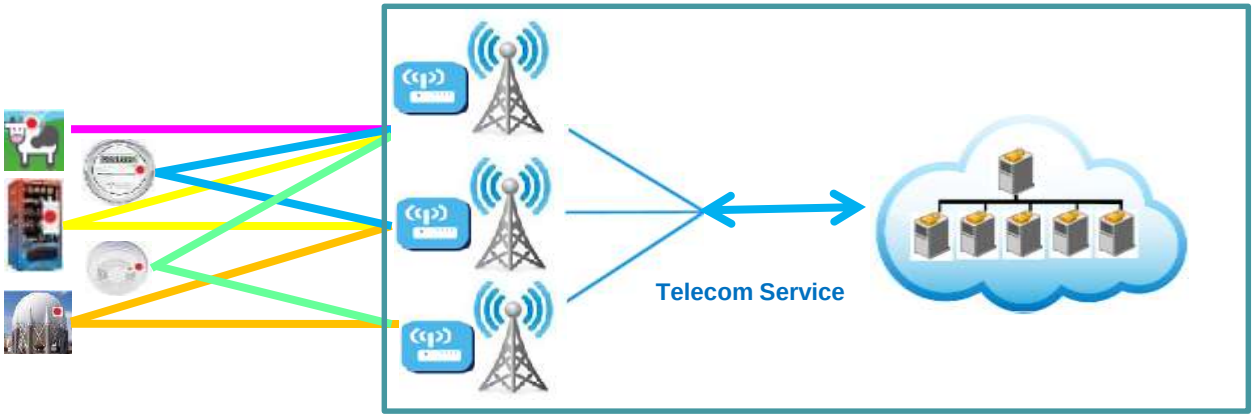
Microchip LoRaWAN™ Modem

Private LoRaWAN™ Gateway

Private Network Server

LoRaWAN™ Infrastructure

- **Public network**
  - Telecom/operator managed networks and gateway



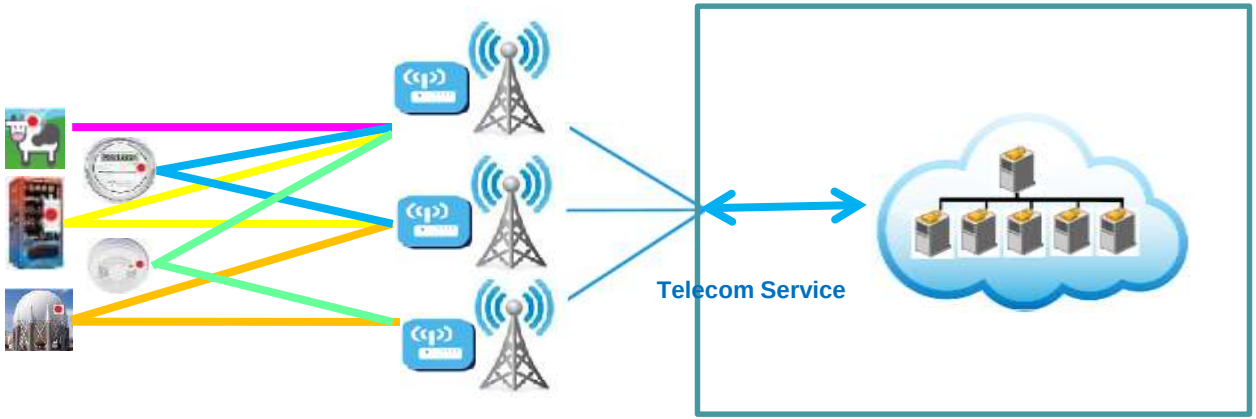
Microchip LoRaWAN™ Modem

Telecom/Operator "Public" LoRaWAN™ Gateway

Telecom/Operator Network Server

LoRaWAN™ Infrastructure

- **Public/Private Hybrid network**
  - Telecom/operator managed server with private gateway



Case Study: Senet (USA)

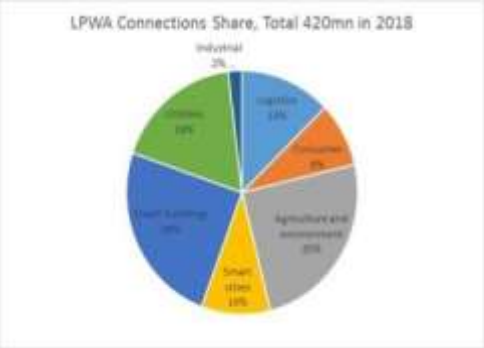
- **A single business case was enough to justify building a private LoRaWAN network**
  - Heating fuel (propane) delivery to residential properties
  - Previously inefficient – were filling cautiously when still 50% full
  - Adding cloud-connected level sensor reduces 2 to 3 deliveries / year
  - Also creates customer interaction, fuel level data is viewable online
  - Looked at cellular (too power hungry) and WiFi (intrusive to customer's network) but found LoRaWAN to be the best solution
- **Once established, Senet is able to open this LoRaWAN network as a public service**
  - **Multi-tenant business model further improves revenue and ROI**
  - **Expands network, improves density & capacity**
  - **'Almost instant' availability of a public network**

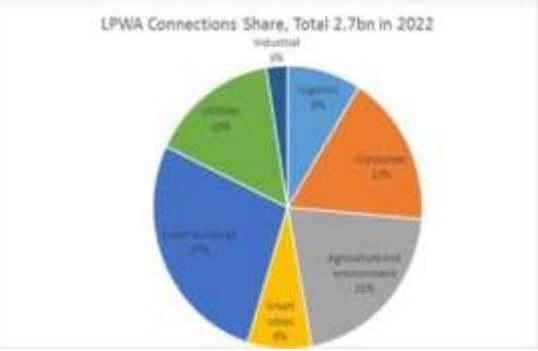
Technology Comparison Summary

Feature	LoRaWAN	Narrow-Band	LTE Cat-1 2016 (Rel12)	LTE Cat-M	NB-LTE
Modulation	SS Chirp	UNB / GFSK/BPSK	OFDMA	OFDMA	OFDMA
Rx bandwidth	500 - 125 KHz	100 Hz	20 MHz	20 - 1.4 MHz	200 KHz
Data Rate	290bps - 50Kbps	100 bit/sec 12 / 8 bytes Max	10 Mbit/sec	200kbps – 1Mbps	~20K bit/sec
Max. # Msgs/day	Unlimited	UL: 140 msgs/day	Unlimited	Unlimited	Unlimited
Max Output Power	20 dBm	20 dBm	23 - 46 dBm	23/30 dBm	20 dBm
Link Budget	154 dB	151 dB	130 dB+	146 dB	150 dB
Batery lifetime - 2000mAh	105 months	90 months		18 months	
Power Efficiency	Very High	Very High	Low	Medium	Med high
Interference immunity	Very high	Low	Medium	Medium	Low
Coexistence	Yes	No	Yes	Yes	No
Security	Yes	No	Yes	Yes	Yes
Mobility / localization	Yes	Limited mobility, No loc	Mobility	Mobility	Limited Mobility No Loc

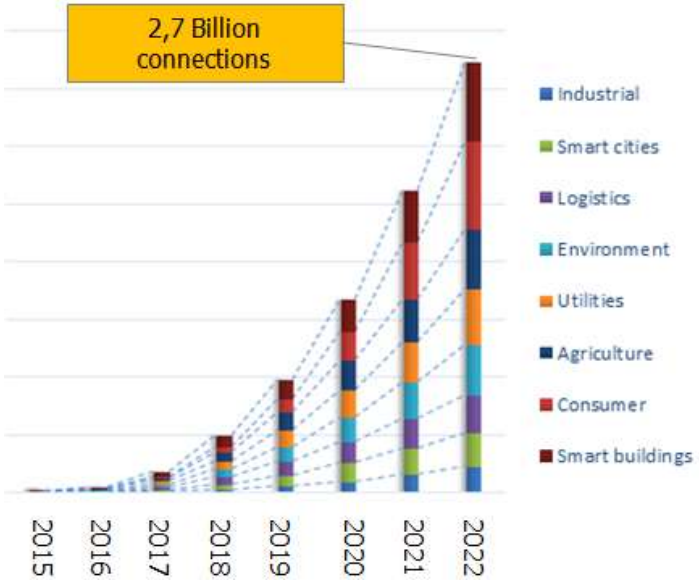
LPWAN Market Size & Focus

- **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



What is LoRa?

Application	App
MAC Protocol	LoRaWAN
PHY	LoRa

LoRa Gateway

Range >cellular at fraction of power

Long Range RFIC

= 5-10 year battery life
= 5x lower sensor cost than cellular
= Low cost basestations (<$100 to $2500)
= Rapid time to market
= Mobile objects
= Geolocation w/o GPS

Open LoRa®

No Frequency License

No IP License

- **LoRa® PHY**
  - Semtech developed
  - Multiple sources available
    - Semtech
    - Microchip

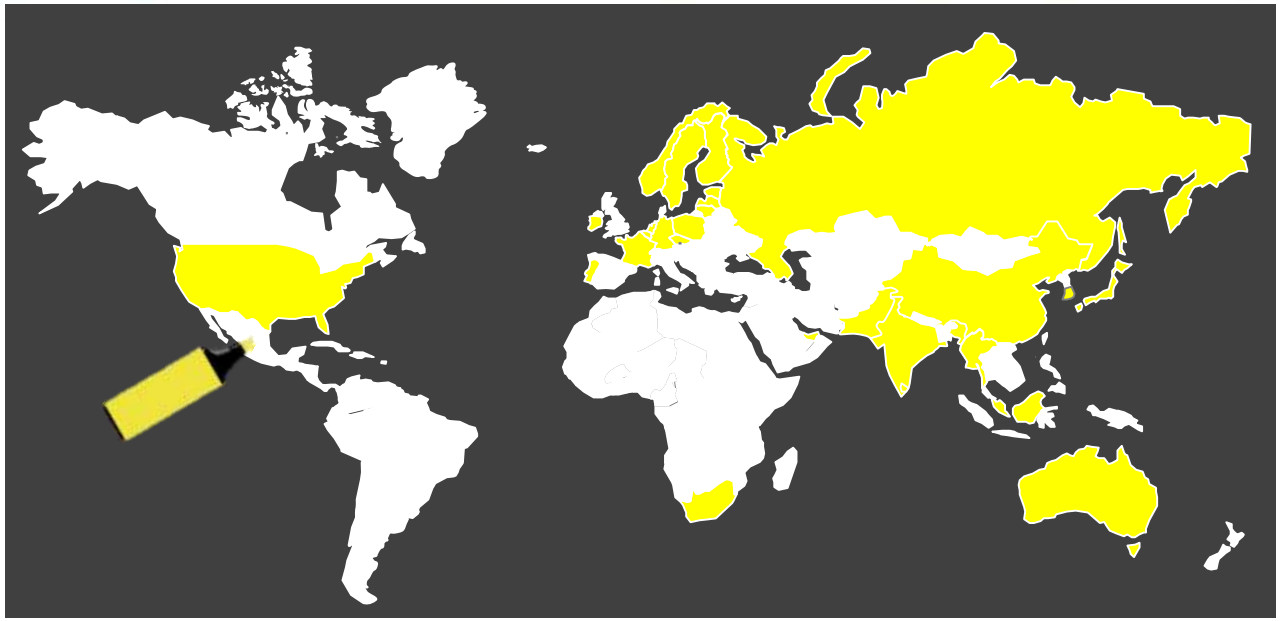
  - Available in frequency bands from 400MHz through 1GHz
- **LoRaWAN™**
  - **Open** standard maintained by the LoRa Alliance
  - Defines frequency band usage by country, security, device classes, protocol, etc
  - Supported by a broad ecosystem
- **Applications**
  - Can be developed independently and run over any connectivity infrastructure as part of an integrated solution incorporating many technologies.

LoRa Alliance™

- **Open & Non-Profit**
- **Founded: March-2015**
- **Board**
  - IBM, Cisco, Bouygues, KPN, Orange, Semtech, Proximus, ZTE, ST, Actility, Kerlink,Agutek, Homerider
- **Chairman**
  - Geoff Mulligan
- **Committees**
  - **Technical:** Nicolas Sornin, Semtech
  - **Marketing:** Tracy Hopkins, EveryNet
  - **Strategy:** Stephen Caldwell, Microchip
  - **Certification:** Derek Hunt, Actility
- **Member Status**
  - 400+

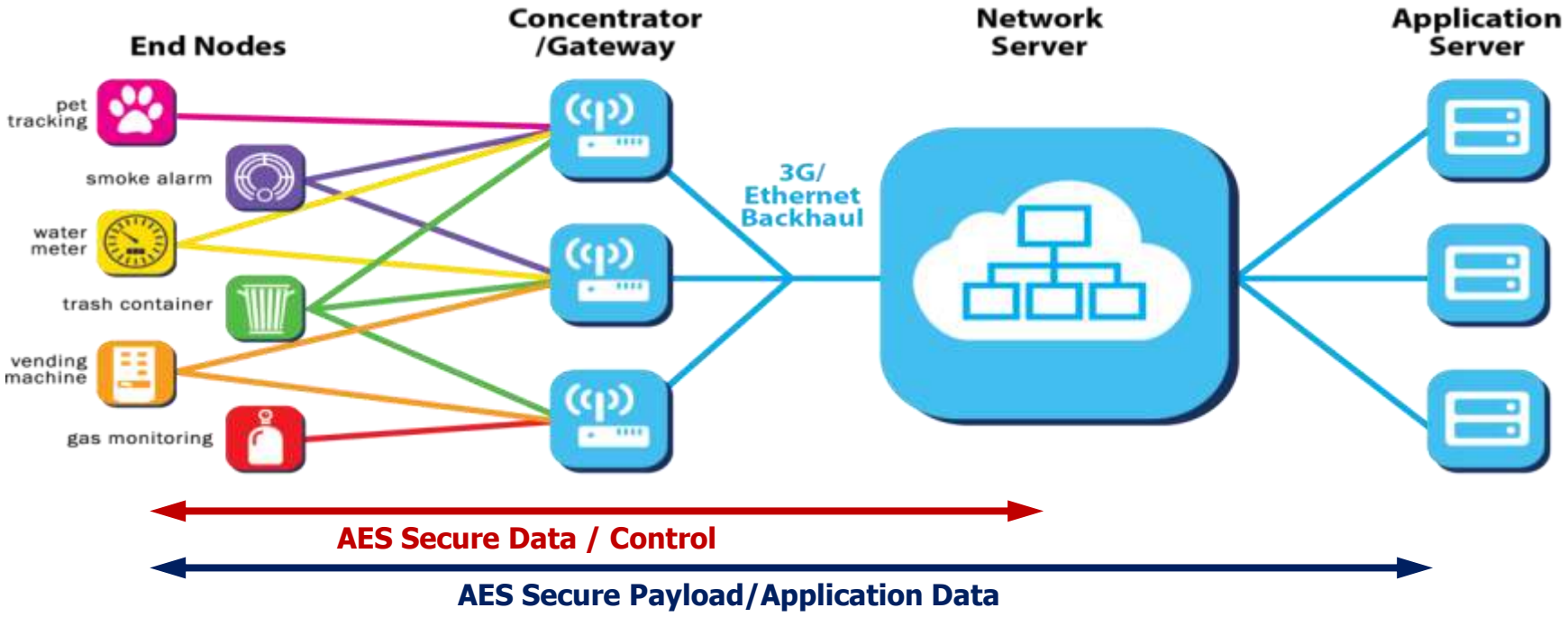
Turning the World YELLOW,

Public Network Operators



- 16 announced Public Operator (MNO) IoT deployments
- 56 on-going operator trials
- 400+ members in the Alliance

LoRaWAN™ Network Concept



Gateway and Deployment Models

Picocell Gateway

Features	
Price	$50-100
Backhaul	Ethernet only
Options	minimal

Industrial Gateway

Features	
Price	$250-400
Backhaul	Eth, cellular, WiFi
Options	configurable

Tower-top Gateway

Features	
Price	$1000-2000
Backhaul	Eth, cell, sat, fiber
Options	IP 67/68, lighting, batt

Multiple Sourcing On Every Level

SX127X family

Transceiver

SEMTECH

life.augmented

MICROCHIP

Modules

imst

MICROCHIP

MultiTech Systems

FOXCONN

Sensors

BOSCH

Schneider Electric

HOMERIDER SYSTEMS

Base Station

Gemtek

CISCO

SAGEMCOM

kerlink

MultiTech Systems

Network Server

IBM

actility

OrbiWise

SAGEMCOM

digi mondo

stream

LORIOT

Application Server

IBM

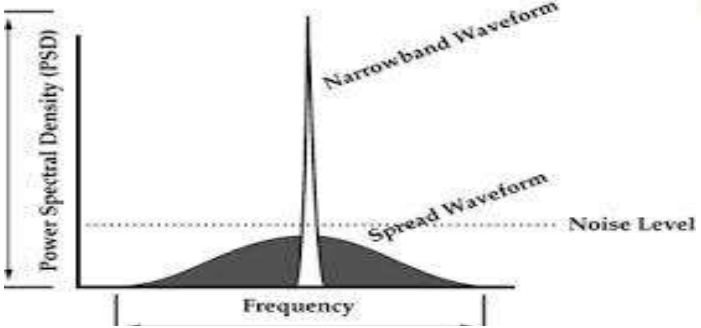
LEROY MERLIN

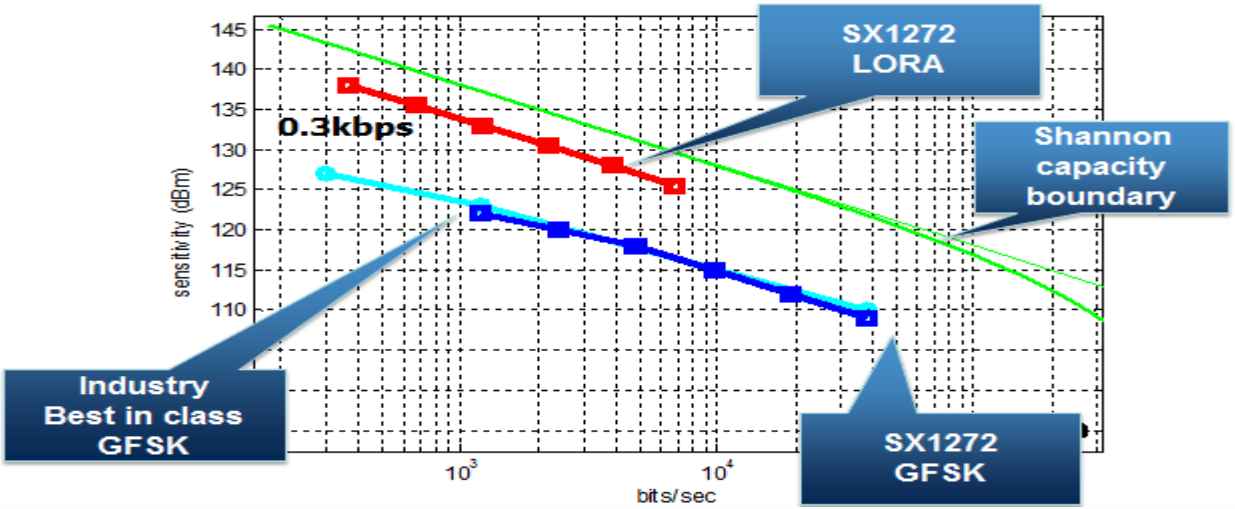
WIPRO
Applying Thought

digi mondo

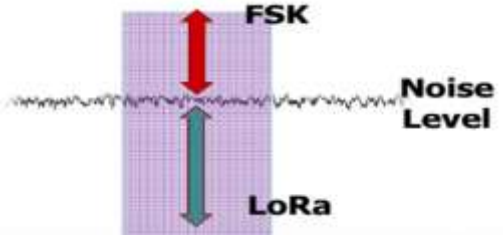
amazon webservices

LoRa® PHY: Spread Spectrum Modulation

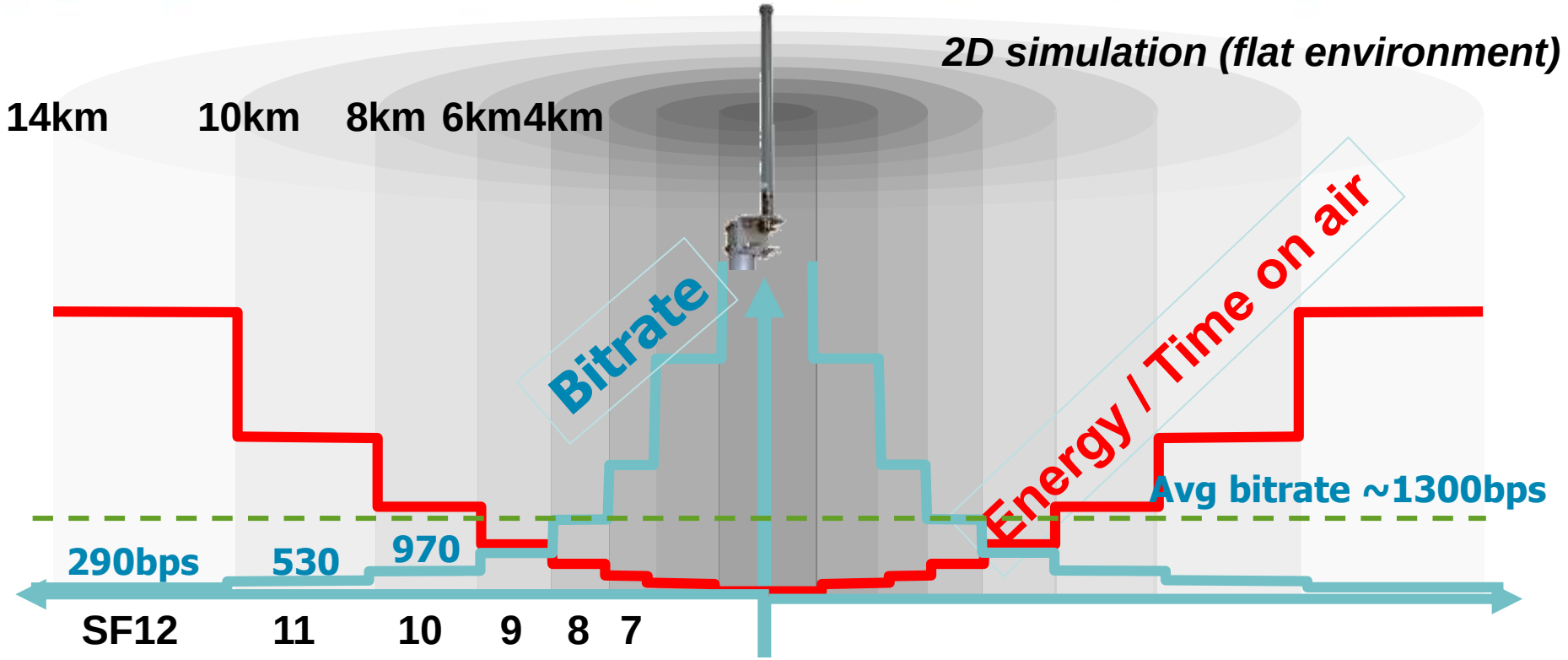




-132dBm @ 1 kbps
No TCXO
No LNA



Fully Bi-directional:
Adaptive Data Rate (ADR)

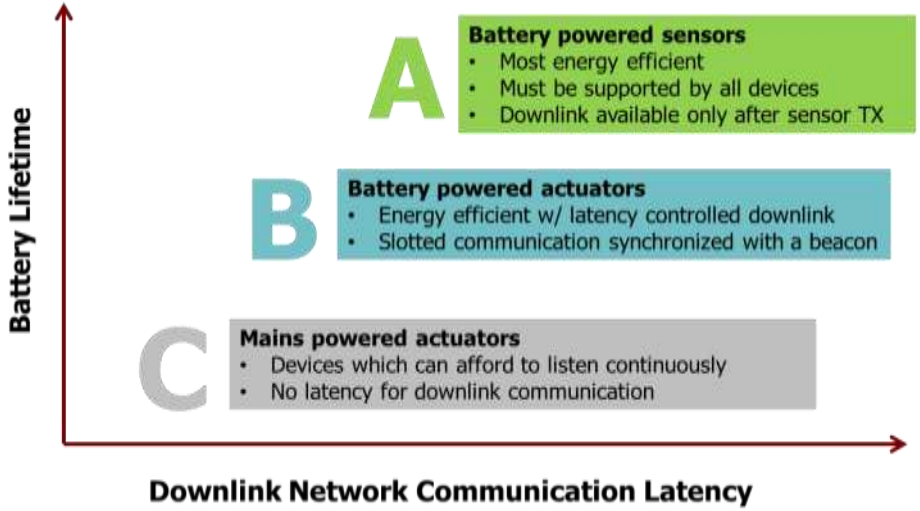


Device Classes & Examples

Class A: Smart City
Report status a few times per day
No planned actuation required
Extremely low energy

Class B: Irrigation
Turn valves on or off
with a few minutes latency

Class C: Smart Lighting
Constantly listens for network «ping»
for low-latency actuation



Geolocation Competitive Advantages

❑ Lowest possible power

- No processing of location in the sensor (no GNSS receiver, CPU)
- No ‘time on air’ required to transmit the location data
- Location possible with the smallest possible LoRaWAN packet

❑ Lowest possible cost

- No GNSS (or other hardware) in the sensor
- Smaller battery as no sensor power used in getting location
- Smallest size (electronics, battery, enclosure)

❑ Lowest environmental impact

- Sensor hardware is minimised (electronics, battery, case size etc.)
- Many sensors will be fitted with lifetime battery

¿Preguntas?

¡Gracias!