LoRaWAN: Long Range and Low Power Communication for Enabling Massive IoT

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Director of Standards and Advanced Technology Development, Actility

Vice-Chair, LoRa Alliance

About

- ## Telecom R&D since 1997
  - Samsung Electronics, DoCoMo USA Labs, Sun Microsystems
  - IETF, 3GPP, WiMAX Forum, ETSI M2M (oneM2M), Zigbee Alliance
  - IPv6, Mobile IP, 4G/WiMAX, 5G, Zigbee/WiSUN, PANA, LoRaWAN

- ## Director of Standards and Advanced Technology Development @ Actility

- ## LoRa Alliance
  - Vice-chair of the Alliance
  - Co-chair, Technical Committee

- ## Founder @ IoTxTR (Nesnelerin Interneti Toplulugu)

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Sensors Need Autonomy

→ Cut the cord
→ Wireless-connected
→ Battery-operated

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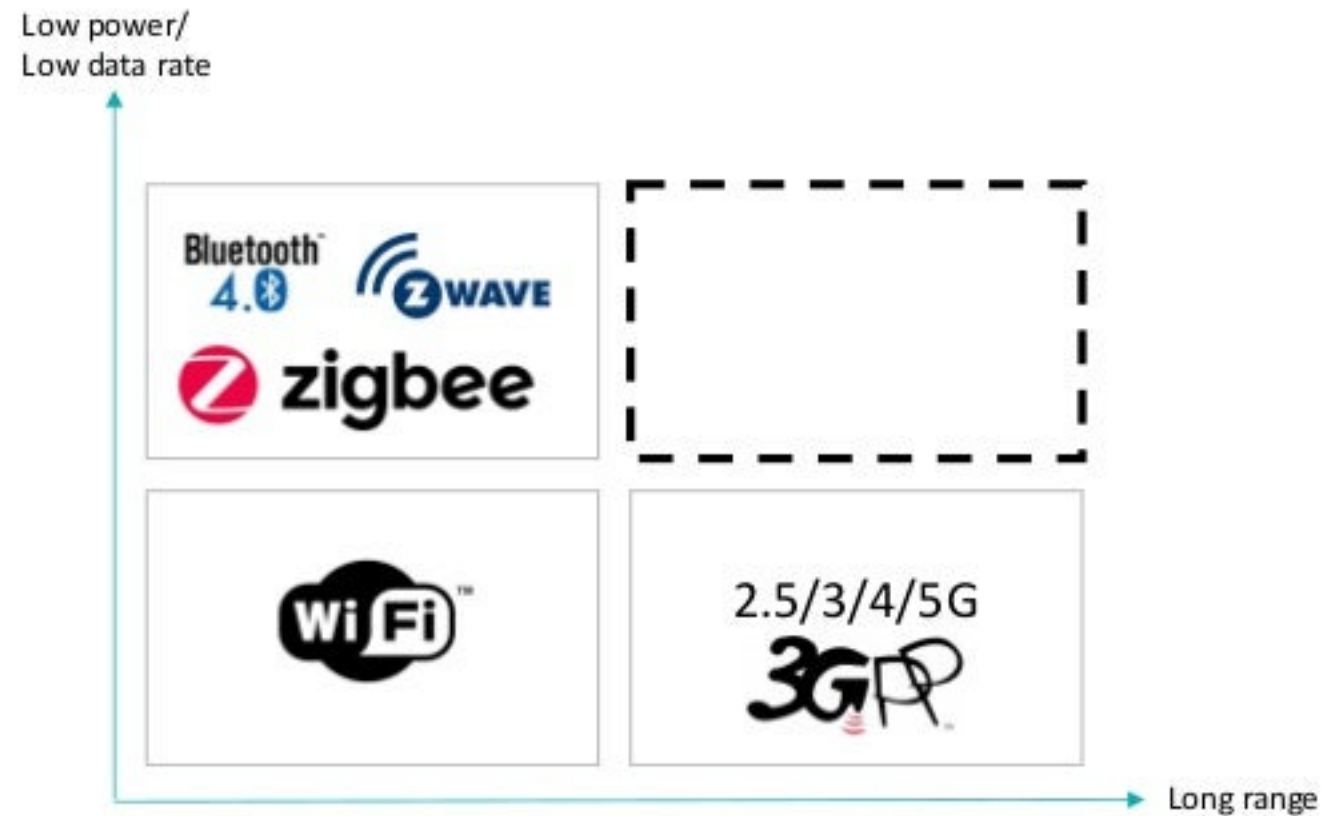# Low Power, But...

Low power/
Low data rate

Long range

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Long Range, But...

Low power/
Low data rate

Bluetooth 4.0   Z WAVE

zigbee

2.5/3/4/5G
3GPP

Long range

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···

Low power/
Low data rate

Long range

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Need Low Power & Long Range

Low power/
Low data rate

Long range

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Low Power & Long Range

Low Power & Long Range

Low power/
Low data rate

Bluetooth 4.0 Z WAVE zigbee

LoRa™

Wi Fi™

2.5/3/4/5G
3GPP

Long range

CYCLEO

SEMTECH

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IBM ...
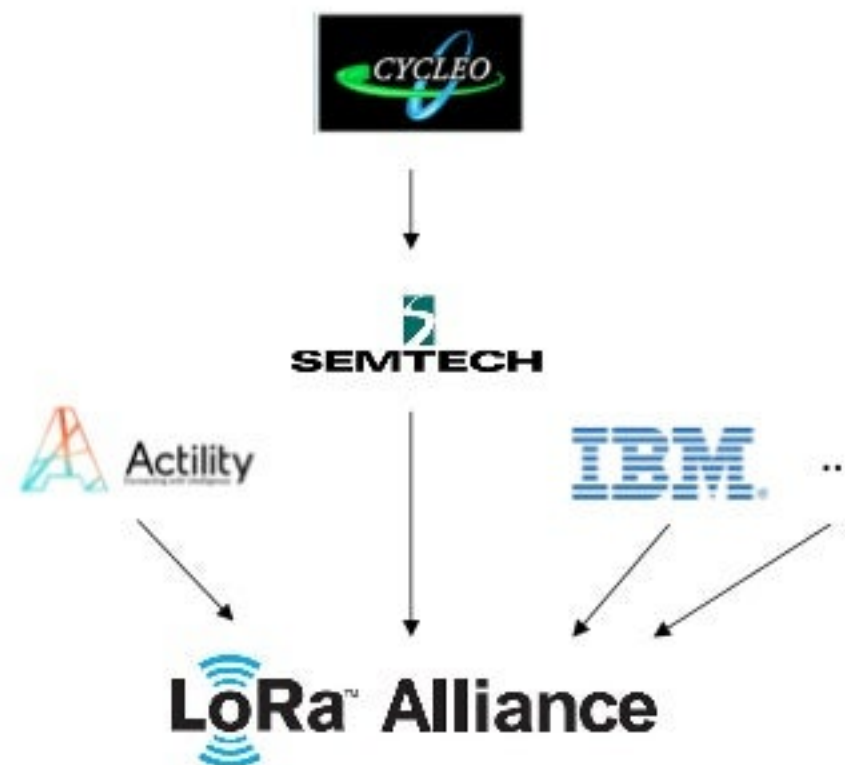
LoRa™ Alliance

Actility
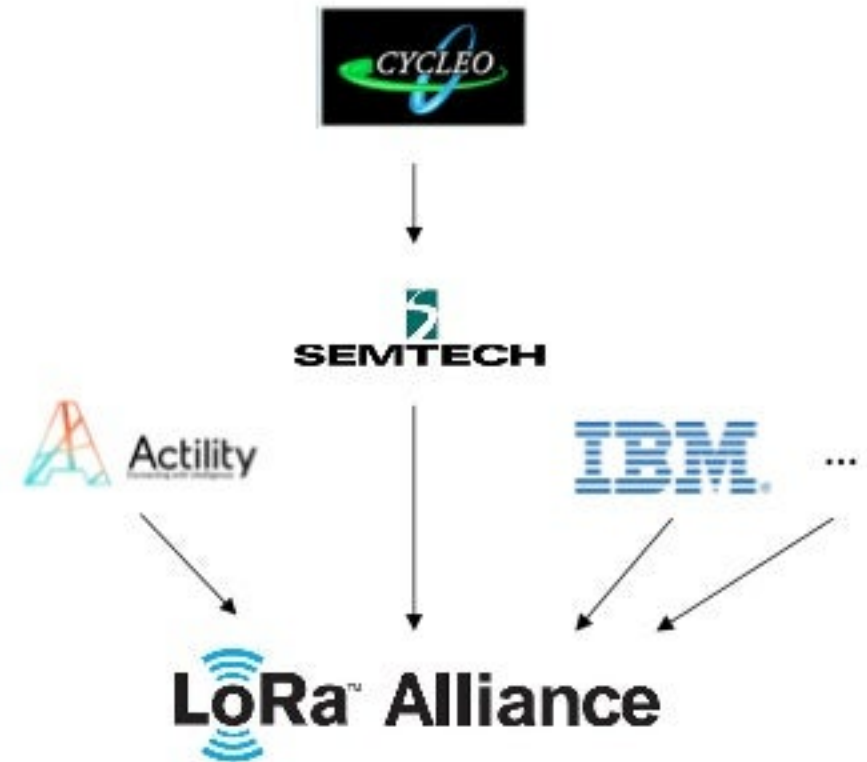
Low Power & Long Range

Trackers

- Tracking scooters @ India

- Tracking belongings @ France

- Panic button @ India

Smart Cities

- Fire alarm
- Acidity and oxygen levels in rivers
- Parking space availability
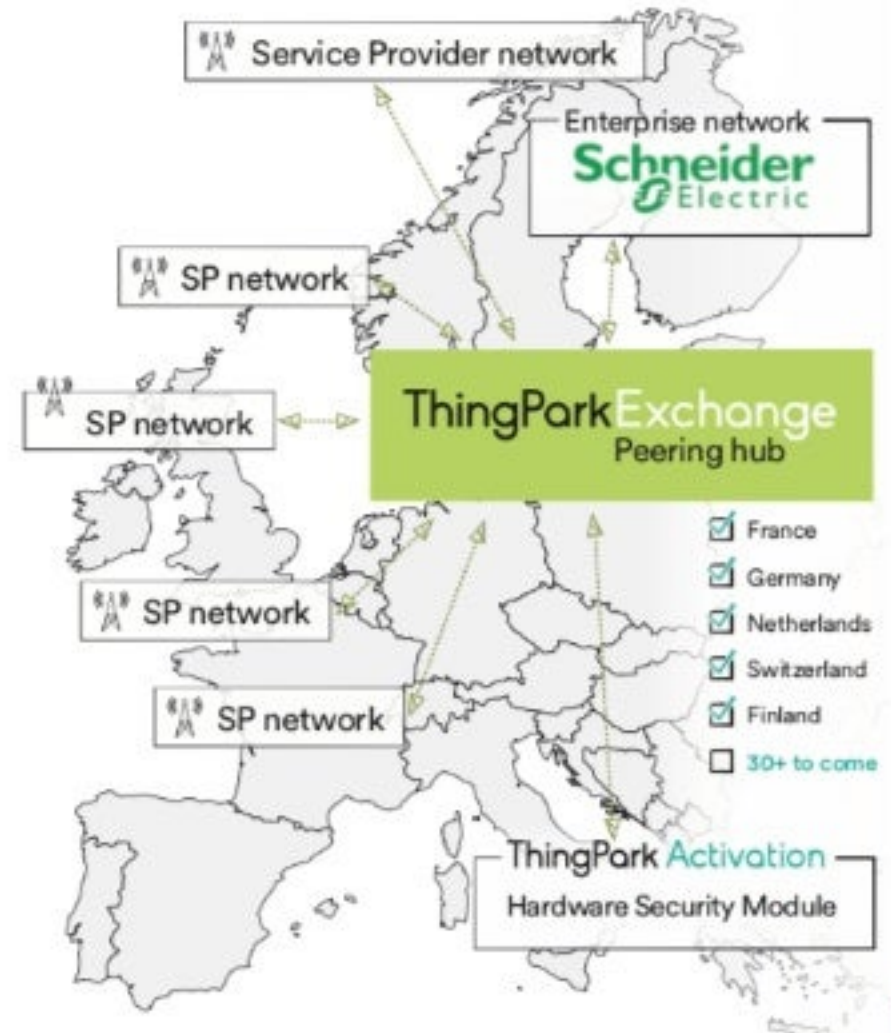- Manhole cover security

@ Shanghai

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Metering

- Water metering @ France
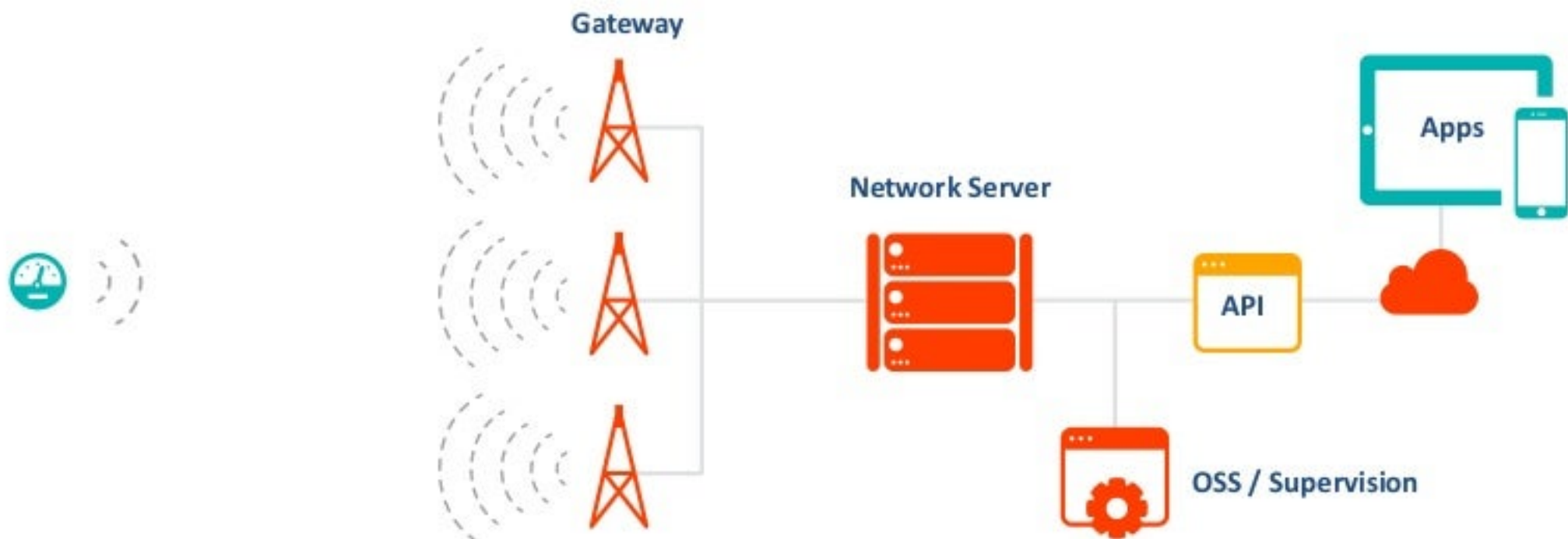
Connected Street Cabinets

- Unauthorized access
- Power loss
- Over-heating/fire

@France, Switzerland, Belgium, Netherlands, ….

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Features

Coverage	Lifetime	Cost	Usage
2 - 10+ km	10+ year battery	License-free spectrum	Public/private networks
Deep indoor	Adaptive Data Rate	Open standards/src	Geoloc (no GPS)
Star topology	(ADR)	Ground-up design	300bps-50Kbps
Bi-directional	Traffic profiles	Low-cost infra	

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Features

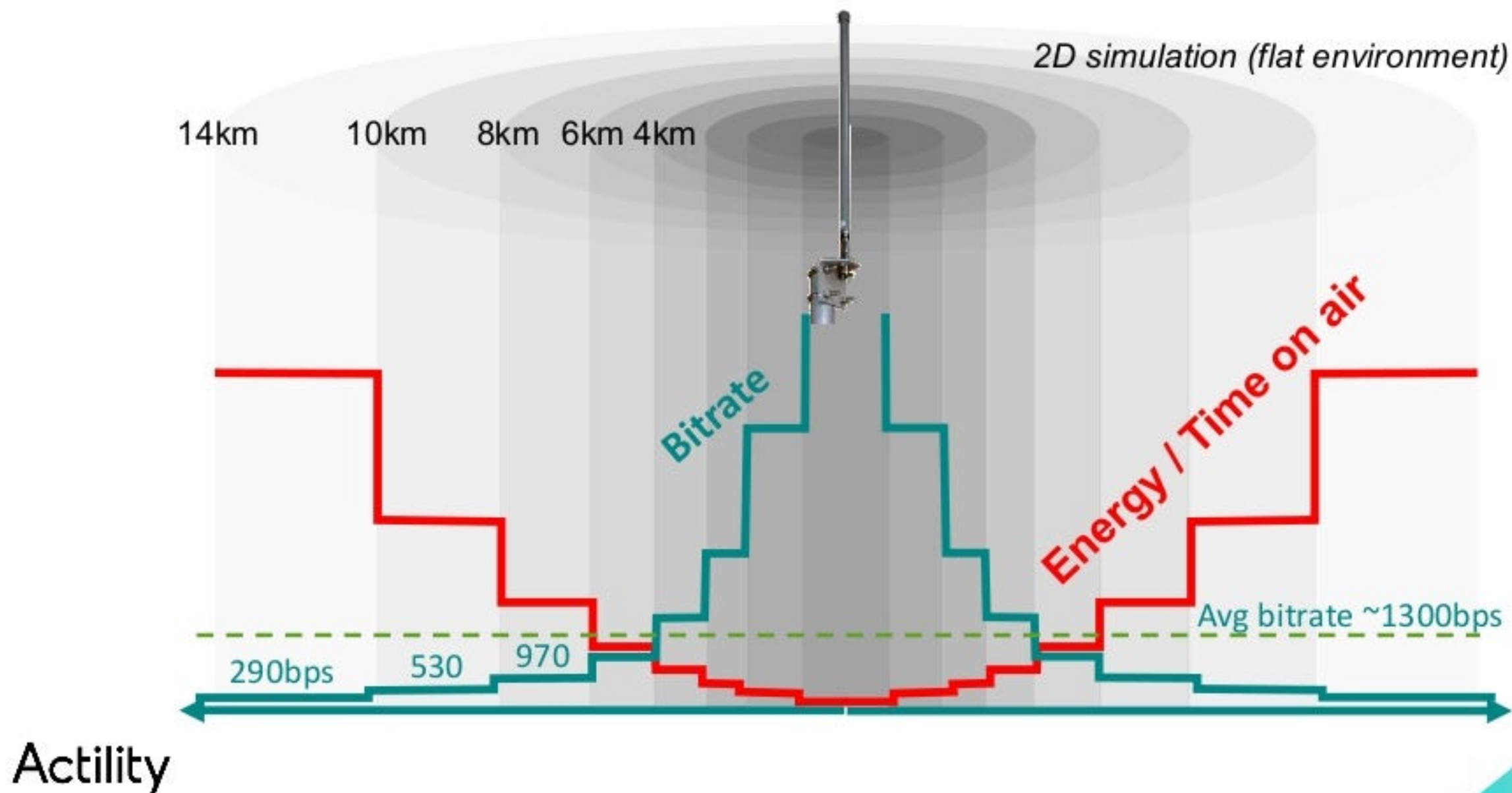| Characteristics	LoRa RF
Modulation	LoRa (Chirp Spread Spectrum)
Frequency	Sub-GHz ISM (868/915Mhz)
Channel bandwidth	125-500 KHz
Data rate	300 bps – 50 kbps
Link budget	155 – 170 dB
Payload size	11 – 242 bytes (variable)
Battery consumption	5mA RX / 18mA (10dBm) TX
Communication type	Bi-directional unicast, network multicast
Interference immunity	Spread-spectrum w/ FEC
Scalability	Self-scaling network capability through Adaptive Data Rate
Mobility	Handover support, geo-location

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Network Stack

App layer	DLMS app stack	App UDP/IP SCHC	Wireless M-Bus app stack	Modbus app stack	Zigbee app stack	Proprietary app stacks …
Link layer	LoRaWAN					
Physical layer	LoRa					

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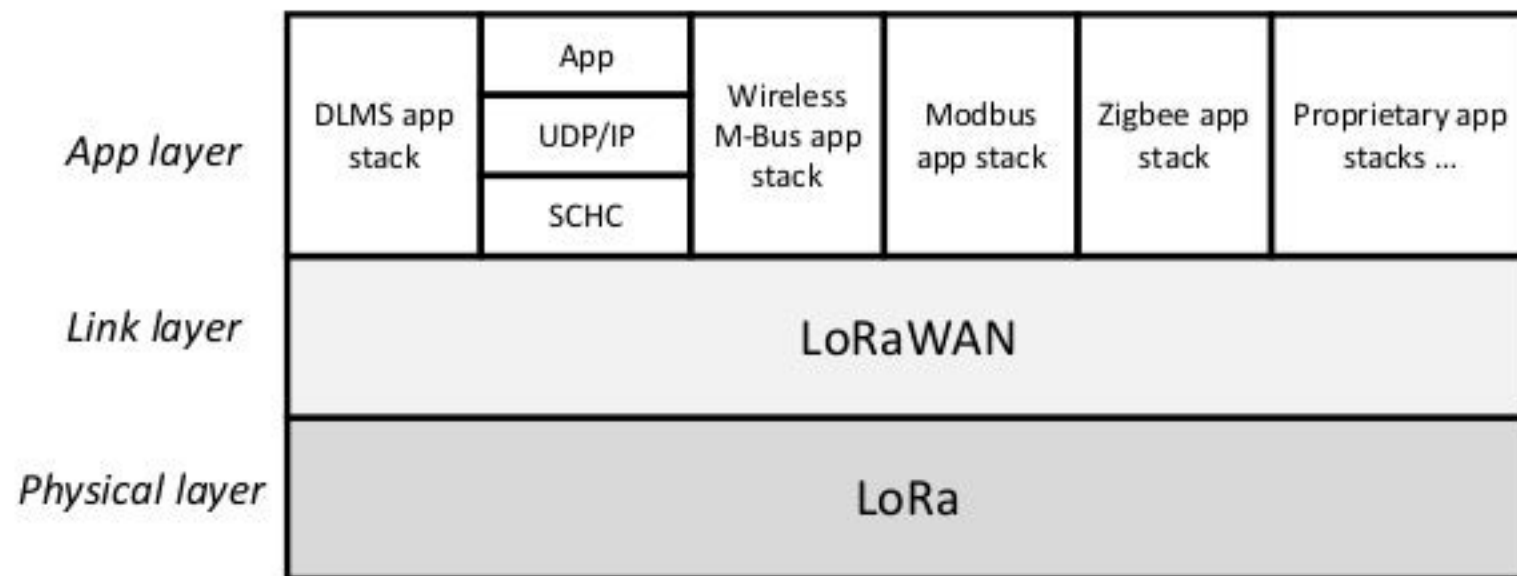
End-device Classes

Class name	Intended usage
A	**Battery powered sensors**, or actuators with no latency constraint
B	**Battery powered actuators** Slotted communication synchronized with the network beacon
C	**Mains powered actuators** Listen continuously

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Adaptive Data Rates

2D simulation (flat environment)

14km   10km   8km   6km 4km

Bitrate

Energy / Time on air

Avg bitrate ~1300bps

290bps   530   970
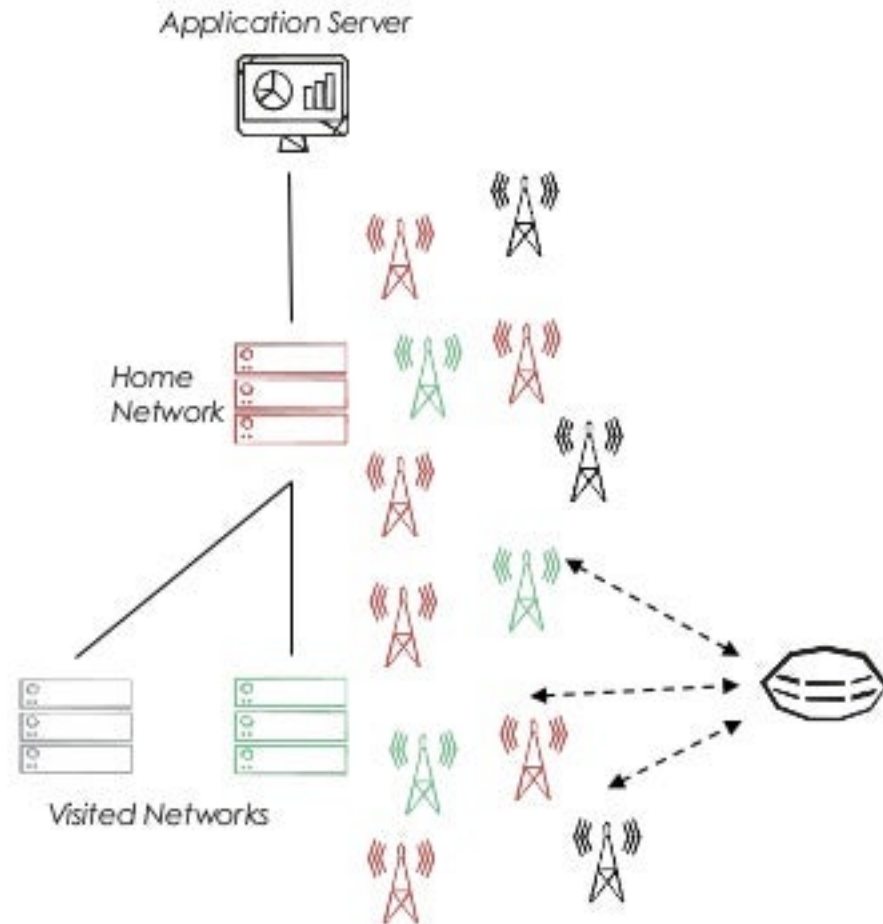
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Geolocation

Location Solver

Network Server
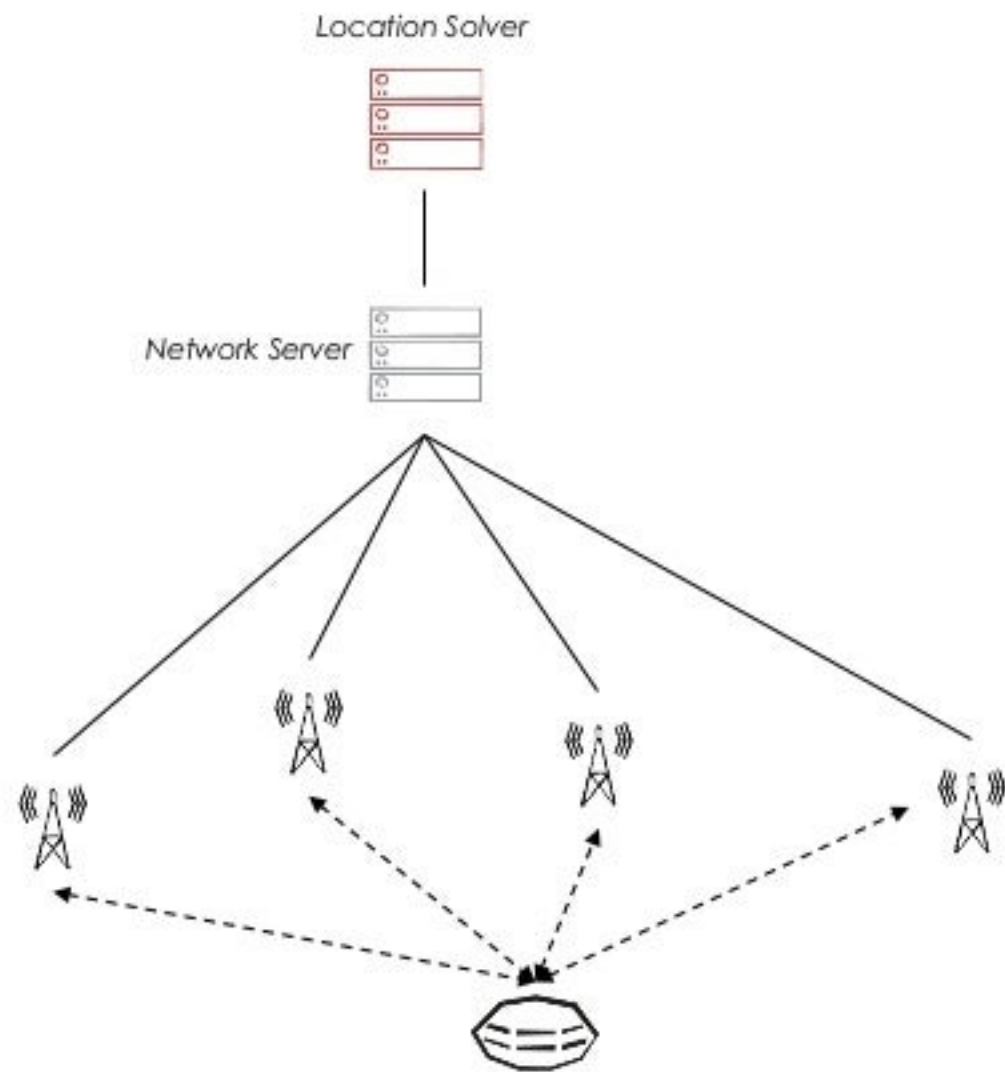
- Physical broadcast + TDoA (Time Difference on Arrival -- nanosec)

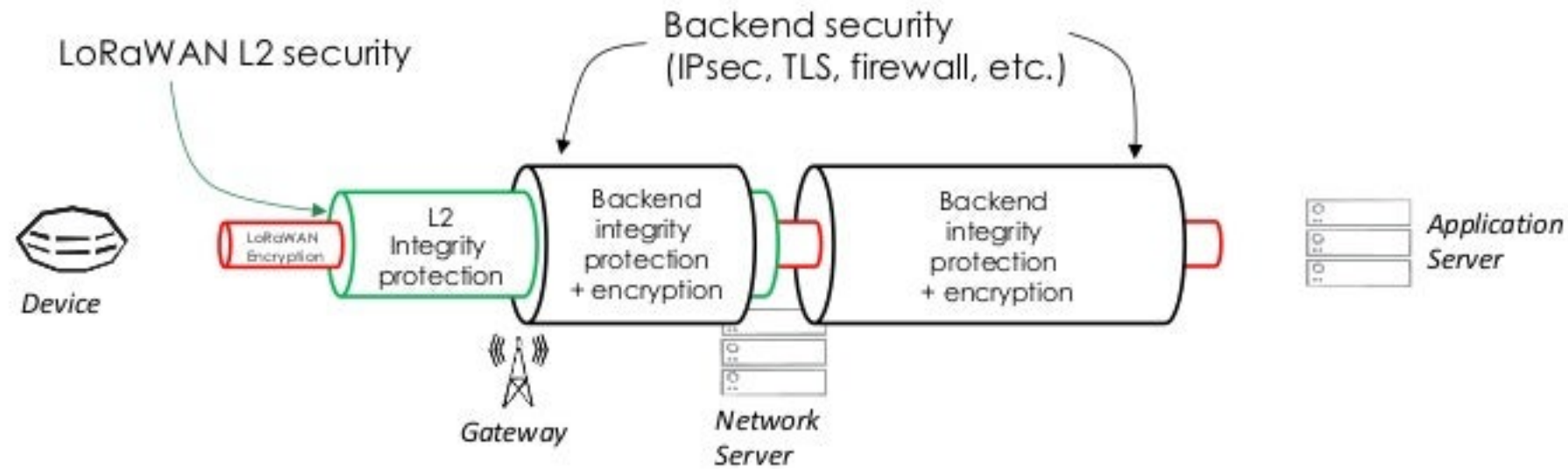- No extra hardware or processing cost on device

→ 20-100m accuracy

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Passive Roaming

Application Server

Home Network

Visited Networks

- **Collaborative reception**
  - Enables higher data rates, lower power (ADR!)
    - Less interference
    - More network capacity
    - Longer battery life
  - Better TDOA/RSSI geoloc accuracy

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Security

LoRaWAN L2 security

Backend security
(IPsec, TLS, firewall, etc.)

LoRaWAN Encryption

L2 Integrity protection

Backend integrity protection + encryption

Backend integrity protection + encryption

Device

Gateway

Network Server

Application Server

Mutual end-point authentication
Data origin authentication
Integrity protection
Replay protection
Data encryption

...using **AES-128** keys and algorithms

\+

FUOTA
(Firmware Update
Over-the-Air)

\+

Hardware-level security
(Secure Elements/
Hardware Security Modules)

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Gateways

Macro-cell

Pico-cell

Dev-kit

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Range

NYC Field Test Oct 28th-29th 2013
Location: 230 Fifth Ave Roof top

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Antenna

1.5->4.5Km range in dense urban/harsh RF environment

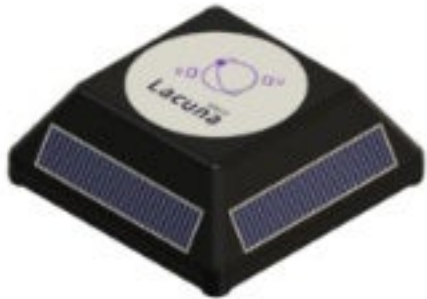**LoRa Range and Coverage**

SEMTECH

❑ Coverage map from a single gateway/concentrator
  • Cisco Webex building in San Jose
❑ >30miles from San Jose to San Bruno

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Sky is the Limit

NORSAT 2
LAT: 32.13
LNG: 139.45
ALT: 607.35 ↓
SPD: 7.55

Powered by N2YO.com · Local Time: GMT+1

NEXT PASS OF NORSAT 2 OVER YOUR CURRENT LOCATION

START AZIMUTH		MAX ELEVATION		END AZIMUTH		TOTAL DURATION
Jan 31 23:07	27° NNE	23:12	18°	23:18	152° SSE	11m 15s

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Lacuna _space_

LoRaWAN™ Operators: Global Adoption

104!
80 LoRaWAN™ networks

56 Countries rolling out

100 Active countries

Publicly
Announced Network

Other LoRaWAN
Deployments

Source: LoRa Alliance™

Operator Diversity - Strengthens LoRaWAN™ Ecosystem

- Cellular operators
- TV and satellite Broadcast Telco
- Utility companies
- Fiber optics Telco
- Cable-co companies
- IOT Solution companies
- System integrators
- Tower-companies

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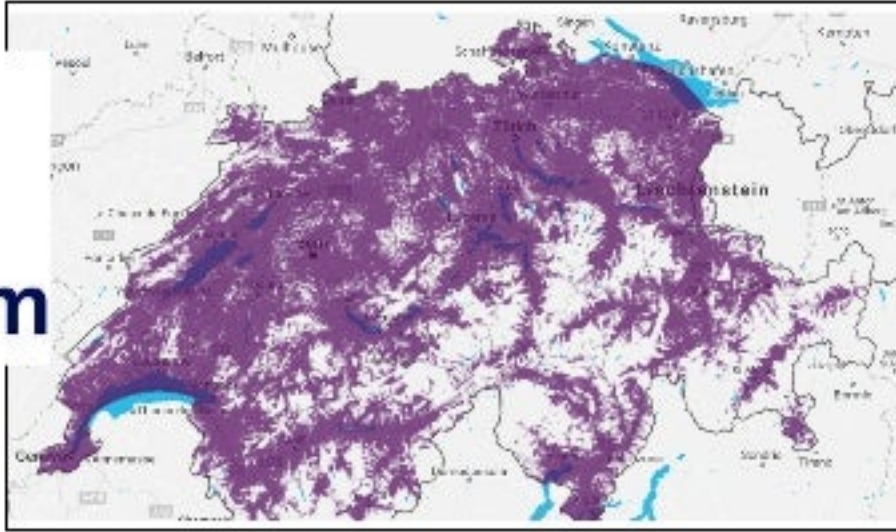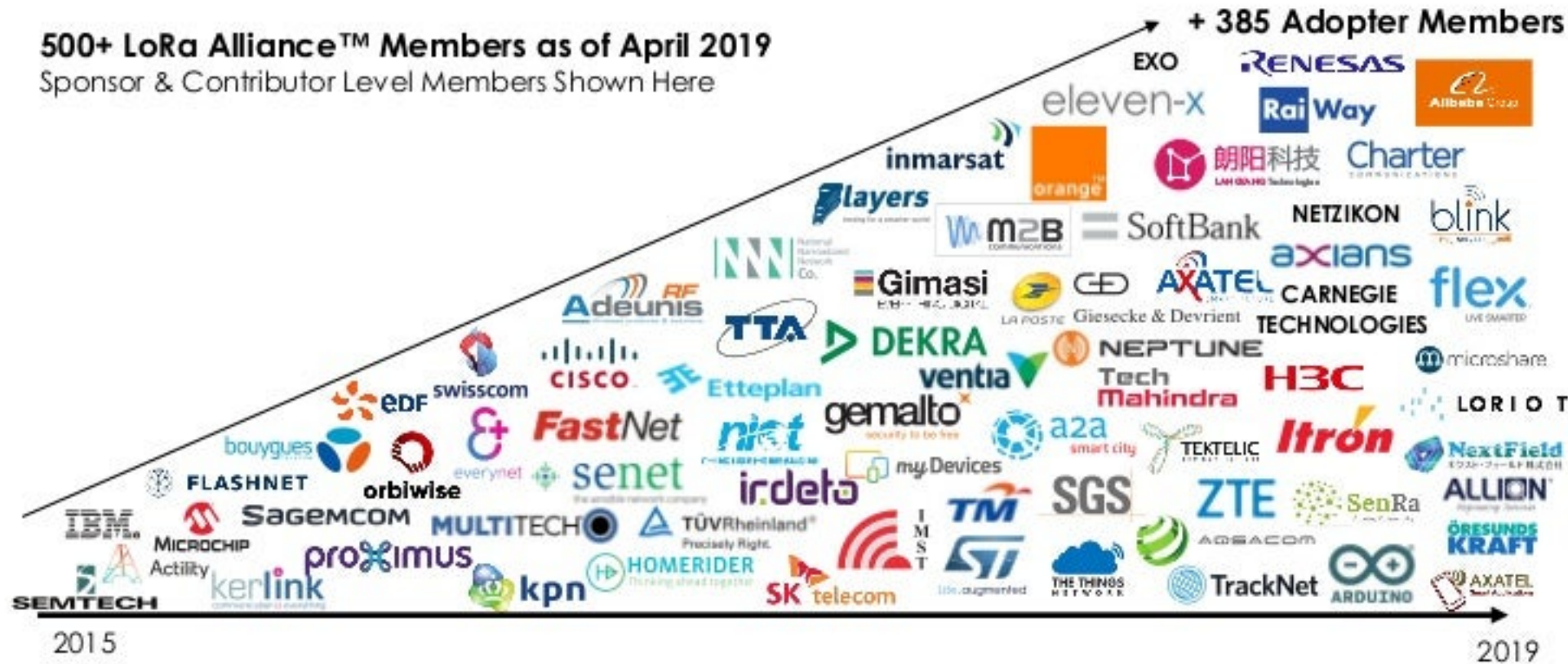ЭНФОРТА

LoRaWAN Coverage Examples

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Google, Cisco, IBM, Orange, ZTE, Comcast, ARM, SKT, Sagemcom, NEC, NTT, Softbank, Alibaba, Tencent, Duracell, Schneider, ...

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Connecting with intelligence

- **Leading LoRaWAN system vendor**
  - Over half of national public networks globally powered by ThingPark platform
- **Most comprehensive product/service portfolio**
- **LoRa Alliance leadership**
  - Founding member, Alliance Vice-chair, Board Member, Technical Committee Co-chair, and active across all groups
- **Developer network**
  - 1000+ registered members
- **B2B marketplace**
  - 150+ sellers

IoT connectivity platform

ThingPark Wireless
Core network management solution For public IoT networks & service providers

ThingPark Enterprise
Powering IoT connectivity solutions dedicated to enterprise applications

ThingPark OS
IoT network business enabler

ThingPark X
Data analytics and control framework

IoT market enablers

ThingPark Location
Geolocation and tracking of IoT devices

ThingPark Energy
Smart grid, flexibility market & energy efficiency

IoT ecosystem digital services

ThingPark Developers
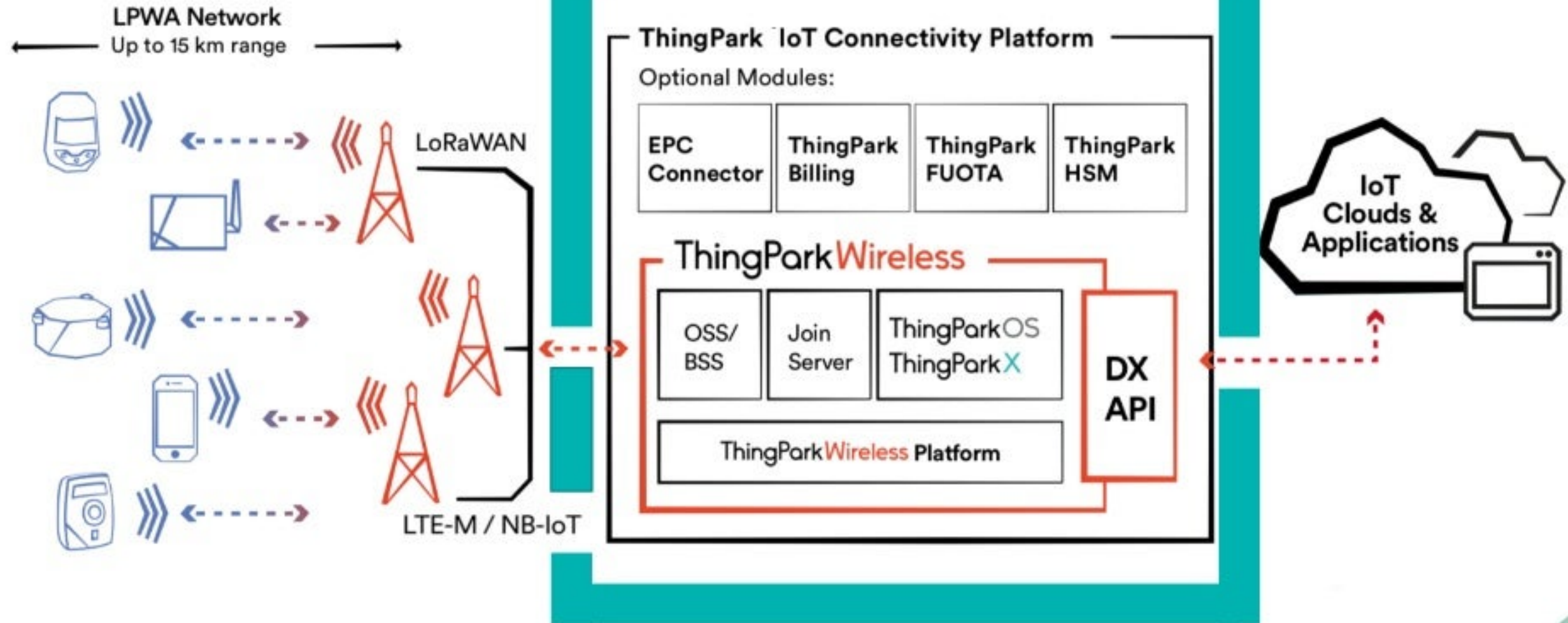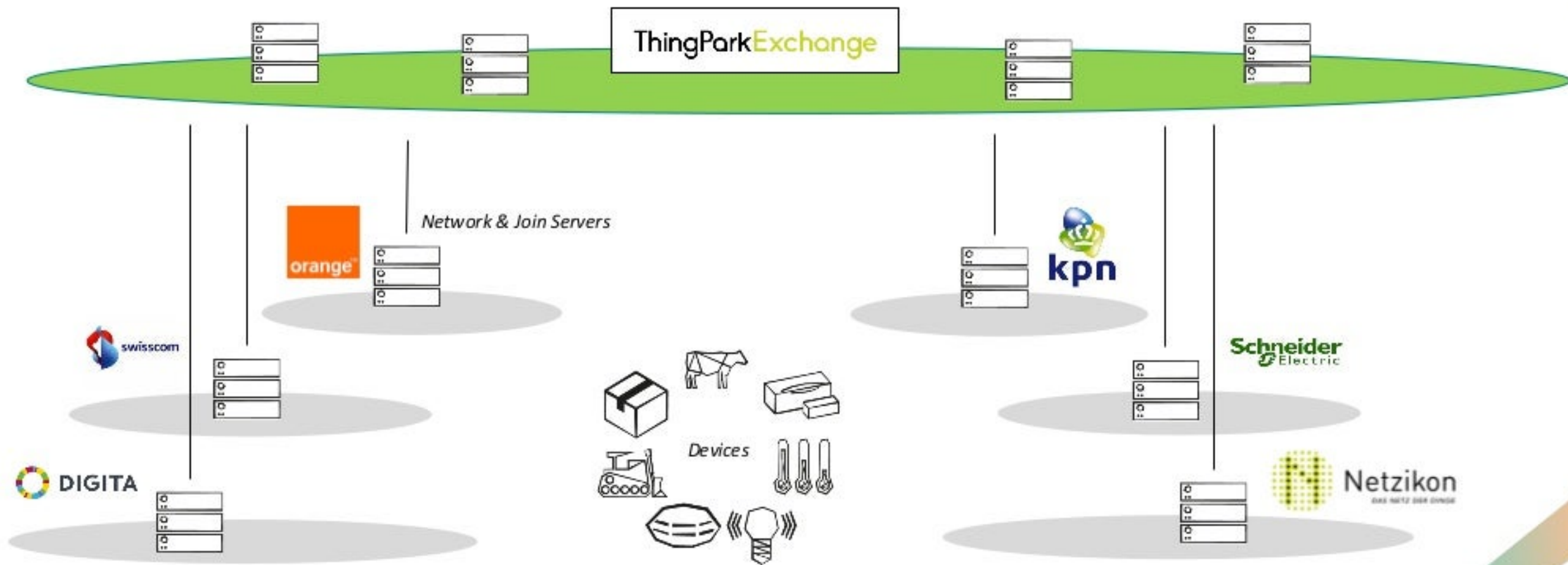Developer support and go-to-market accelerator

ThingPark Market
B2B e-commerce hub for IoT

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LPWAN Backbone

ThingPark Exchange

Network & Join Servers

orange

swisscom

DIGITA

Devices

kpn

Schneider Electric

Netzikon

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LoRaWAN vs SigFox

sigfox

Sub-Ghz ISM
Public networks
Closed ecosystem
Single business model
Constrained (*) traffic

Early start

LoRaWAN™

Sub-Ghz ISM
Public + private networks
Open ecosystem
Flexibles business models
Less constrained traffic
Dynamic power management
Collaborative networking

(*) 12 byte frame, 140UL/4DL per day, 100bps

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LoRaWAN vs NB-IoT

NB-IoT

Licensed bands
Public networks
Emerging deployments

Real-time
Higher data-rate (250Kbps)
Marketing power (GSMA)

LoRaWAN

ISM (unlicensed band)
Public + private networks
Accelerating deployments
Low-power (1/5th! of NB-IoT)
Low-cost infra
Collaborative networking

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