LoRaWAN[®] repeaters

Workshop RSD LPWAN

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LoRa coverage

Orange Labs LoRaWAN[®] extender

Relay work at the LoRa Alliance®

Conclusions

LoRa coverage

Long range radio helps reaching nation-wide coverage

Couverture LoRa® Orange



Coverage?

- About 5000 gateways
- 95% pop. covered
- Still some white areas
- Still some hard-to-reach places

Hard-to-reach places

- Behind thick walls
- In deep wells
- In underground car parks
- Inside metallic cabinets, shacks
- At remote back-country sites





Improving coverage

Adding gateways

- Equipment, backhaul, power source
- Associated CAPEX and OPEX



Repeaters?

- Well-known in other IoT networks
- So far, LoRaWAN has eschewed repeaters





Orange Labs LoRaWAN[®] extender

Orange Labs goals (back in Q1 2017)

Address coverage issues with LoRaWAN devices

- including existing devices *that were already in the field in 2017*
- without requiring the devices to be relay-aware
- compatible with current LoRaWAN 1.0 and 1.1 devices, both in OTAA and ABP modes

Extender shall be battery- or harvester-powered

No change to the network infrastructure (black box)



Data forwarding



RX1 Rx2 delays, make room for repetition Extender impersonates End Device on uplink OTAA Join Accept sets Rx Delay into End Device

GW





Frequency / Spreading factor restrictions

Extender uses device-type radio chip (sx1272, 1276, 1261)

• Samples the medium on 1 (or 2, or 3) frequency / SF combinations

End Device $\leftarrow \rightarrow$ Extender communication uses existing LoRaWAN modes

Devices cornered into one frequency / one SF after Join

GW

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Orange Labs solution

Extender is a Device in its own right

Has dedicated Application Server

No change to the existing infrastructure (black box)

- Extender Backend Server is added over the top
- Backend Server registers joined End Devices via NS management interface



Lab prototype demoed Dec 2017



3 patents delivered

Extender implemented by equipement vendor partner

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TECHNOLOGIES	PRODUITS	APPLICATIONS	SUPPORT		



Répéteur LoRaWAN ACW/LW8-EXT

Répéteur pour devices LoRaWan

L'ACW/LW8-EXT est un dispositif vous permettant de répéter des produits LoRaWAN situés dans des zones où la couverture réseau n'est pas favorable tels que les parking sous-terrains ou les chaufferies en sous-sol. Il a la capacité de répéter uplinks et downlinks vers et depuis le réseau en utilisant l'infrastructure publique d'Orange.

Grâce à une application dédiée, il est possible de gérer les différents appareils répétés (ajout, suppression, affichage d'informations). L'intégration de l'Extender dans son environnement est très facile, il suffit de l'installer, de brancher l'alimentation puis de configurer les appareils à répéter. Ceux-ci seront répétés après avoir réalisé une phase de join avec l'Extender.

L'ACW/LW8-EXT ne nécessite aucune modification des produits LoRaWAN que vous souhaitez répéter.



Acheter

Catégorie : Gamme ACW Étiquettes : LoRaWAN, répéteur

www.atim.com/fr/produits/catalogue/gamme-acw/repeteur-lorawan-acw-lw8-ext/ (retrieved July 2019)

Back-end server implemented by Orange Applications for Business

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			0018B200000	001848 27000001848	ZZZ EDA FEEDBACK NOW	-128/-7/il y a 5 jours	-114/-2/8	.atl	il y a 5 jours	Actif ★		
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			0018B200000	0016F5 2700000016F5	ZZZ EDA FEEDBACK NOW	-113/8/il y a 5 jours	-111/1/9	ait	il y a 5 jours	Actif ♣		
15						Affichage 1 - 6 de 6 é	léments.				Ŧ	

Field trials are on-going (H1 2019)

Selected business customers

- Jooxter, smart office management solutions <u>https://hellofuture.orange.com/fr/liot-simplifie-aussi-la-vie-de-bureau/</u>
- A few others in France and Europe











- would benefit from longer preamble duration, but negates goal to serve existing LoRaWAN devices
- use first uplink data transmission (of a repetition) as a preamble?

Going forward, opening the "black-box" of the network infrastructure

- With Join Server, quick response time, Extender no longer needs to act as a Join Proxy
- With standardized GW-NS interface, Extender Backend Server can act as a vGW (caveat: becomes operator-only solution)

Relay work at the LoRa Alliance

Highlights

Work on Extender/Relay at the Alliance started Summer 2018

- Use cases
- State of the Art

LoRa Alliance working documents restricted to Alliance members

Technical proposal refined over H1 2019 (Alibaba, Semtech)

- Adds Relay mode option to LoRa Alliance stack, as a separate addition
 Main LoRaWAN documents not modified by appearance of Relay
- Reduces Relay power consumption by introducing long preamble into End Device Relay link
- Wake-on-radio protocol specification

Receiver recognizes long preamble, acknowledges ACK includes timing information (a la WiseMAC) Authentication between End Device and Relay

• Network Extender specification

Relay samples the medium with WOR, learns of upcoming transmission, stays awake, forwards End Device listens to potential direct responses from network (Rx1/Rx2), then from Relay (Rx3) Impersonation or Encapsulation choice are left to system integrators LoRaWAN proposed wake-on-radio and extender

LoRaWAN[™] Device to Device Communication

Technical Proposal RX frame + send ACK LW Forward ower Analysis to network Wake-up Average Voltage 45mA pattern Average Power 40mA Total Charge 35mA detected Total Energy 5 30mA C.A.D Lifetime Estimate RX1 RX2 25mA Batt. Charge [mAh] a 20mA 3600 ម្ម ^{15mA} Channel B 10mA 5mA Auto-scroll 0mA ✓ Automatically fit Y Show zero 21919 21920 21921 21922 21923 21924 -ChR-Cursor Delta Cursor 1/Delta #1 ChA Current #1 ChA Voltage ChA Avg Current ChA Estimated Battery Life Window Average Instant Window Average Instant 513.2ms 1.949Hz 3.581V 67.22µA 2231d 10h 27m 0.000A

#TheThingsNetworkConference



Conclusions

Conclusions and Future Work

A LoRaWAN-LoRaWAN extender solution already in the field $\ensuremath{\textcircled{\sc b}}$

Fully compatible with existing LoRaWAN[®] devices and networks

LoRaWAN topology evolving to more complex architectures

- Still some flexibility in the Alliance Extender specification
- Leaves many architectural choices open

Extensive simulations/experiment still needed

- Architectural choices
- Limits, parameter tuning
- Strategies for roaming into / out of extender coverage

Explore more-than-one-hop relaying

Revival of mesh networks?



Thank you

