Making Things Smart

Making Things Smart

Un nouveau standard pour les réseaux bas débits LPWA de collecte de données multi-fluides pour les Smart-Cities

AGENDA

- Introduction to LPWA
- Use cases
- Technology overview
- The ecosystem

Low-power RF : A new option for M2M

- M2M conquers new domains !

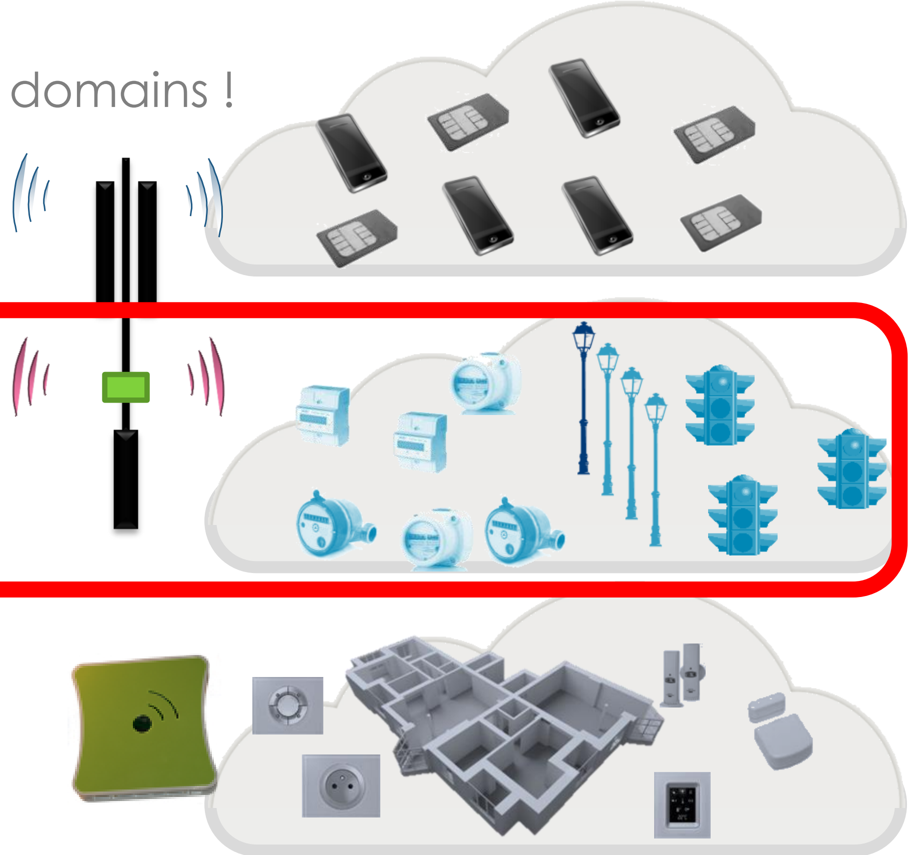
B2B

Mobile Broadband
(Mobile, SIM Card)

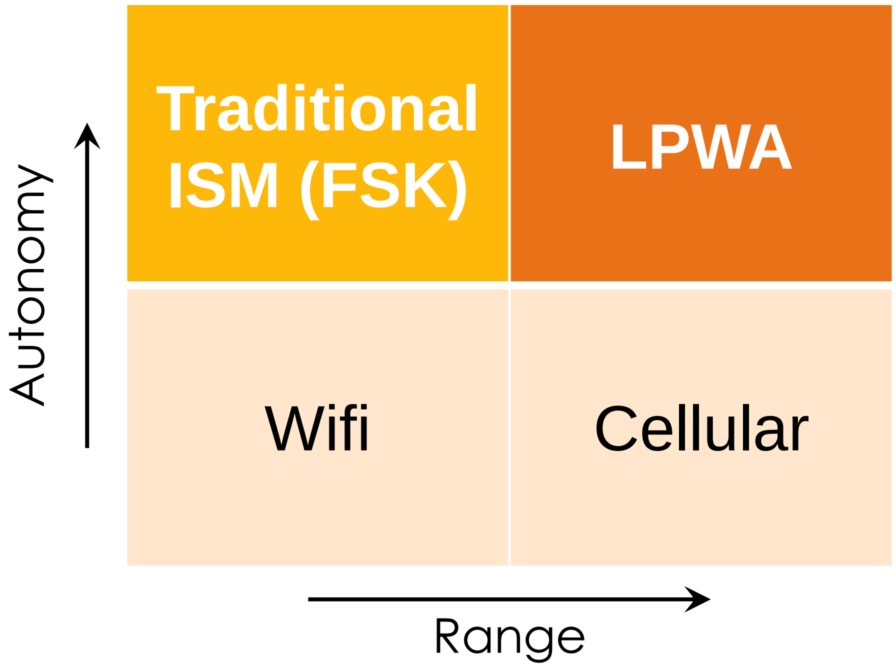
Low Power RF
(Smart metering, Smart city…)

B2B2C
B2C

Fixed Broadband
(Security, Confort, Safety…)

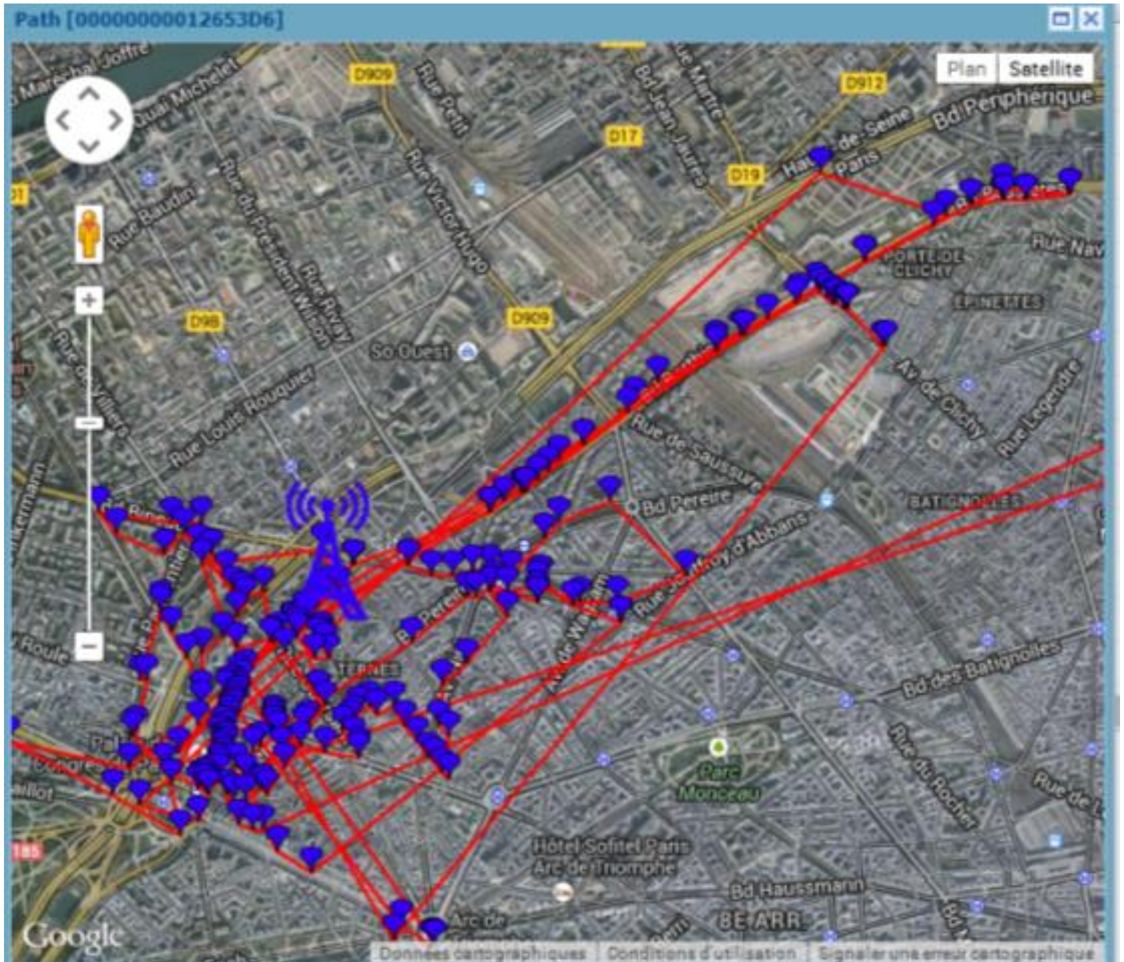


Positioning.



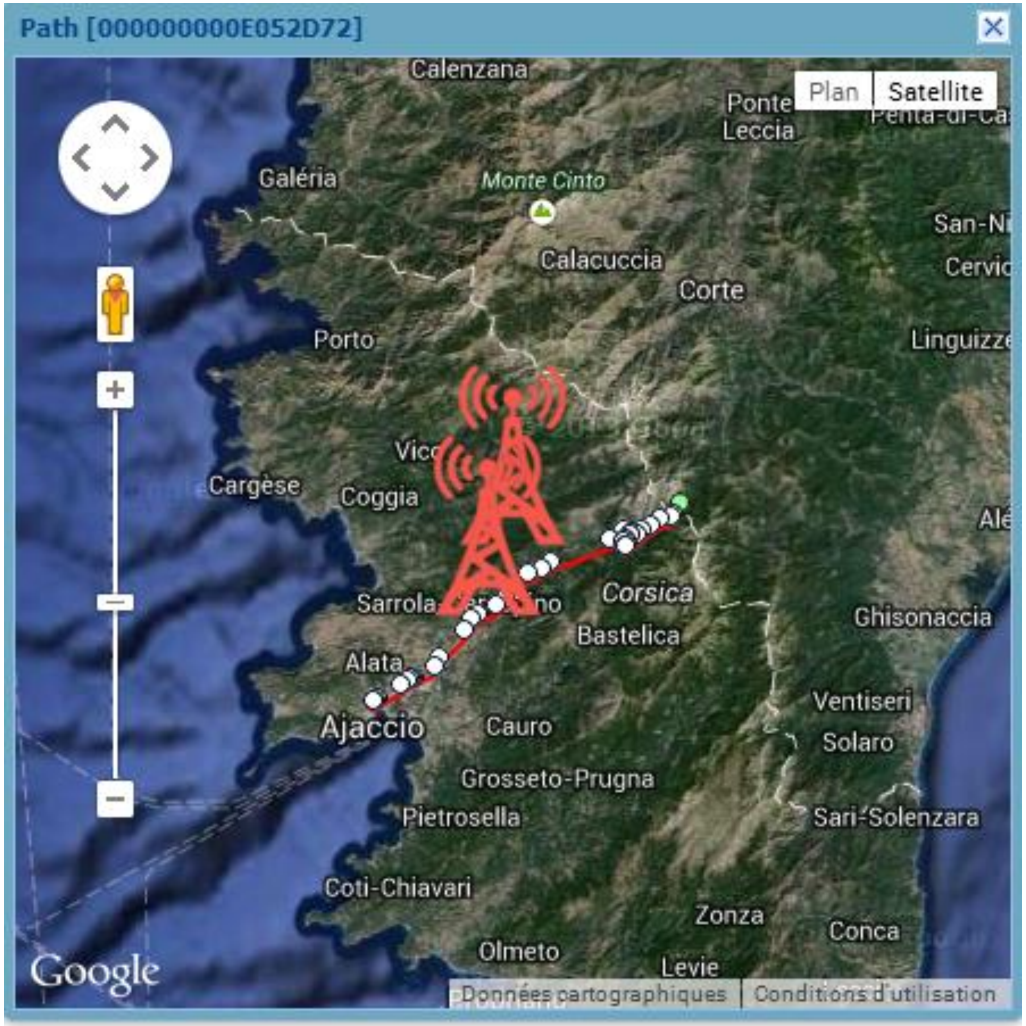
Ultra long range over unlicensed spectrum optimized for **battery powered** sensors and actuators.

Typical range : dense city



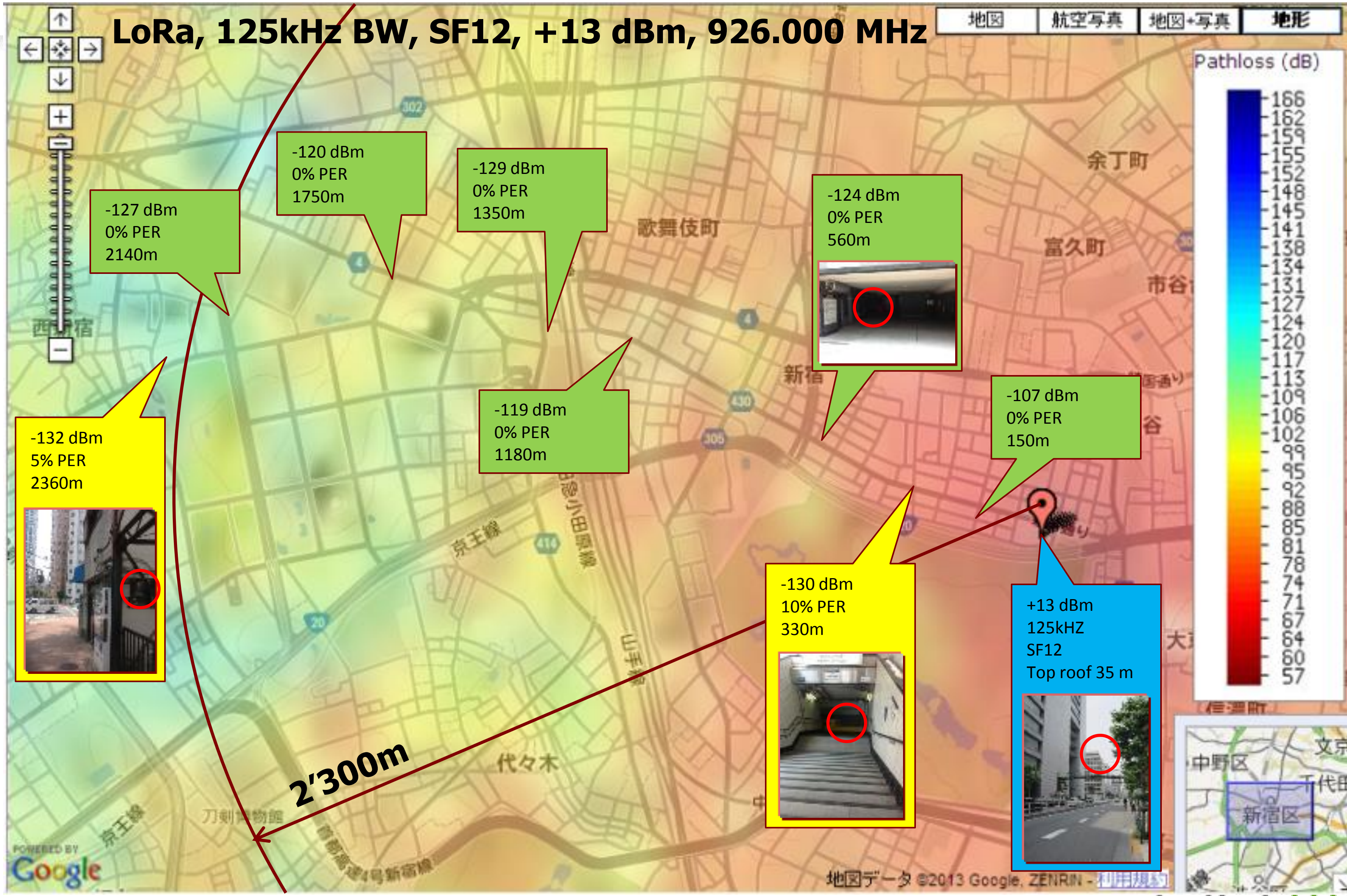
- **8th floor of building**
- **facing NE, omni antenna 30cm**
- **Noise level >-110dBm**
- 3km NE in directions where antenna is above mean rooftop level
- 1km NE in directions where antenna is about 10m below roof level
- About 600m behind and on sides of building (shielding by Base station building)

Typical range : rural area with hills



- 20m high telecom pole
- Omnidirectional antenna 30cm
  - 18km in directions where antenna is above mean hill level

LoRa Range Test – Shinjuku, Tokyo



LoRa Alliance

kerlink · cisco · actility Making Things Smart · SEMTECH · IBM · imst

MultiTech Systems · Microchip · éolane · Sagemcom

Bouygues Telecom · swisscom · proximus · kpn · SingTel · FastNet

Membership

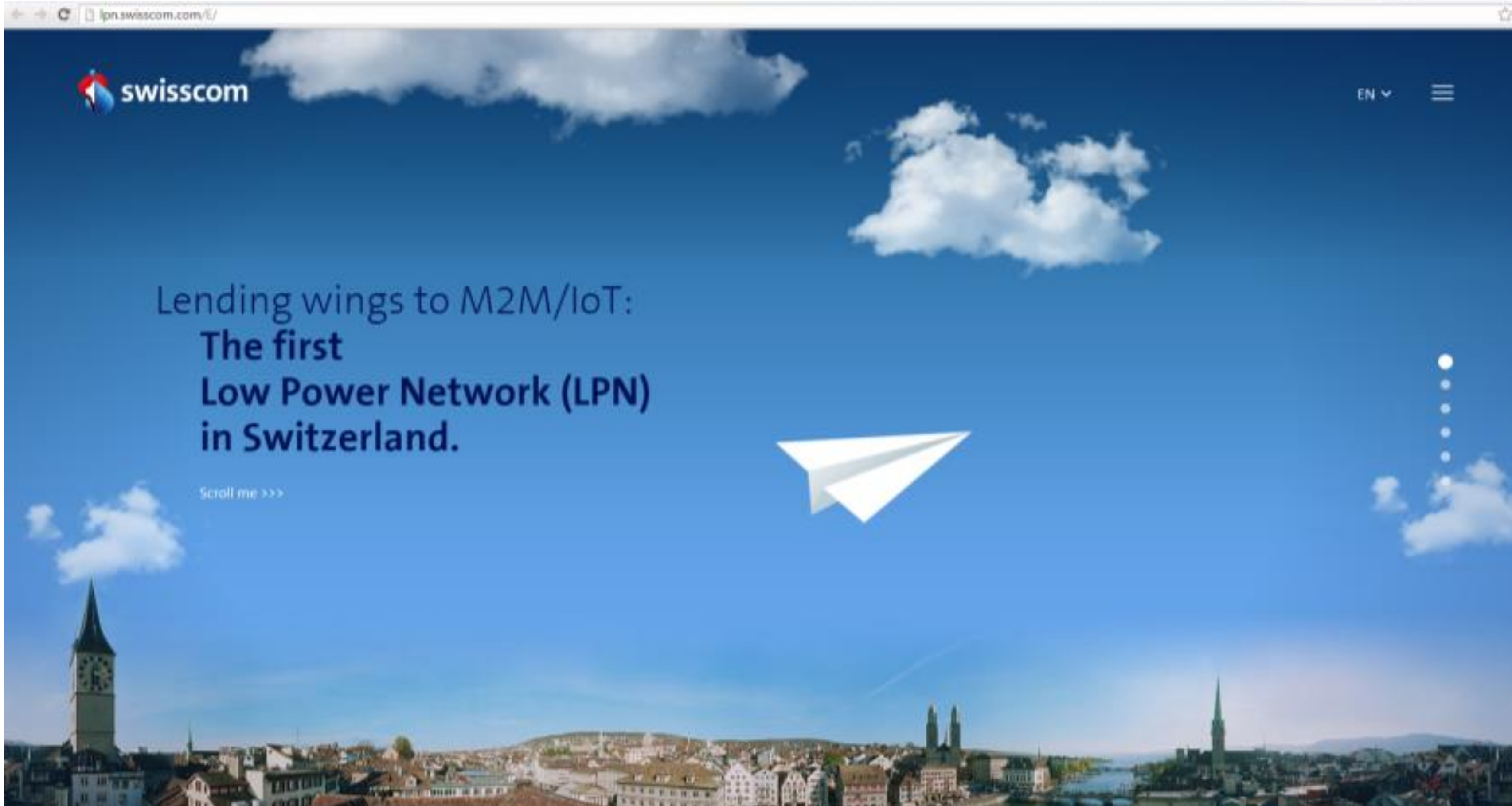
LoRa Alliance Membership rights	Sponsor ($50k)	Contributor ($20k)	Adopter ($3k)
The right to request Board of Director seat	x		
The right to submit Alliance Deliverables for final approval by the Board Of Directors;	x		
The right to access Alliance operational data	x		
The right to initiate, participate in, vote and chair Committees;	x		
The right to initiate, participate in, vote and chair Work Groups;	x	x	
The right to contribute to Draft Deliverables and access Final Deliverables (1)	x	x	
The right to participation in press articles & interviews	x	x	
The right to certify Compliant Products	x	x	x
The right to use Alliance and/or Certification Logo on certified products	x	x	x
The right to access to members only website	x	x	x
The right to participate in general or annual meetings	x	x	x
The right to receive Alliance communications	x	x	x
The access Final Deliverables (1)	x	x	x

LoRa™ Alliance
Member

LoRa Alliance and standardization

- ETSI LTN (Low Throughput Network)
- 3GPP GERAN
  - GSM Edge Radio Access Network
- GSMA
- IEEE

Swisscom



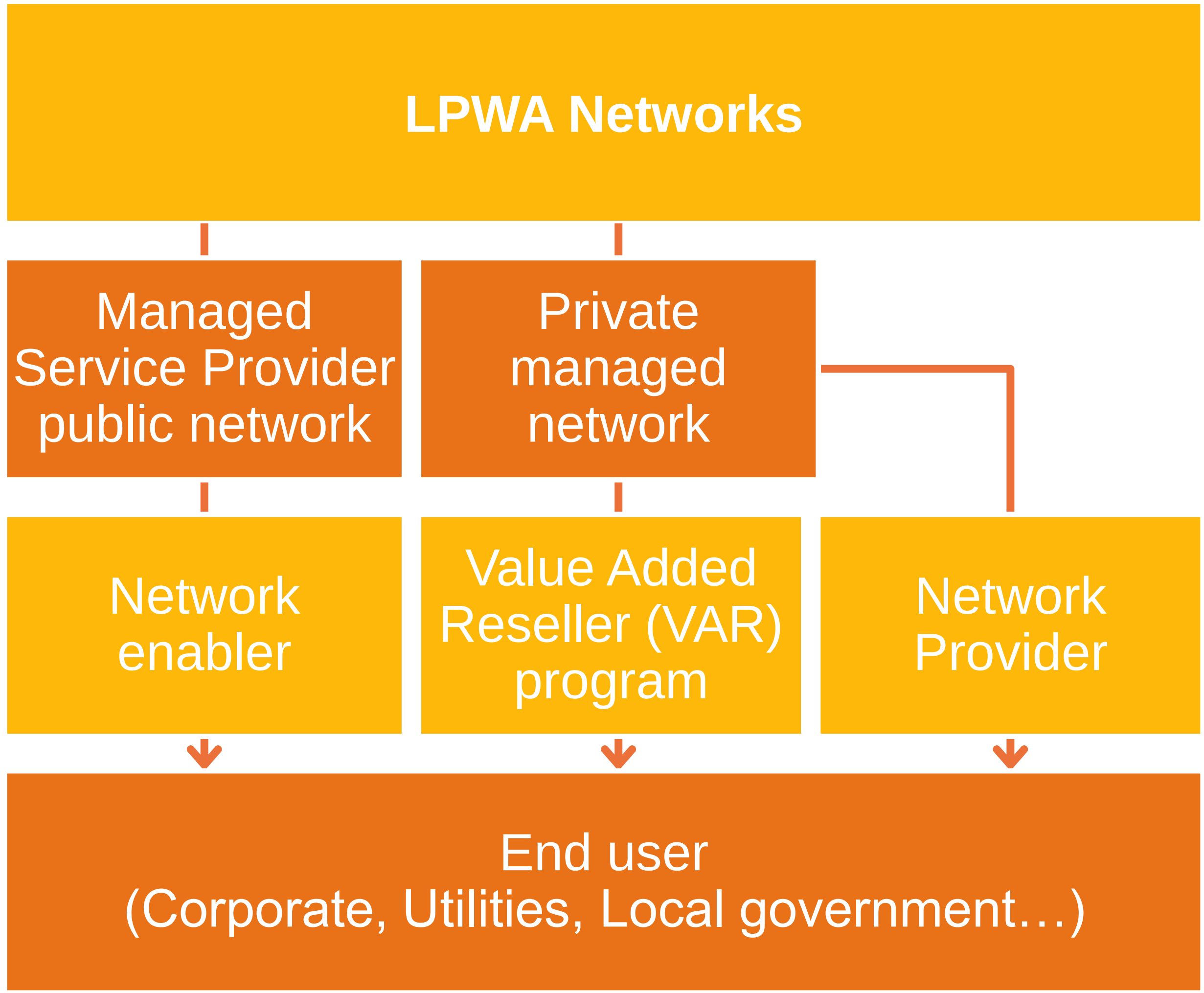
lpn.swisscom.com/E/

Base Stations

Operator LRR Roll Out

Operator roof-top roll-out 2/2

LPWA GTM



LPWA Networks
Managed Service Provider public network
Private managed network
Network enabler
Value Added Reseller (VAR) program
Network Provider
End user
(Corporate, Utilities, Local government…)

AGENDA

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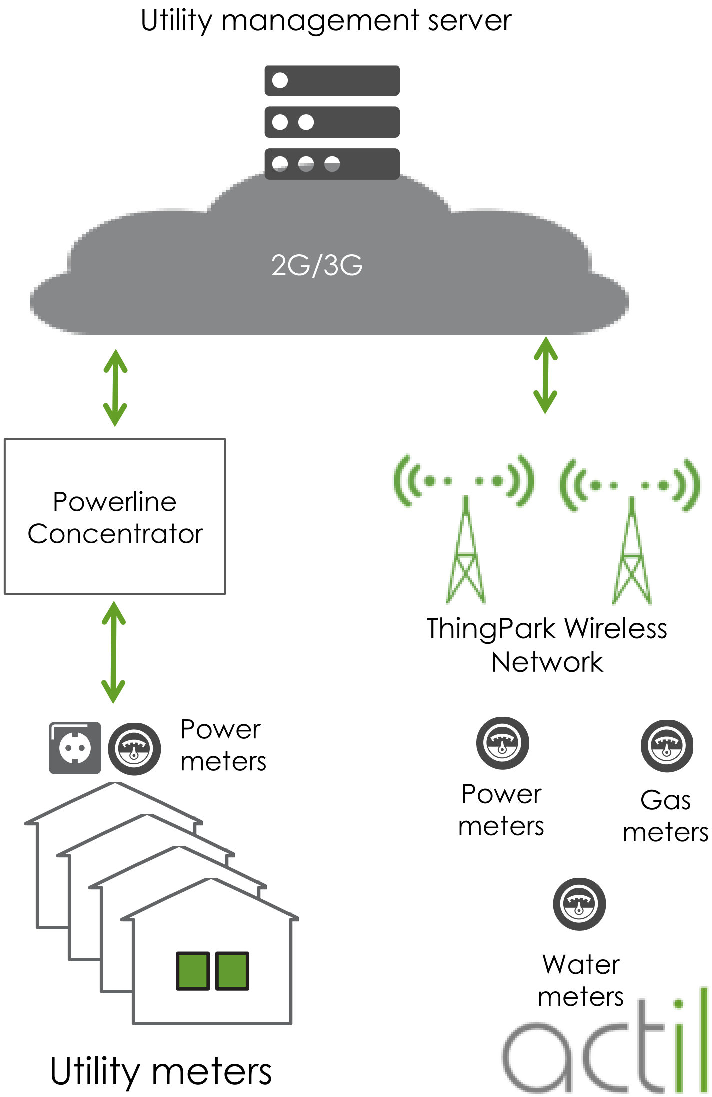
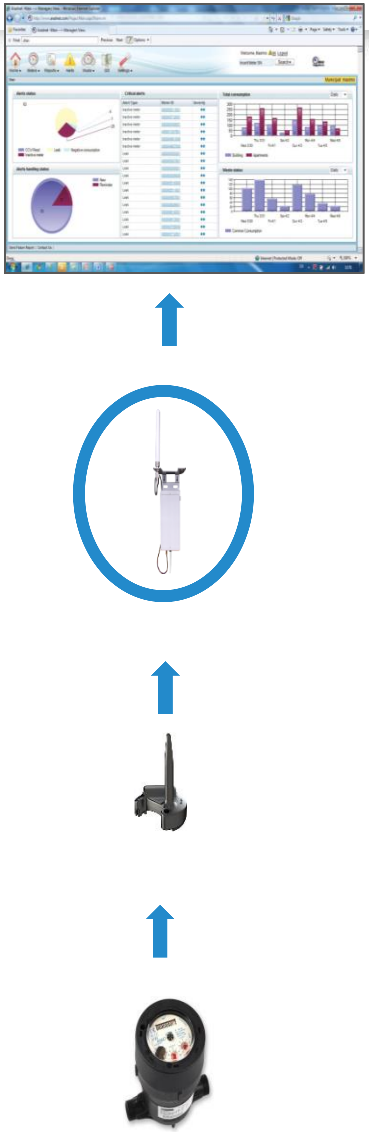
Smart metering data transport issues

- LPWA networks represent a better alternative to Powerline:
  - One common network for all utility meters
  - Lower cost structure
  - Lower latency for upstream and downstream

- Lower cost related to high range of LPWA networks such as ThingPark Wireless
- Based on Utility high points, 15 km range reachable in rural areas
- Pricing based on number of end-points and number of transactions per day (Power metering represents more transactions than water meters)



Local Water Metering for City office

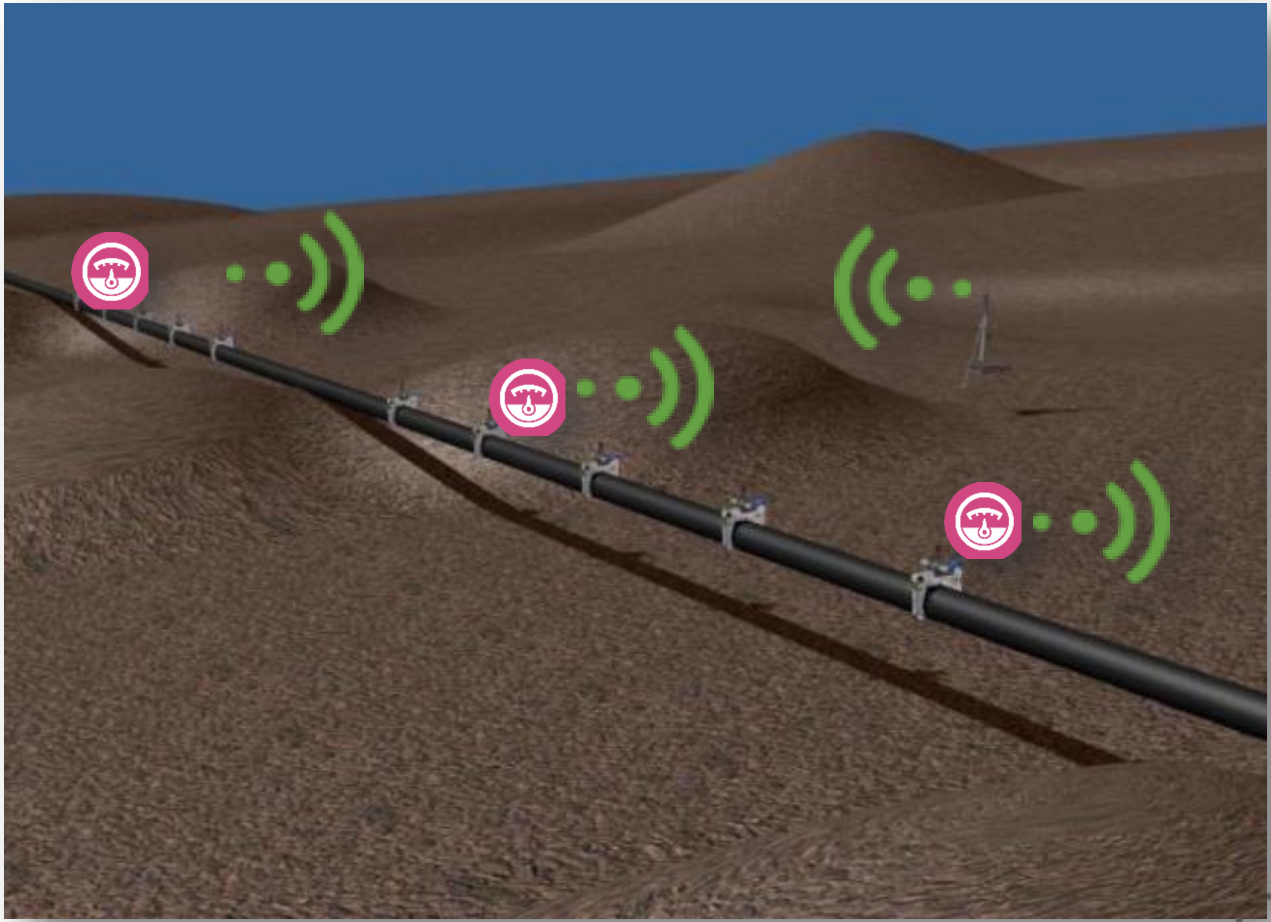


Smarteo Water

- A solution that matches loca requirement for open LPWA network
- Yearly subscription per meter
- 10 year guaranteed battery life
- Consumption dashboard and alerts
- Billing management
- Analytical algorithm for leak detection
- Cloud-based data storage
- Quick decision making tool

Pipeline monitoring

- Pressure measurement and Maintenance

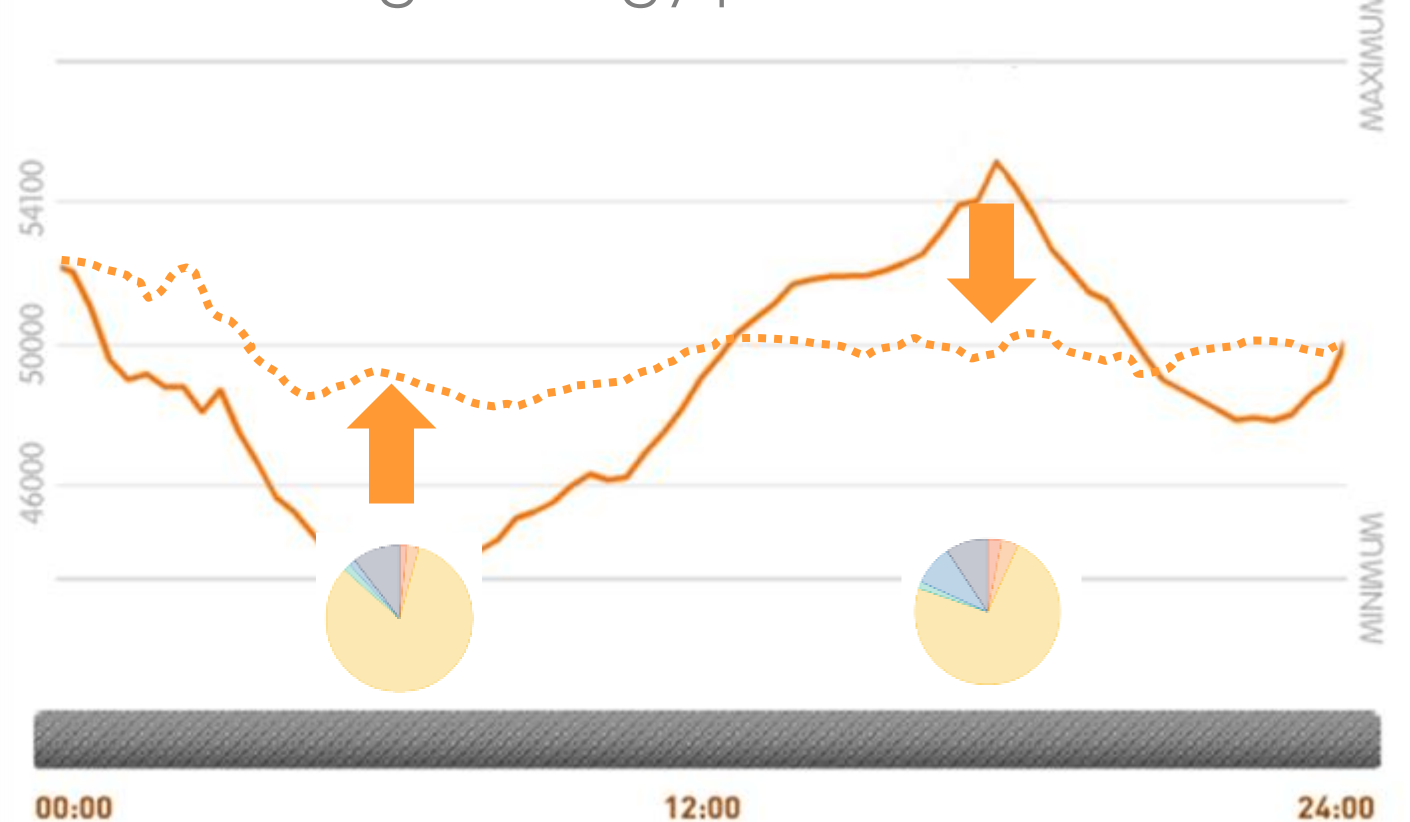


Fault Management Roll-out Monitoring utility poles

- Retrieving fault messages from the ErDF (French power distribution utility) subsidiary in Corsica
- Overhead power lines are equipped with an electronic control equipment (ILD)
- Base stations are rolled out on selected utility poles in the 30km Corsica valley
- The ILD is equipped with a pulse sensor to send fault status to a central control center.

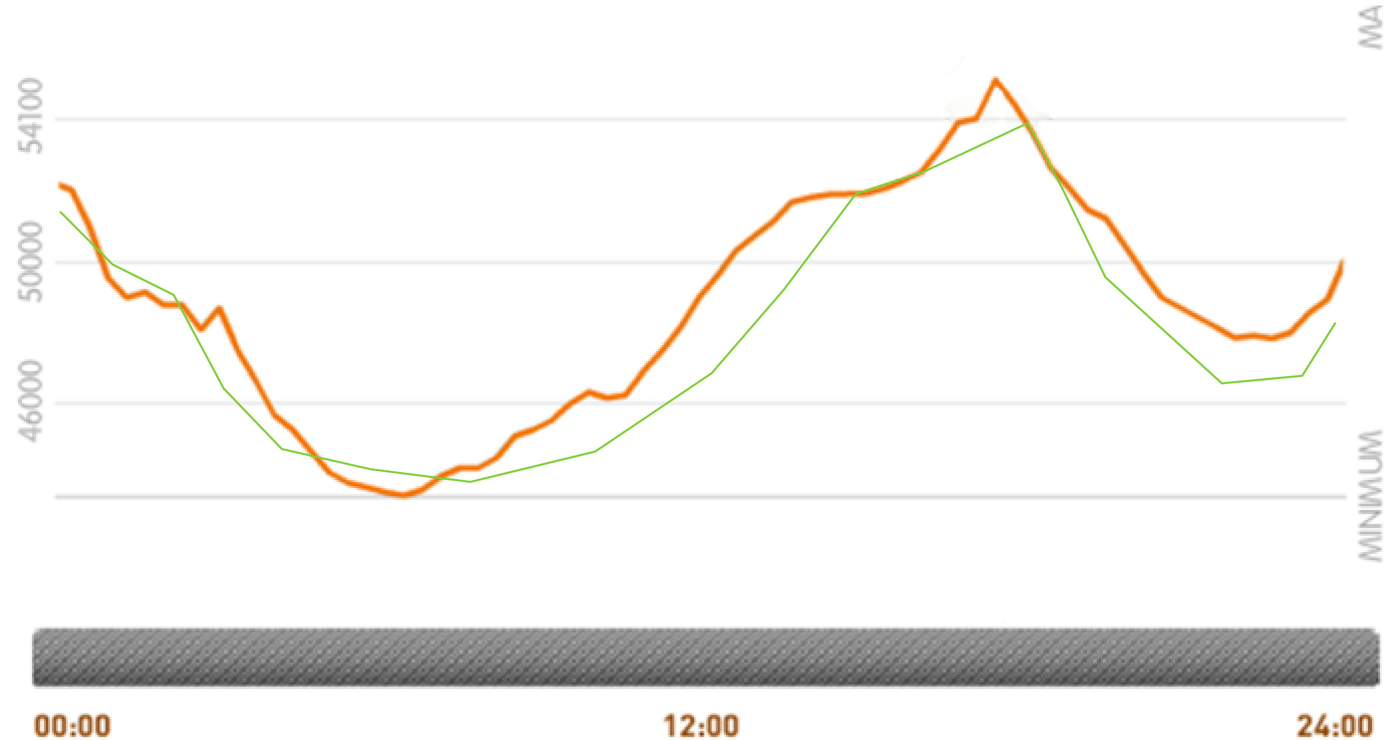
Load shifting (Smart-LS)

- Shift demand from peak hours to off-peak hours of the day
- Reduce average energy price and CO2 content.

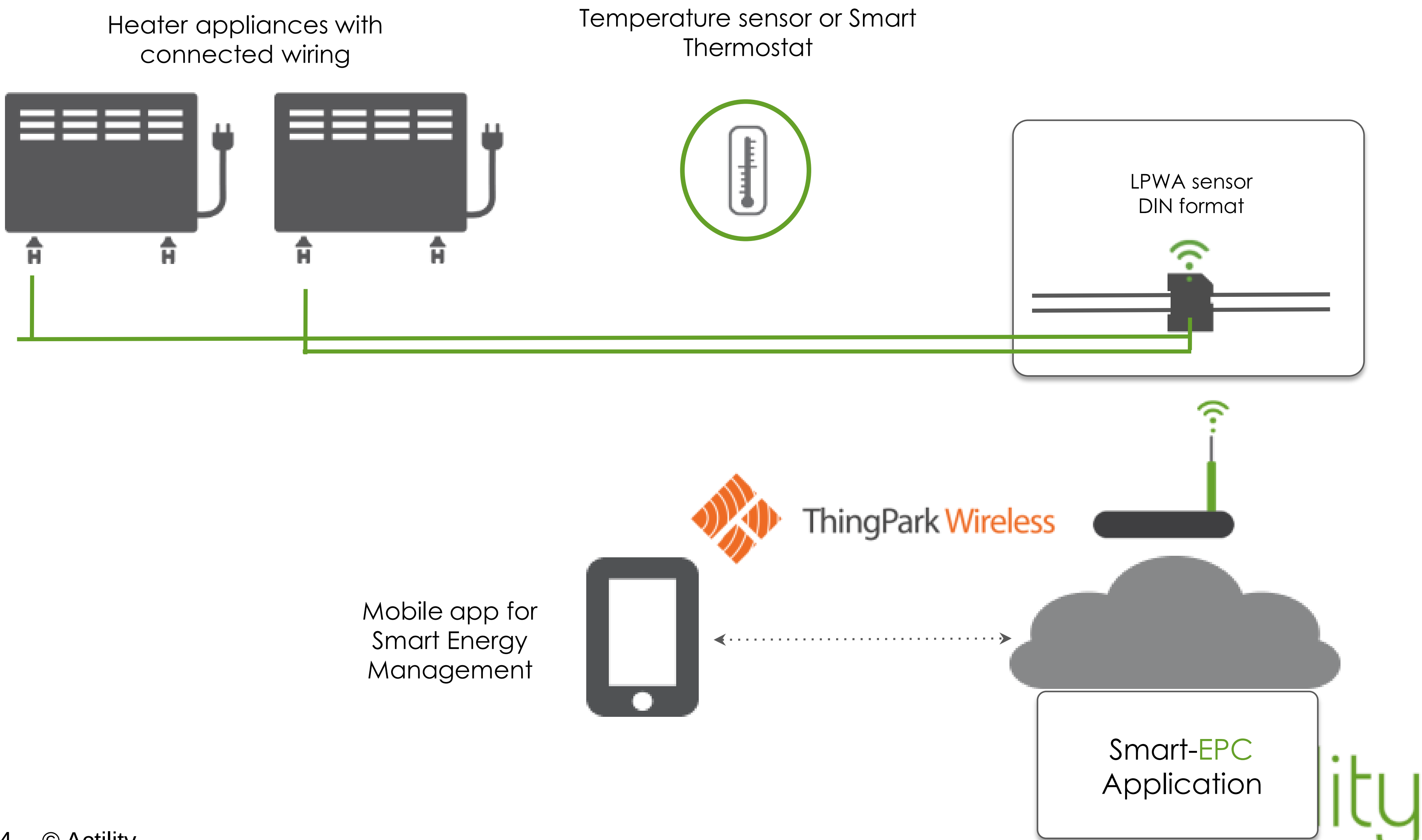


Demand Response (Smart-DR)

- TSOs need to ensure production = consumption at any time
- Consumption flexibility can be turned into revenues and avoids starting Gas/Fuel power plants



Taking Smart Home Energy Performance to the next level with Fast Demand Response



Remote Energy & Utility Metering Case Study

Enel

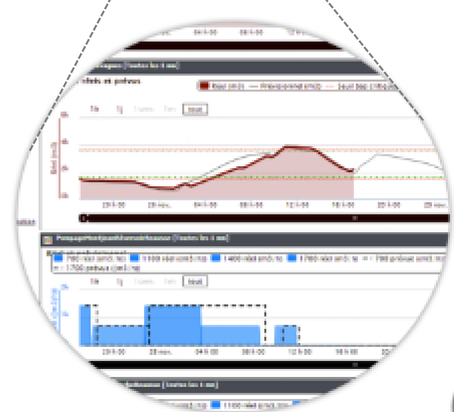
- Wireless sensor for CO_2 level monitoring
- Wireless temperature sensor
- Reading sensor for electric meter
- Sensor for gas meter
- Humidity sensor

Actility's Energy & Utility sensor instrumentation

ThingPark Wireless Connectivity Network

- REST API for Application Development
- Big Data storage infrastructure
- Sensor provisioning & management
- Graphical analytics tools

ThingPark Cloud



- ✔ A single solution for all utility meters
- ✔ Plug'n'play solution on existing meters
- ✔ Support energy harvesting mode
- ✔ Supports long-range connectivity
- ✔ Includes Datalogger real-time analysis tool

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Presenting the Habitat Toulouse Case Study

Local Social Housing organization

Manages 17500 social housing properties representing 30% of the capacity of Toulouse

Trusted Long Range Data collection & Storage

Provides all utility and environmental sensors & network connectivity

French body for technical building standards

Energy performance and inverse modelling application for measuring the viability of energy efficiency investments

The objective of Habitat Toulouse is to measure the viability of energy efficiency investments and define new implementation of building retrofits.

Scope of the Habitat Toulouse Energy Performance Project

ThingPark Wireless

19 buildings

700 T/H sensors

173 Power meters

34 Shared Power meters

69 Gas meters

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LPWA
Key vertical solutions

Smart parking

Reduces parking spot search time. Increases parking payment.

Smart Building

Instrumentation for Energy Performance Control (EPC)

Remote metering

Instrumentation for metering of all utillity meters + CO2, illuminance and humidity

Fault management

Monitoring fault on large scale infrastructure

Bin level management

Monitoring waste level. Optimizing rounds for municipality vehicles

People tracking

People tracking with LoRa/GPS bracelet

Asset tracking on-site

Managing assets on industrial warehouses or campuses

Monitoring EV Charging stations

Retrieving EV charging infrastructure data as a primary backhaul or as a back-up to 2G/3G

AGENDA

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A bit of theory …

The IoT Graal : Ultra-long range bidirectional communication within ISM power limits

Probability of Gaussian variable to exceed value x

Bit error rate

Received power

Information rate (bit/s)

$$Pe = \frac{1}{2} erfc\left(\sqrt{\frac{P(1-\beta)}{2NoD}}\right)$$

For a given reception power:

When D (bit/s) decreases, Pe also decreases

→ Low bitrate means longer range

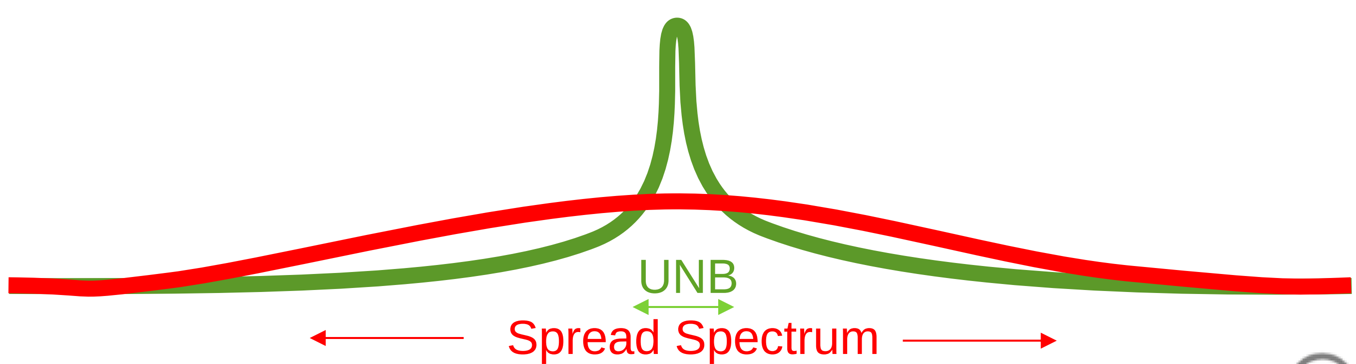
The spread spectrum approach (1)

Originally used for military communication, spread spectrum transceivers transmit a known pattern of bits for each information bit.

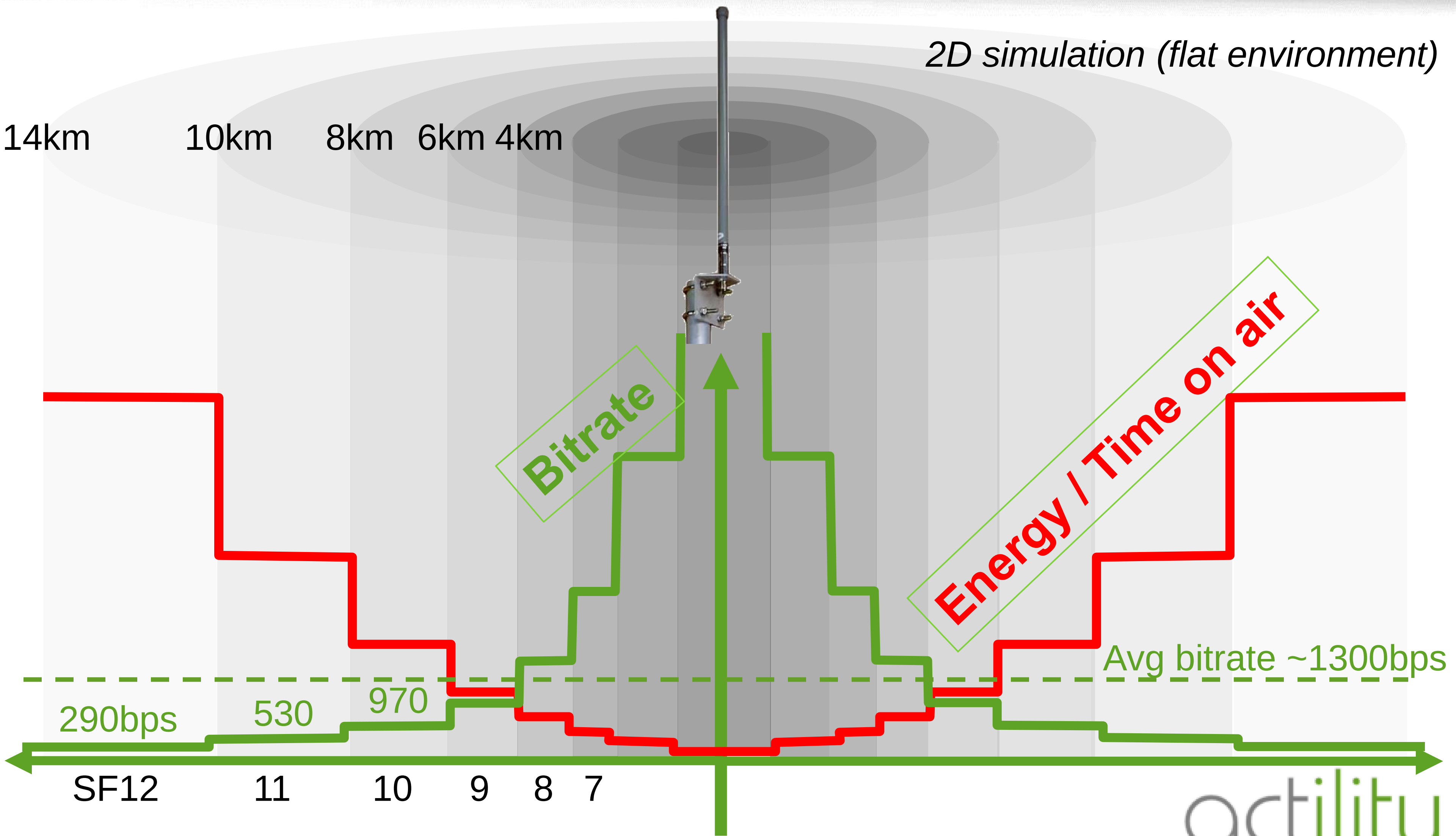
« 0 » → « 01001011101001110101011101111011 »

« 1 »→ « 10011011011010101111101101110111 »

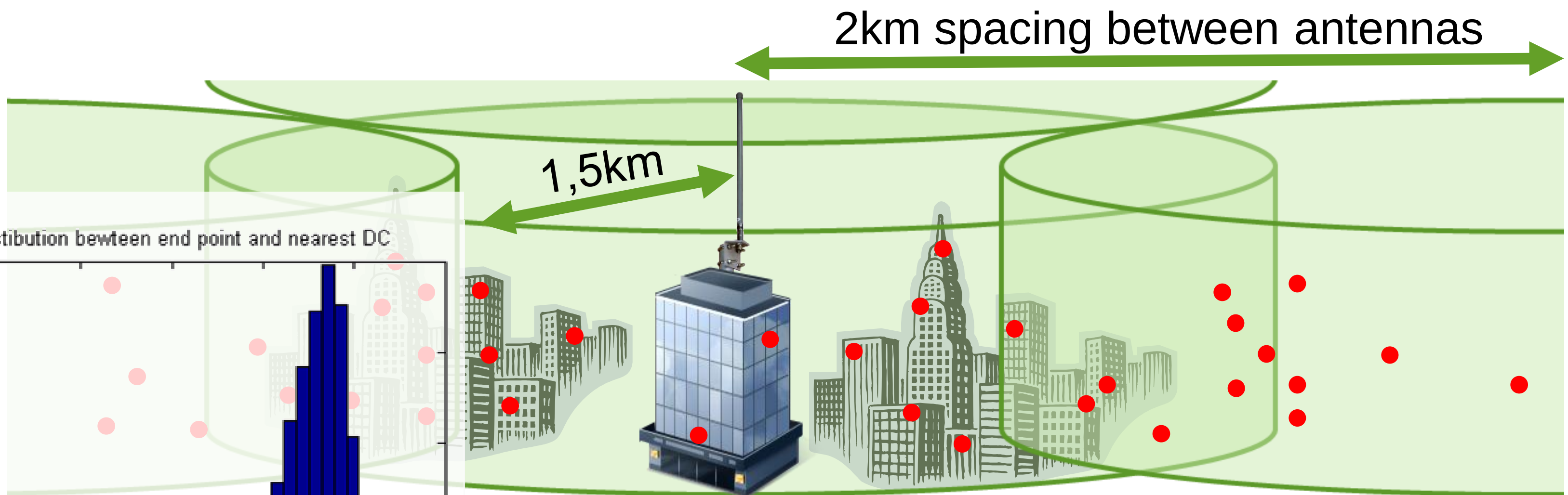
- RF spectrum is « spread » accordingly
- Channel becomes wide enough for a quartz receiver : symmetrical bidirectional communication becomes possible

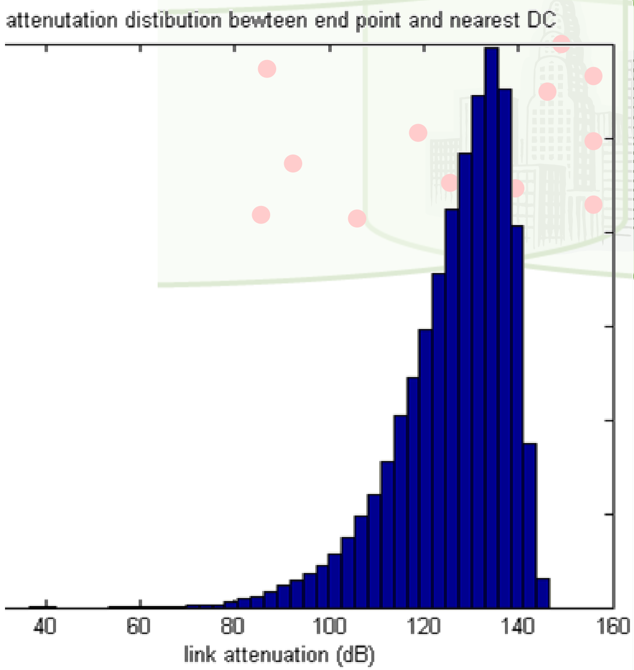


Adaptive Data Rate (ADR)
2D case, flat landscape



Adaptive Data Rate (ADR)
3D case (city), sensors along Z axis



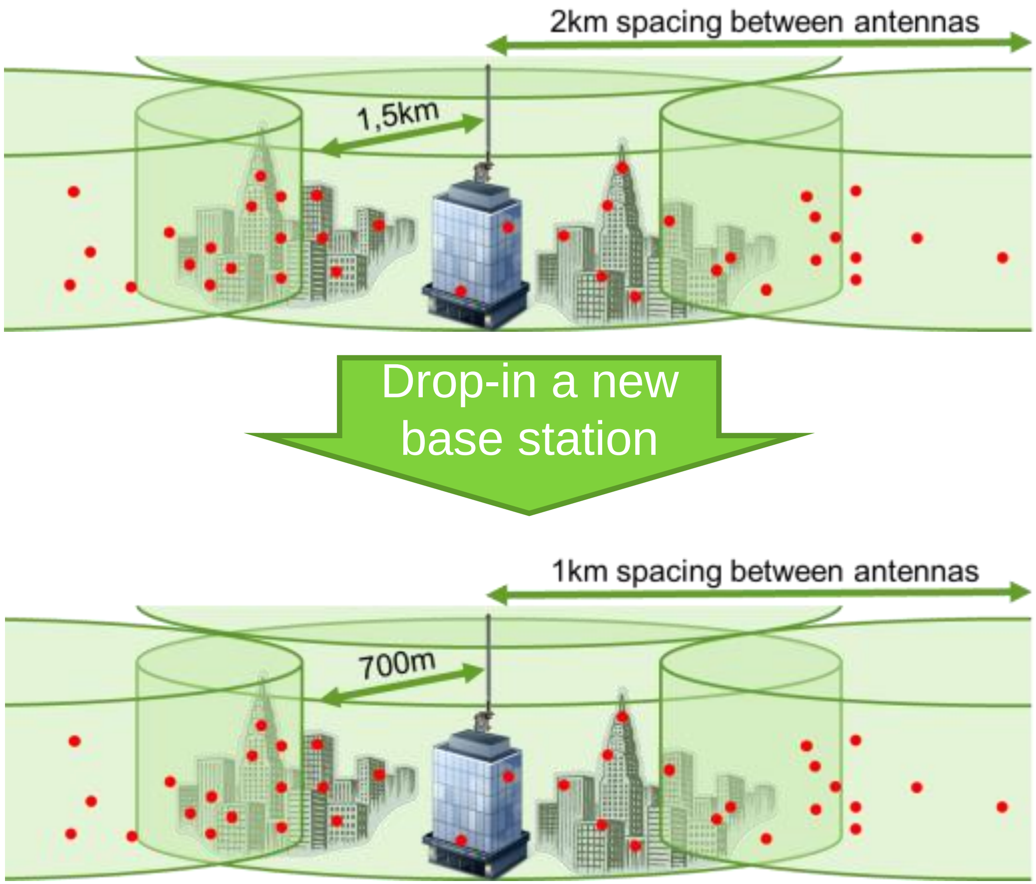


- 2km average between base stations
- Nodes at street level and above, outdoor
- Nodes received by 4 base stations on average
- 10 bytes payload + overhead

Msgs / day	Simulated cell capacity	SX1301 max capacity
Uplink	44000000 (3% PER)	**26000000**
Downlink	**1100000**(1% DC)	5000000

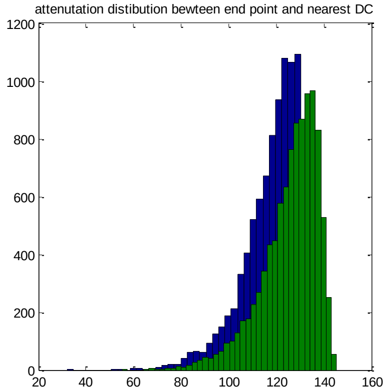
120 to 140dB attenuation of 80% of nodes

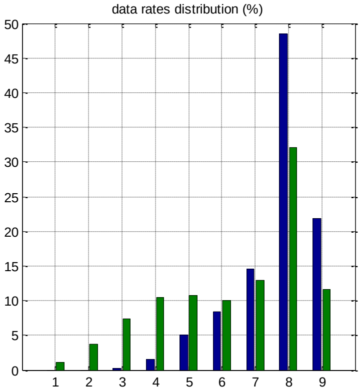
Ease of capacity increase



Effects of adding a new base station (macro or pico cell):

- 2x capacity per cell
- 2x avg battery life
- 8x capacity for network





Example of bettry life for end node

- Case : 1 way, payload of 12 bytes, 1 UL transaction per hour, no retry, +14 dBm.

	Energy required for 10 years
LoRa SF12	2592 mA.h
LoRa SF7	898 mA.h

To compare with different type of battery

Format	Type	Voltage	Capacity
LR06	NiCd	1,5V	2850mA.h
LR03		1,5V	1250mA.h
BoutonLi	Lithium	3V	620mA.h
BoutonAl	ZnAr or Alcalines	1,5V	150mA.h

	Estimated life time for LR06
LoRa SF12	13 years
LoRa SF7	30 years

LoRaWAN - MAC layer design objectives

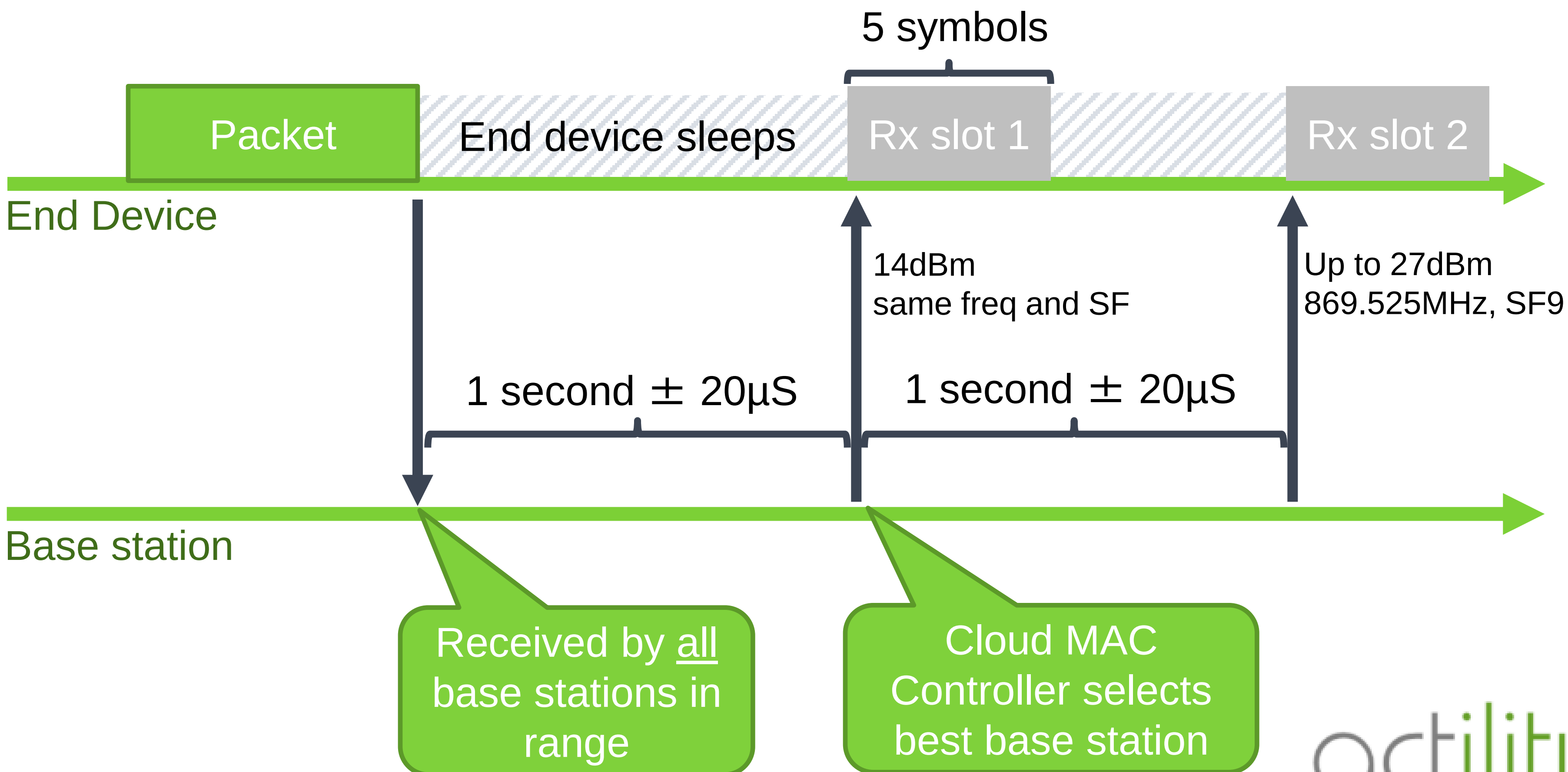
- Designed for virtualized cloud based MAC layer:
  - Simpler base stations, less maintenance
  - All NW antennas behave as one, no handover necessary.
- Close alignment with IEEE 802.15.4 in order to preserve higher layers
  - 6LoWPAN compatibility
  - IEEE sensor address space
- Eliminate useless overheads
- Enable smooth versioning

LoRaWAN device classes

Class name	Intended usage
A (« all »)	**Battery powered sensors**, or actuators with no latency constraint Most energy efficient communication class. Must be supported by all devices
B (« beacon »)	**Battery powered actuators** Energy efficient communication class for latency controlled downlink. Based on slotted communication synchronized with a network beacon.
C (« continuous »)	**Mains powered actuators** Devices which can afford to listen continuously. No latency for downlink communication.

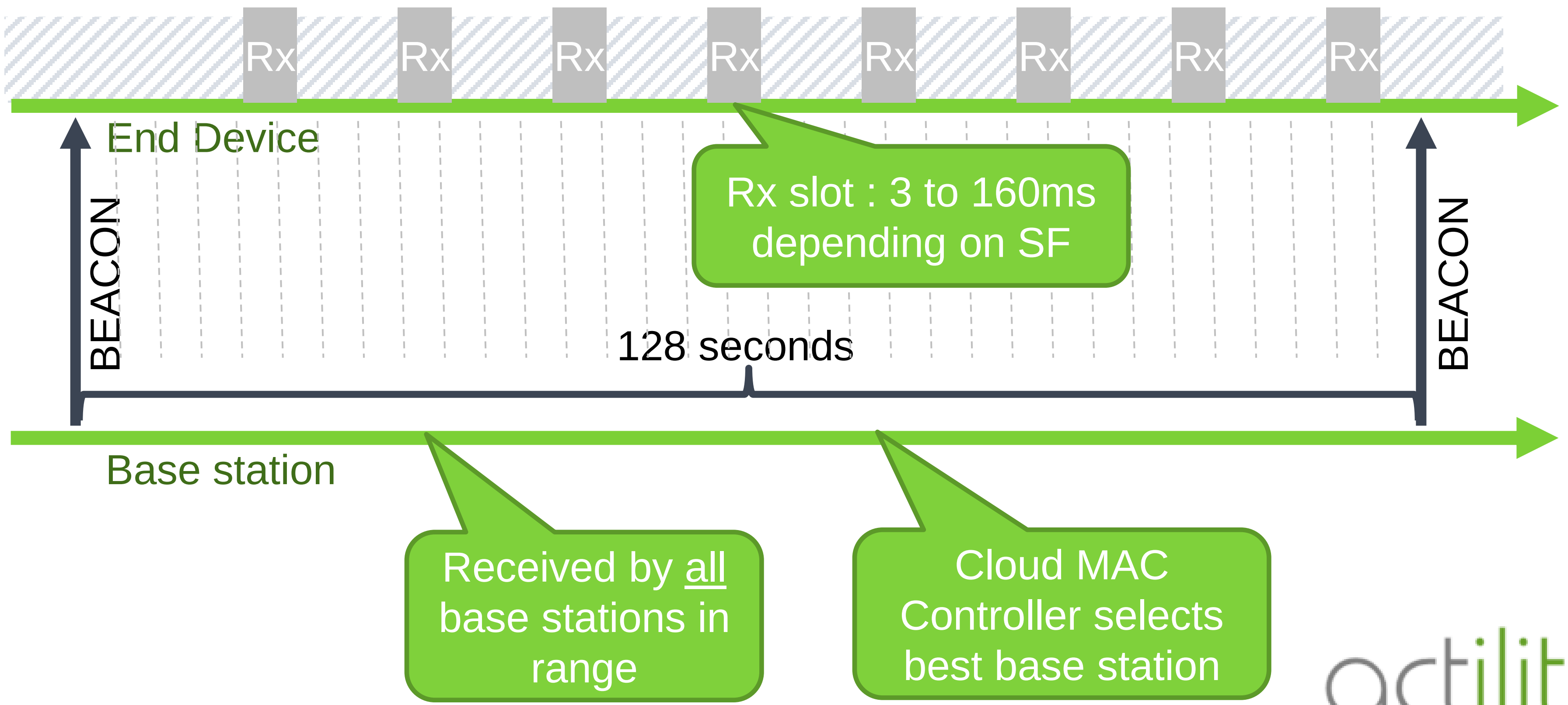
Bidirectional communication, class A

- Receiver Initiated Transmission strategy (RIT)



Bidirectional communication, class B

- Coordinated Sampled Listening (CSL) : Network may send downlink packet to node at any Rx slot

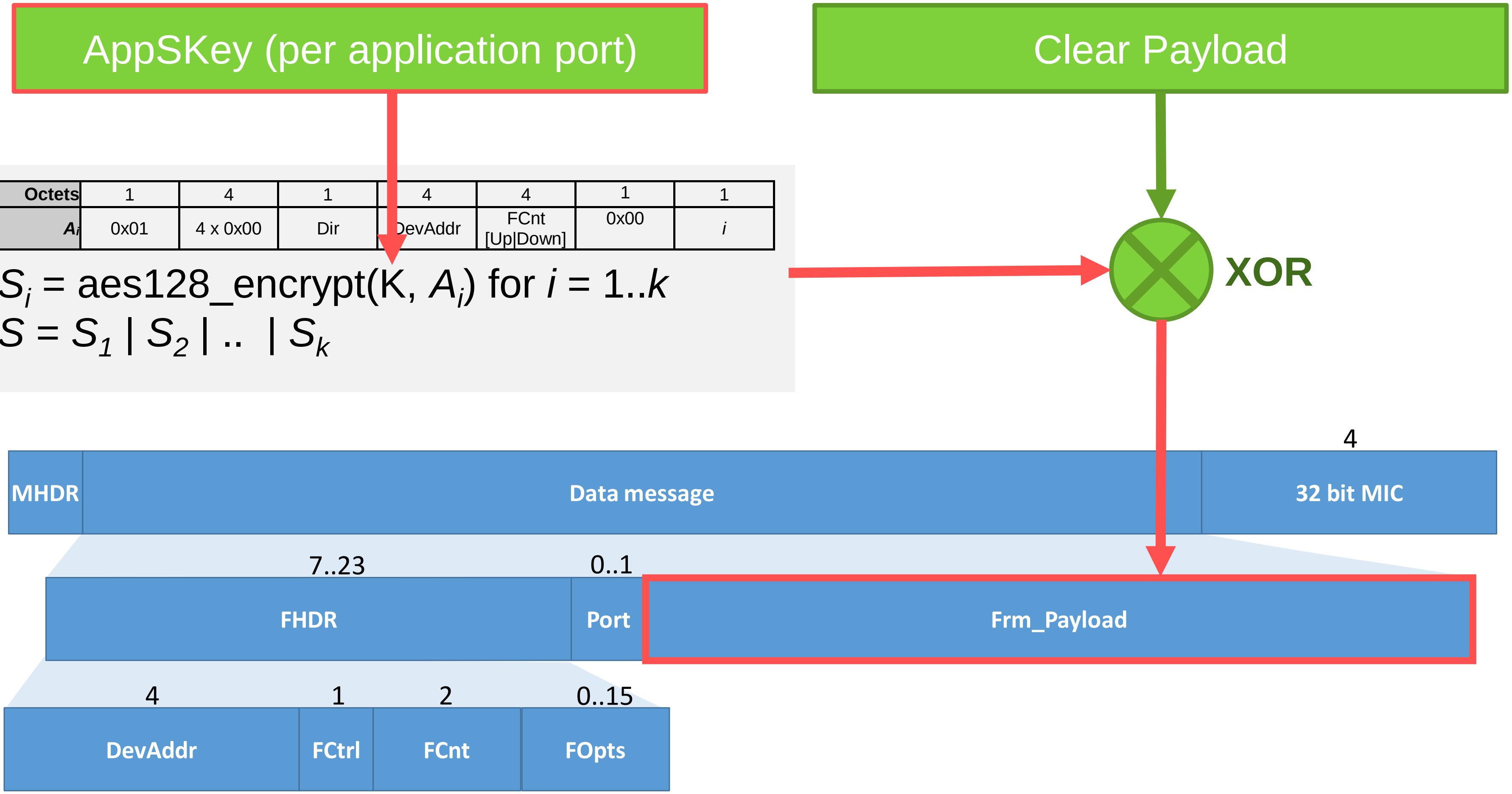


Bidirectional communication, class C

Class C is targeted to powered actuators:

- C stands for « continuous » : class C devices listen continously
- Class C devices are a straightforward extension of class A, filling the « listen gaps »

MAC Security : payload encryption



Octets	1	4	1	4	4	1	1
A_i	0x01	4 x 0x00	Dir	DevAddr	FCnt [Up|Down]	0x00	i

S_i = aes128_encrypt(K, A_i) for $i = 1..k$

$S = S_1 \mid S_2 \mid .. \mid S_k$

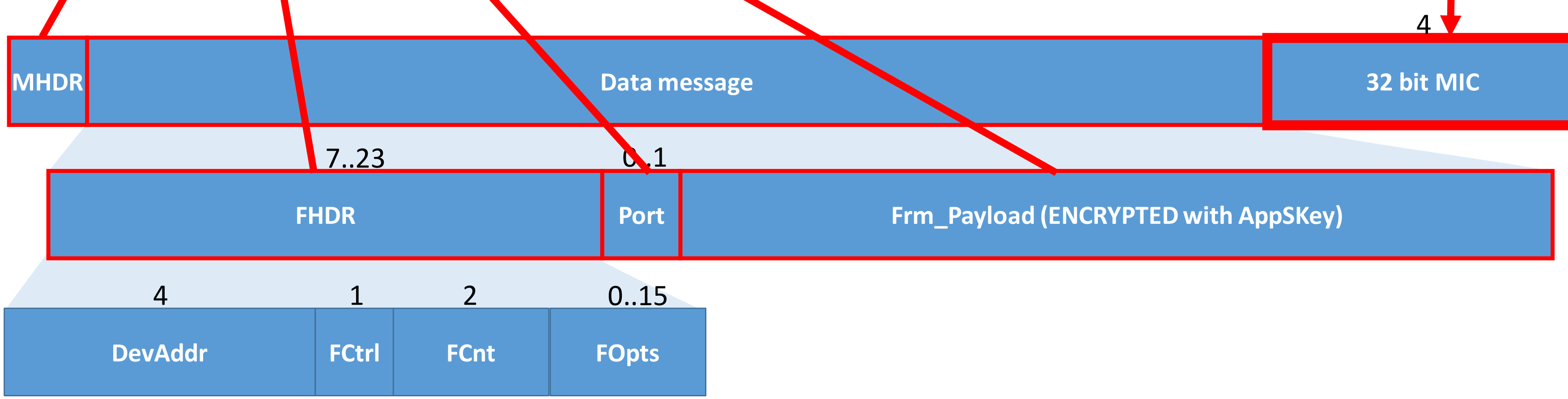
MAC Security : message integrity

NwkSKey (known to NW operator)

Octets	1	4	1	4	4	1	1
B_0	0x49	4 x 0x00	Dir	DevAddr	FCnt [Up|Down]	0x00	len(*msg*)

msg = MHDR | FHDR | FPort | FRMPayload

RFC4493:
$cmac$ = aes128_cmac(NwkSKey, B_0 | msg)
MIC = $cmac$[0..3]



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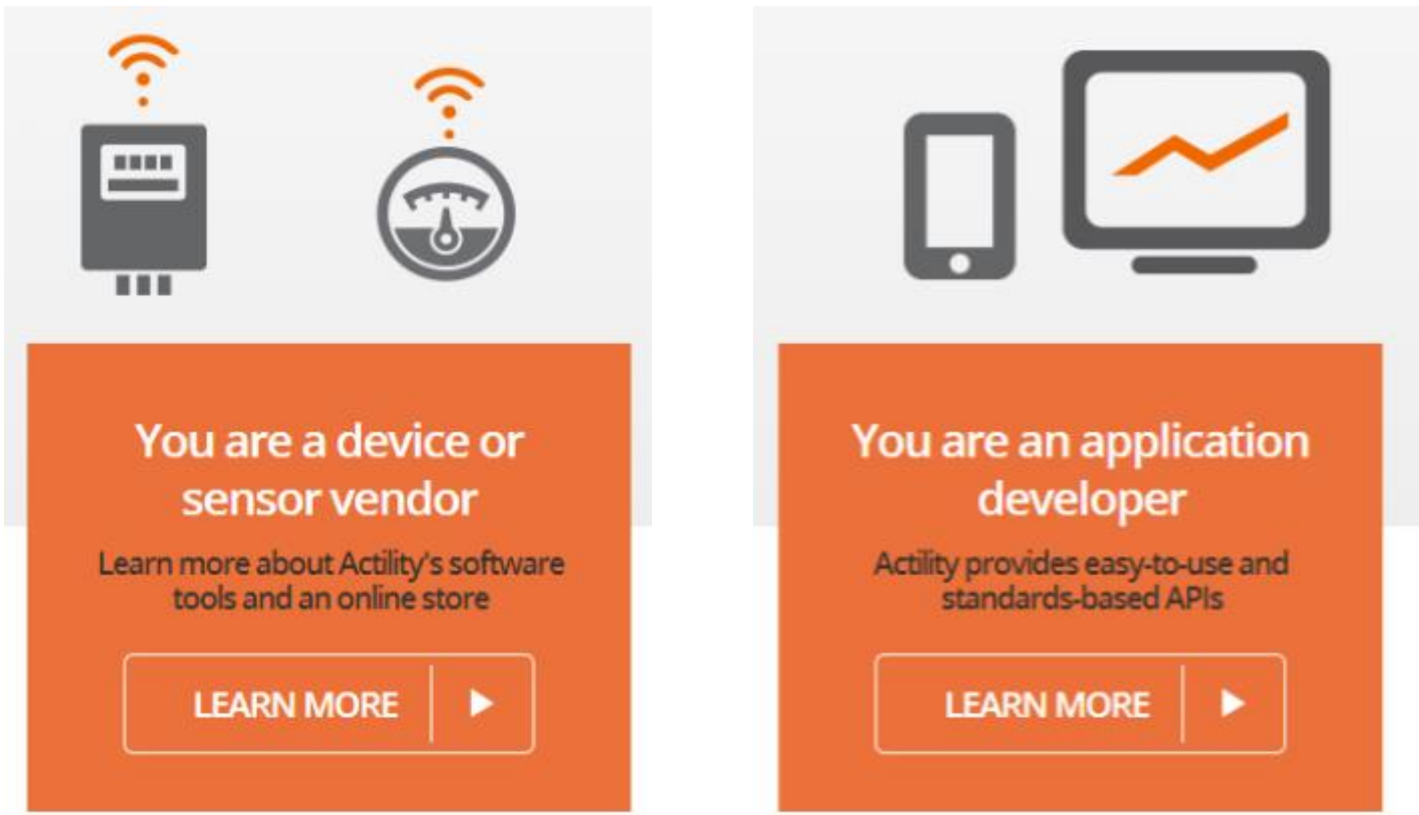
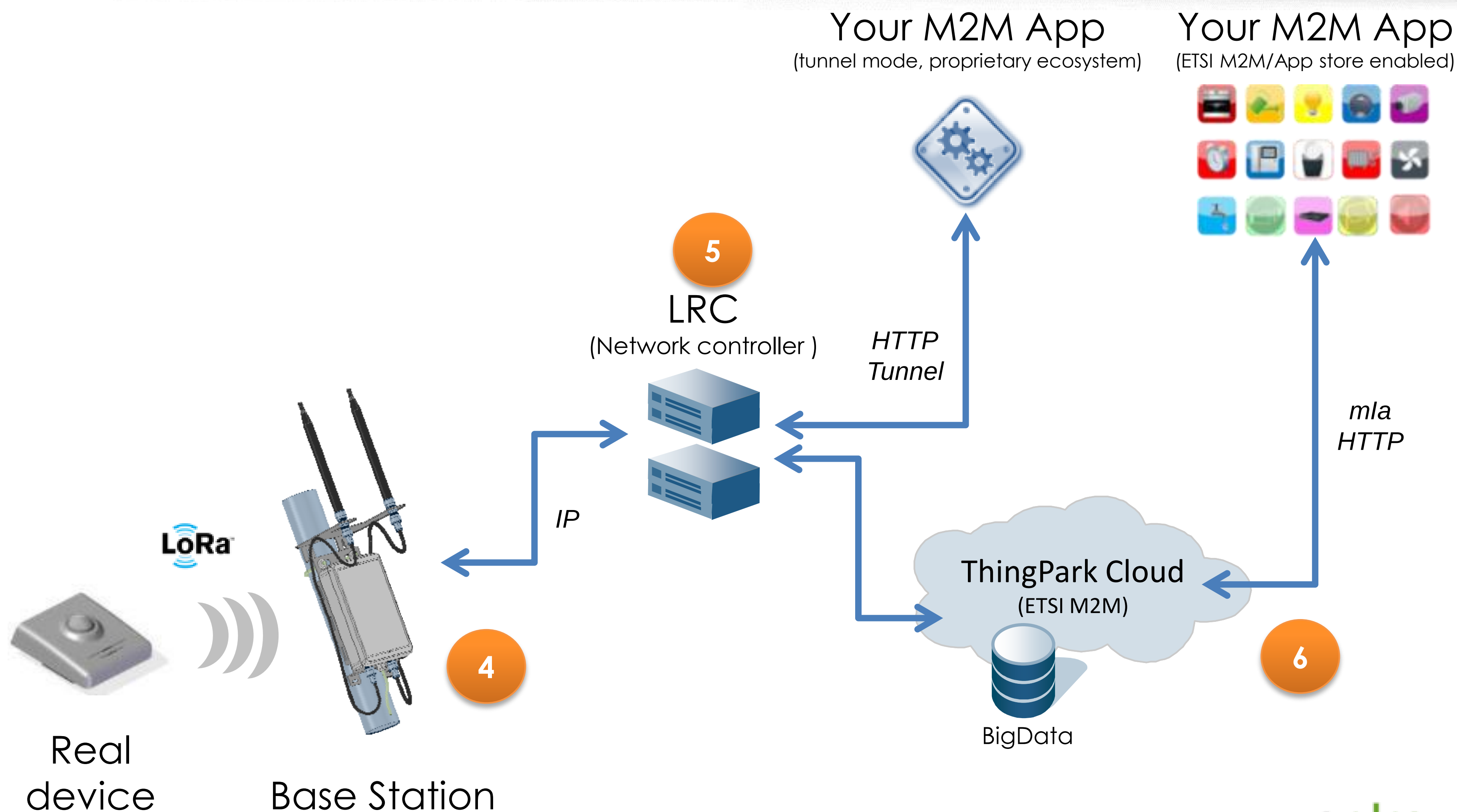
ThingPark Wireless integration program and certification



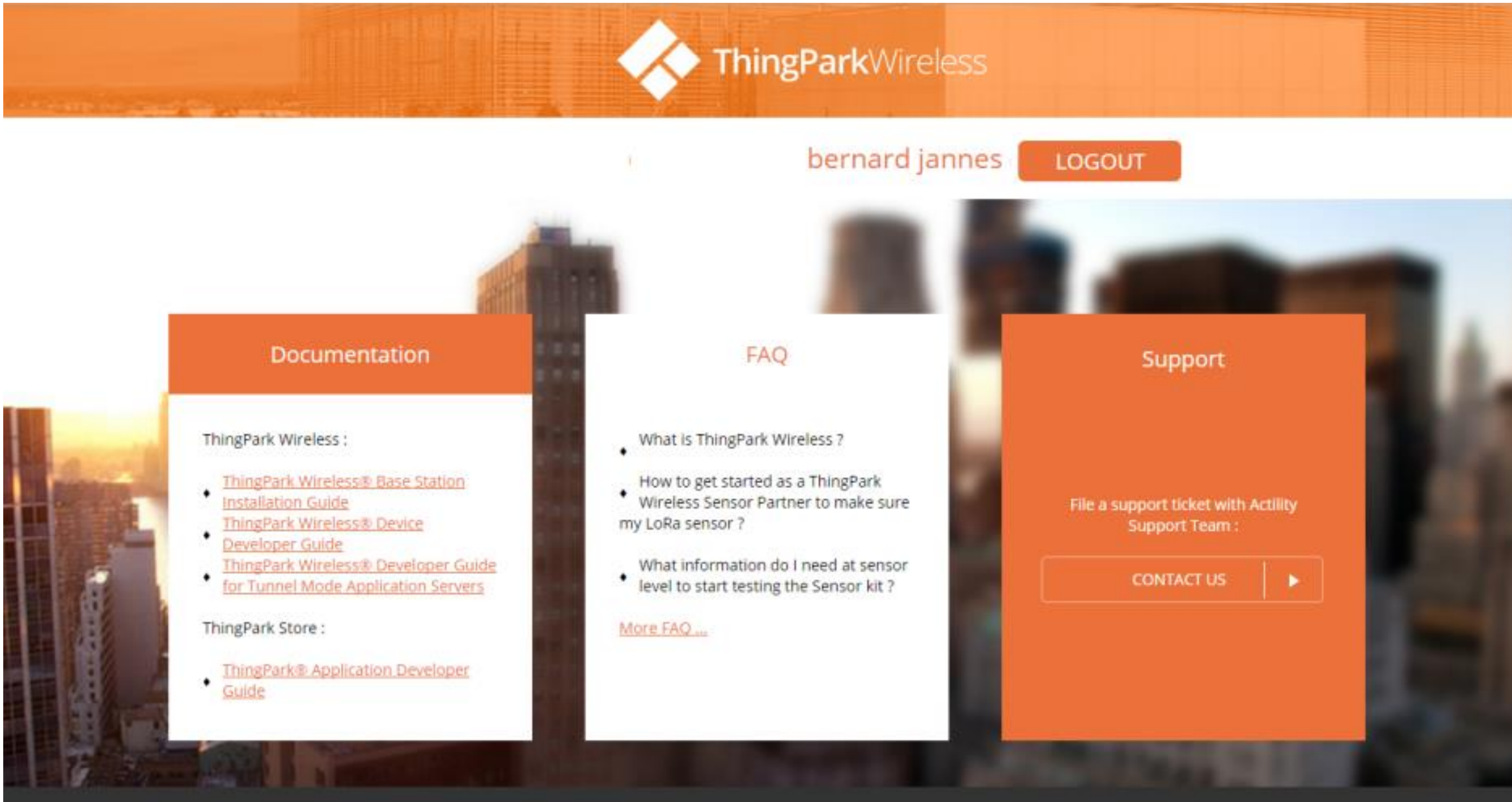
Selected LPWA partners

abeeway Location / GPS sensors	CISCO Gateway	FINSECUR Smoke detector	IMST German module maker
MICROCHIP US module maker	NEMEUS French module maker	nke ELECTRONICS Marine Electronics	SENSING LABS Metering & environment
Smarteo Water Water metering	WAGO BMS Automation	WATTECO Metering & environment	WORLD SENSING Smart parking
AUREL AUTOMATION Module maker & Sensors	embit Smart-thermostat, module	MultiTech Systems Gateway	Adeunis RF Module maker & Sensors
kerlink Gateway	intent TECHNOLOGIES Smart Building App	ATIM Module maker & Sensors	FINDSTER Location / GPS sensors

Integration program: available tools

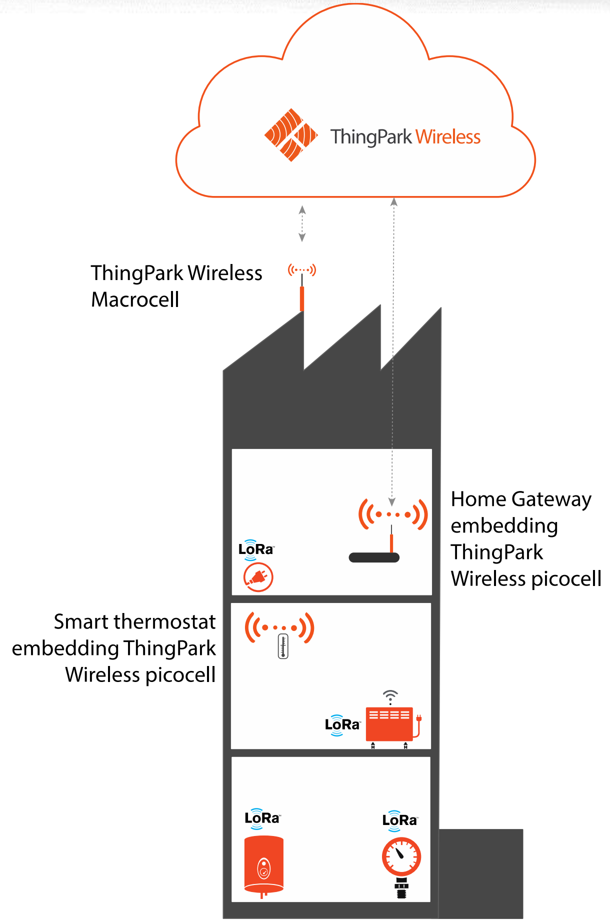


Partner Zone



Adding density to LPWA networks with PicoCells

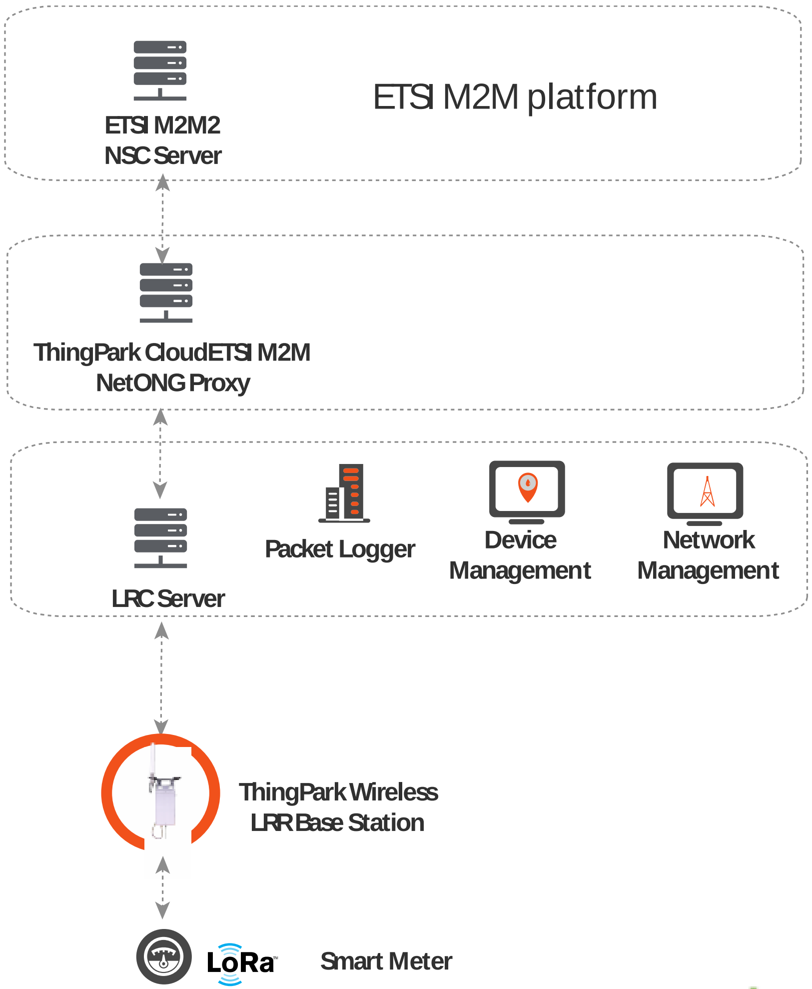
- LoRa-based networks can support a wide range of both outdoor and deep indoor vertical applications
- The LoRa propagation model allows a significant capacity increase by rolling out pico-cells in high density cities
- Service providers can complement their macro-cell LPWA strategy with high density indoor coverage in dense cities



Actility provides a full module plus software solution to be embedded into smart home objects and gateways transforming them into base stations

Network + Cloud

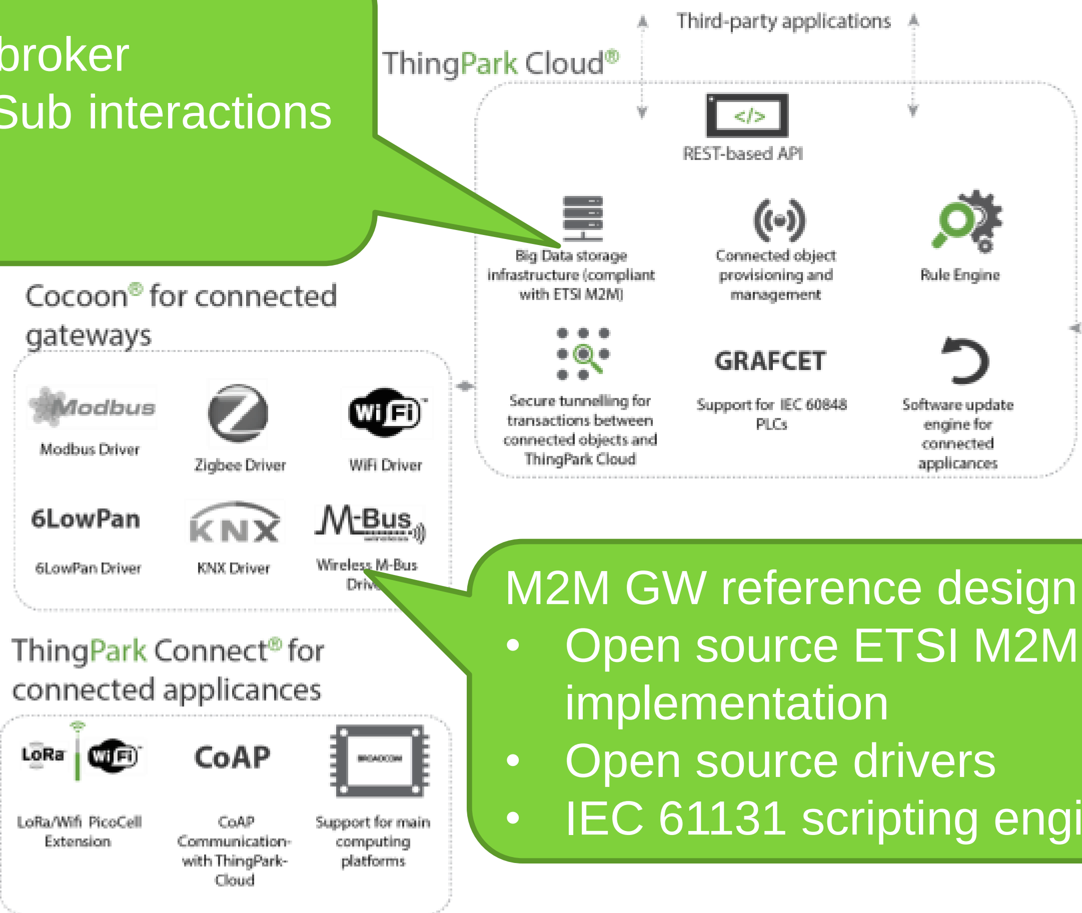
- ETSI M2M interworking allowing Smart Meters to avoid any ETSI M2M stack on top of LoRa Mac in the Smart meter



M2M Architecture

M2M cloud:

- ETSI M2M NCS broker
- Sync/Async/PubSub interactions
- Big Data storage
- Security



M2M GW reference design

- Open source ETSI M2M implementation
- Open source drivers
- IEC 61131 scripting engine (PLCopen)

Global standardization

→ **Service Provider IoT architecture is being prepared at ETSI within the « M2M Technical Committee »**

→ **ETSI M2M has joined the Global M2M partnership project**

- → ETSI (Europe), JapanTTC (Japan), ATIS (US), TIA (US), CCSA (China), TT

THANK YOU

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