New and emerging technologies to address LPWAN for IoT nodes

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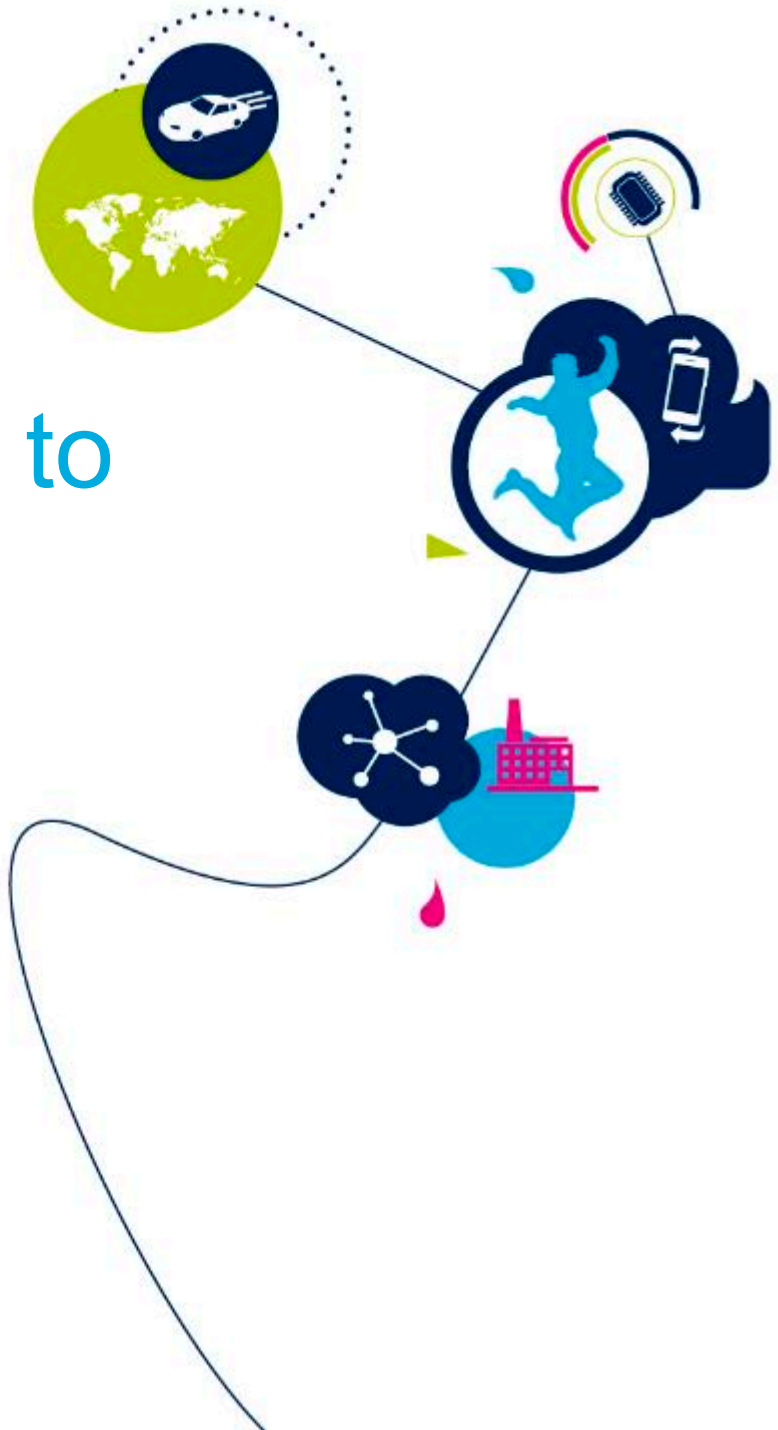

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Internet of Things World

New and emerging technologies to address LPWAN for IoT Nodes

- What are the Technology needs for Low Power Sensors in Smart Cities and Smart Industries?
- Examine how existing technologies are unable to provide competitive solutions
- Identify the evolution of emerging technologies to cover market requirements
- Key features and advantages of LoRa, SigFox & LTE

Internet of Things World

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How Mega Trends
Impact Technology Needs

Mega Trends

Accelerating Urbanization

60% of the world's population (about 4.7 billion people) will live in cities in 2025 (1)

Smart is the new Green

Demographics

72.1 million Americans over the age of 65 by 2030 (2)
Healthcare costs projected to be 20 -30% of GDP by 2025

Wellness

Sub-trends

Need Smart Cities

Infrastructure: Power, Water, Transport
Smart Home and Buildings
Smart Transportation
Smart Banking
Smart Learning
Data usage doubling / 18 month (3)

Need to reduce Chronic diseases costs

Chronic disease accounts for 86% of US healthcare costs(3)
Innovative technologies could cut the costs of chronic disease treatment by as much as 50 percent (1)

Impact

Convergence of technology

Home: Automation, Entertainment,
Energy and Security
Smart Energy & Water
Resource sharing (Smart Apps)
Transportation efficiency
Autonomous vehicles and Robots

Predictive diagnostics

Wearables
Implantable, injectable, and ingestible
Non-wearable connected measurement devices
Predictive diagnostics

The challenge: the ability to monitor and Control things in the physical world

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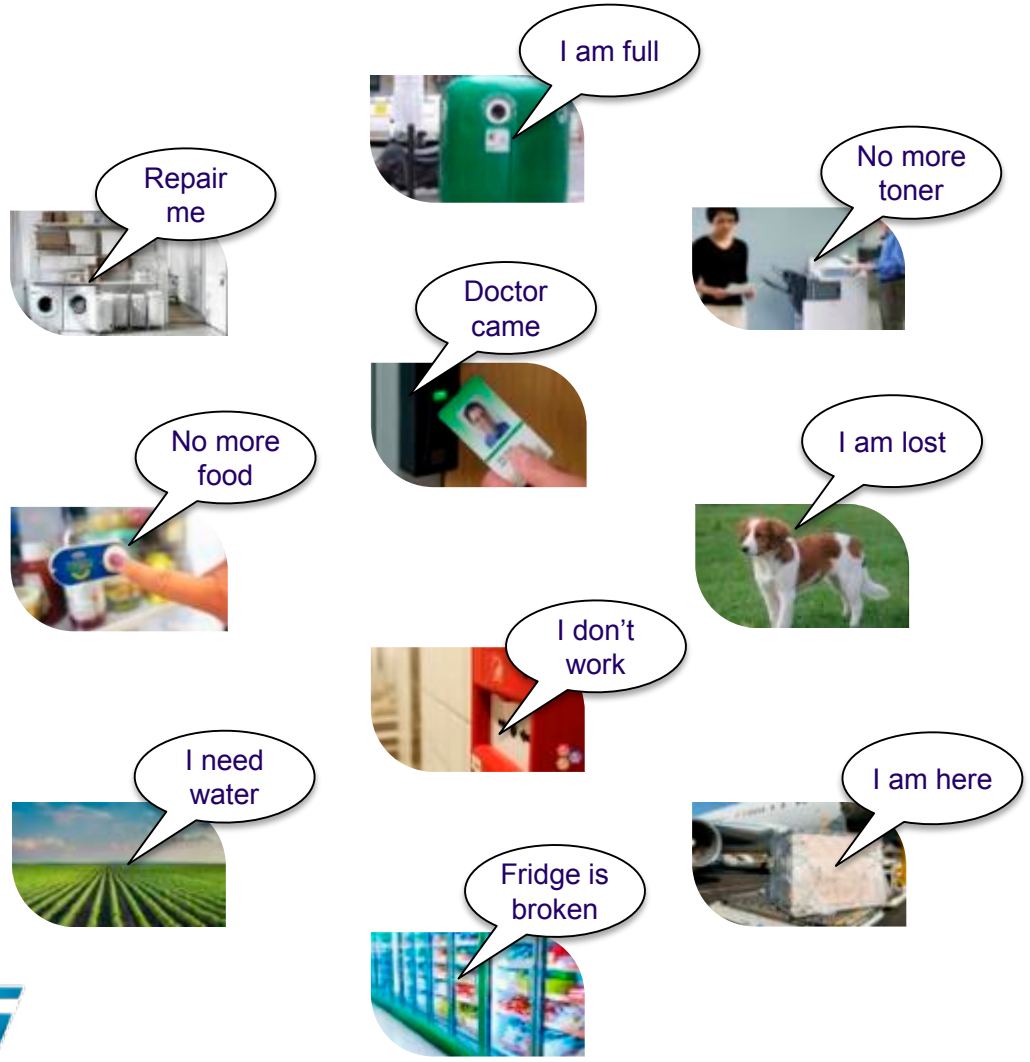
Source. 1 McKinsey Global Institute June 2015. 2 pwc April 2014. Frost $ Sullivan 2014

The IoT Challenge



- IoT will soon impact our everyday life, and connect all objects around us
- Many of tomorrow's great ideas are technically possible today, but merely constrained by power and budget issues.
- Small inexpensive objects simply don't have the power to communicate with large mobile networks.

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Internet of Things

Smart Driving

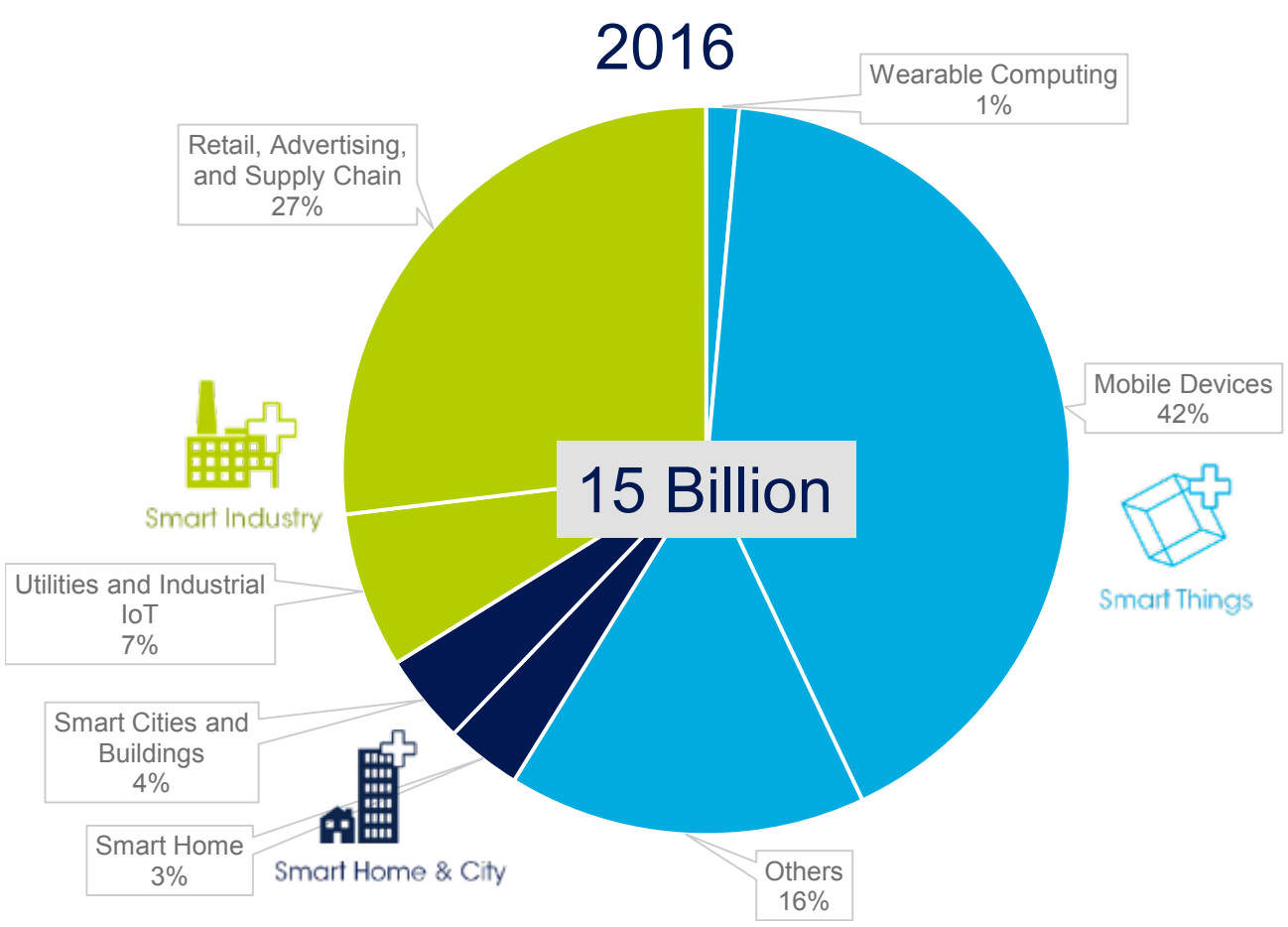
Smart Things

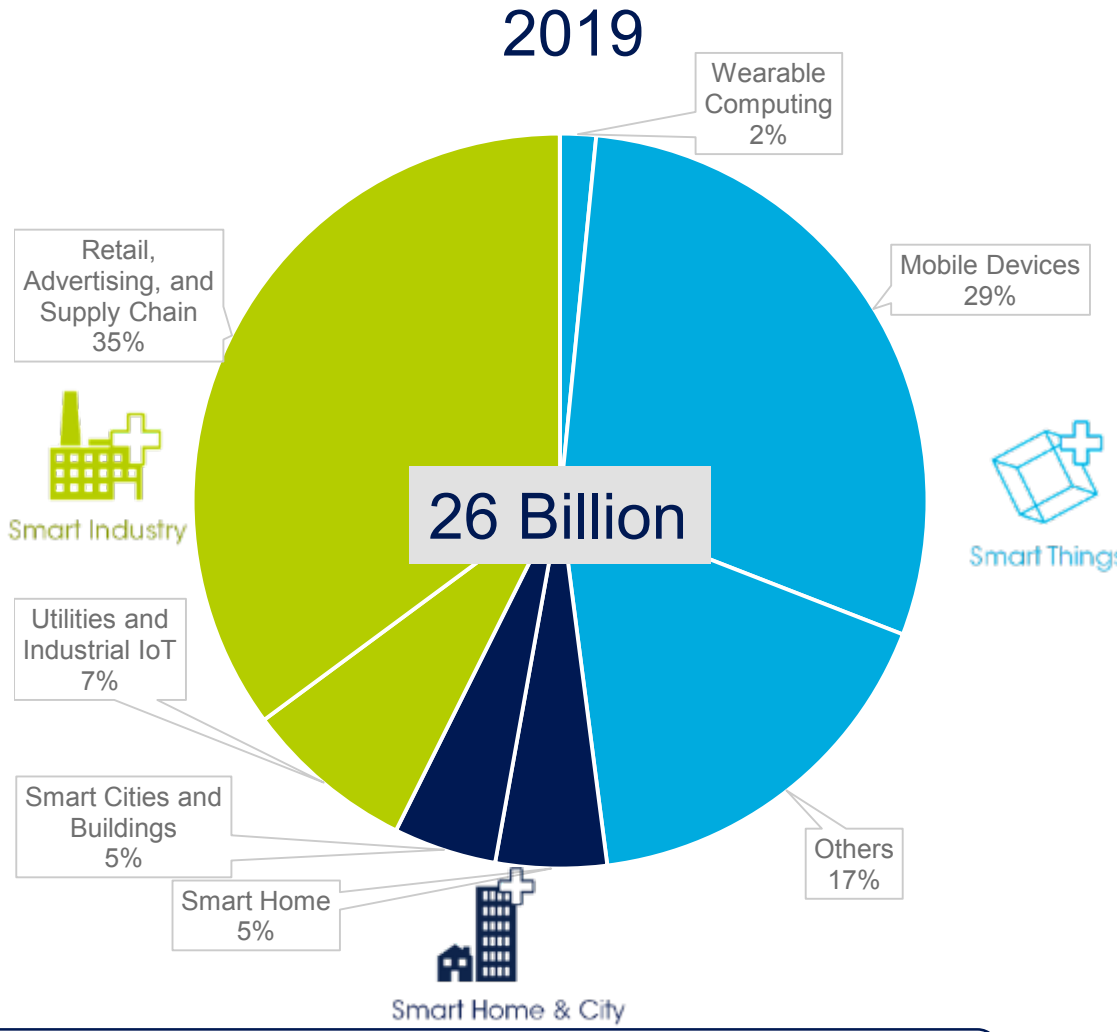
Smart Home & City

Smart Industry

Smart Driving

Internet of Things Connected Devices





Smart Industry Smart City	5.7 Billion, 38%	12 Billion, 47%

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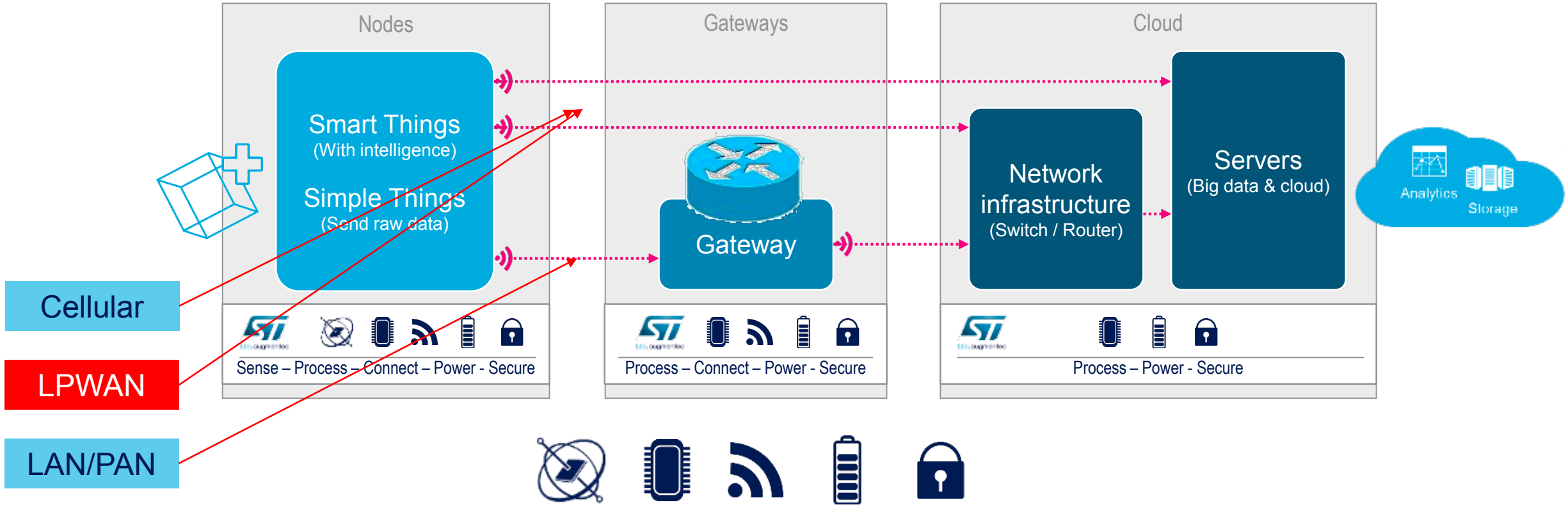
Source: IHS-Markit, excluding PC & digital home, connected cars

Connectivity in the IoT Movement

IoT is a movement where any system is able to leverage the Internet and its eco-system

Cloud computing – Low cost embedded computers – Explosion of reliable wireless connectivity – Rapid innovation of low cost sensors



Sense – Process – Connect – Power - Secure | The building blocks

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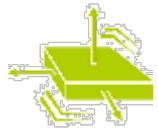
Connectivity Use Cases in the IoT

- **Diverse use cases and solutions with competing requirements:**
  - Bandwidth
  - Latency
  - Power Consumption (Battery)
  - Remoteness (global reach)
  - Reliability
  - Cost effectiveness

Node to node

Node to cloud

cloud to cloud



Vibration Monitoring

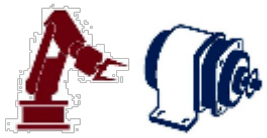
Alarm panel and sensors monitoring

Asset tracking

Cold Chain monitoring

HVAC control and monitoring

Fault detection



Predictive maintenance

Factories and Buildings

Smart Things

Smart Home

Smart City

Smart Industry

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Connectivity Use Cases in the IoT

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  - Cost effectiveness

Node to node

Node to cloud

cloud to cloud

Agriculture and farming:

- irrigation, fertilizers, soil
- hive, cattle, livestock, fishing monitoring

Disaster Monitoring:

- River flood detection
- Eartquake detection
- Forest fire detection

Environment monitoring:

- Air quality
- Hazardous gas
- Wind monitoring

Agriculture and Environment

Smart Things

Smart Home

Smart City

Smart Industry

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Connectivity Use Cases in the IoT

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  - Reliability
  - Cost effectiveness

Node to node

Node to cloud

cloud to cloud

Smart Meters (water, gas, electricity)

Leak detection
water pressure and quality monitoring
Tank level monitoring

Smart Parking
Fleet Management

Utilities, Energy, City Management

Smart Things

Smart Home

Smart City

Smart Industry

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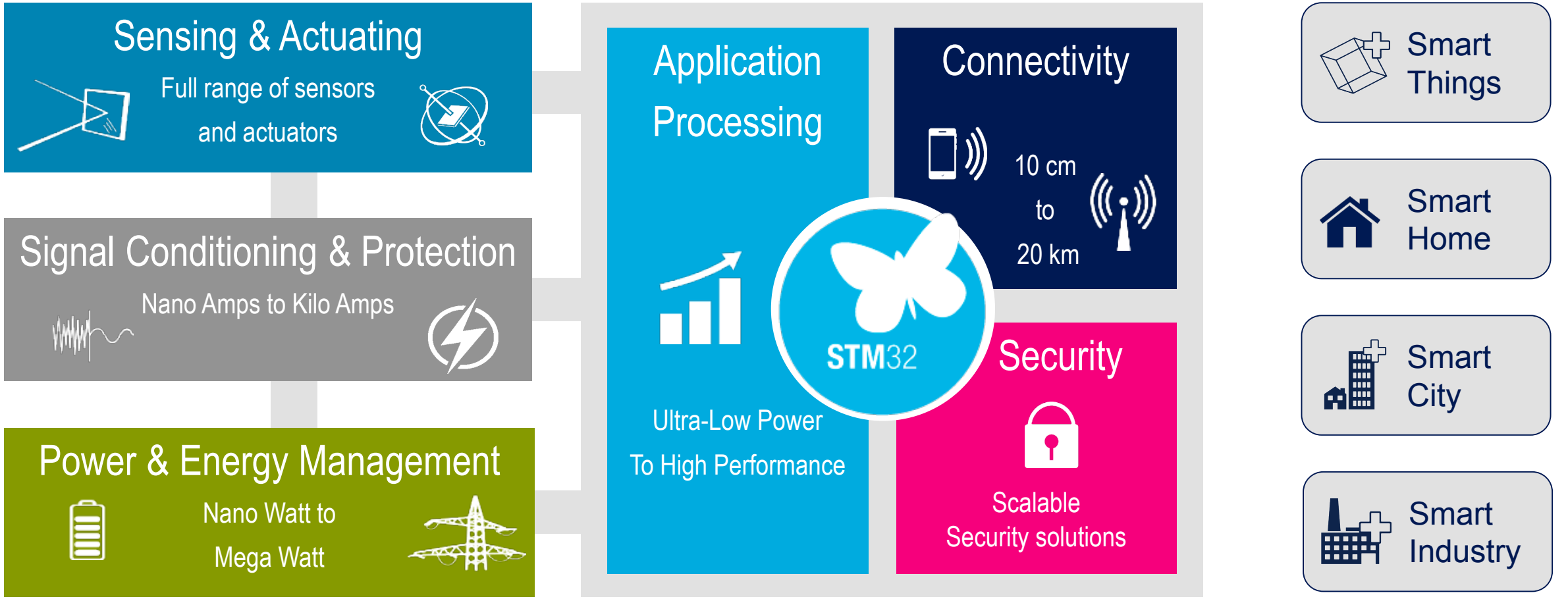
The Building Blocks of the IoT



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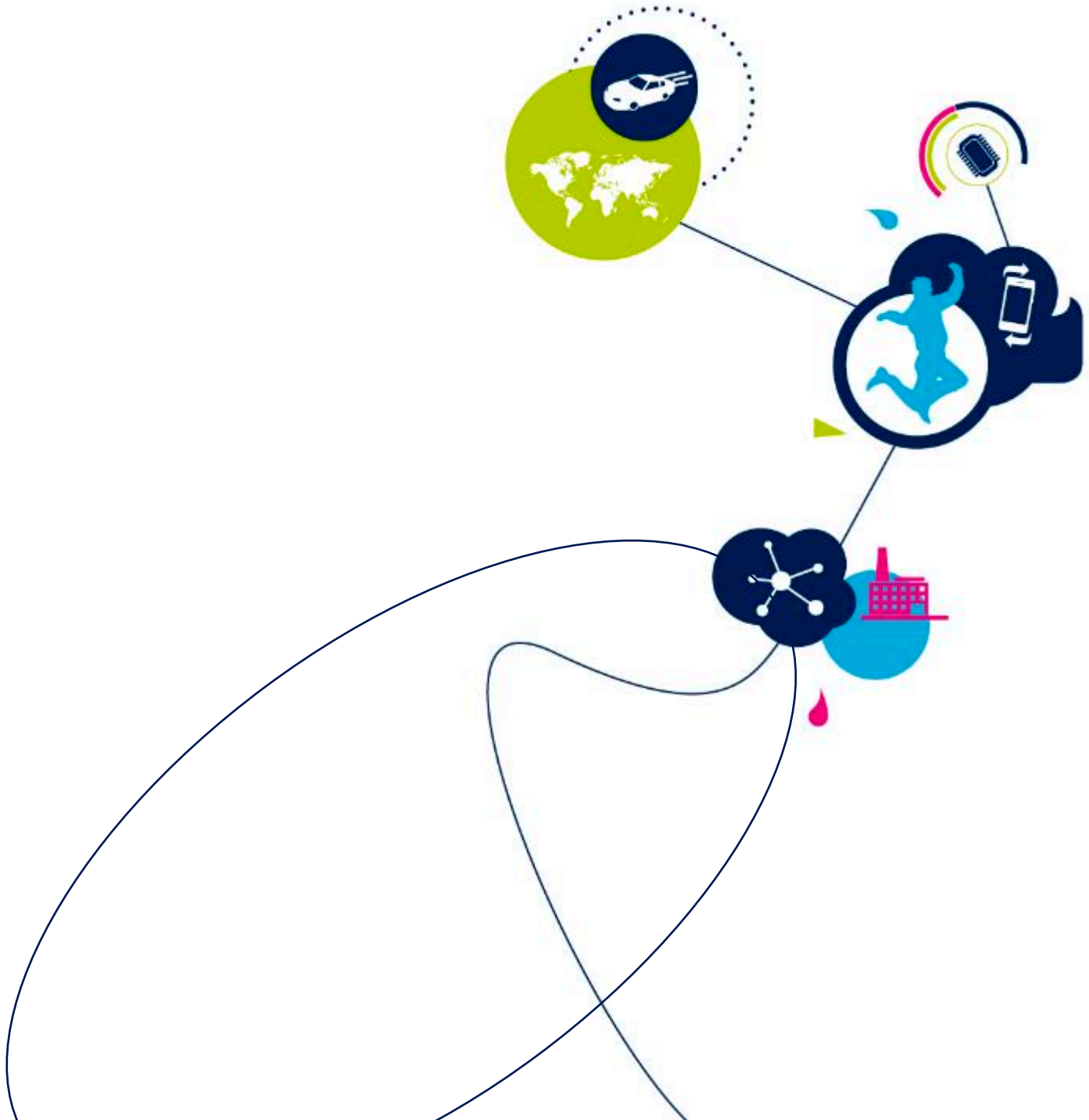
LPWA Market



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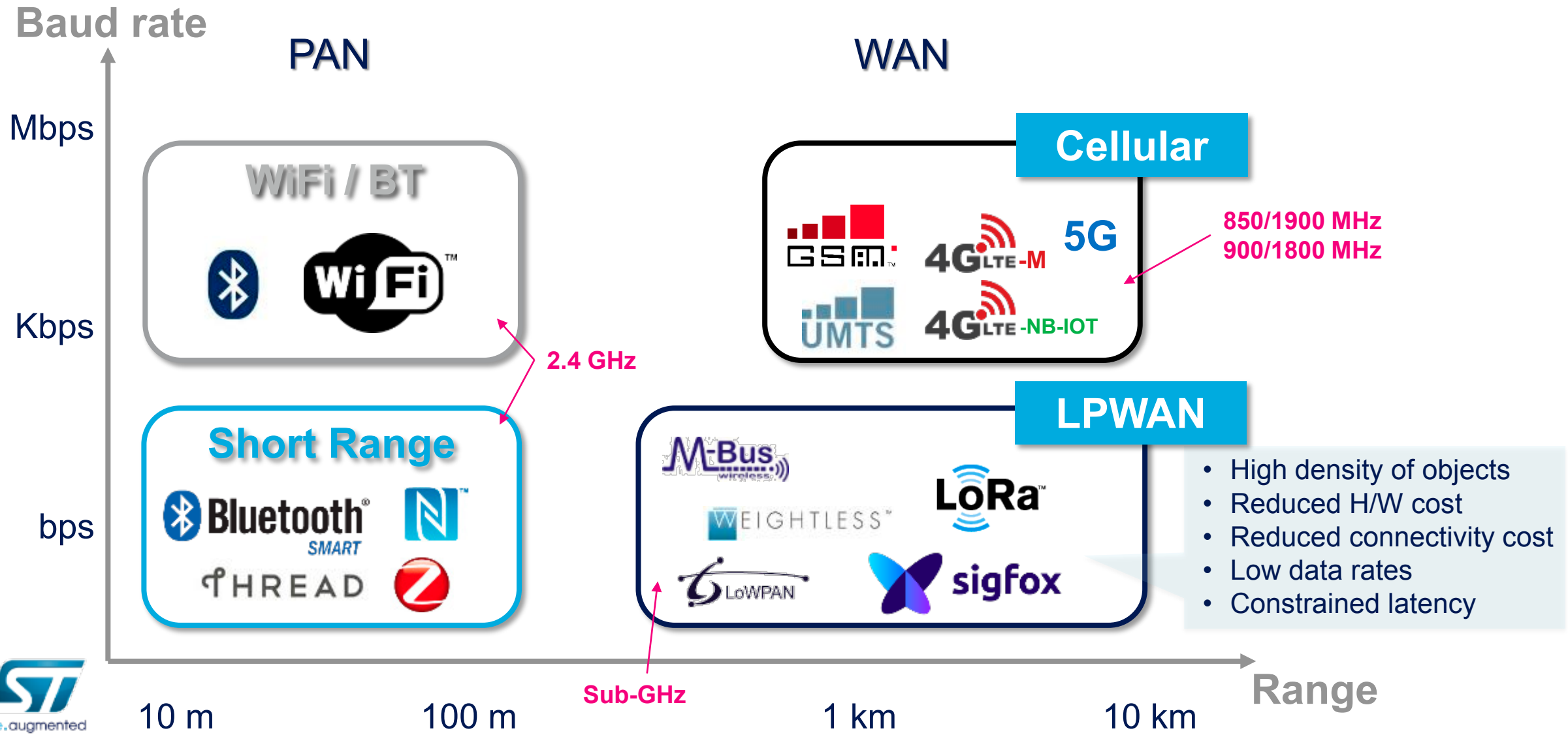
IOT CONNECTIVITY:
NO ‘ONE-SIZE-FITS-ALL’ NETWORK

Global M2M/IoT Market in 2025

27 billion connections

Source: Machina Research, 2015

Communication Technologies - Overview



- High density of objects
- Reduced H/W cost
- Reduced connectivity cost
- Low data rates
- Constrained latency

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Communication Technologies - Overview

Existing Technologies

Address:

- Short range low power
- Long range high power (also expensive)

Emerging Technologies

Address:

- Long Range Low Power

4G LTE Cat M1 (eMTC)
Cat NB1 (NB-IoT)

- Public network
- Higher data rate
- Leveraging existing infrastructure

LoRa

- Proprietary PHY, Open MAC
- Regional regulatory differences
- Inexpensive

sigfox

- Public network
- Regional regulatory differences
- Suited for upstream communications (sensor networks)
- Inexpensive

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Technology Comparison

	sigfox	LoRa	LTE-M1	NB-IoT
Wide Area Deployment Available	Now	Starting	>2017	>2018
Coverage (BS Sensitivity)	-142 dBm	-138 dBm	-124 to -138 dBm	-142 dBm
Power Consumption	Low	Medium[4]	Optimized for rich traffic Models (several K Bytes/day)	
Security	AES128 No IP	AES128	eSIM	eSIM
Bandwidth	0.1 - 0.6 kHz	0.3 - 50.0 kHz	10.0 - 100.0 kHz	0.2 - 10.0 kHz
2-Way	Device triggered	Class A only	Yes	Yes
Data Rate	100 - 600 bps	11 Kbps	27.6 Kbps	28.3 Kbps
Daily Traffic per device	1.6 Kbyte	10 Kbytes	Several 100 Kbytes	Several 100 Kbytes

some assumptions:

- Sigfox – become a global Internet of Things operator
- LoRa – provide a technology that lets other companies enable a global Internet of Things
- LTE-M – evolve an existing technology to exploit the existing infrastructure

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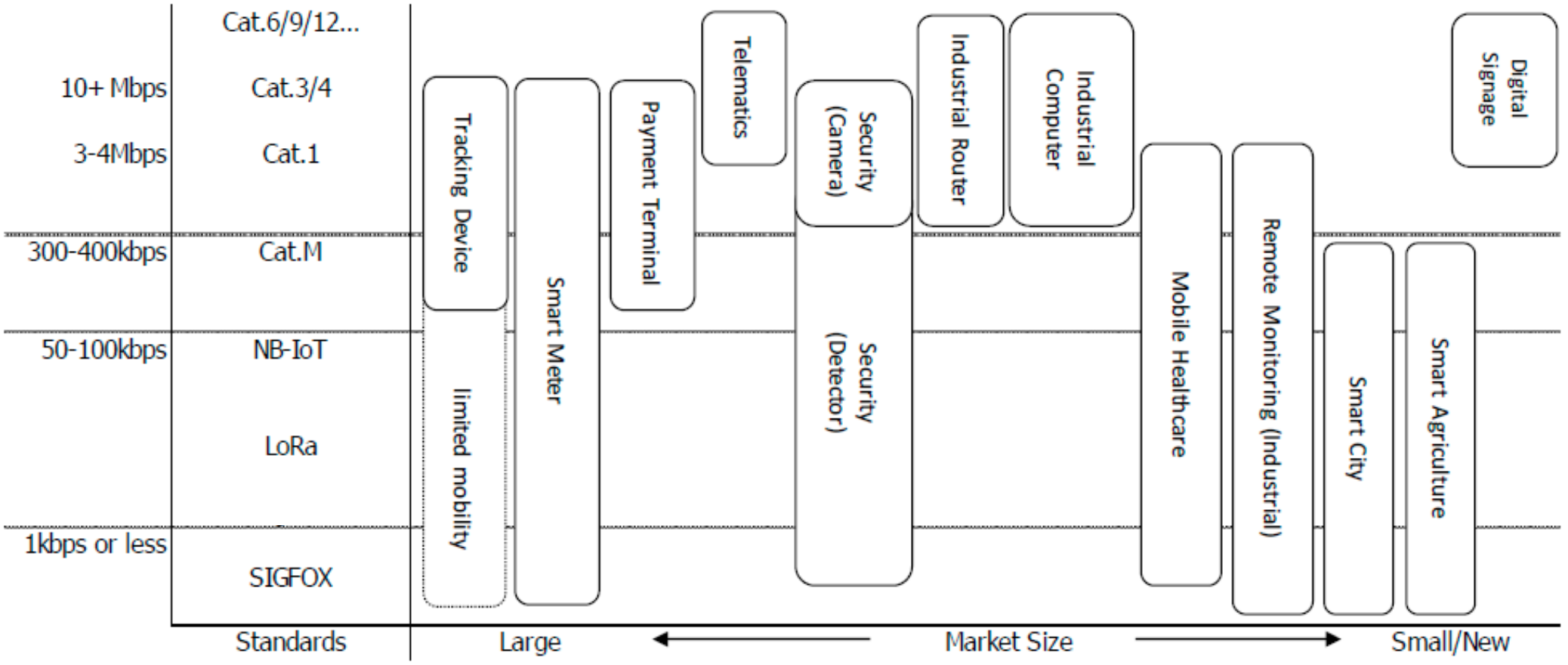
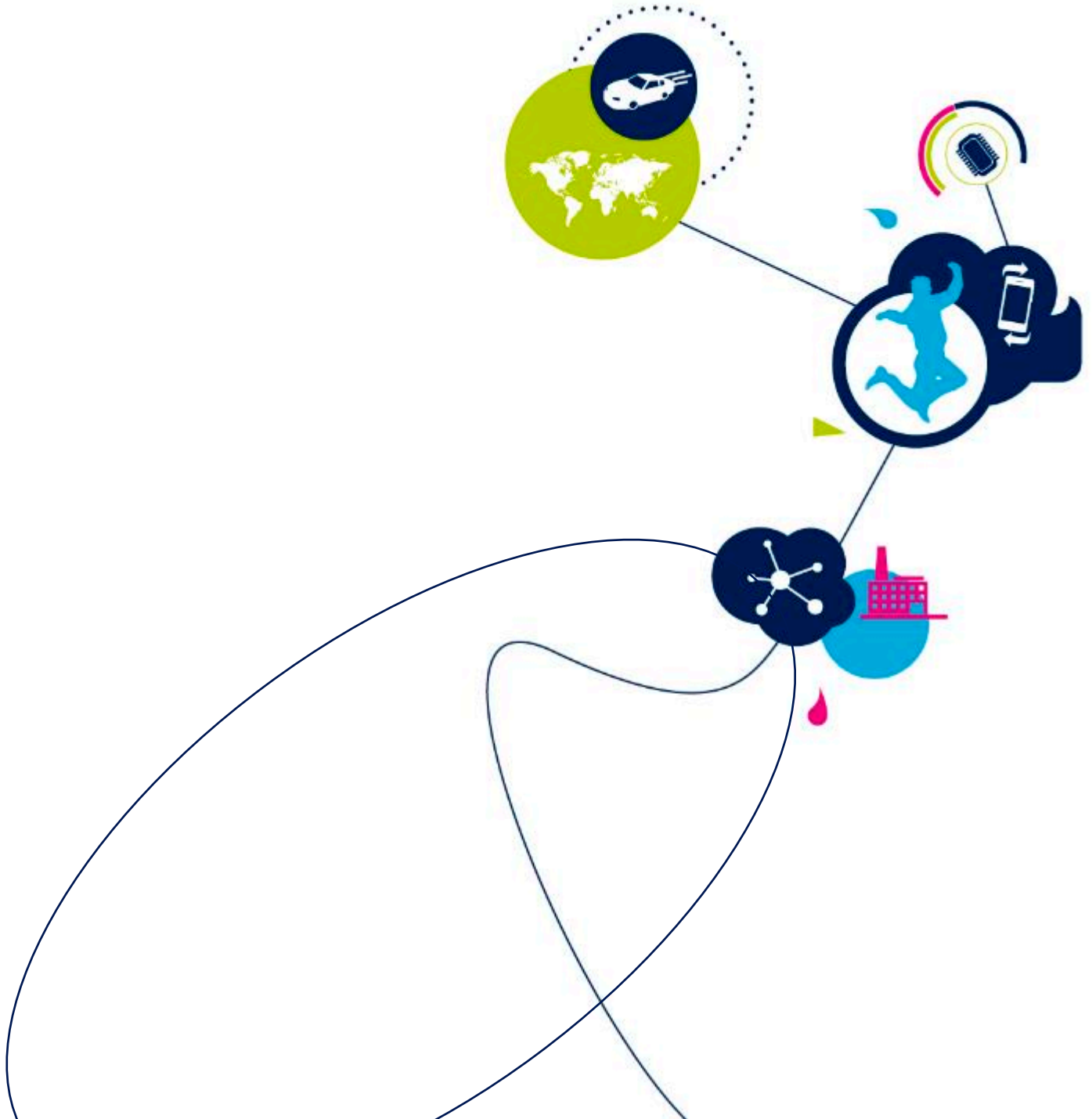
Cellular/LPWA Applications



LoRa™



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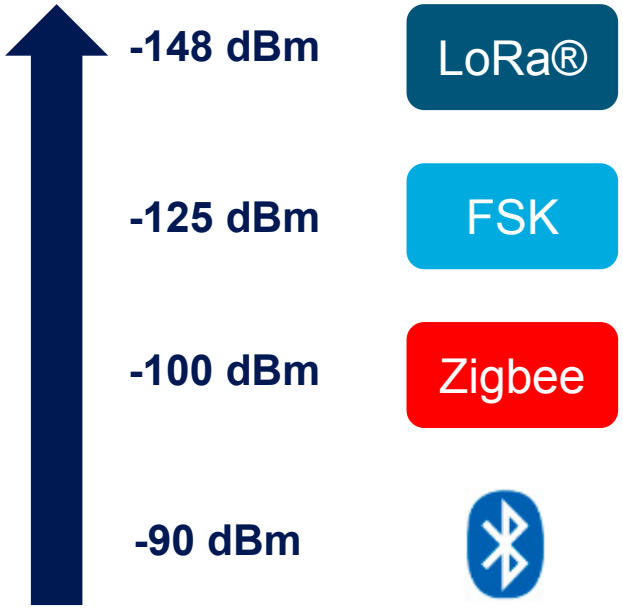
What is LoRa ?

1. A Sub-GHz wireless technology enabling low data-rate communications over long distances
2. Is targeting M2M and Internet of Things applications
3. LoRa technology is a solution providing a WAN capability, using a MAC protocol named LoRaWAN



- Long range, low power & small form factor
  - In Sub-GHz: > 2km dense urban, > 15km suburban, > km VLOS
  - More than 10 years in operation without changing battery
- Concentrator with network capacity & security
  - Star Network / Link rate Adaptation / Fully Scalable Network
  - More than 4M transaction per day per GTW
- Robust communication
  - Robust to interferer / coexistence with other ISM
  - Robust to Jamming
  - Suitable for Mobile, Nomadic & fixed nodes
  - Indoor / Outdoor coverage

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LoRa™ Network Features

True location

- Indoor and outdoor
- Position monitoring

Bidirectional

- Bidirectional
- Scalable capacity
- Broadcast

Long range

- Greater than cellular
- Deep indoor coverage
- Star topology

Max lifetime

- Low power optimized
- 10-20 years lifetime
- >10x vs cellular M2M

Global mobility

- True mobility
- Seamless
- Roaming

Security

- Unique ID
- Application
- Network

Multi-usage

- High capacity
- Multi-tenant
- Public network

Low cost

- Minimal infrastructure
- Low cost end-node
- Open software

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LoRa Alliance

- The LoRa Alliance is a non-profit open consortium of companies promoting the technology
  - Mission is to ensure that LoRaWAN is THE standard for SECURE, CARRIER-GRADE IoT connectivity
  - Promotes interoperability, certification and drives future use-cases and features

- There are players in all facets of the network
  - Gateway hardware suppliers (Multitech, Actility, etc)
  - Network Server space (Senet)
  - Application Server space (MyDevices, Loriot, etc)
  - Certification houses
  - End-nodes (also called “Mote’s”)
  - www.lora-alliance.org

ST is SPONSOR and Board Member

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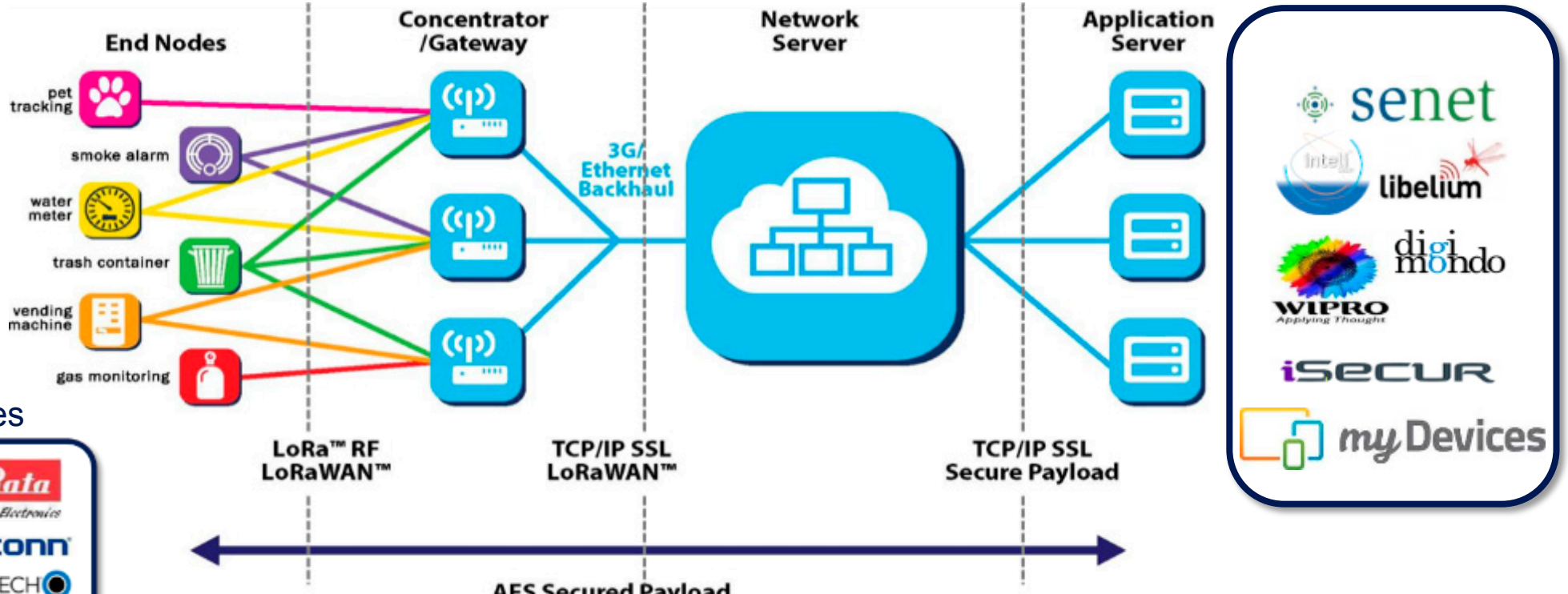
Premise of LoRaWAN



silicon

modules

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LoRaWAN Device Classes

3 classes to cover all the use cases

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	***Mainly uplink with two potential downlink slots after each uplink***
B (« beacon »)	**Battery powered actuators** Energy efficient communication class for latency controlled downlink. Based on slotted communication synchronized with a network beacon.	***Programmed downlink slots to allow control within certain latency limits***
C (« continuous »)	**Mains powered actuators** Devices which can afford to listen continuously. No latency for downlink communication.	***Lowest latency command and control for less power critical devices.***

Let's Get Started

With a wide and existing ecosystem

(Click on the icon or link)

HW tools

Nucleo pack

ST and Semte

P/N: P-NUCLEO-LR\

Expansion board

ST and USI®

P/N: I-NUCLEO-LRWAN1

Discovery board

ST and Murata®

P/N: B-L072Z-LRWAN1

Dev tools

STM32CubeMX

ST-Link Utility

Partners IDE

KEIL Tools by ARM

ARM mbed enabled

System **Workbench** for STM32

IAR SYSTEMS

LoRaWAN stack

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I-CUBE-LRWAN

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sigfox

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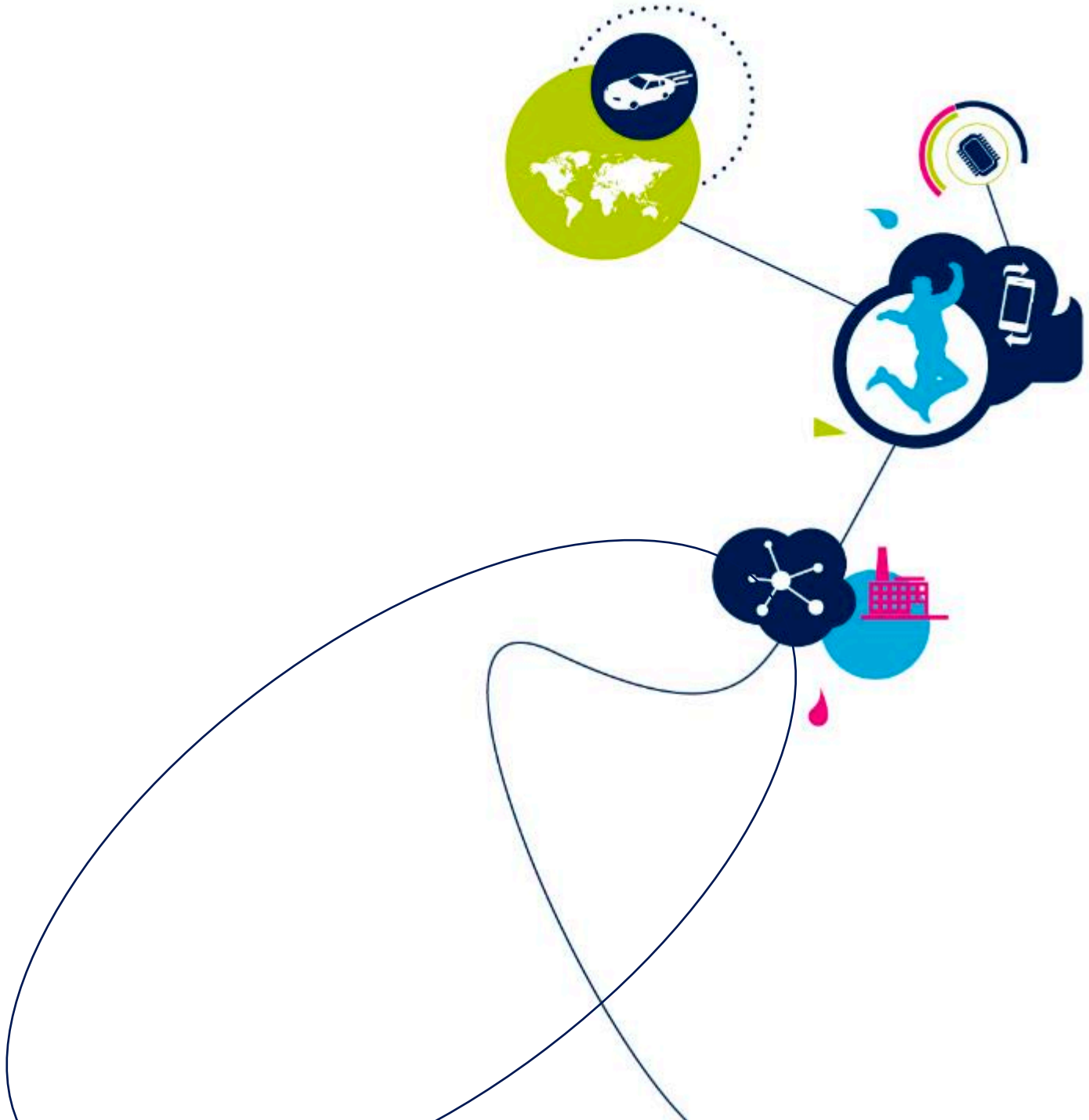
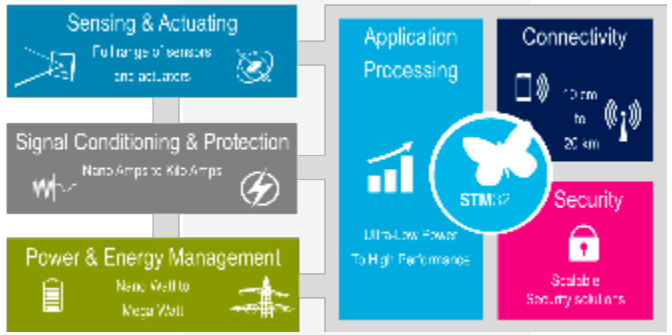


How Sigfox Works

Devices integrate a **connectivity module**



Sigfox certified Royalty free radios

Devices **send data**

Small messages optimized for sensor data

Messages are transmitted through the **sigfox network**

Global network with high capacity

They are **stored in the sigfox cloud**

Standard and easy access

They can be analyzed on **Big Data analytics platforms**

Interoperability with top-tier Big Data platforms

They **turn into actions and insights** through the customer IT

Partners with specific applications for your business

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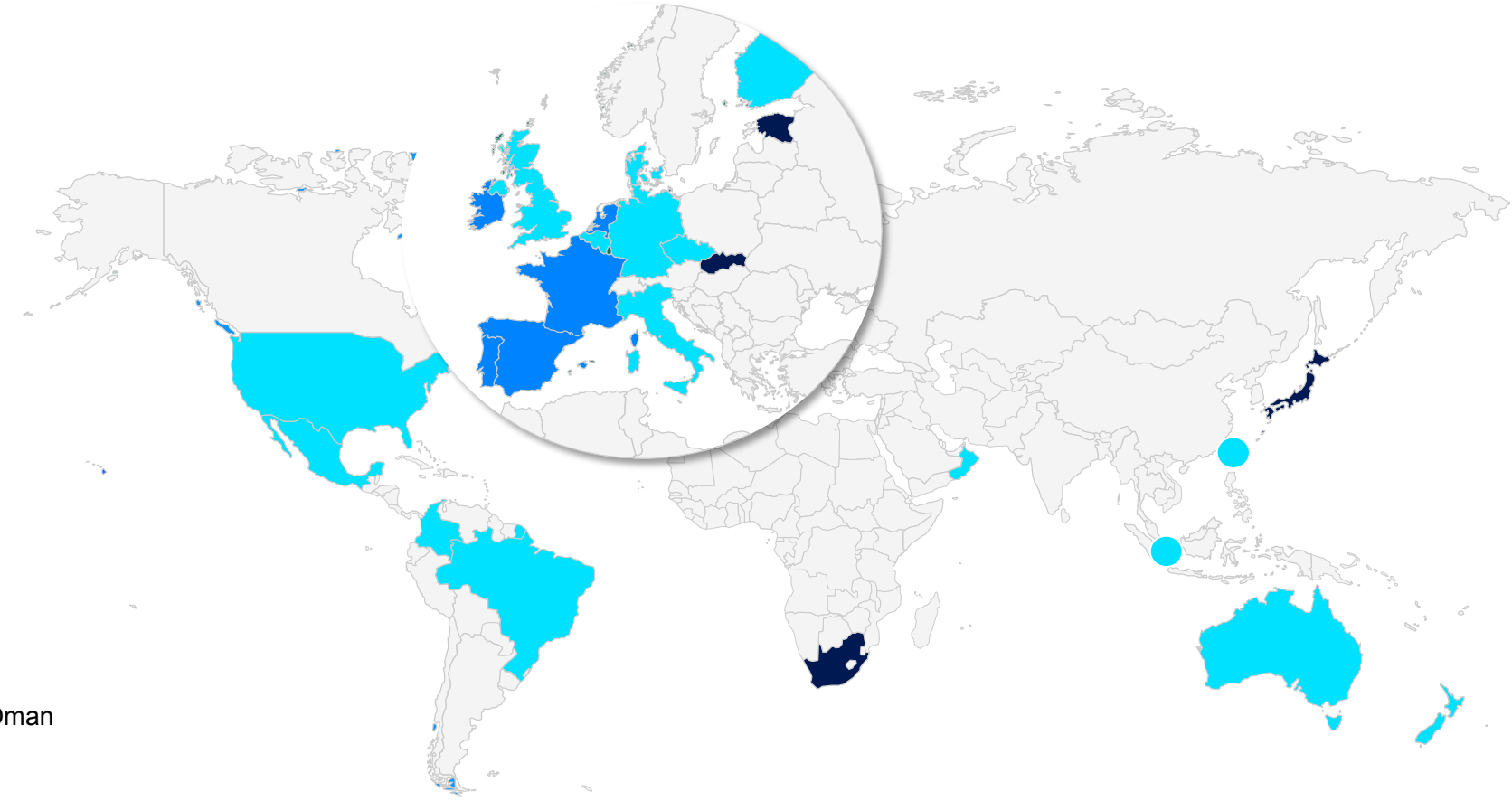
How Sigfox Works

… across the globe
Present in 28 countries, targeting 60 countries by 2018



Covered countries

France
Ireland
Luxembourg
Portugal
Spain
The Netherlands

On going country deployment

Australia
Belgium
Brazil
Colombia
Czech Republic
Denmark
Estonia
Finland
Germany
Italy
Japan
Malta
Mauritius Island
Mexico
New Zealand
South Africa
Slovakia
Singapore
Taiwan
The Sultanate of Oman
The U.K
The U.S.

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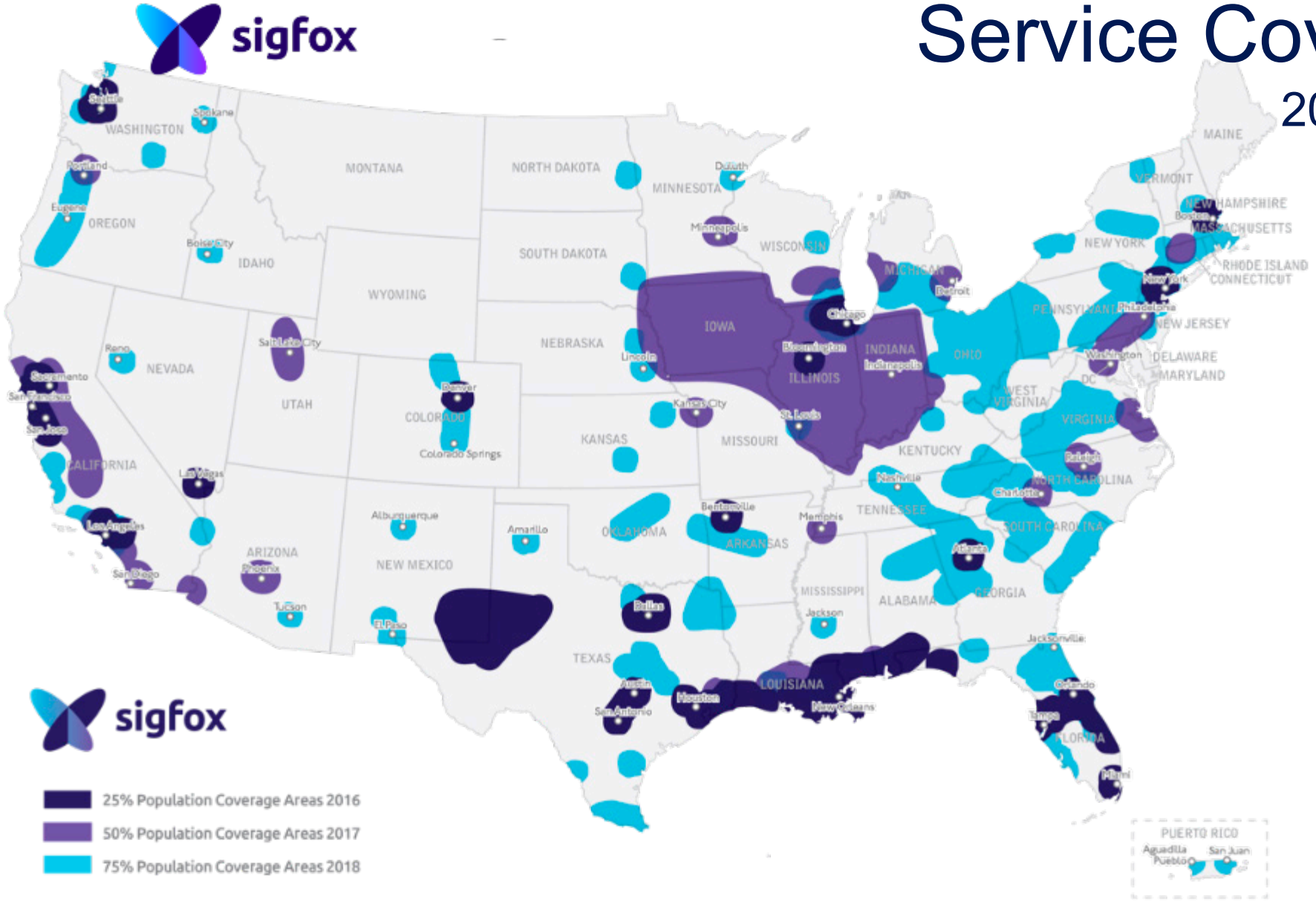
Service Coverage Area

2016, 2017 and 2018



- Connectivity as a Service (CaaS) – includes equipment, RMA, software and support
- Maverick program – free installation of the network for eligible sites
- Coverage kit – full kit to build a device and get started

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How to engage

Build a device

1. Build a prototype with STM devkit
2. Certify your device with Sigfox
3. Promote your device

startusa.sigfox.com

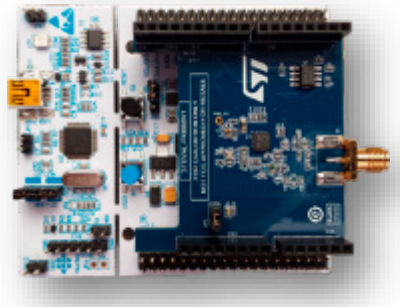
Integrate a device

1. Find your device in the Sigfox ecosystem
2. Certify your solution with Sigfox
3. Promote your solution

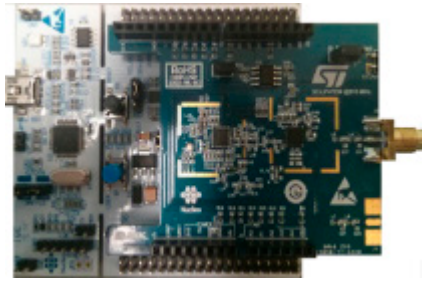
partners.sigfox.com

Radio Configuration Zones

- The channel frequency, datarate and other relevant parameters depend on the applicable radio control zone (RCZ).
  - RCZ1 (Europe):
    - 868MHz
    - DBPSK for uplink (14dBm at 100bps)
    - 2GFSK for downlink



  - RCZ2 (US, Canada, Mexico, Brazil)
  - RCZ4 (New Zealand, Colombia, Peru', Singapore)
    - 915MHz + PA
    - DBPSK for uplink (22dBm at 600bps for RCZ2/4)
    - 2GFSK for downlink



ID, PAC, KEY

- Each node is identified by a 32 bits **ID.**
- Each ID has an associated 8-bytes Porting Authorization Code (**PAC**), that is a checksum needed to register the node to the backend.
- An 128-AES **Key** (unique for each node) is used to encrypt the messages. The base stations will apply the same Key to decrypt the message.

Additional ST Security features

- STSAFE-A1SX is CC EAL5+ AVA_VAN5 certified
- Data integrity over the Sigfox network:
  - Signature of payloads before uplink
  - Verification of downlink payloads
- *Optional* data confidentiality over the Sigfox network:
  - Encryption of payloads before uplink
  - Decryption of downlink
- *Optional* Secure channel using AES-128

UFDFPN 8 pitch 2x3
SO8N

SIGFOX certified tools

STEVAL-FKI868V1 / FKI915V1

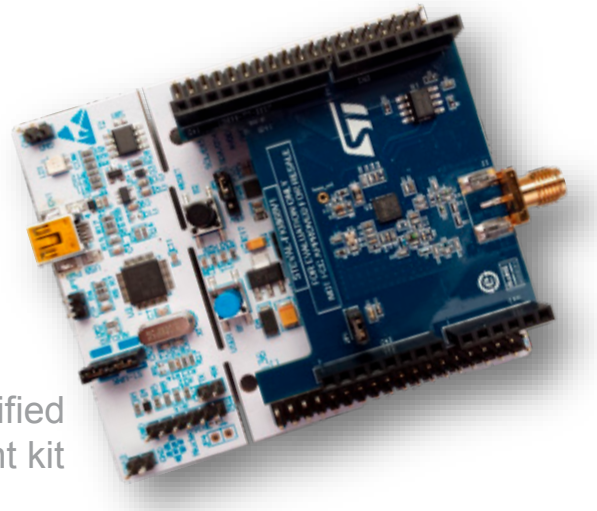
SIGFOX-ready sub-1GHz RF kits

accelerate sensor-to-cloud IoT applications

- Development kit:
  - Region AME: STEVAL-FKI915V1
  - Region EMEA: STEVAL-FKI868V1
- Sigfox SDK:
  - STSW-S2LP-SFX-DK

- Based on STM32 Nucleo board
- no need for a local gateway or access point.
- Read more

Development Kit for Out-of-the-box Sensor-to-Cloud Connectivity



SIGFOX End Product certified Development kit

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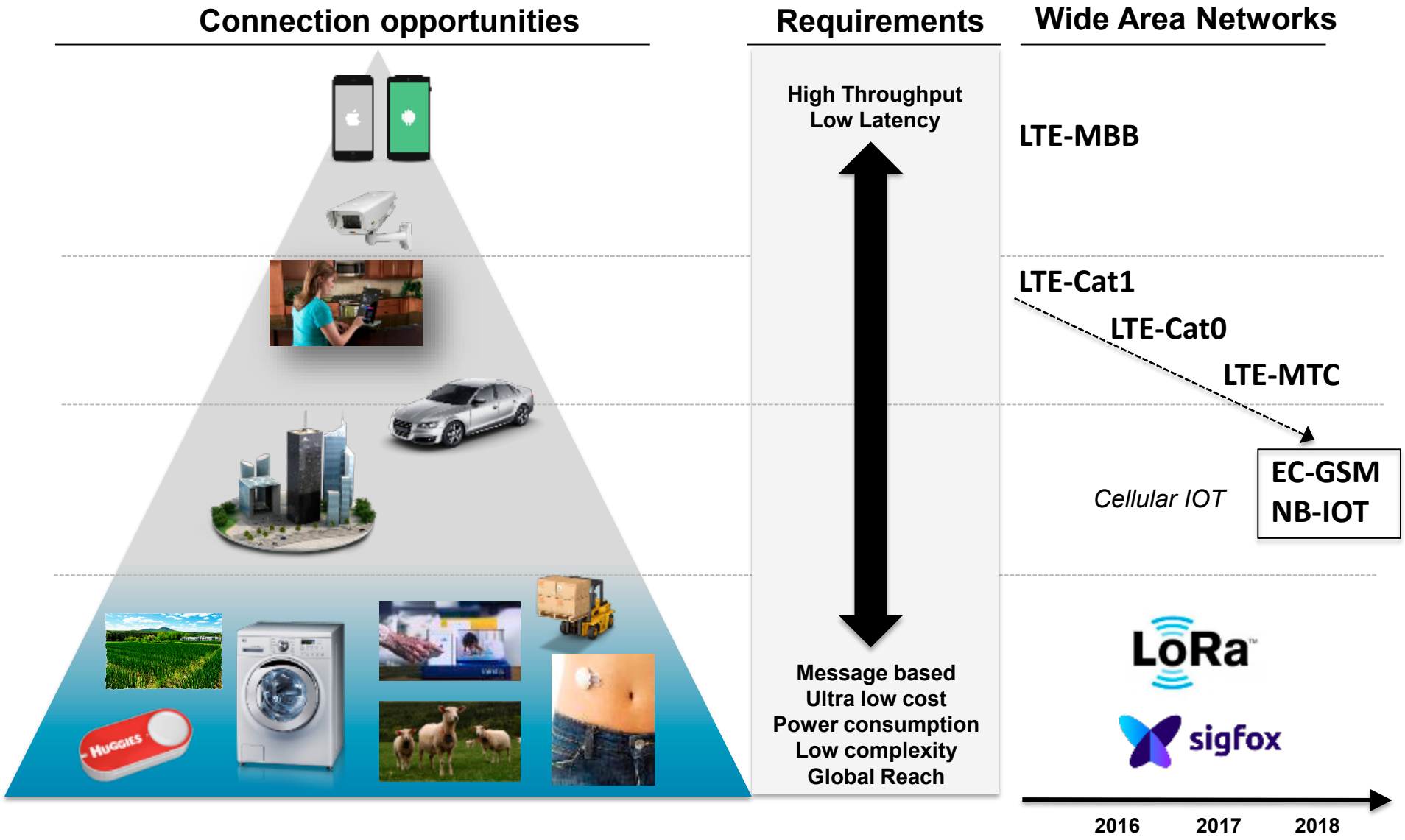
Conclusions



ST Strategy and Offer for the IoT

IoT is an end-to-end system from device to cloud involving many actors

ST has a coherent strategy to cover the market needs

The right building blocks for IoT devices	Lower barriers for developers getting started	Lower barriers from prototyping to first product	Lower barriers to connect devices to the Cloud	Enable product & service commercialization
Building Blocks	**Stackable Boards & modular SW**	**Application specific SW**	**Integration of Cloud Provider SDKs**	**Partner Program**

Processing | Security | Sensing & Actuating | Connectivity | Motor Control | Power & Energy Management | Conditioning & Protection

Audio Algorithms

Sensor Fusion

Pre-integrated Software for vertical Applications

Smart Home | Building automation | Wearable

amazon web services | Microsoft Azure | Watson IoT

Ready to use Smartphone Apps

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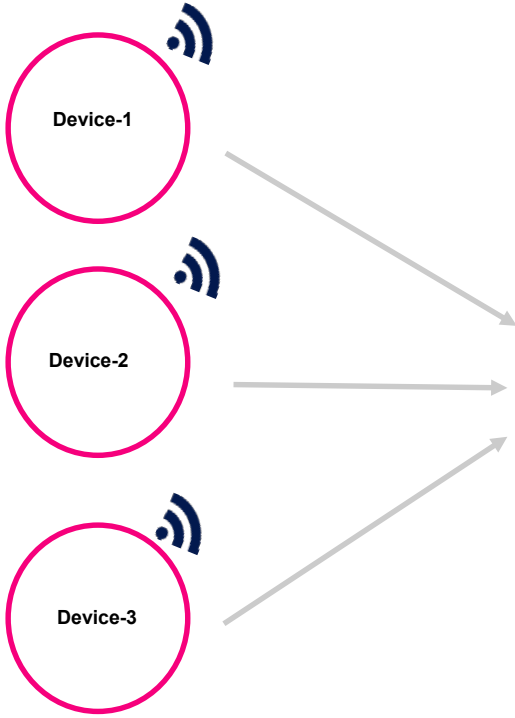
Partner Program

ST – Semtech – Senet - MyDevices Demo



Devices

The aim is to sense, track, record, monitor any activity. They could be connected to several Gateway and many devices could be connected to the same Gateway. Devices are base on SX1276(100MHz – 1020MHz) or SX1272 (800MHz – 1020MHz) radio.

Gateway

Is ‘‘just’’ a bridge between the devices and the network server.
The Gateway(Base station) are Telco properties (Verizon, Orange, Vodafone …)
The Semtech radio chipset is the SX1301.

Network Server

Will decode the data from the device to route the right devices information to the right Application server.
Other players on top of Telco may offer Network Server services

senet

Application Server

Runs the application. The App could run on a cloud server, PC, Phone … . Then the data are sent back to the right device via the N.S and the Gateway.

myDevices

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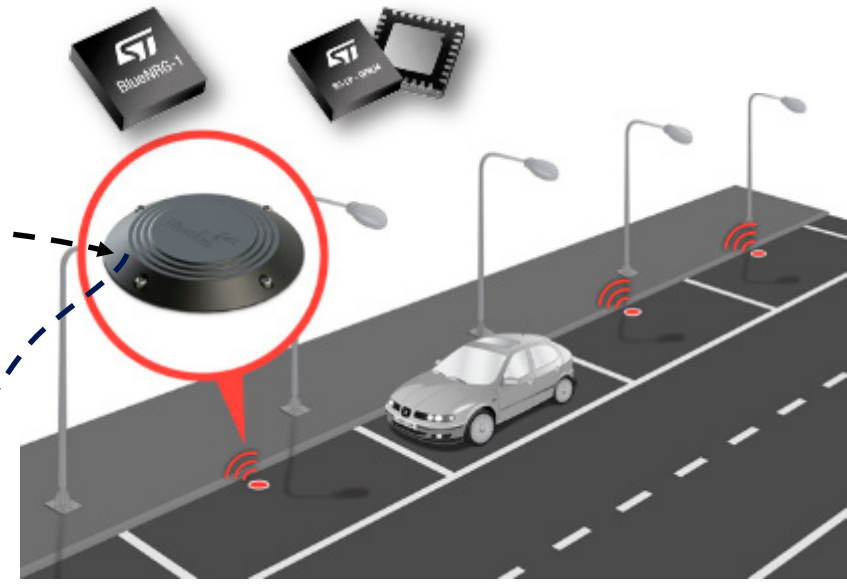
Smart City - Parking

Challenge

Make the management of parking spaces more efficient.

Solution

Dual Chip Sigfox and Bluetooth LE smart parking meter



How it works

① **Park** Search available parking spot with the app on your phone

② **Pay** using a Bluetooth LE secure connection to the Smart Parking Meter

CLOUD

sigfox

Back End

③

- **Send** the car presence or remaining time in the Sigfox back end
- **Notify** the user via a Sigfox call back to his phone app

sigfox

Base Stations

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