LONG RANGE IOT : OVERVIEW

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AGENDA

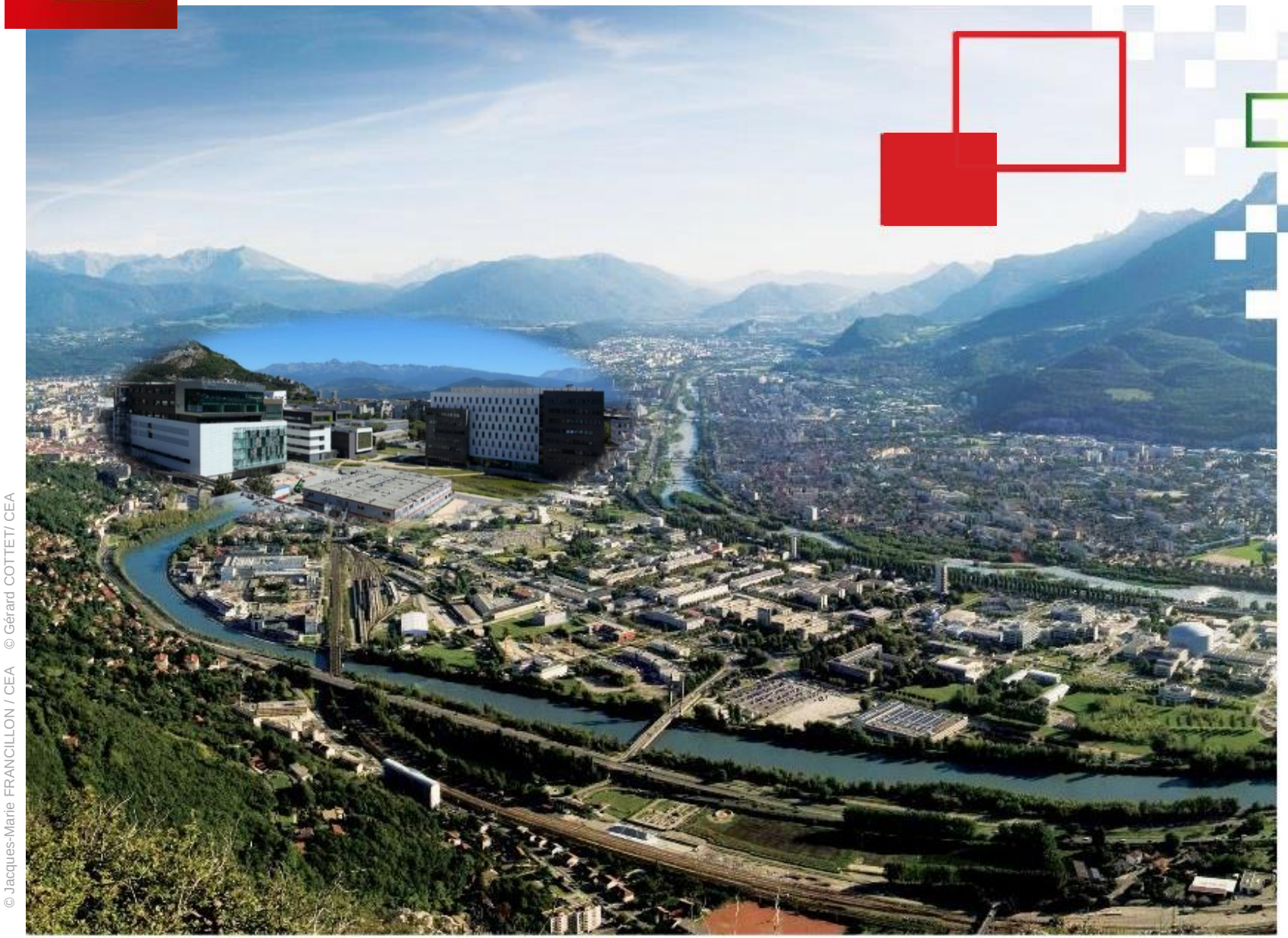
MAIN USE-CASES & KEY REQUIREMENTS

SIGFOX, LORA, LTE-M & NB-IoT

5G

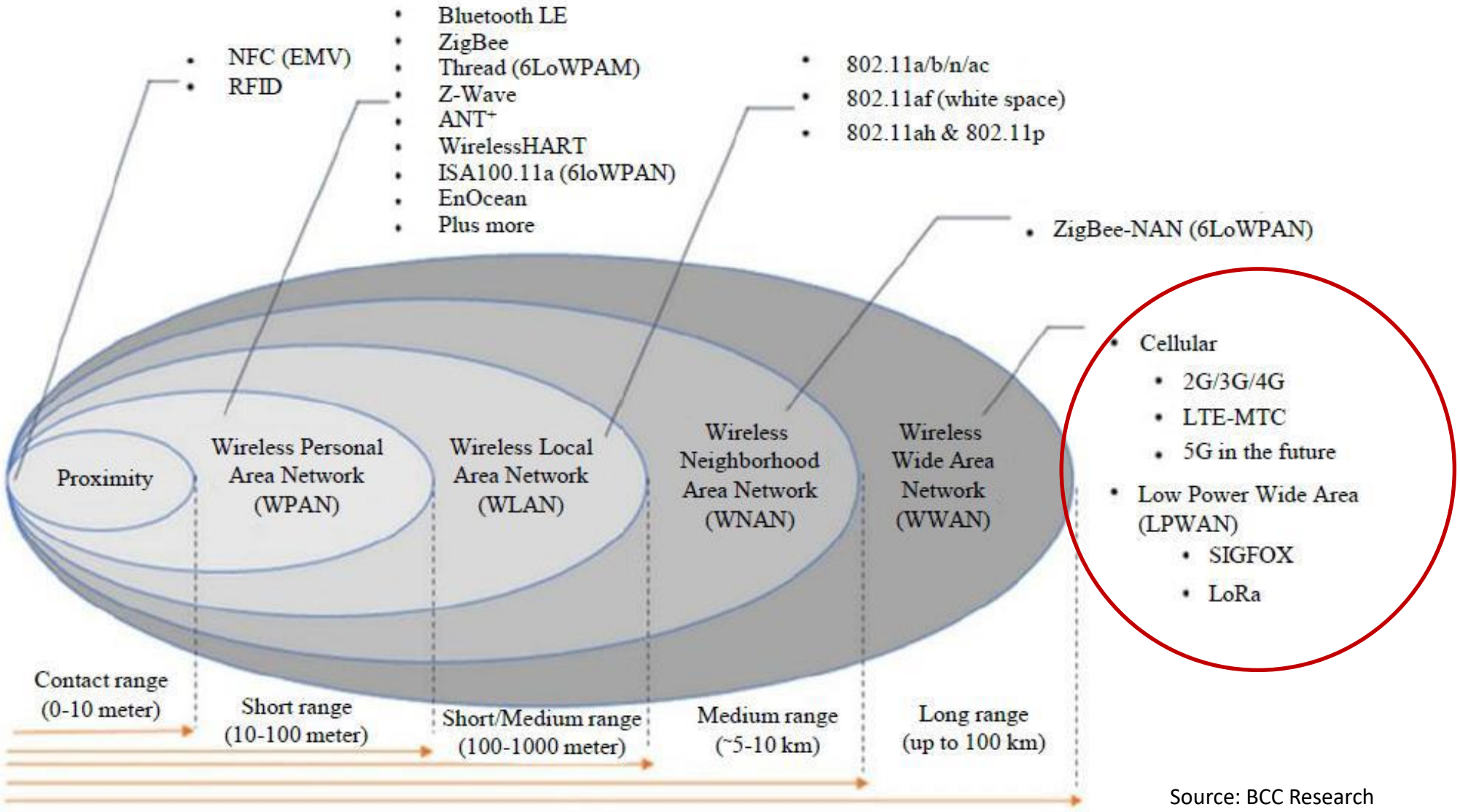
R&D CHALLENGES

Leti, for 50 Years, the Place to be to Invent Tomorrow



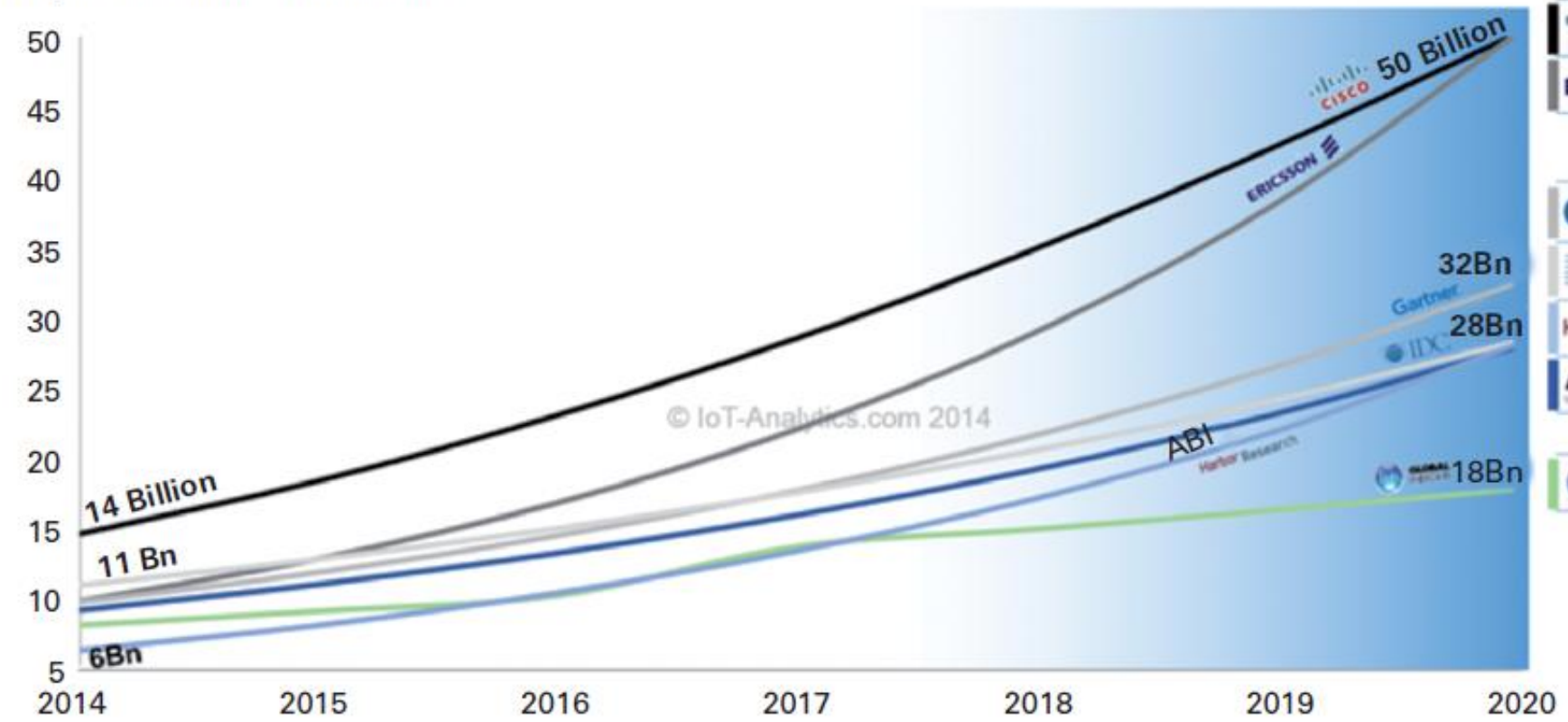
- Since **1967**
- France, USA, Japan
- **2,000** People
- **> 2,760** Patents in Portfolio
- **350** Industrial Partners
- **> 65** Startups Created
- **10,000 m²** Cleanroom 200-300mm
- **315 M€** Budget
  (**85%** from R&D contracts)

IoT WIRELESS LANDSCAPE



Source: BCC Research

IoT MARKET FIGURES



Source	Date	CAGR[1] 2014-2020
CISCO	2013	23 %
ERICSSON	2010	-
Gartner	2013	23 %
IDC	2014	17 %
Harbor Research	2014	29 %
ABI research	2014	21 %
IHS GLOBAL INSIGHT	2014	14 %

1) Taux de croissance annuel moyen
2) Le terme « objet connecté » inclut tout objet autonome (chaque analyste a sa définition), sont exclus les portables, téléphones mobiles et tablettes.

Sources : Cisco, Ericsson, ABI Research, Gartner, IHS, IDC, Harbor Research, IoT-Analytics.com

MAIN USE-CASES & KEY REQUIREMENTS

USE-CASE : ASSET TRACKING

Louis Vuitton Echo,
service launched in April 2018

Key requirements :

- **Low power**
  - Current autonomy : 6 months
- **Worldwide indoor/outdoor coverage**
  - Current coverage : 120 airports
- **Indoor/outdoor localization**

sigfox

USE-CASE : SMART CITIES

Morphosense predictive maintenance service launched in 2016

Key requirements :

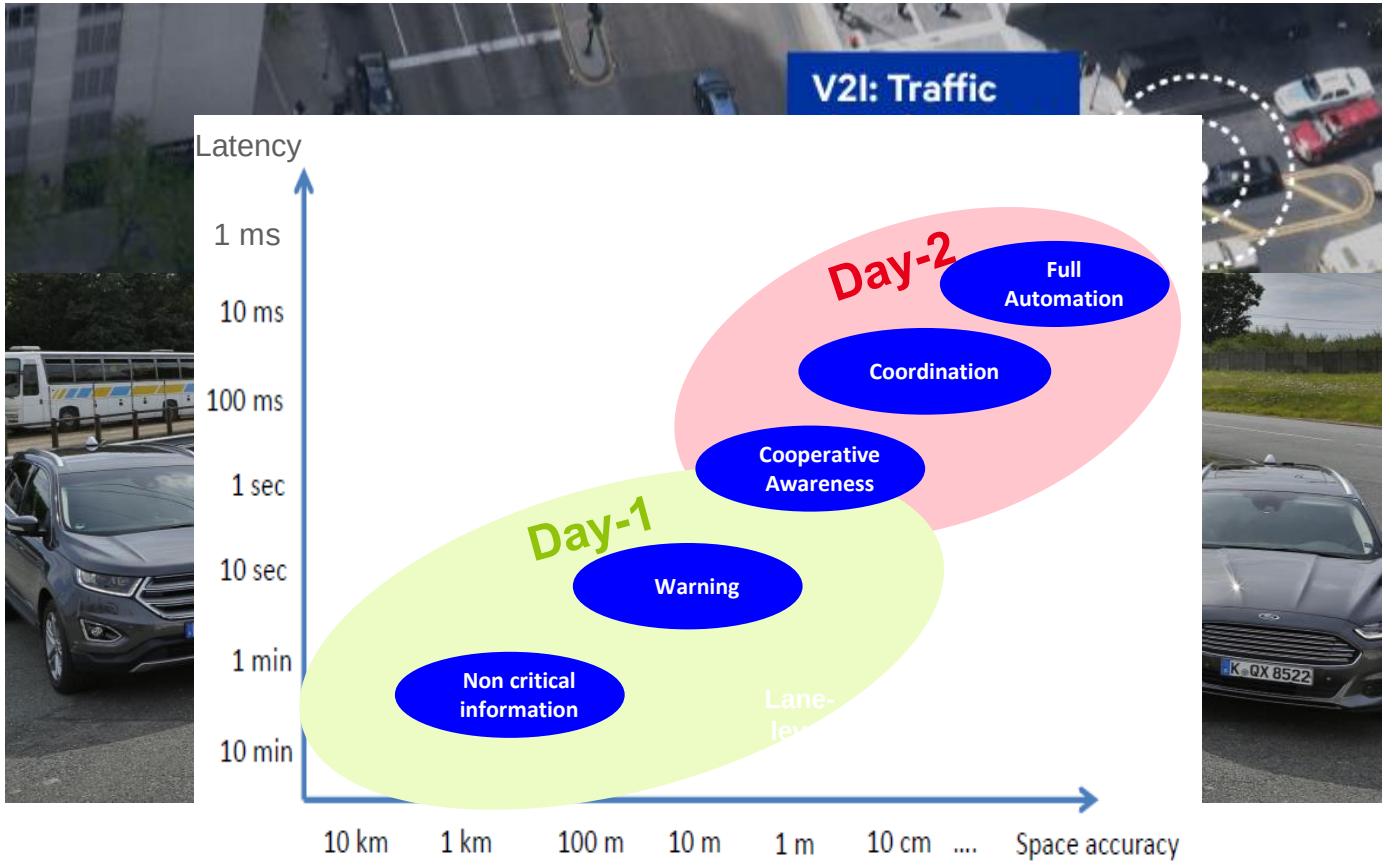
- **Reliability**
- **Service dependent data rate**
- **Worldwide coverage**

USE-CASE : CONNECTED MOBILITY

From traffic monitoring to road safety & autonomous vehicle use-cases

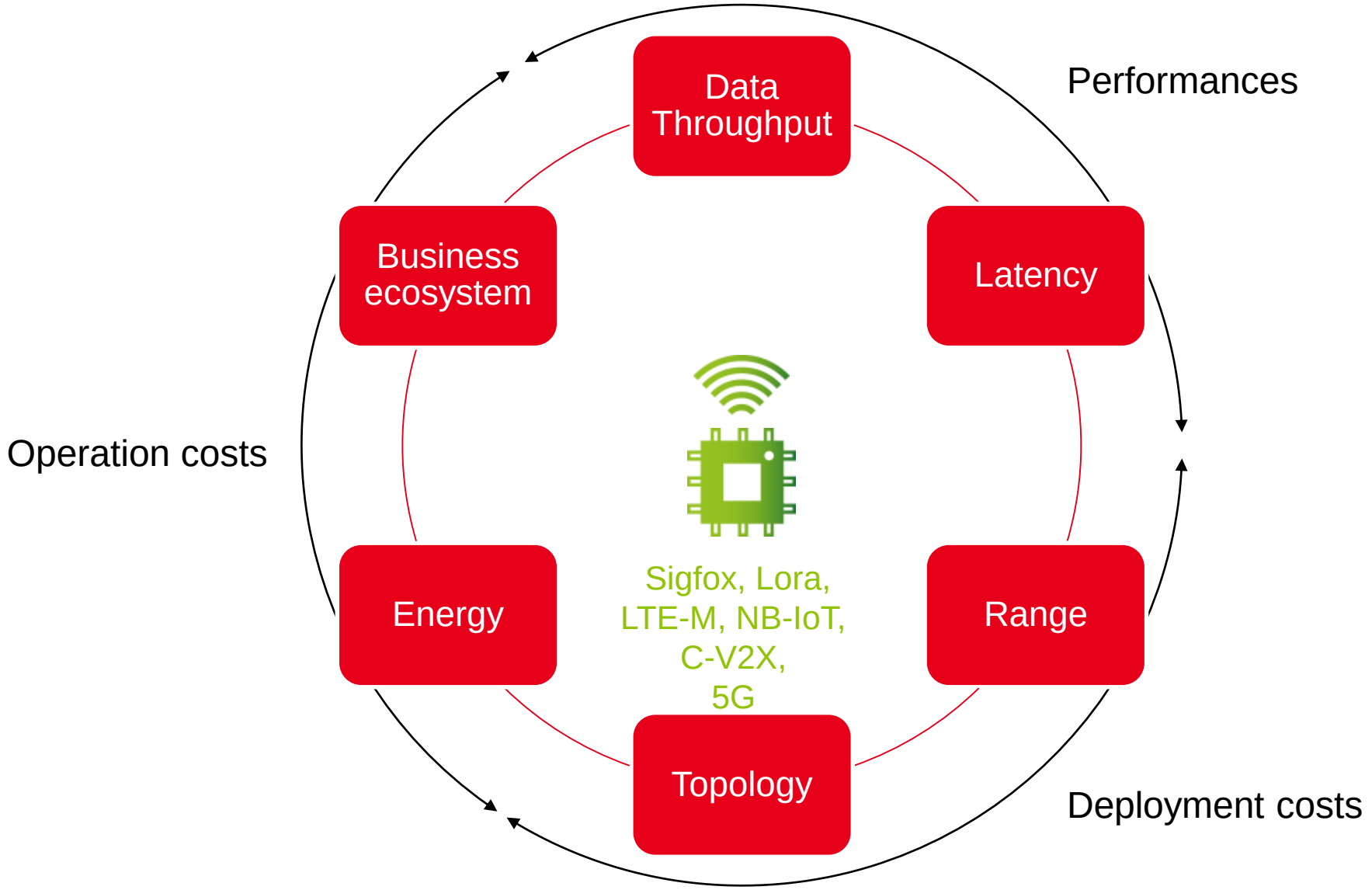
Key requirements :

- **Low latency**
- **Ultra Reliability**
- **Ad-hoc network support**
- **Interoperability**
- **Precise Localization**



11/07/18: 5GAA, BMW Group, Ford and Groupe PSA Exhibit First European Demonstration of C-V2X Direct Communication Interoperability Between Multiple Automakers

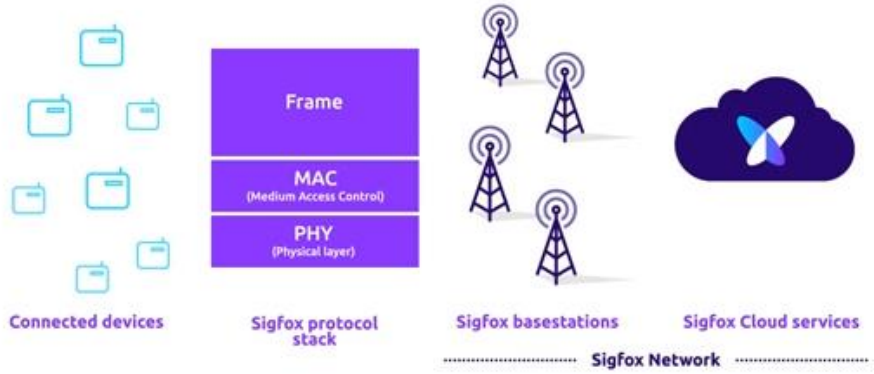
IoT wireless connectivity key requirements



SIGFOX, LORA, LTE-M, NB-IOT

SIGFOX

- Sigfox, French startup created in 2009
- Deploy and operate a long range radio network
- July 2018 : 3 millions objects connected,
  December 2018 : 6,2 millions
- Chip provider : STM, NXP, CGT, Microchip….



SIGFOX protocol stack is proprietary,
provided free of charge to modem manufacturers

SIGFOX	
FREQUENCY BAND	Unlicensed ISM Bands 868 Mhz (Europe), 915MhZ (USA), 433MHz (Asia)
BANDWIDTH	200 kHz UNB (one message on 100 Hz)
DATA RATE	100bit/s to 600bit/s
RANGE	- 30 to 50km rural areas - 3 to 10 km urban areas
MOBILITY/ LOCALISATION	Mobility RSSI

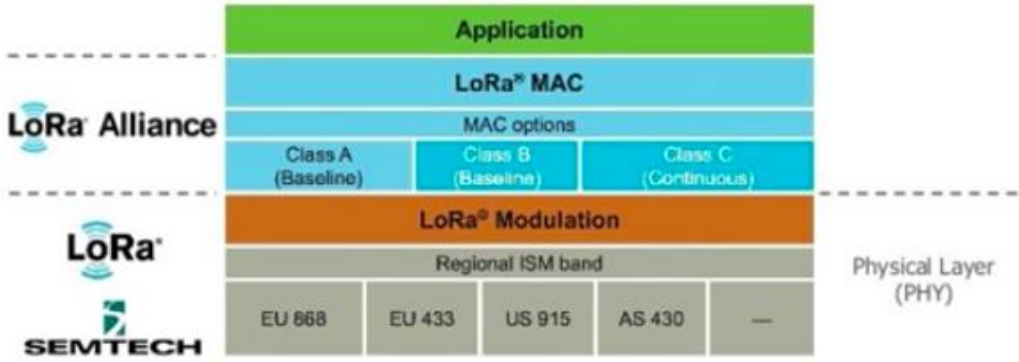
LORA

- **Lora : technology developed by French startup Cycleo acquired in 2012 by SEMTECH**

- **Lora Alliance : industrial ecosystem which promotes LoRa technology & LoraWan protocol**
  Founding members include Actility, Cisco, Eolane, IBM, Kerlink, IMST, MultiTech, Sagemcom, Semtech, Microchip Technology, Bouygues Telecom, KPN, SingTel, Proximus, Swisscom, and FastNet

- **Operational model: public or private**
  Expectation : 80% public

- **Chip provider : Semtech, announces 80millions lora enabled nodes early 2019**



LORA protocol stack

LORA	
FREQUENCY BAND	Unlicensed ISM Bands 868 Mhz (Europe), 915MhZ (USA), 433MHz (Asia)
BANDWIDTH	125 kHz/250kHz
DATA RATE	300bit/s to 50kbit/s
RANGE	- < 15km rural areas - 2 to 5km urban areas
MOBILITY / LOCALISATION	Conditioned by roaming agreement TDoA

LTE-M & NB-IoT

- **Two technology under the same 3GPP standard : release 13 / LTE Advanced Pro**

- **Early push from Verizon, Deutsche Telekom and Vodafone**
- **Deployment :**
  - In February 2019, the GSMA indicates that Mobile IoT is available in more than 50 countries.
  - China:
    - China Mobile has launched NB-IoT in 346 cities using chipsets from five companies.
    - Ministry of Industry and Information Technology MIIT's targets
      - End of 2017 : all major cities in China, 400K BSs, 20M connections
      - 2020: nationwide coverage, 1,5M BSs, 600M connections

- **Worldwide coverage technical challenge for NB-IoT**

- **Chip providers : about 15 companies announced chip development: Qualcomm, Sierra Wireless, Sequans, GCT Semiconductor, ublox…**

16/10/18 : MICHELIN, SOFTBANK ET ADLINK DÉPLOIENT UNE SOLUTION IOT AU JAPON

02/19: CHINA MOBILE ANNOUNCES 3 MILLION EBIKE CONNECTED IN ZHENGZHOU TO REDUCE THEFTS AND ACCIDENTS

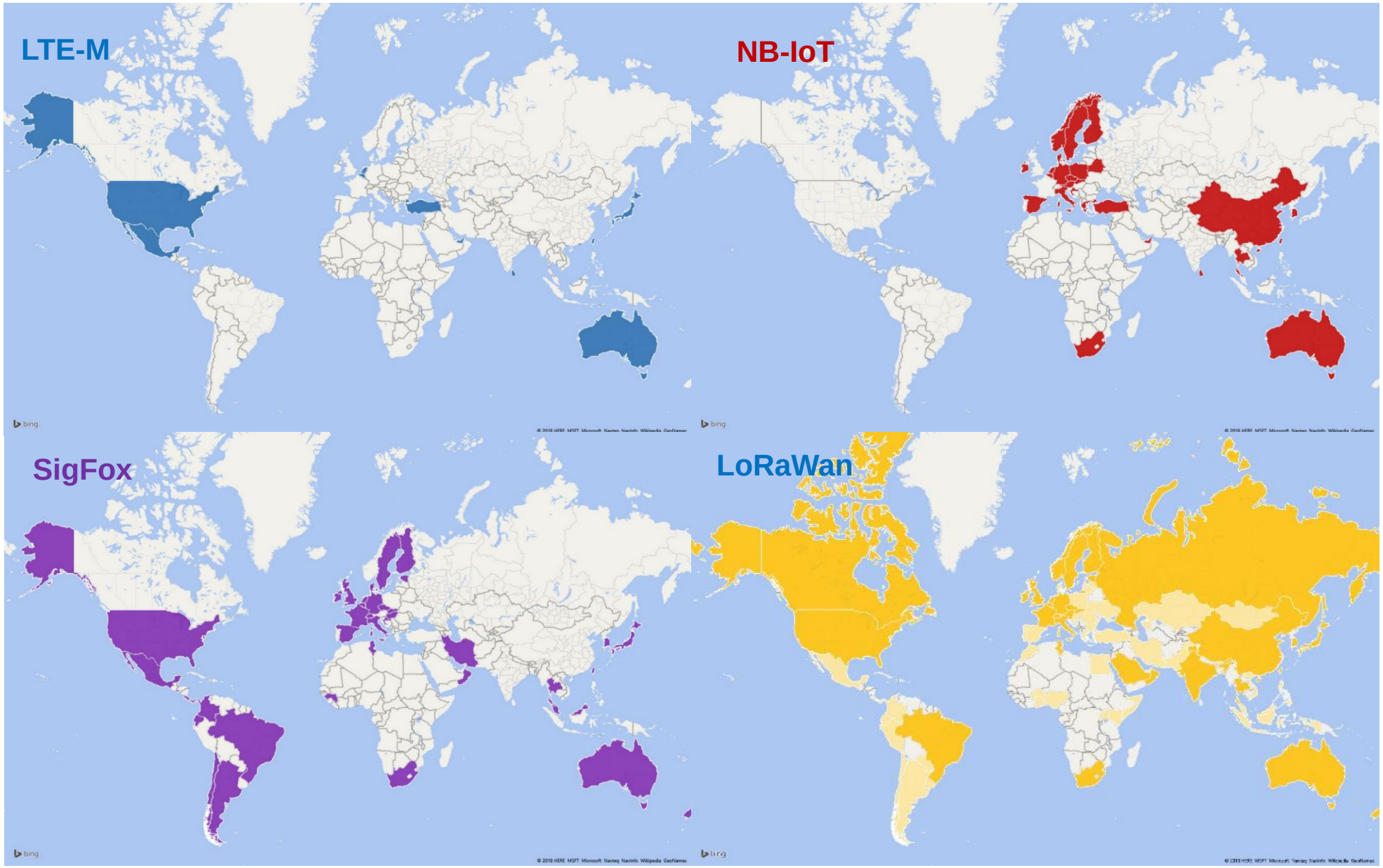
LTE-M & NB-IoT

	LTE-M	NB-IoT
NAMES	eMTC Cat-M1 / LTE-M release 13	NB-IoT Cat-NB1 / NB-LTE release 13
FREQUENCY BAND	Licensed (700 – 900MHz)	Licensed LTE Band
BANDWIDTH	1,4 MHz	200kHz
DATA RATE	<1 Mbits/s	<150kbits/s
RANGE	NA	NA
MOBILITY/LOCALISATION	Mobility	No (Mobility in release 14)

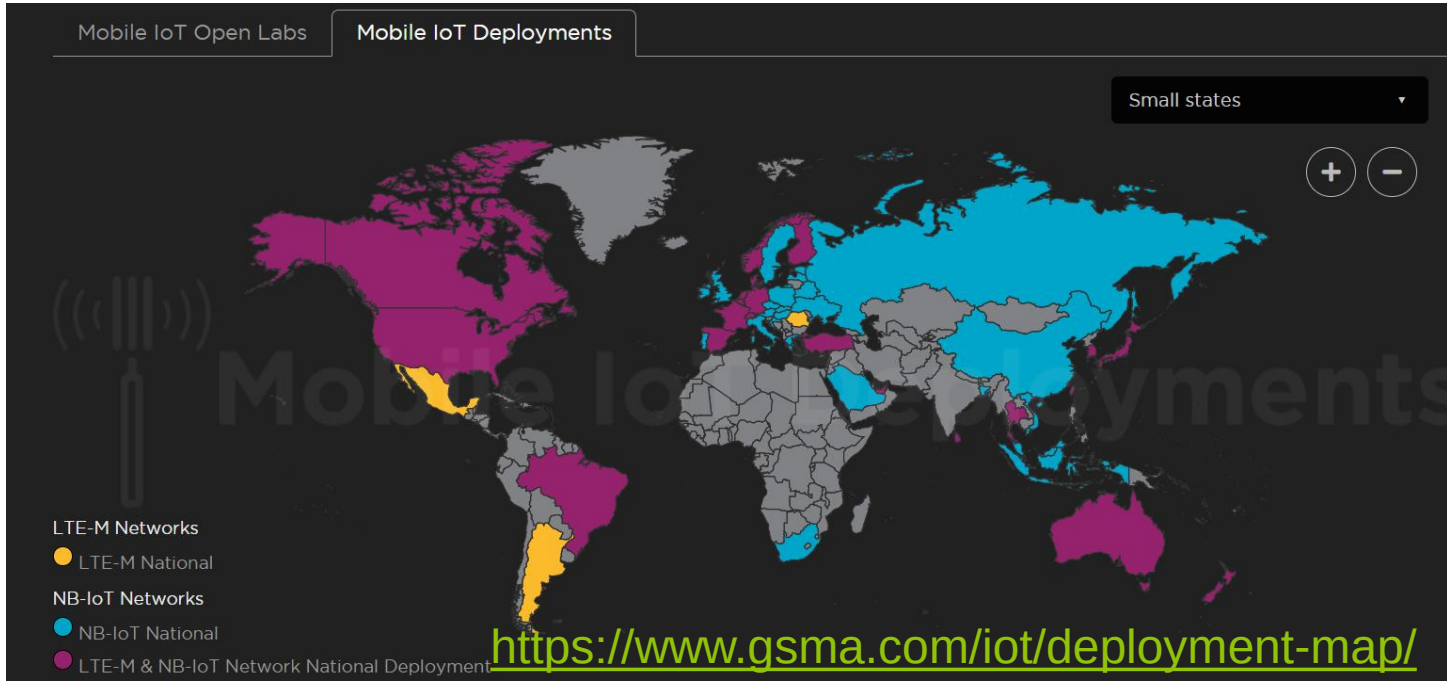
- ✓ Optimized for voice & browser I/F IoT
- ✓ Compatible with the existing LTE network (software upgrade only)

- ✓ Optimized for massive IoT
- Require an infrastructure upgrade

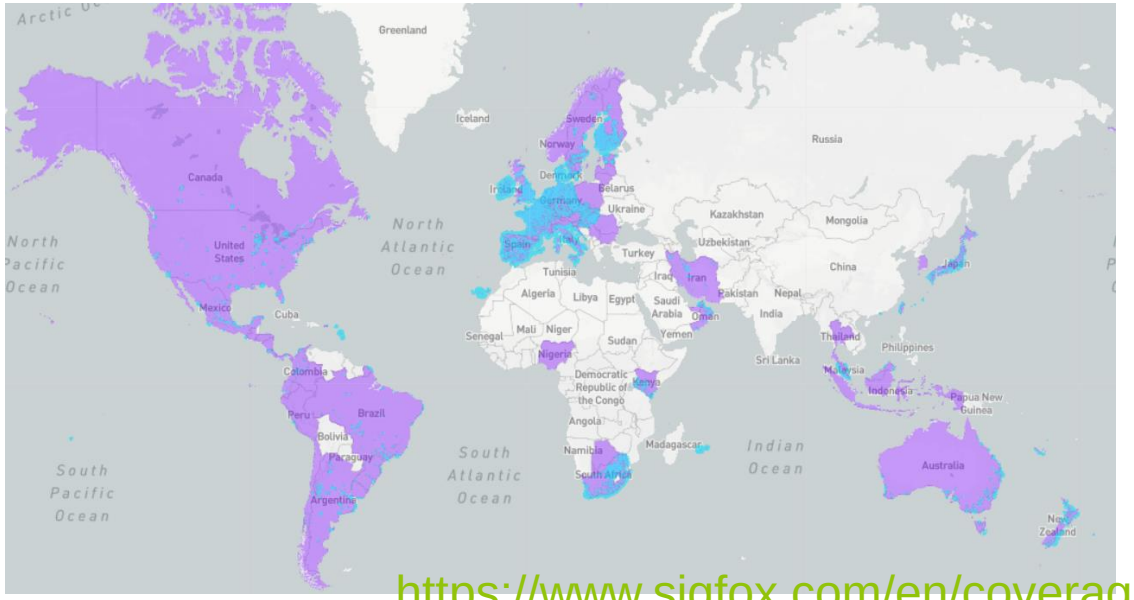
DEPLOYEMENT (JULY18)



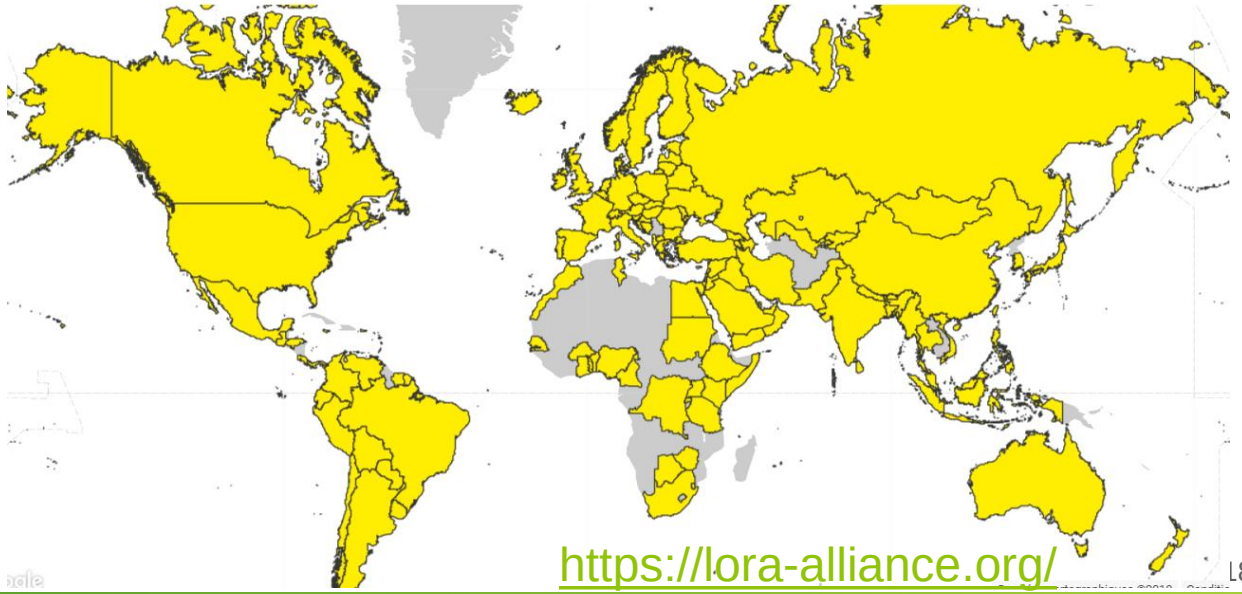
DEPLOYEMENT Q3 2019



https://www.gsma.com/iot/deployment-map/

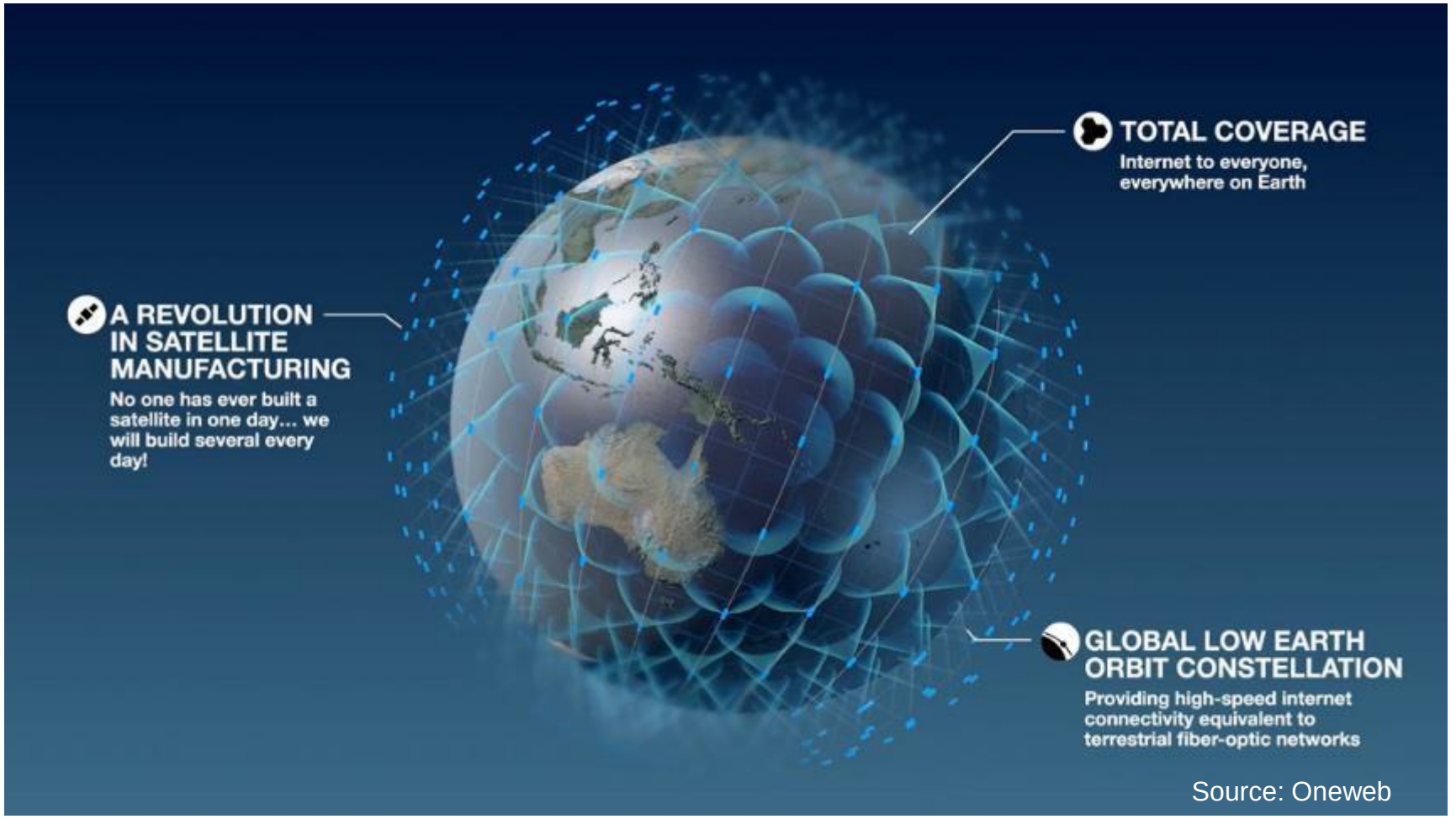


https://www.sigfox.com/en/coverage



https://lora-alliance.org/

DEPLOYMENT:
GLOBAL SATELLITE NETWORKS ANNOUNCED!



Iridium in collaboration with Amazon Web Services on CloudNet project announce an IoT satellite connectivity in 2021
Other initiatives : Eutelsat, SpaceX,…

leti
ceatech

5G

5G NETWORKS : NEW FEATURES

4G+	LPWA+	5G NR
		
Ubiquitous mobile high-speed internet	Massive IoT	Critical missions
Mass market Accelerate deployment	Low-cost connectivity High density	Low latency Ultra reliable

5G SPECIFICATIONS

10x
More
Spectrum

×

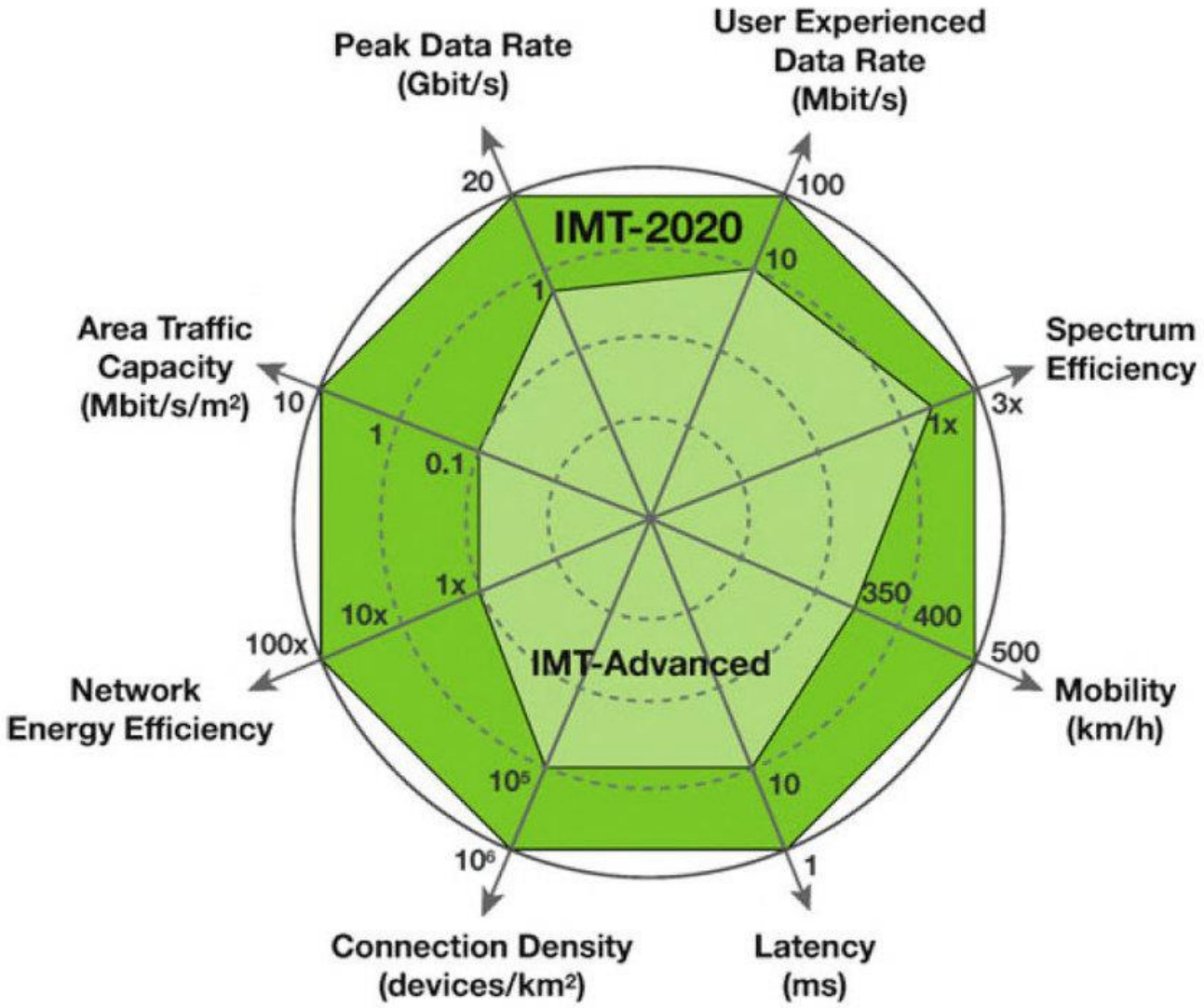
10x
Spectrum
efficiency

×

10x
More
base-stations

=

1000x
Capacity



5G

C-V2x chip (5GAA)

Mobile IoT in 40+ countries (GSMA)

First 5G smartphone (ZTE)

Olympics Korean

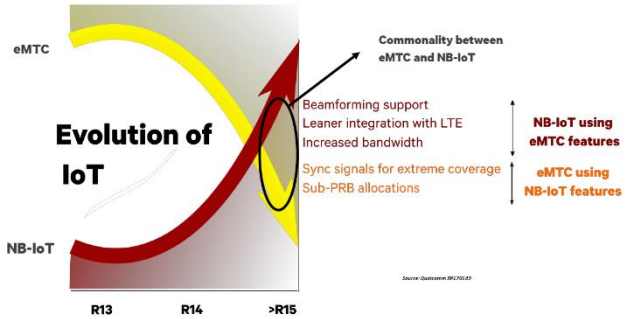
ITU WRC

2018 2019 2020 2021 2022 2023 2024

Rel 15
5G phase 1

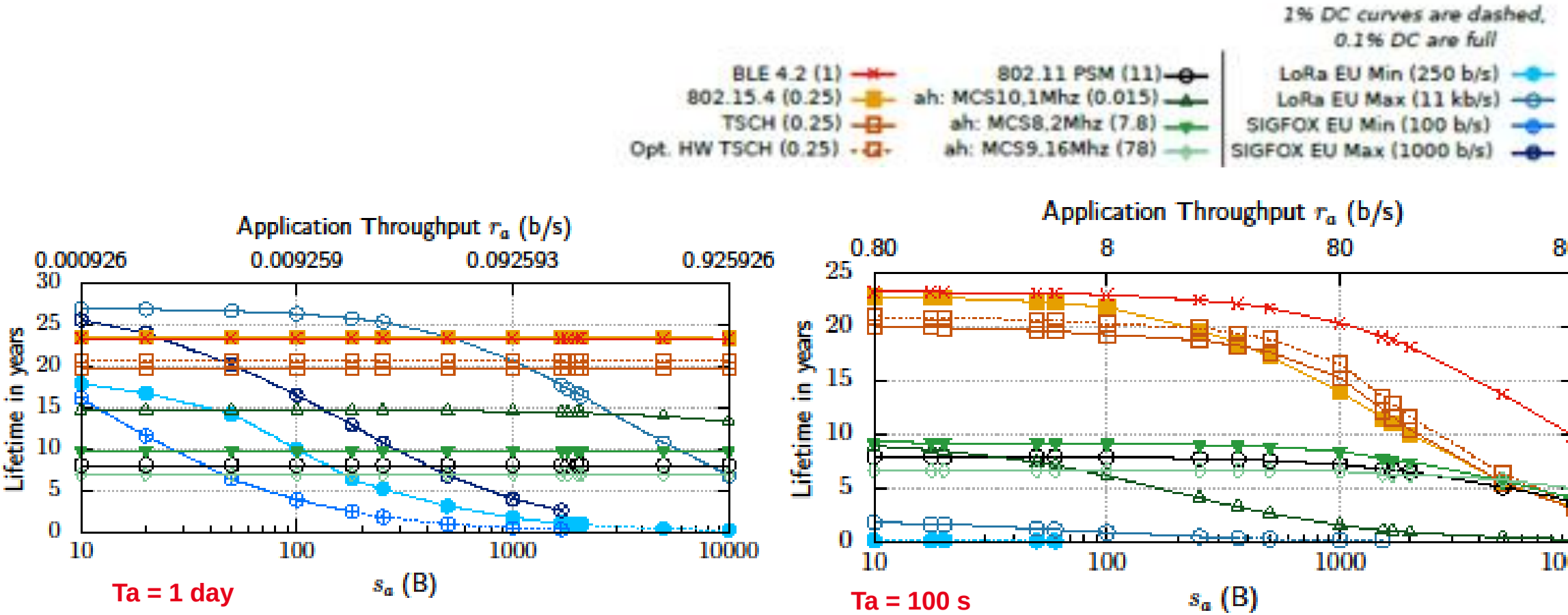
Rel 16
5G phase 2

5G deployment in France (Orange)



R&D CHALLENGES

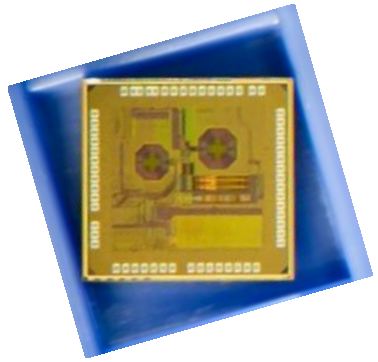
IOT POWER CONSUMPTION STANDARD ANALYSIS



Ta = 1 day

Ta = 100 s

LPWA : TOWARDS ULTRA LOW POWER NODES



Full compatible SoC with SIGFOX protocol

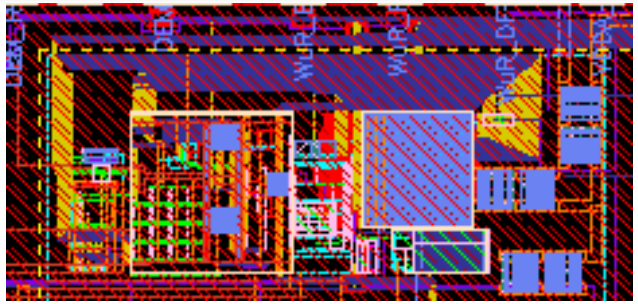
ULP RF SoC transceiver for Ultra-Narrow Band (UNB) applications - FOXY

- Sub-GHz ISM Frequency Bands
- Low Data Rate / Narrow-Band receiver 100 bps to 1 kbps
- Low-Power RX target : **10 mW** / Very High sensitivity at **-136 dBm**
- Low-Power TX target : **5 mW/0 dBm** - Integration of a **+14dBm/33mA** PA
- Low-Cost target for very high volume applications
- Very low leakage current target for very long battery life
- Technology : TSMC **65 nm**

Functionalities

- Ready to use IC : integrated digital process / application features
- Fully compatible with Sigfox protocol World Wide
- Last version ready for industrialization phase

WAKE-UP – ALWAYS-ON RECEIVER



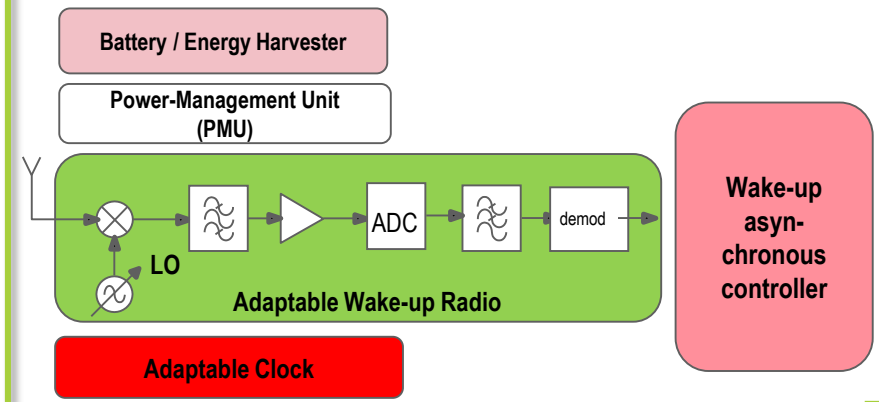
Snapshot of the full Wake-Up RX

Multi band capability

- 868-915 MHz / 1.4 GHz / 2.4 GHz

Adaptive power consumption

- Event-driven activity
- Target to burn **~ 50 µW in active mode**
- Analog front-end to demodulation : 20 µW
- Synthesizer and LO : 30 µW



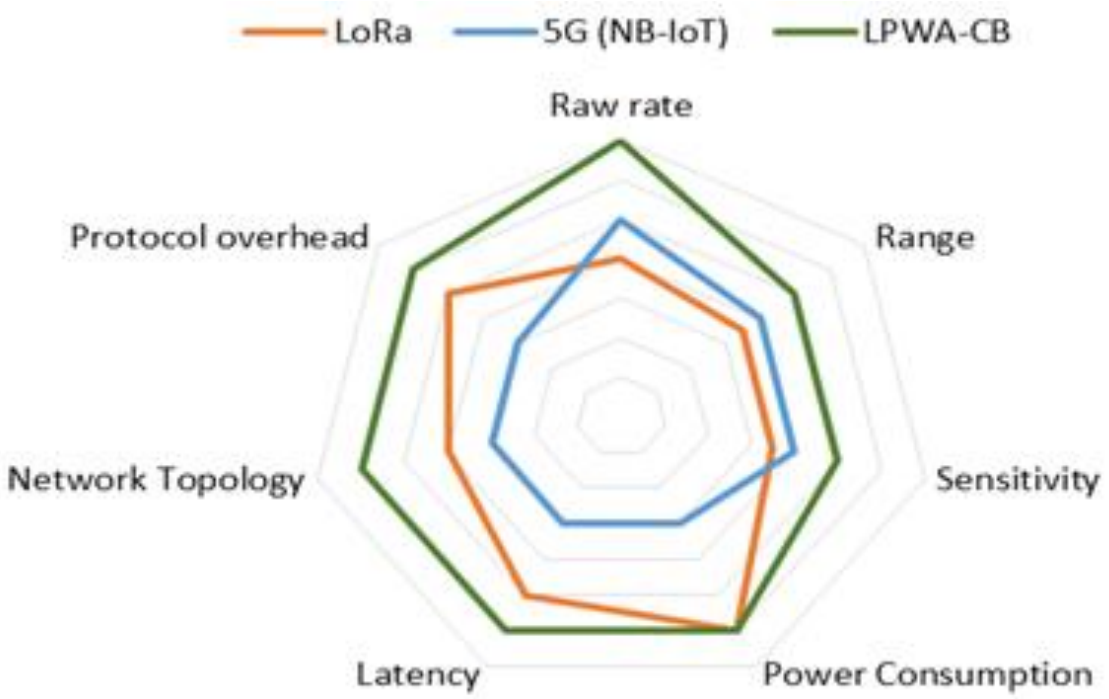
Low-cost and easy implementation

- Inductorless design
- Calibrationless design

- **28nm FD-SOI**
- **-65dBm sensitivity**
- **Less than 50µW of $P_{consump.}$**
- **Compatible with Duty Cycling**
- **-25 dB SIR**

NEW WAVEFORM APPROACH FOR IoT

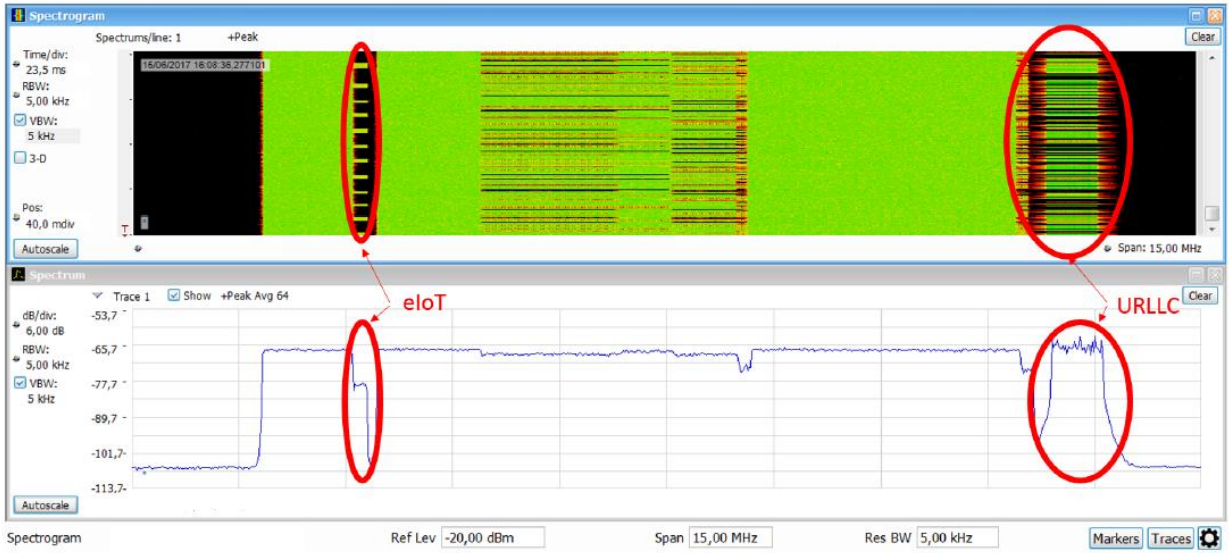
- **Goal : Address with one system a variety of scenario**
- **Approach**
  - Channel bonding : ability to aggregate non-contiguous communication channels to deliver higher data rate : 3 Mbit/s and longer range
  - Flexible waveform design
    - Turbo FSK
    - SC-FDM
    - OFDM
  - Self-adaptation to context at MAC level



5G NR FIELD TRIALS IN GRENOBLE

Multi-service transmission
3,5GHz band

Ultra Reliable Low Latency
Latency 0,25ms
+
NB-IoT

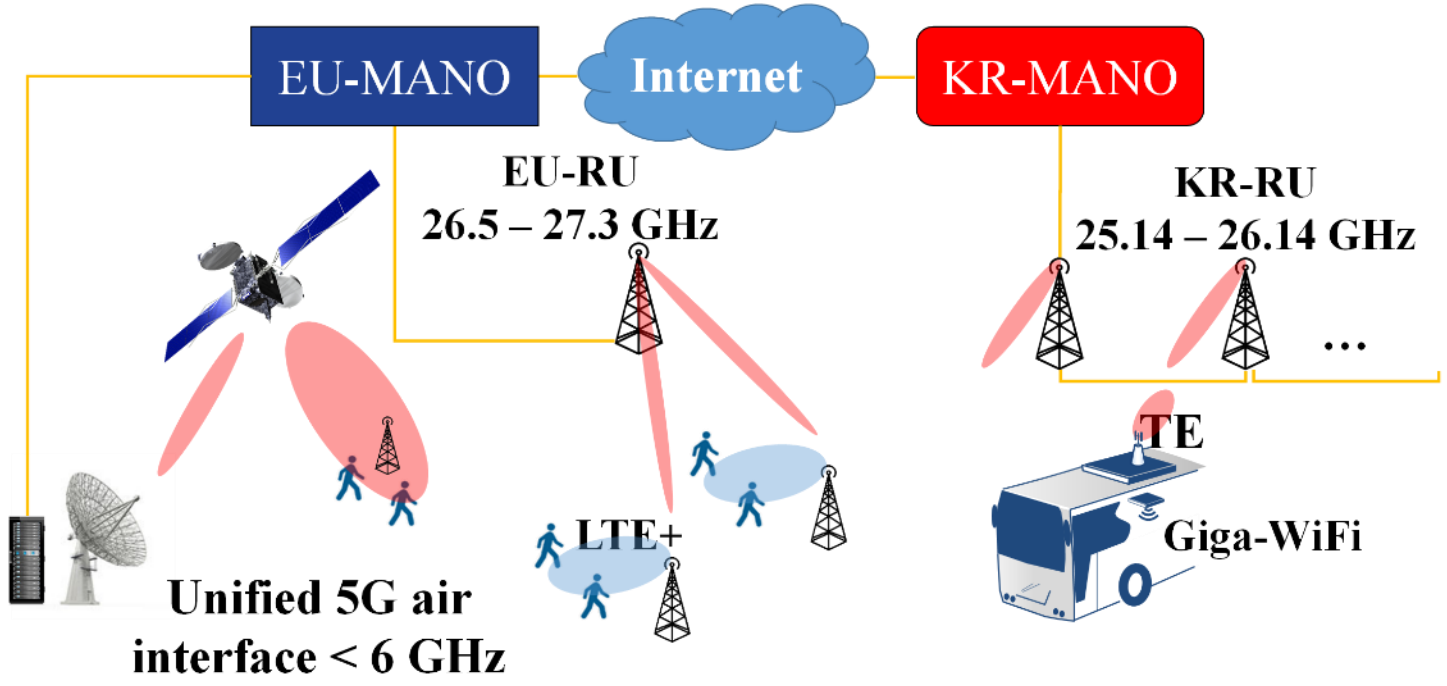


Other investigations:

- Mobile Broad Band
- Full-duplex radio

5G NR FIELD TRIALS IN KOREA

PoC demonstration in Seoul
2018, the 23rd of February



Key Technologies and Contributions

- 5G mm Wave Backhauling
- 5G Evolved Packet Core Network
- SDN interface
- 5G Narrowband Sub 6 GHz Satellite Access
- Satellite & mmWave Positioning

Source: Eu project 5GChampion

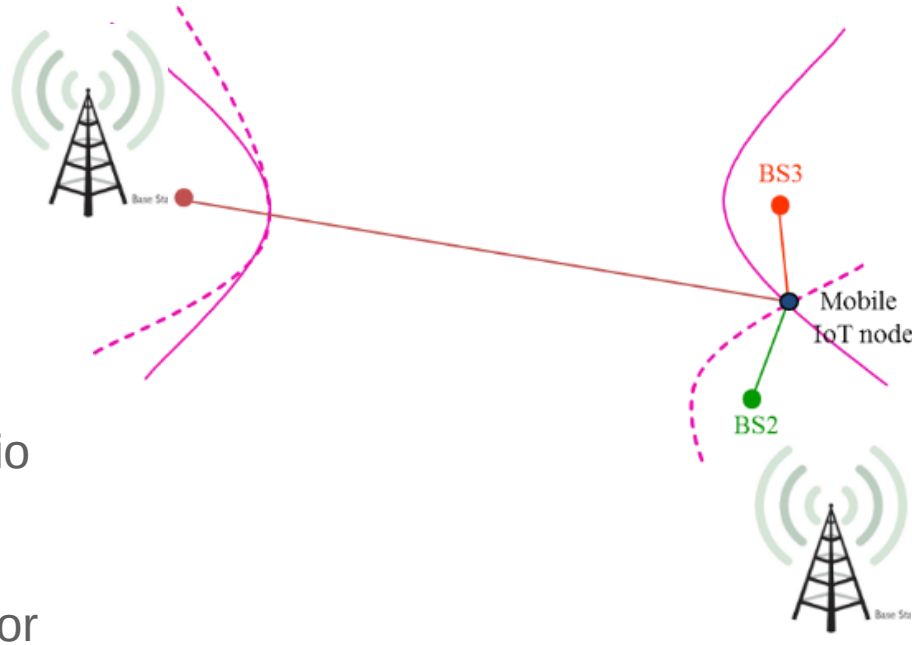
LOCALIZATION FOR LONG RANGE IoT RADIOS

- **How to perform precise localization with LPWA system limitations ?**

  Low data rate + long range

  => low bandwidth

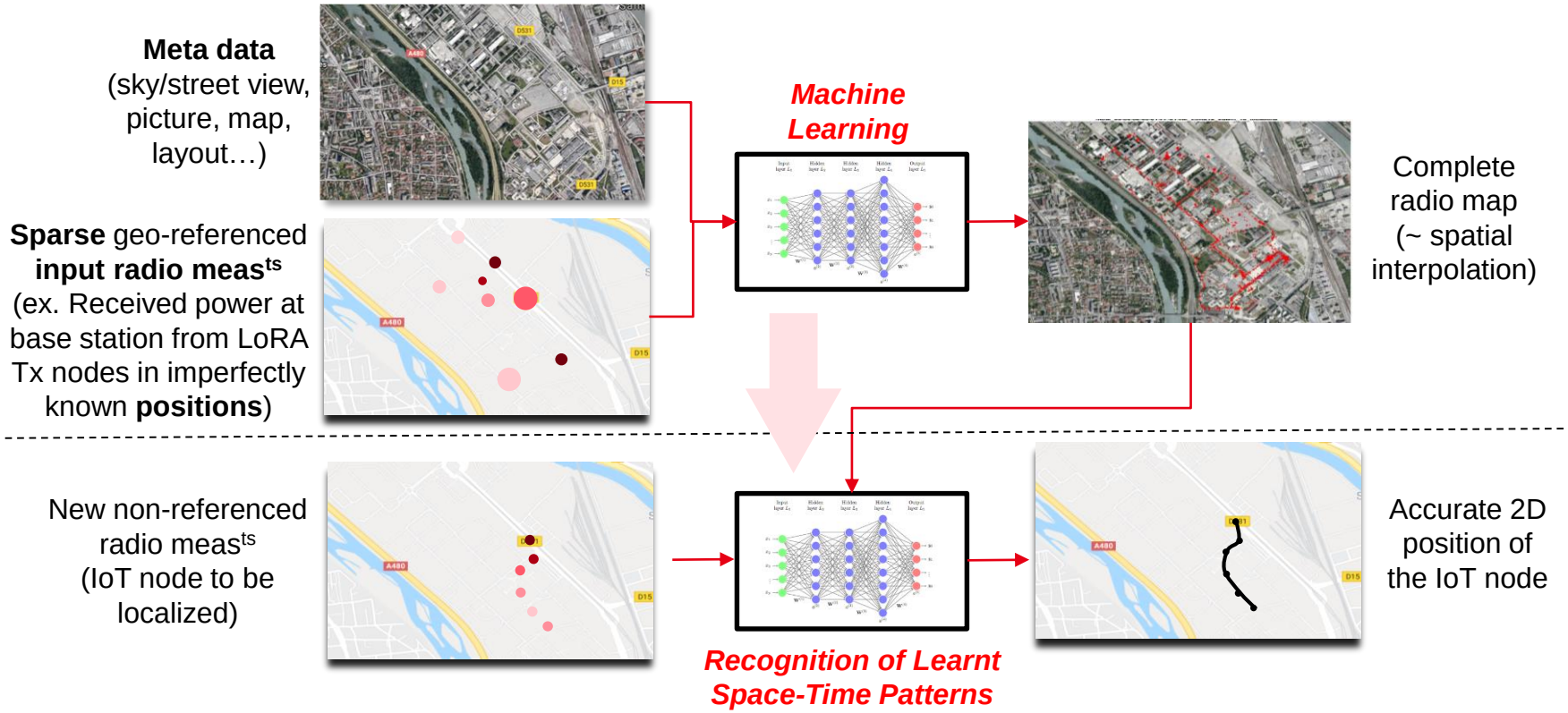
  = >low temporal resolution



- **Approach**
  - Benchmark and/or combination of various location-dependent radio metrics (e.g., Time Difference of Arrival, Received power, Phase Difference of Arrival)
  - Evaluate pragmatic approach and associated performance limits for IoT narrowband system (LPWA or 3GPP NB-IoT)
  - Overall system design and optimal synchronization/deployment schemes accordingly
- **Target : Increase by 10 the precision of localization by improving ranging metrics**

AI-BASED LOCALISATION FOR DENSE LPWA NETWORKS

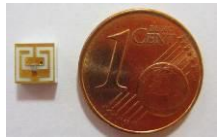
(1) Offline participatory construction of (multi-parameter) radio maps



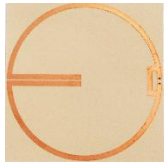
(2) On-line localization (~ Advanced fingerprinting)

COMPACT & EFFICIENT ANTENNAS

- **Antennas & Antennas systems**
  - Radiating sources (10 MHz to 300 GHz)
  - Multi-antennas and arrays
  - Reconfigurable antennas
- **Antenna Context influence**
  - Modeling
  - Characterization
  - Emulation



Miniature antenna @ 2.4 GHz



Miniature antenna @ ISM 433 MHz

31dBi at 57-77GHz for backhaul/fronthaul point to point transmission at 20gbit/s

From channel characterization to system performance evaluation

V2V

OTA test