IoT connectivity made easier

STM32 MCUs & LoRa®

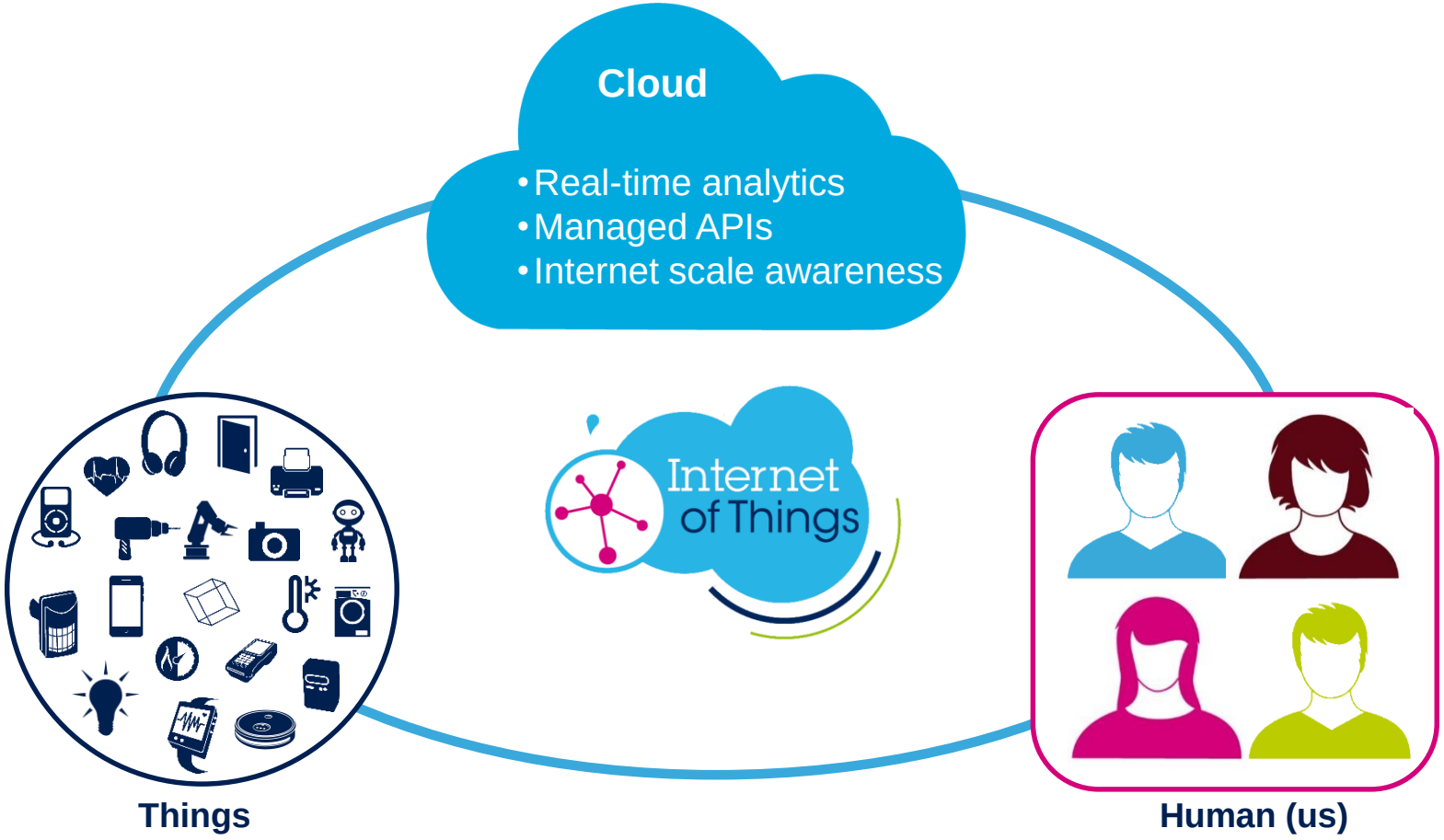
life.augmented

Summary

1. What is IoT ?
2. Communication technologies – Overview
3. LPWAN
4. LoRa® and LoRa Alliance
5. LoRa® technology modulation and LoRaWAN™ network protocol
6. STM32 boosting LoRa® (Roadmap, demos, competition, and schedule)

What is IoT ?

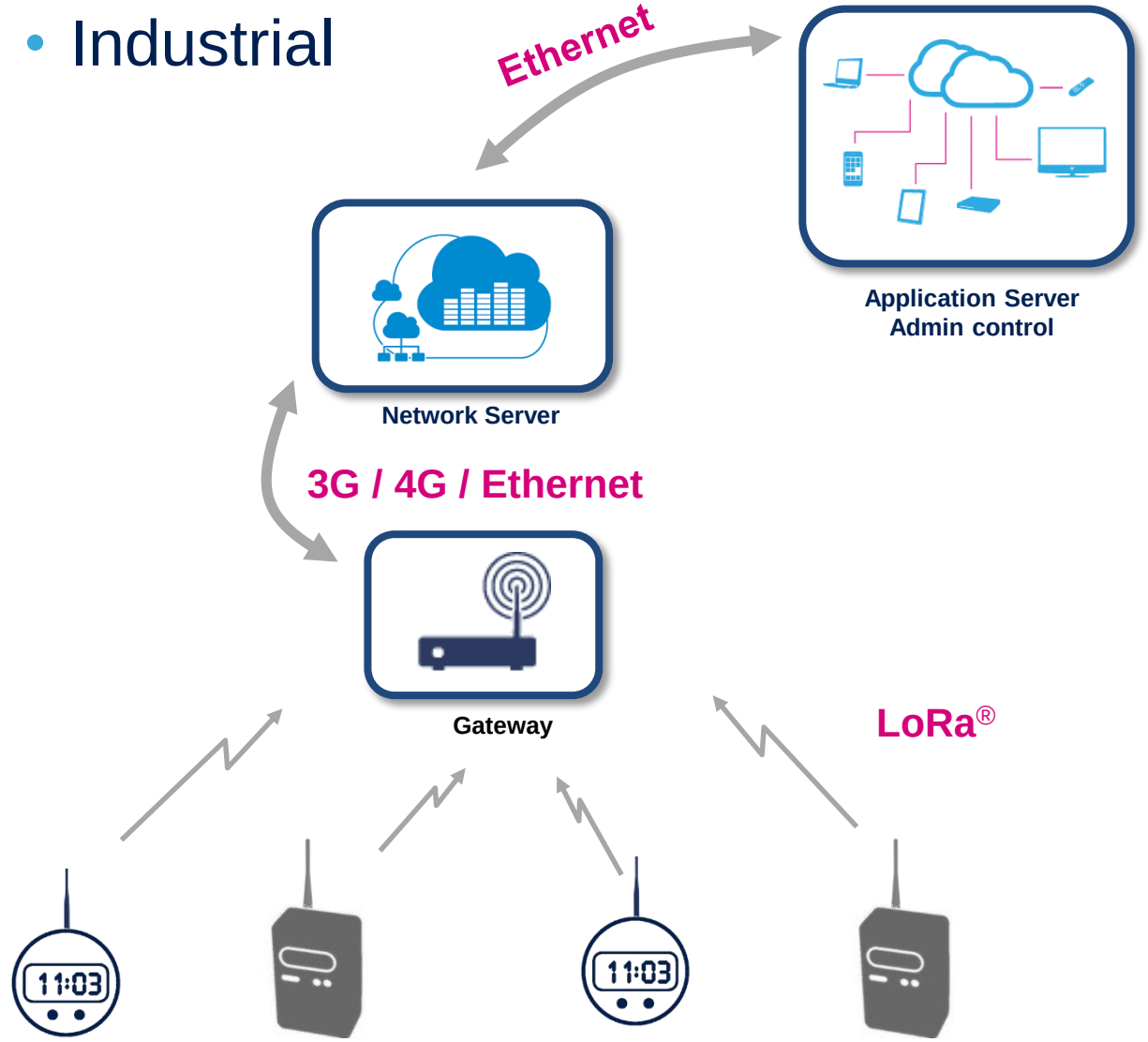
While M2M networks connect machines in closed systems,
IoT enhances the exiting networks through an intelligent cloud.



IoT use cases

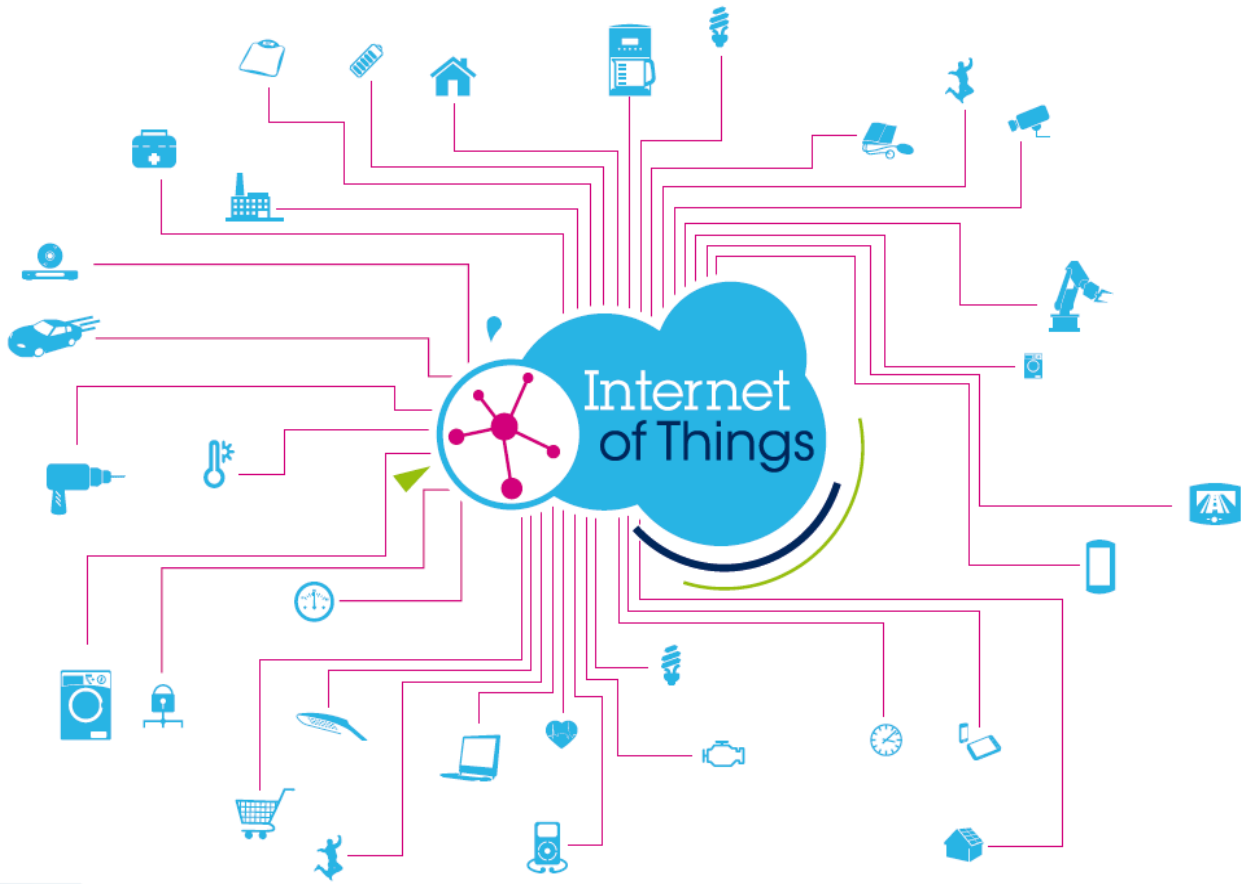
- Consumer

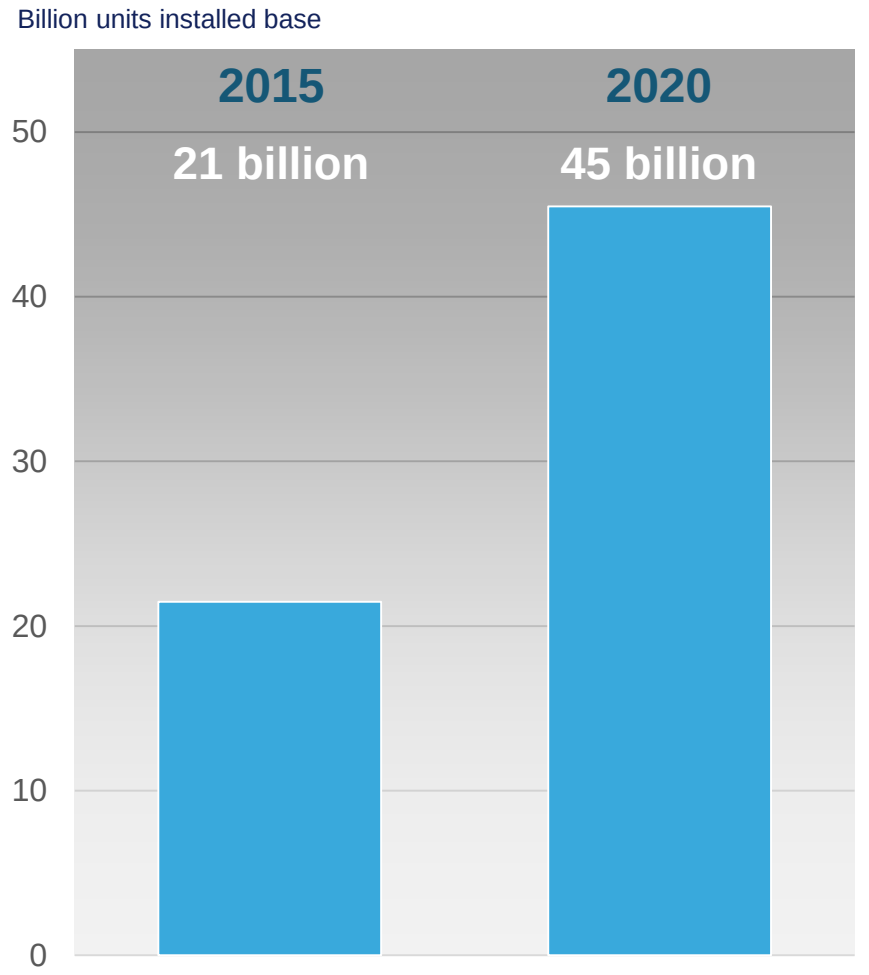
- Industrial



IoT - Driving the next semiconductor growth

45 billion connected devices are expected by 2020

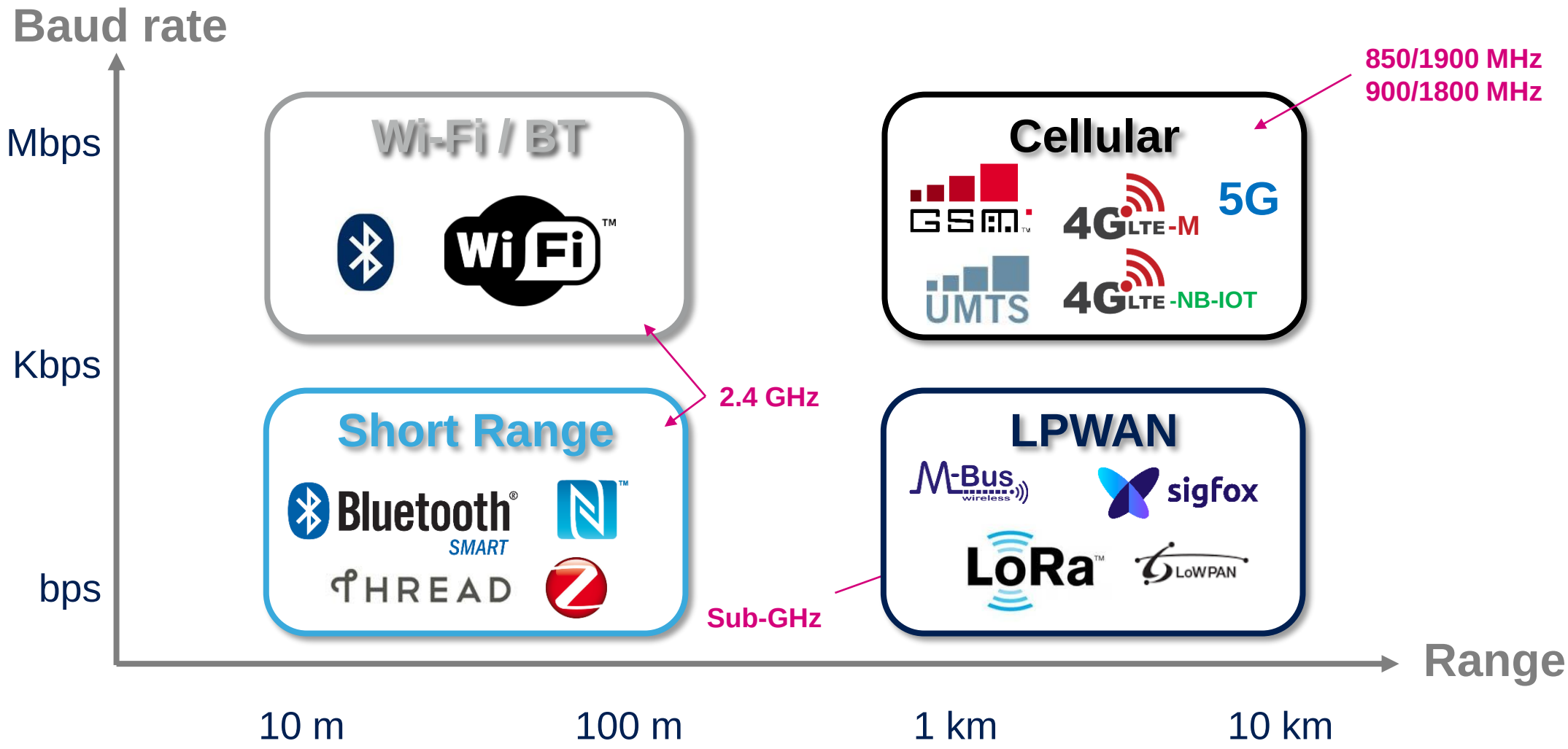




Source : ABI, ST

life.augmented

Communication Technologies - Overview

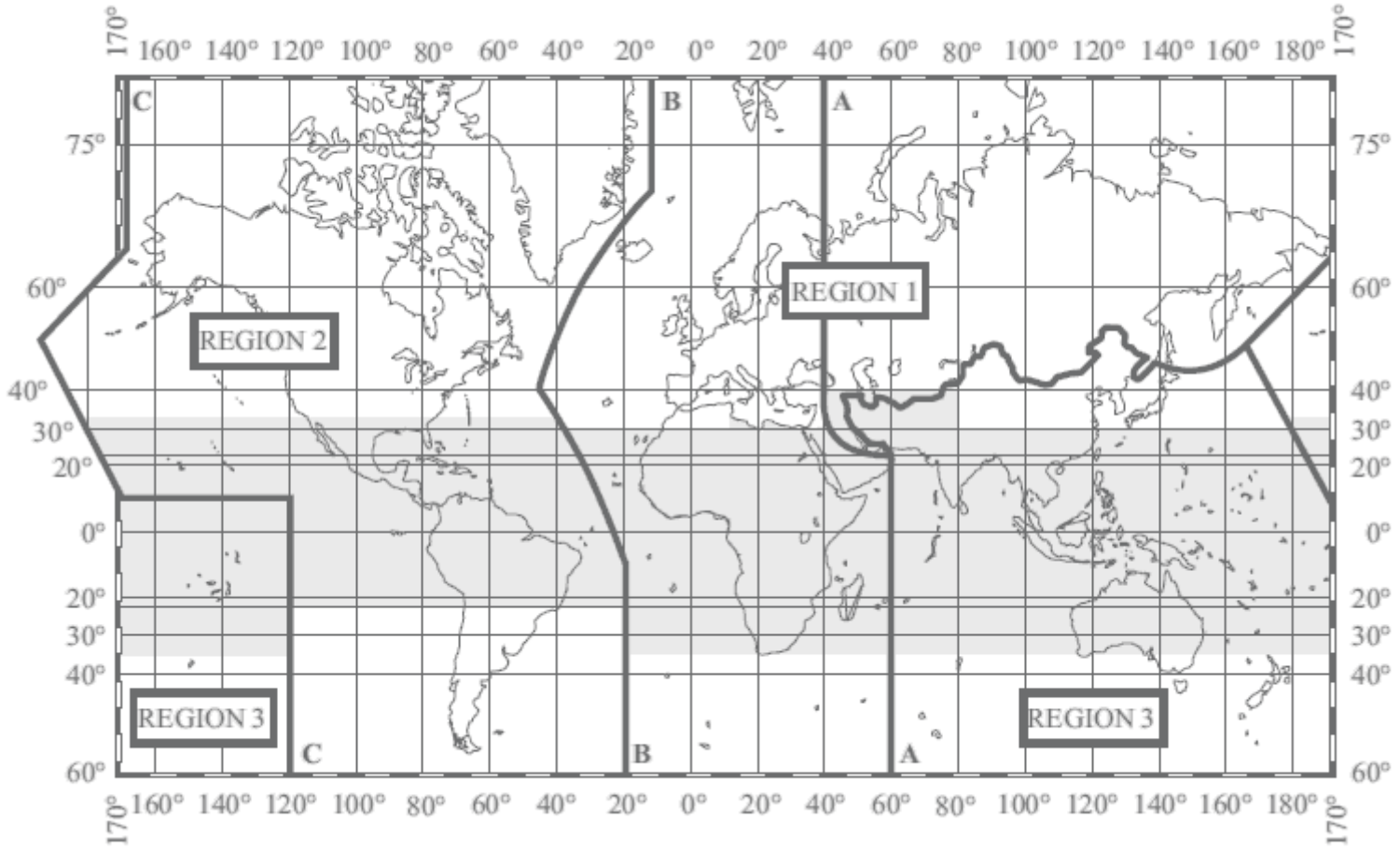


life.augmented

ISM worldwide regulation

Output Power vs Duty Cycle

Countries	Frequency band review	Max. output power
EU	868 MHz	14 dBm
USA	915 MHz	20 dBm
Korea	900 MHz	14 dBm
Japan	920 MHz	
Malaysia	862 to 875 MHz	20 dBm
Philippines	868 MHz	
Vietnam	920 to 925 MHz	
India	865 to 867 MHz	
Singapore	922 MHz	
Thailand	920 to 925 MHz	
Indonesia	922 MHz	
ANZ	915 to 928 MHz	
Taiwan	920 to 925 MHz	
China	470 to 510 MHz	17 dBm



life.augmented

Sub-GHz and IoT

The 2 solutions to address the IoT over LPWAN

- **Sub-GHz is a fragmented** segment with many dedicated protocols and solutions to address different needs
- An **initiative of standardization** is on-going with **LTE, LoRa®, Sigfox** …
- **Standardization** will be an **enabler** for **industrial** applications (meters), **Smart Cities**

Source: Semtech

What is LoRa® ?

1. A Sub-GHz wireless technology enabling low data rate communication over long distances
2. Targeting M2M and Internet of Things, IoT applications
3. LoRa® technology provides a WAN capability, using a MAC protocol named LoRaWAN

Long range

- Greater than cellular
- Deep indoor coverage
- Star topology

Max lifetime

- Low power optimized
- **10- to 20-year** lifetime
- >10x vs cellular M2M

Multi-usage

- High capacity
- Multi-tenant
- Public network

Low cost

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

True location

- Indoor and outdoor
- Accurate

Bidirectional

- Bidirectional
- Scalable capacity
- Broadcast

Global mobility

- True mobility
- Seamless
- Roaming

Security

- Unique ID
- Application
- Network

life.augmented

Source: LoRa Alliance

ST and the Alliance

The Internet of Things era is now

ST is SPONSOR and Board Member

LoRa® Alliance

Wide Area Networks for IoT

The LoRa® Alliance is an open, non-profit association of members. Its mission is to ensure that LoRaWAN™ is THE open global standard for SECURE, CARRIER-GRADE IoT LPWAN connectivity.
Visit www.lora-alliance.org

life.augmented

Source: LoRa Alliance

The LoRa® Alliance

2017 *
MEMBER GROWTH:

+193

58% increase over 2016

2017 SPECIFICATION
DOWNLOADS:

8,024

2017 CERTIFIED
PRODUCT GROWTH:

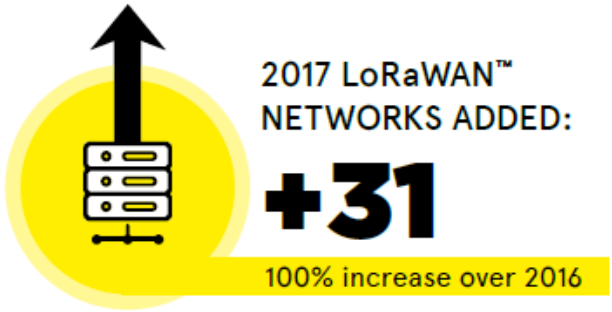
+176%

increase over 2016

REGIONAL SPECIFICATIONS
EXPANSION: NEW MARKETS

INDIA

Adding support for Australia's recent regulatory change to its ISM band, expanded Korea band



2017 LoRaWAN™
NETWORKS ADDED:

+31

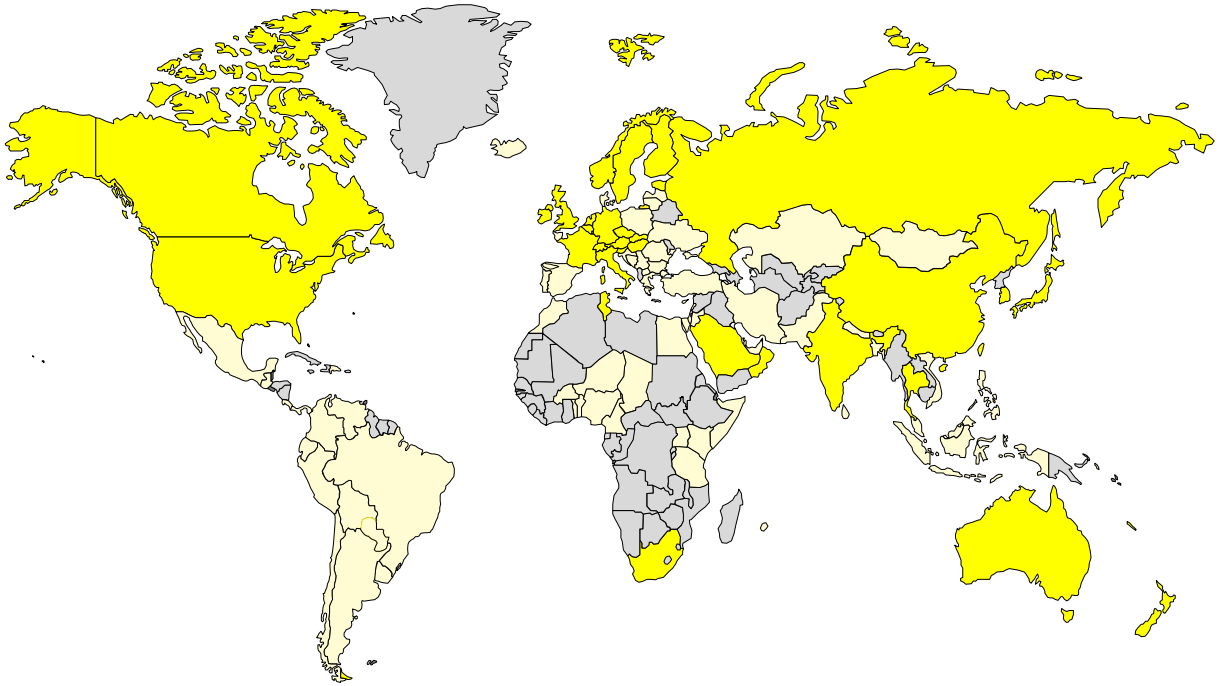
100% increase over 2016

life.augmented

** More than 480 members in July 2018*

Source: LoRa Alliance

The LoRa® Network Deployment



- **80** Network Operators
- Operating in **46** countries
- **54** Alliance Member Operators
- Near **100** Countries with LoRaWAN deployment

Legend:

- Alliance Member Public Networks
- Other LoRaWAN deployment

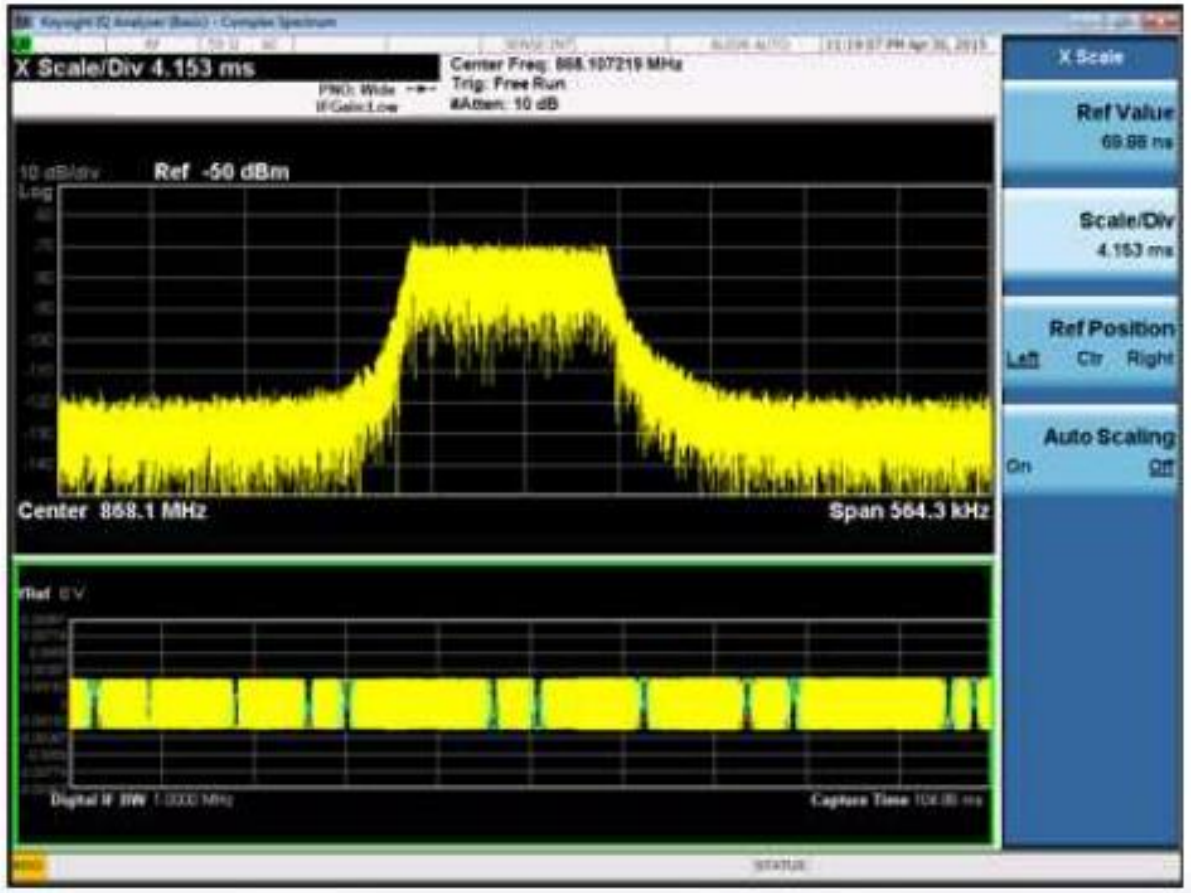
April 2018

life.augmented

Source: Semtech

LoRa® technology modulation

- LoRa® technology is based on the Spread Spectrum Technology
- It is a Chirped Frequency Modulation



Source: Semtech

life.augmented

Source: Semtech

LoRaWAN™ device classes

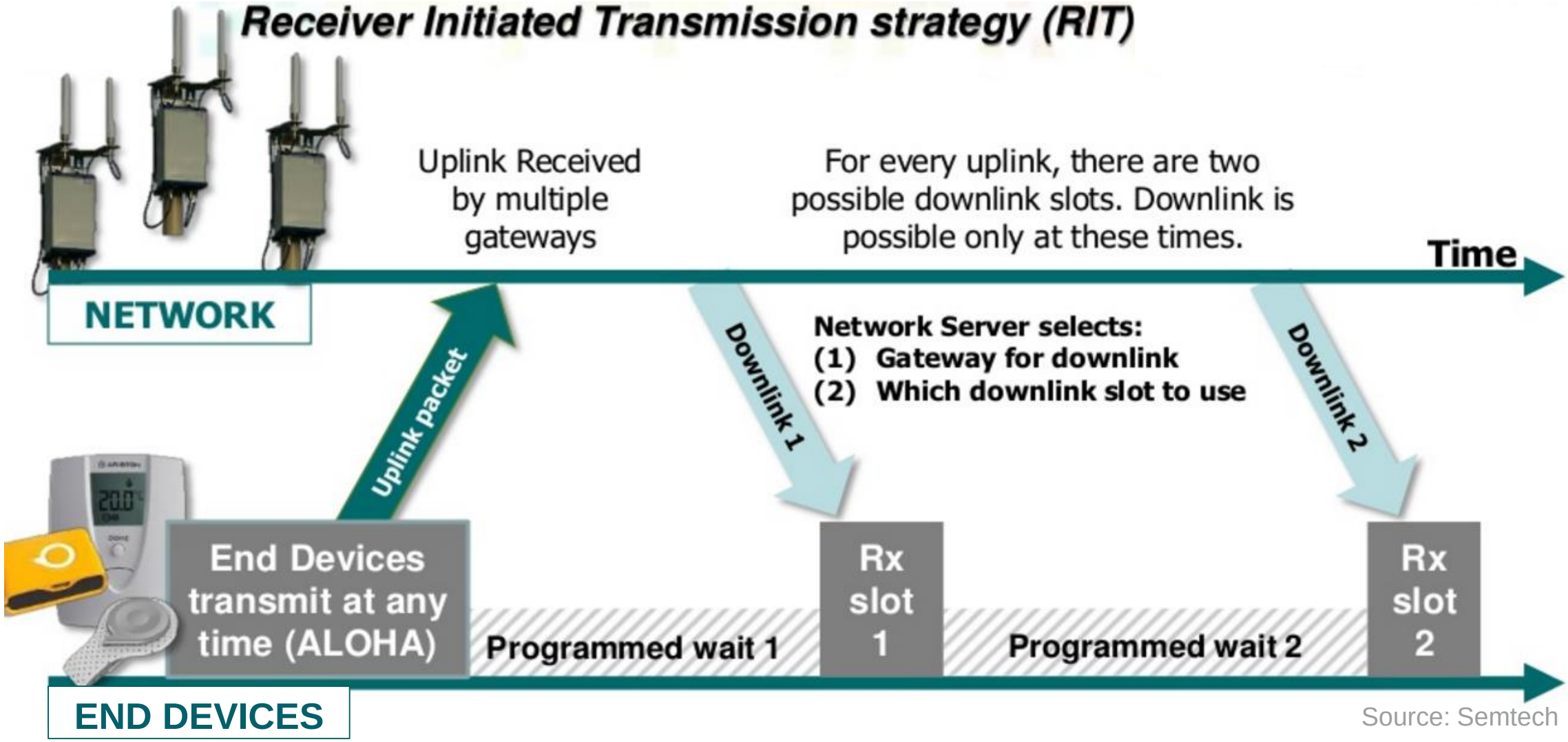
3 classes to cover all use cases

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”)	**Main powered actuators** Devices witch can afford to listen continuously. No latency for downlink communication.	***Lowest latency command and control for less power critical devices***

Source: Semtech

LoRaWAN™ device classes

Class A – Bidirectional Communication



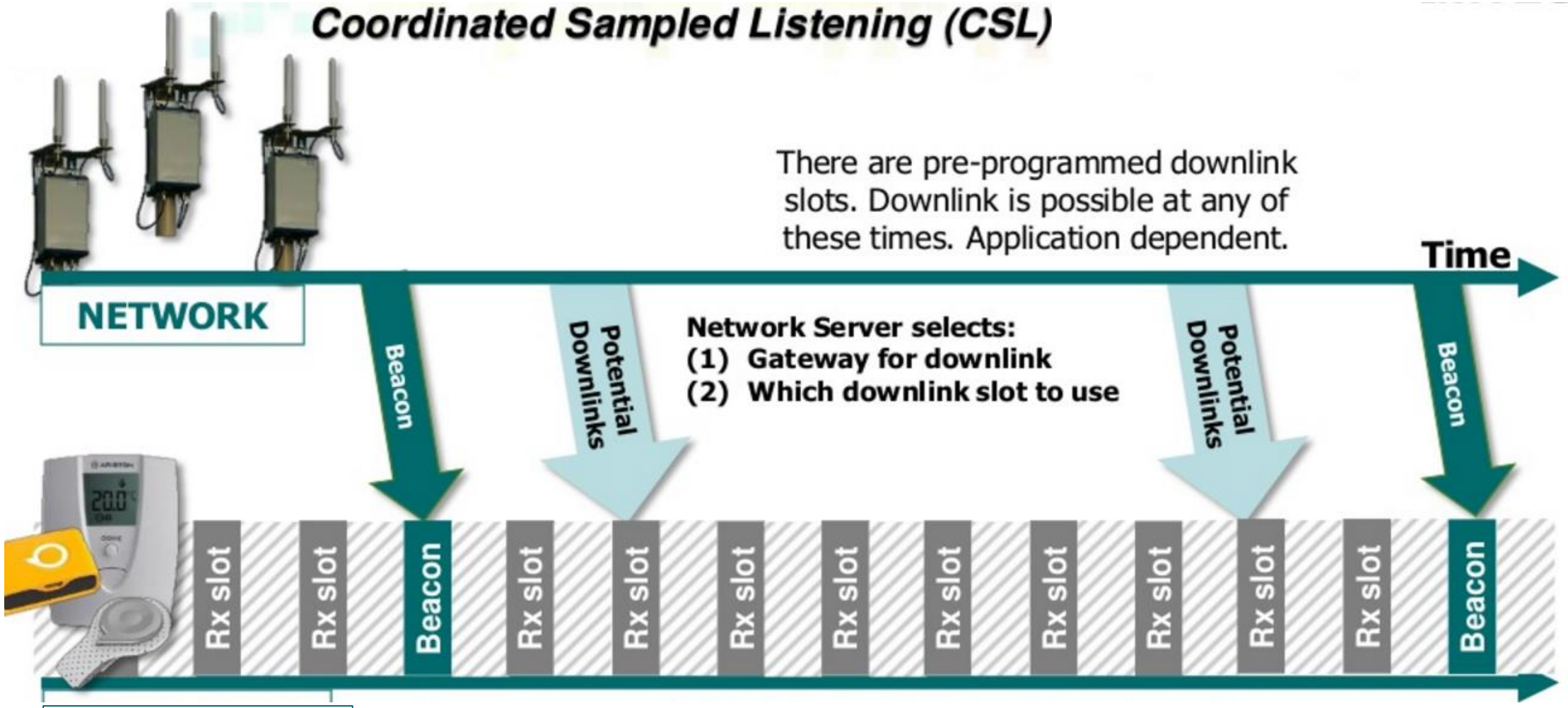
life.augmented

Source: Semtech

Source: Semtech

LoRaWAN™ device classes

Class B – Bidirectional Communication



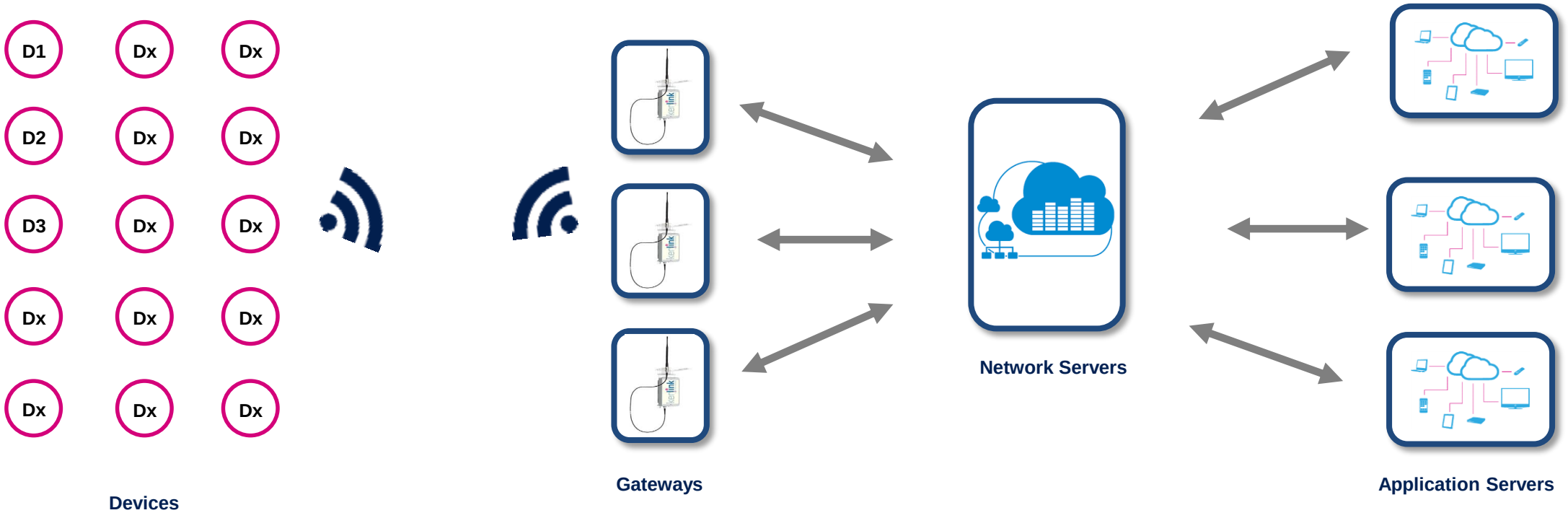
Pre-programmed RX slots synchronized by gateway beacons

Source: Semtech

life.augmented

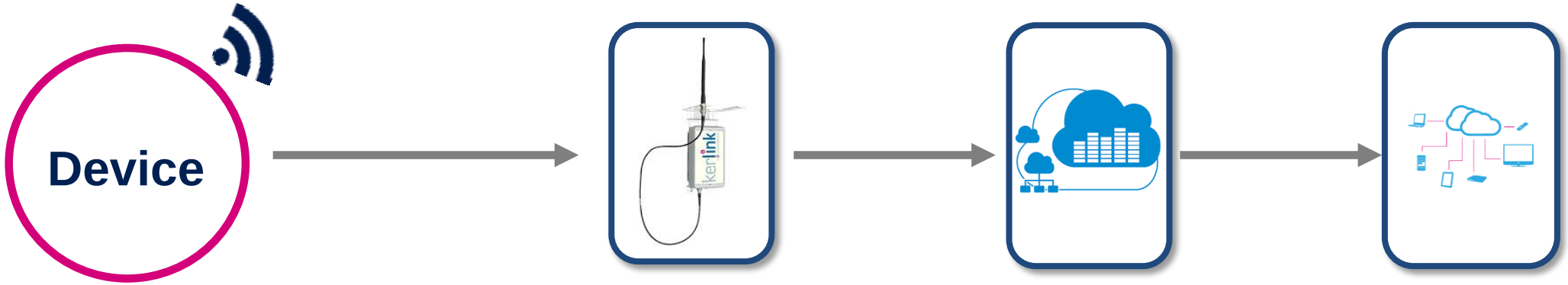
LoRa® network protocol

Network topology overview



LoRa® network protocol

Solution providers



SILICON

SEMTECH

MODULES

muRata Innovator in Electronics

FOXCONN

MULTITECH

USI

NEMEUS

DEVICES

BOSCH

Mueller SYSTEMS

Schneider Electric

HOMERIDER SYSTEMS

GATEWAY

CISCO

everynet

Sagemcom

kerlink

MULTITECH

RISINGHF

NETWORK SERVER

IBM

hp

OrbiWise

actility

LORIOT

stream

everynet

Sagemcom

senet

APPLICATON SERVER

senet

intel

libelium

WIPRO Applying Thought

digimondo

iSECUR

myDevices

life.augmented

- *Powered by STM32*

LoRaWAN™ - Security

A native 128-bit AES security network protocol

- Device Address (DevAddr) is a 32-bit identifier
  - Unique within the network
  - Available in each data frame and shared between end-device, N.S and A.S
- Network Session Key (NwkSKey) is a 128-bit AES encryption key
  - Unique per end-device and shared between end-device and N.S
  - It allows message integrity communication between end-device and N.S
- Application Session Key (AppSKey) is a 128-bit AES encryption key
  - Unique per end-device and shared between end-device and A.S
  - It is used to encrypt / decrypt A.S server messages to the end-device
- To increase end-device authentication and security, a secure element can be added to the device

ST and Semtech LoRa® Agreement

- Semtech Corporation and STMicroelectronics announce an **agreement on Semtech's Lora®** long-range wireless RF technology
- Intended to **boost STM32 MCUs with LoRa®** technology to target internet of things deployments by mobile network operators and large-scale private networks

-> ST and Semtech partnership press release

LoRa® powered by STM32™

www.st.com/stm32-lrwan

USI® Module
AT command

Murata® Module
All-in-one Open

Cost-optimized solution

Flexible design architecture
More than **1000 STM8/STM32 part numbers**

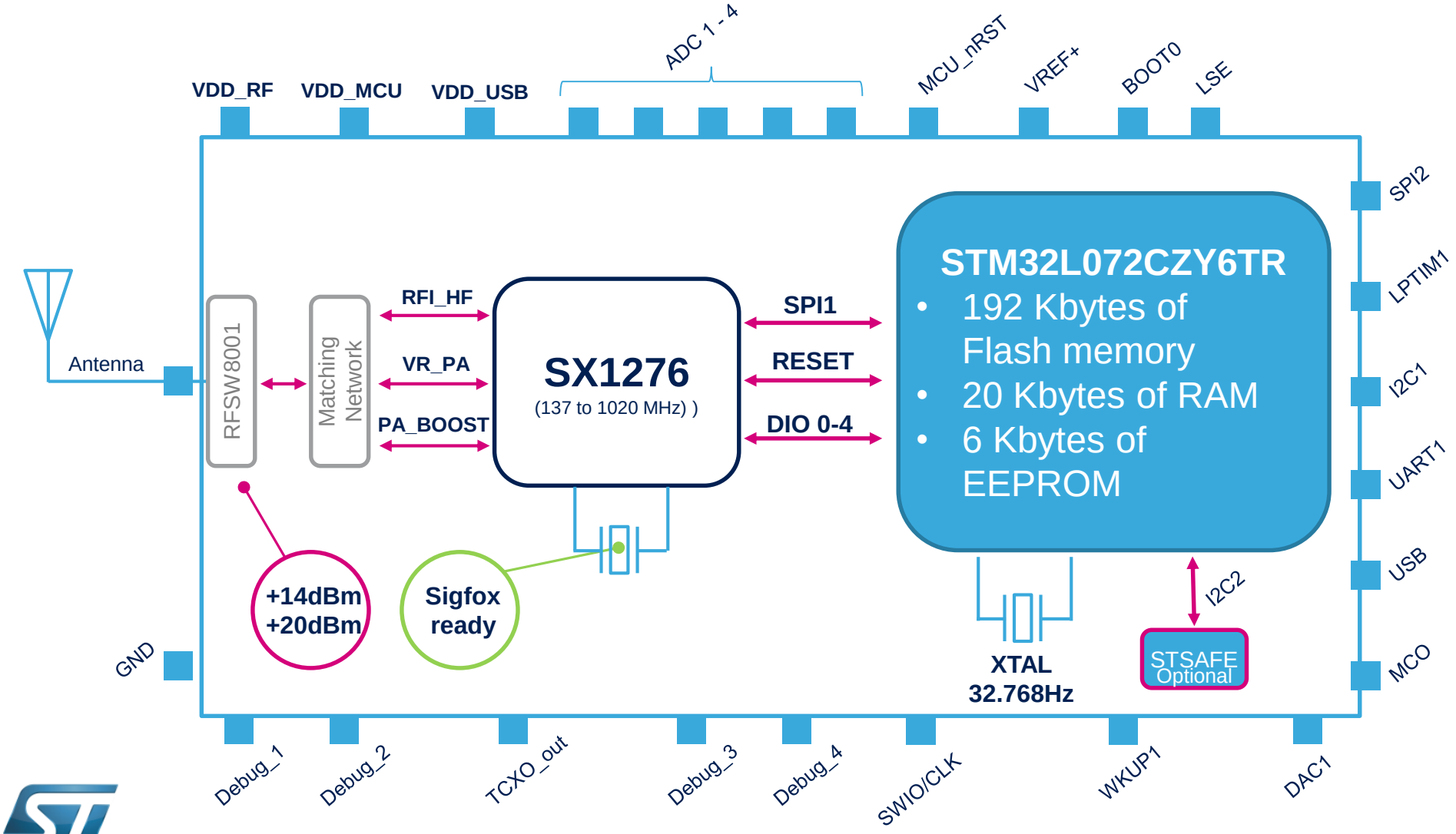
All-in-one LPWAN

life.augmented

* I-CUBE-LRWAN *STM32 Embedded Software (LoraWAN stack) is compatible with Semtech SX127x & SX126x transcievers*

Open Murata® LoRa® module

Powered by STM32L0



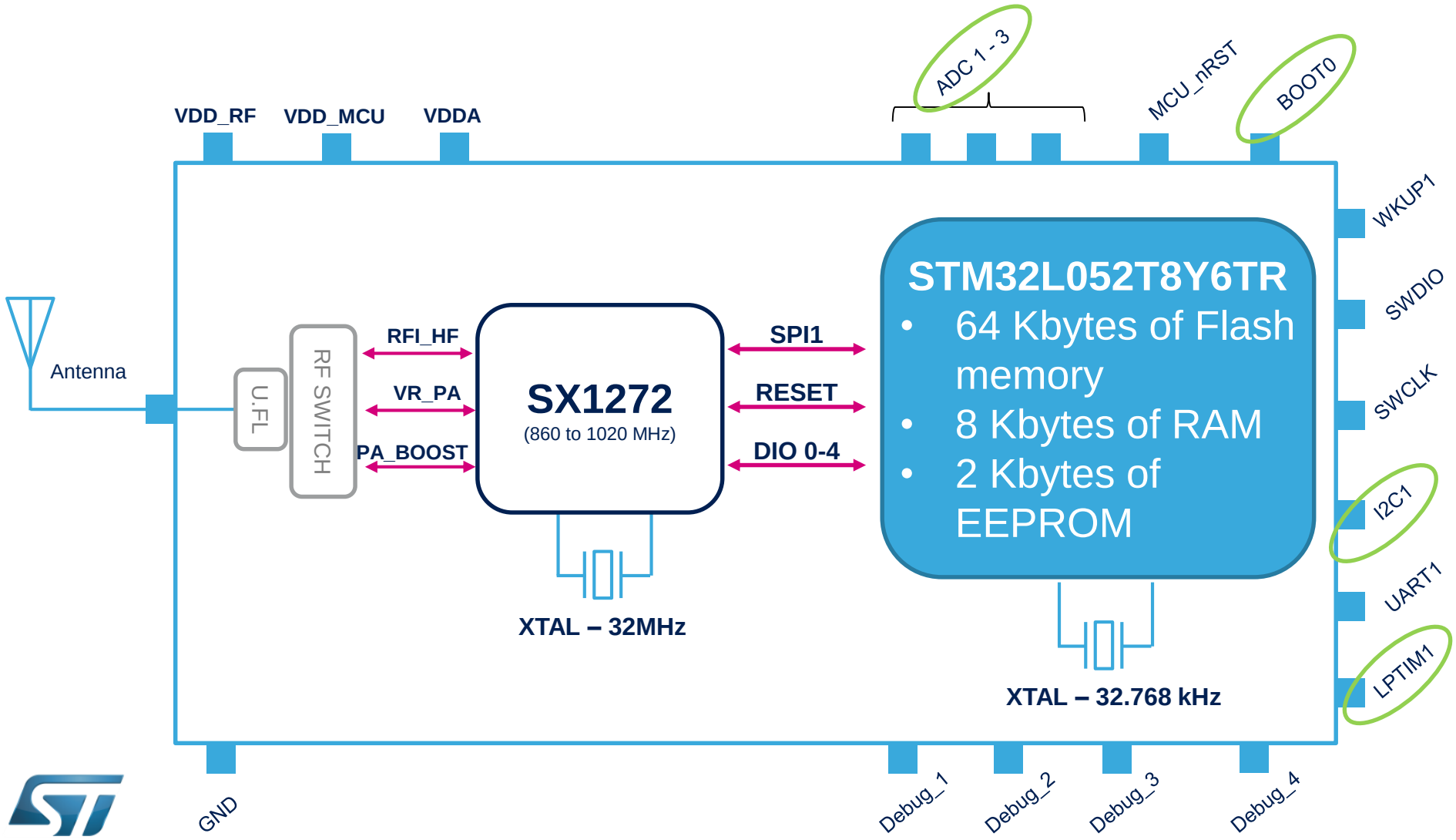
Open LPWAN Module

muRata
INNOVATOR IN ELECTRONICS

life.augmented

USI® LoRa® module - AT command set

Powered by STM32L0



Cost optimized

USI®
Realizing IDEAS Together

Optional on open module version

life.augmented

Let’s get started

With a wide and existing ecosystem

(Click on the icon or link)

Hardware tools

Nucleo pack
ST and Semtech
P/N: P-NUCLEO-LRWAN1

Expansion board
ST and USI®
P/N: I-NUCLEO-LRWAN1

Discovery kit
ST and Murata®
P/N: B-L072Z-LRWAN1

Dev tools

STM32CubeMX

ST-Link Utility

Partners IDE

arm KEIL

arm MBED Enabled

System Workbench for STM32

IAR SYSTEMS

LoRaWAN™ stack

life.augmented

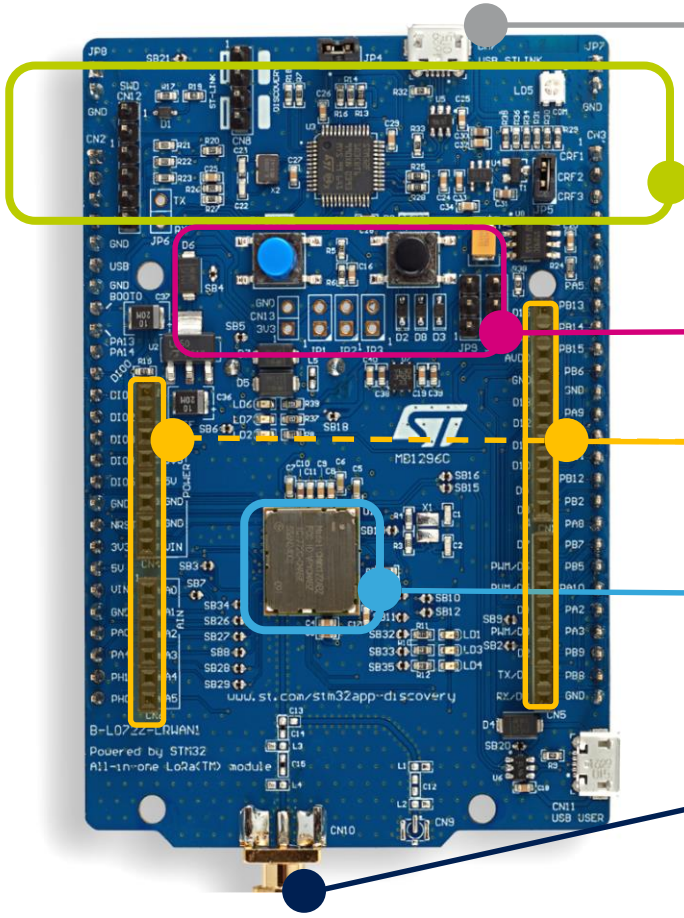
I-CUBE-LRWAN

life.augmented

New hardware tool

B-L072Z-LRWAN1: Murata® STM32™ and LoRa® Discovery kit

arm MBED Enabled



Flexible board power supply:
through USB or external source

Integrated ST-Link/V2-1:
mass storage device flash programming

2 push buttons, 2 color LEDs,
Jumper settings

Arduino™ extension connectors :
easy access to add-ons

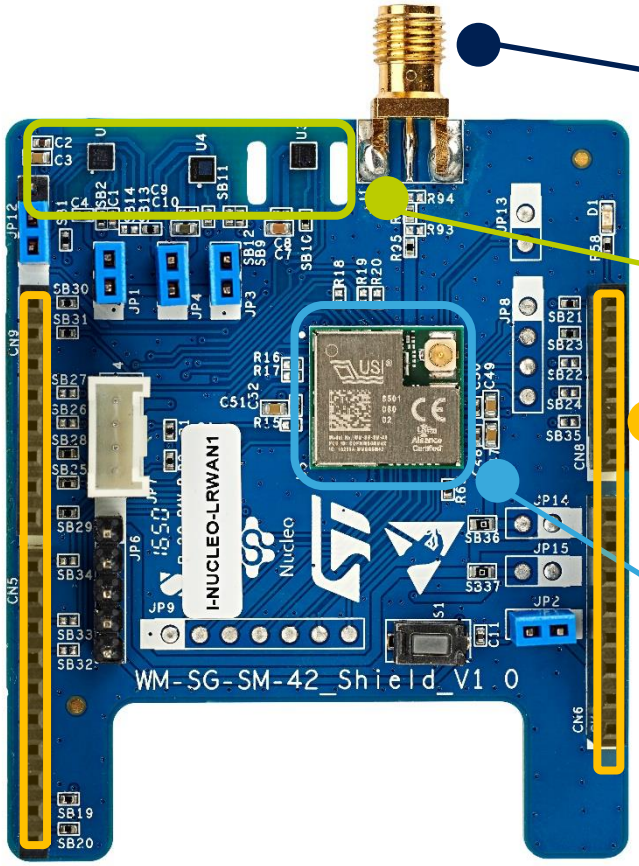
Murata® module

SMA Antenna connector

life.augmented

New hardware tool

I-NUCEO-LRWAN1: USI® STM32™ Nucleo expansion board for LoRa®



SMA antenna connector

Pressure, humidity, temperature, and 3D MEMS

Arduino™ extension connector

USI® module

life.augmented

LoRa® technology powered by STM32

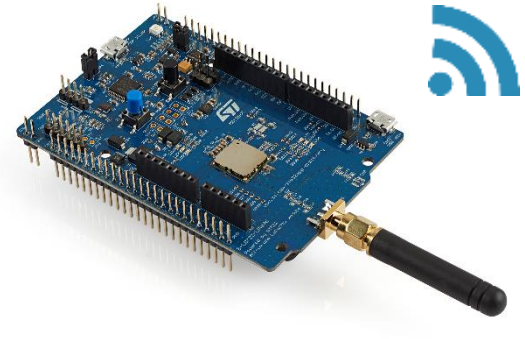
The widest ecosystem-ever now available !

Best-in-class in ultra-low-power and Long Range

Widest HW and SW ecosystem

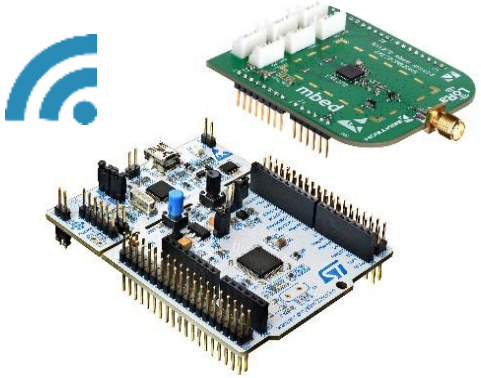
Easy to use

LoRa® Gateway STM32F7 based



B-L072Z-LRWAN1
LPWAN Discovery kit

I-NUCLEO-LRWAN1
LoRa® + Mems Shield



P-NUCLEO-LRWAN1
LoRa® Nucleo Pack

life.augmented

Release your creativity
with the STM32

/STM32 @ST_World community.st.com st.com/e2e

www.st.com/stm32-lrwan

life.augmented