

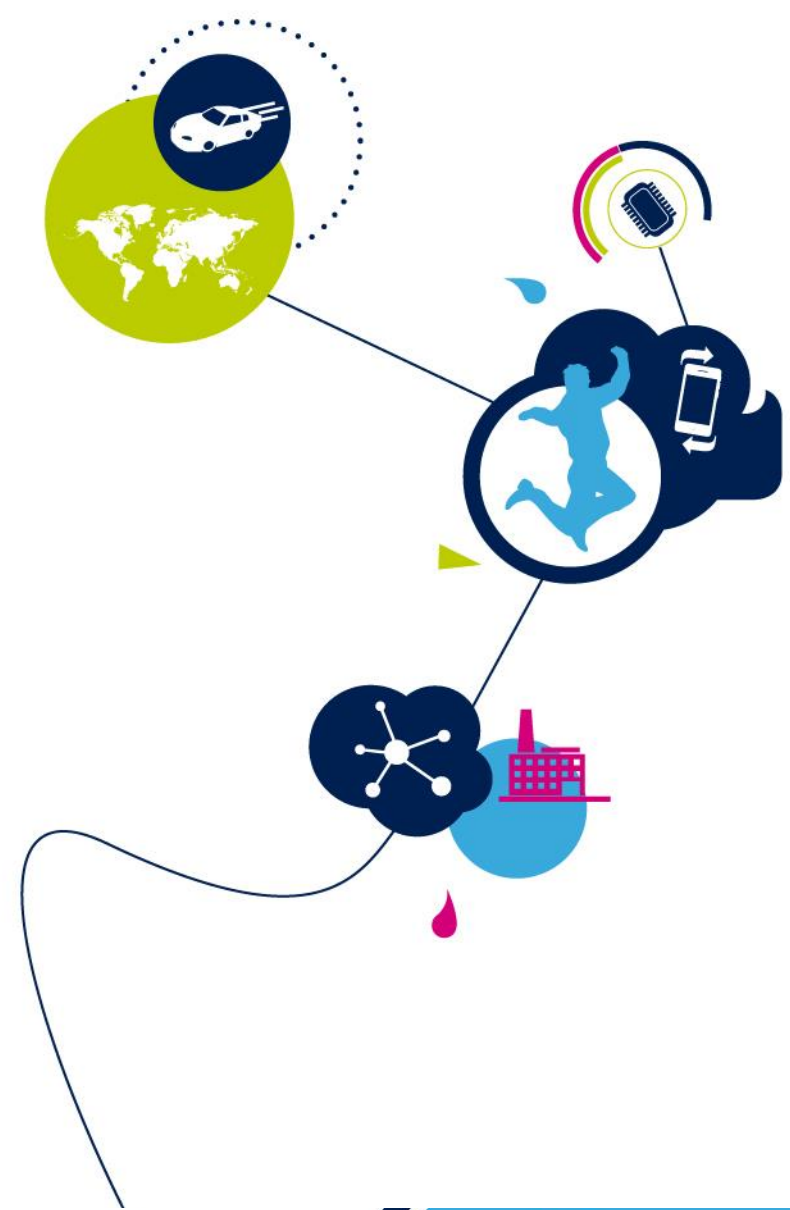
LPWAN (LTE & LoRa®) IoT Solutions

Marc Hervieu
Marketing Manager



**ST Developers
Conference**

September 12th, 2019
Santa Clara Convention Center - Mission City Ballroom
Santa Clara, CA



- LPWAN Market Overview
- ST IoT & Operator Strategy
- ST IoT LPWAN Cellular
 - AT&T, Verizon, Truphone, Telus Dev-Kits
- ST IoT LPWAN LoRa
 - MachineQ Dev-Kits
 - GNSS LoRa Tracker Dev-Kits & Ref. Design
- Wrap-Up

LPWAN

Low Power Wide Area Network

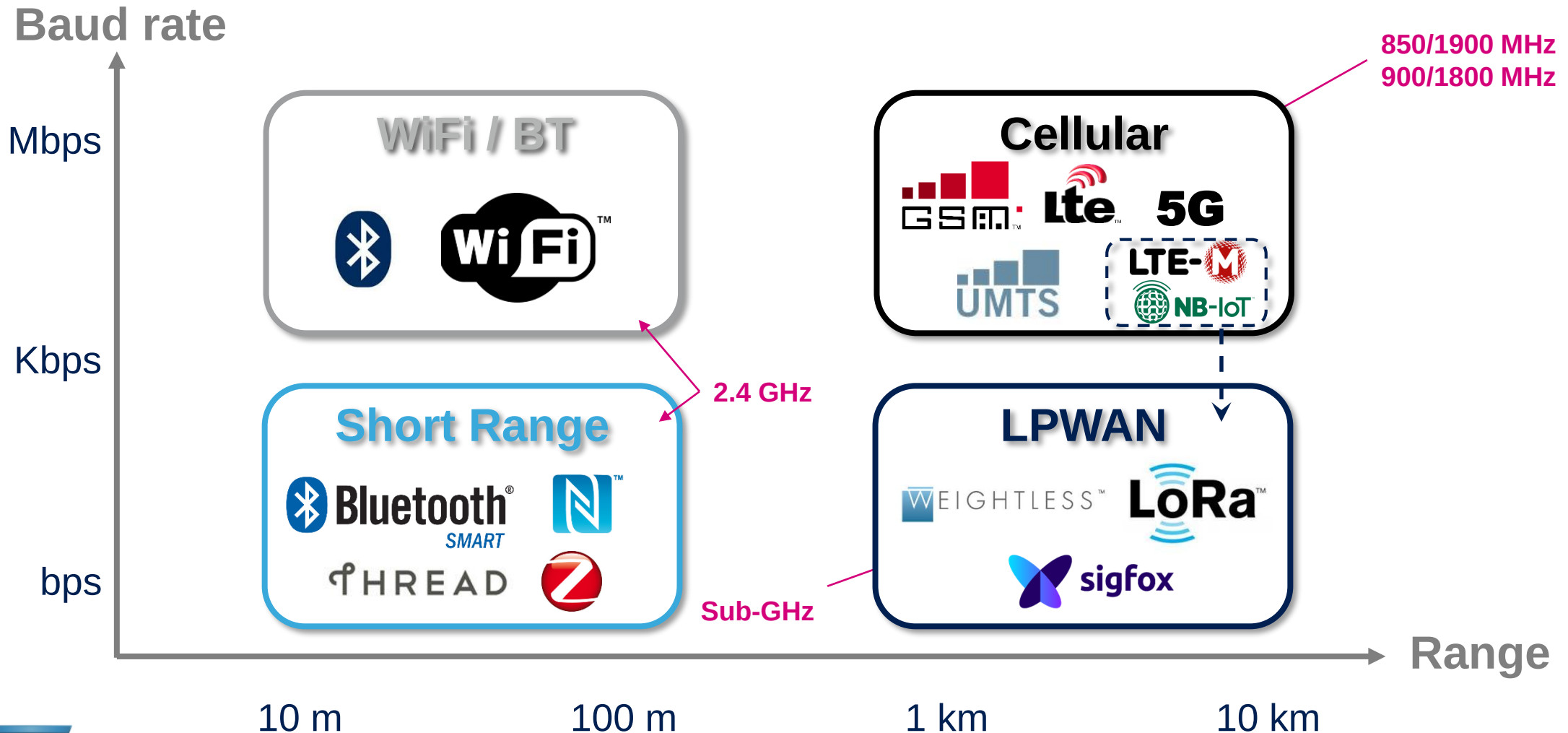
3



LPWAN Market Overview

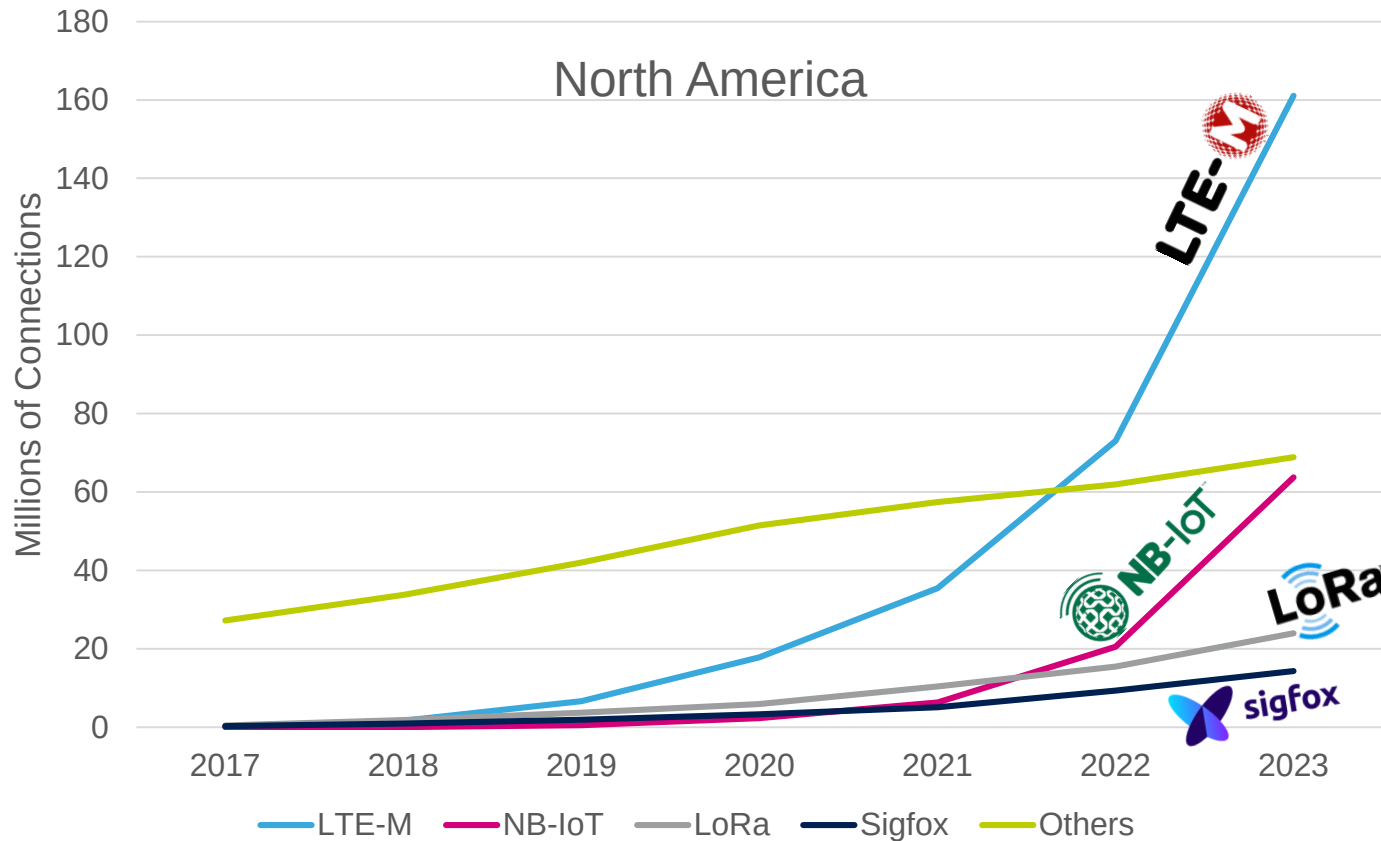
Communication Technologies - Overview

4



North America – LPWAN Market Trends

5



Applications driving LPWAN growth



Asset Tracking
People / Pet Tracking
Home Auto.
Metering
Street Lighting



Asset Tracking
Metering
People / Pet Tracking



Agriculture
Asset Tracking
Home Monitoring
Metering



Agriculture
Asset Tracking
Home Monitoring

Others

Home Automation

Communication Technologies - Overview

6

Emerging Technologies

- Long Range Low Power

LTE-M  **NB-IoT**

LoRa

 **sigfox**

- **Public network**
 - Telco carriers
- **Leveraging existing infrastructure**
- Higher data rate
- **Private Network**
 - Localized Coverage
 - Provide technology for companies to build an infrastructure
- Proprietary PHY, Open MAC
- Regional regulatory differences
- **Public network**
 - SigFox USA
- Regional regulatory differences
- **Suited for upstream**
- Inexpensive

Technology Comparison

7



				
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	300 Kbps	50 Kbps
Daily Traffic per device	1.6 Kbyte	10 Kbytes	Several 100 Kbytes	Several 100 Kbytes

Americas Operators – LPWAN Activity

8

LTE-M



NB-IoT



LoRa

machineQ
A COMCAST SERVICE

senet

COX

Sprint

U.S. Cellular

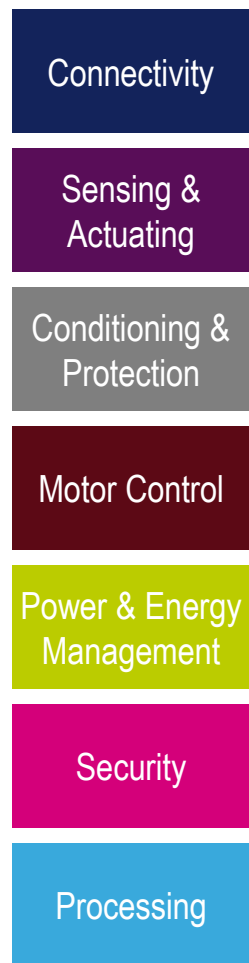
sigfox

[MVNO]



ST IoT & Operator Strategy





**>17 Billion
ST MEMS**



**WW Top
#1 #2**



**Industrial
WW Top #3**

**>3 Billion
ST MCU**



**WW Top #2
>60,000 Customers**



SensorTile



BlueCoin



SmarTAG



Discovery Kit IoT Node



STM32 Nucleo Development
& Expansion boards

Pre-integrated SW for vertical applications



Smart Things



Smart Home



Smart City



Smart Industry

*"Re-use the embedded code
from prototype to product"*

Development Ecosystem



Code generators



Prototyping
software



Development
environments



Debug
solutions



Simulation
and analysis tools



On-line
design tools



STM32 portfolio positioning

11



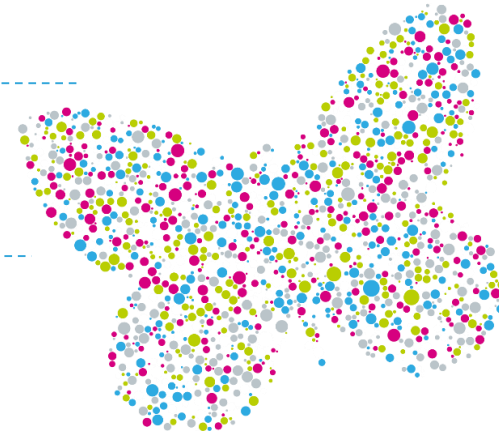
Largest Market Offering with ~1000 STM32 Part Numbers



High-performance



Mainstream



Ultra-low-power



Wireless



arm

Cortex-M0
Cortex-M0+

Cortex-M3

Cortex-M33

Cortex-M4

Cortex-M7

A7, Dual-A7



MEMS Sensors and Actuators

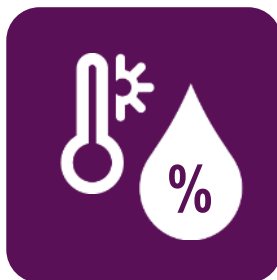
12

ST is the only company to offer the full range of Sensors & Micro-actuators



Motion

Gyroscope
Accelerometer
Magnetometer
6 & 9-axis inertial module
Optical image
stabilization



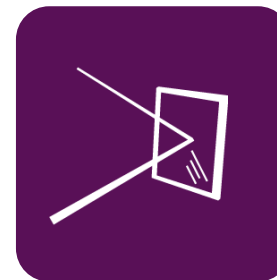
Environment

Temperature
Humidity
Pressure
VOC (Volatile Organic
Compound)



Interactivity

MEMS microphone
Touchscreen
controllers



Micro-Actuators

Micro-mirrors
Thin-film
Piezo-electric MEMS



Optical

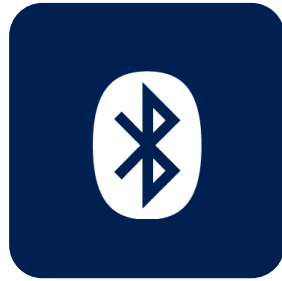
FlightSense™
Time-of-Flight
ranging sensors

Low-power wireless connectivity solutions



NFC and RFID

NFC/RFID tags
Dynamic NFC/RFID tags
NFC transceivers



Bluetooth

Bluetooth 4.x single core
Network Processors and SoCs
Multiprotocol, multi core
(Bluetooth 5.0/802.15.4)
Wireless SoC



SubGHz

Transceivers
Modules
LoRa and SigFox
compatibility



Wi-Fi

Plug & Play Wi-Fi module
Pre-certified solutions



Cellular

LTE CatM
LTE NB-IoT
Partner Radio
Partner Modules

ST Operator LPWAN Strategy

14



Packaged
Embedded
Solutions

HW, SW, Documentation...

Targets:

- Embedded Developers
- IoT evangelist
- OEMs
- Mass market

New Products on
the market

Return On Investment:

- Use ST products
- Use Operator service

- Faster Time to Market
- Easier development: Less cost/resources

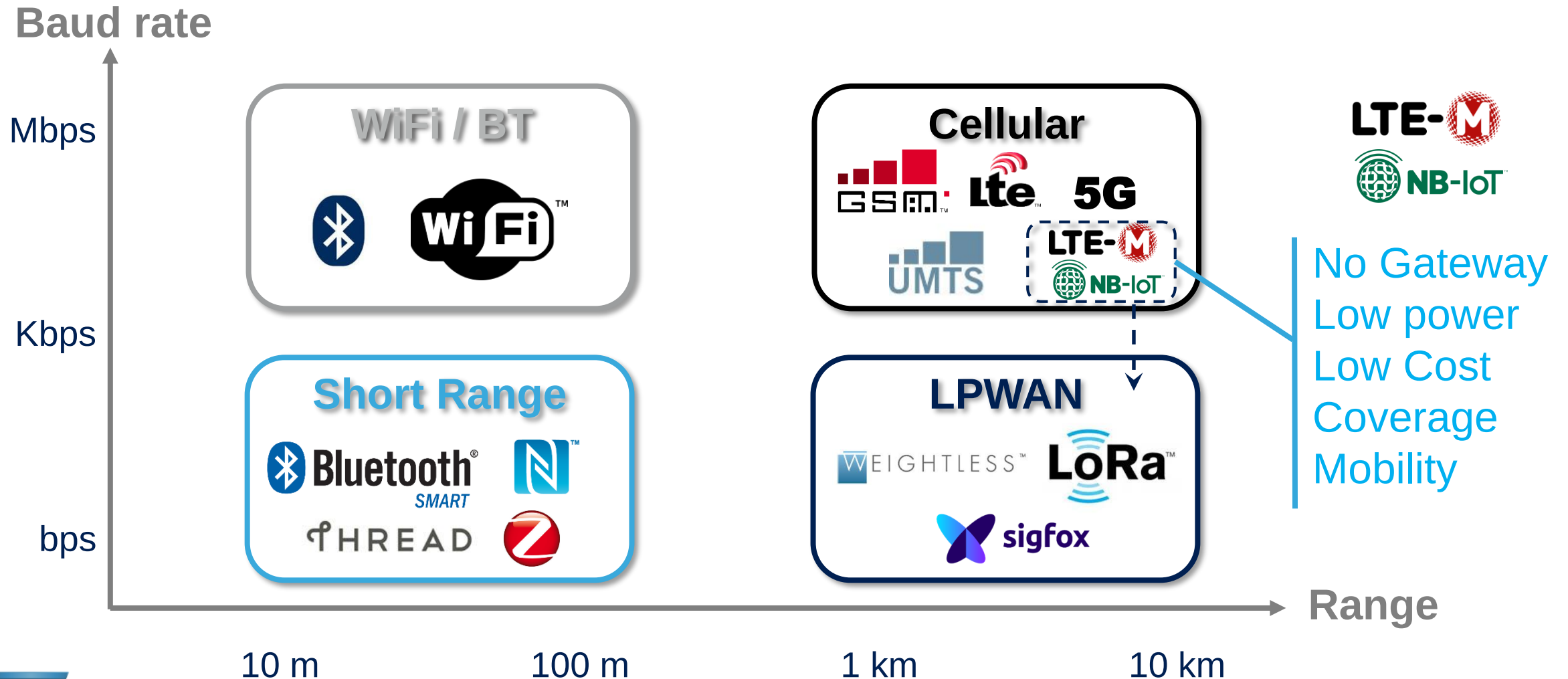


ST IoT LPWAN Cellular



Communication Technologies - Overview

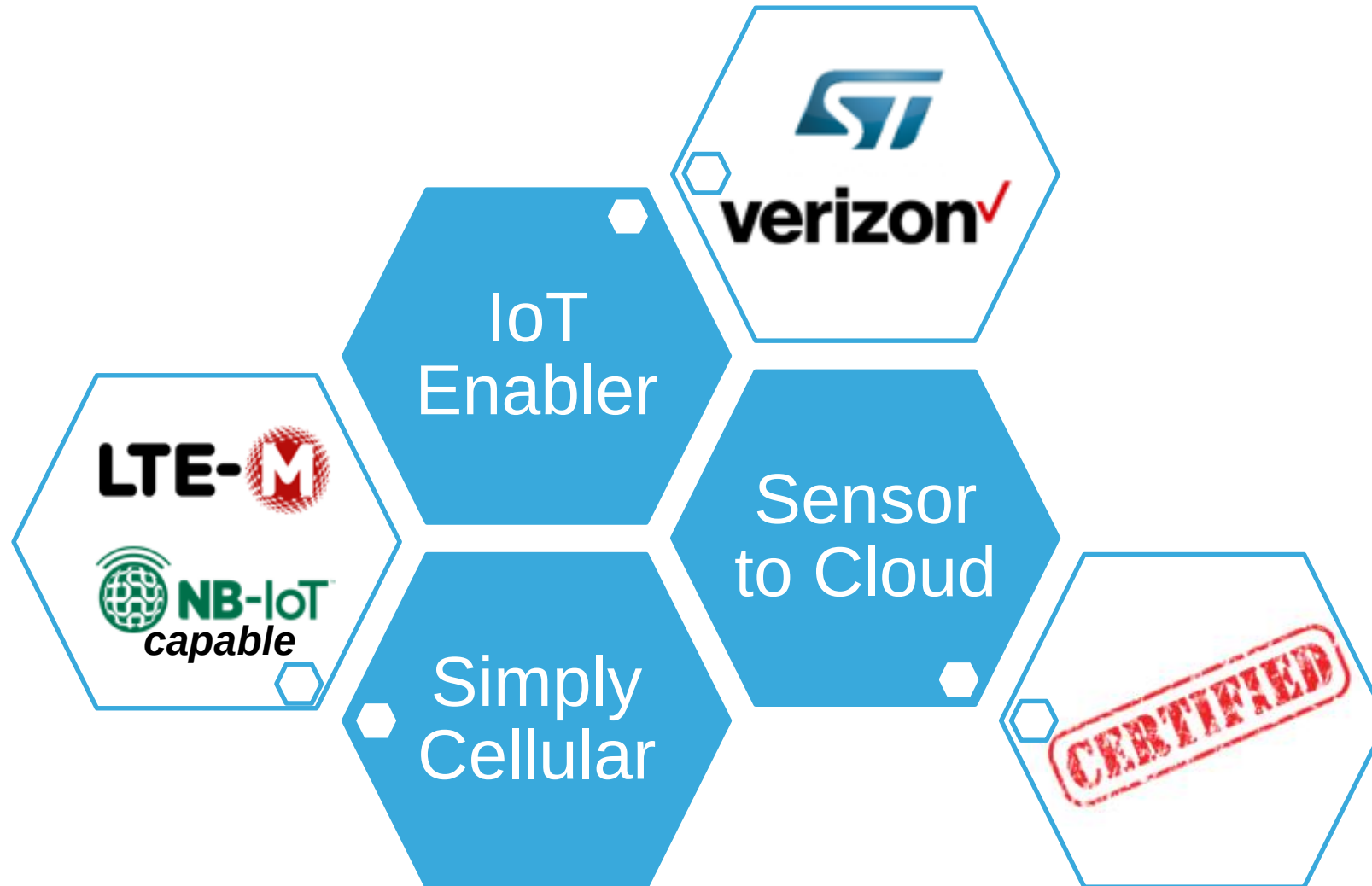
16



VERIZON LTE Starter Kit

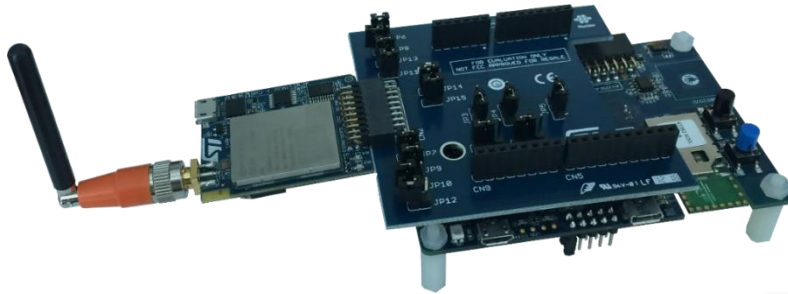
Targets IoT Embedded Developers

17



IoT STM32 LTE Starter Kit

18

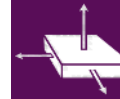


LTE-M

NB-IoT



STM32L4



Accelerometer
Gyroscope



Humidity
Temperature



Magnetometer

Pressure

2x MEMS
Microphone



Time of Flight
Proximity Sensor

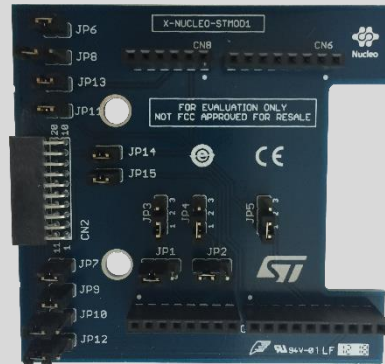


ST LTE Modem

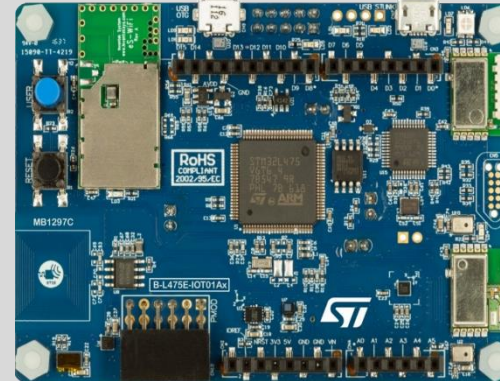


verizon

ST SIM-Card



X-Nucleo
Expansion Board



STM32L4 Discovery
Kit IoT Node



Bluetooth[®]
Low Energy



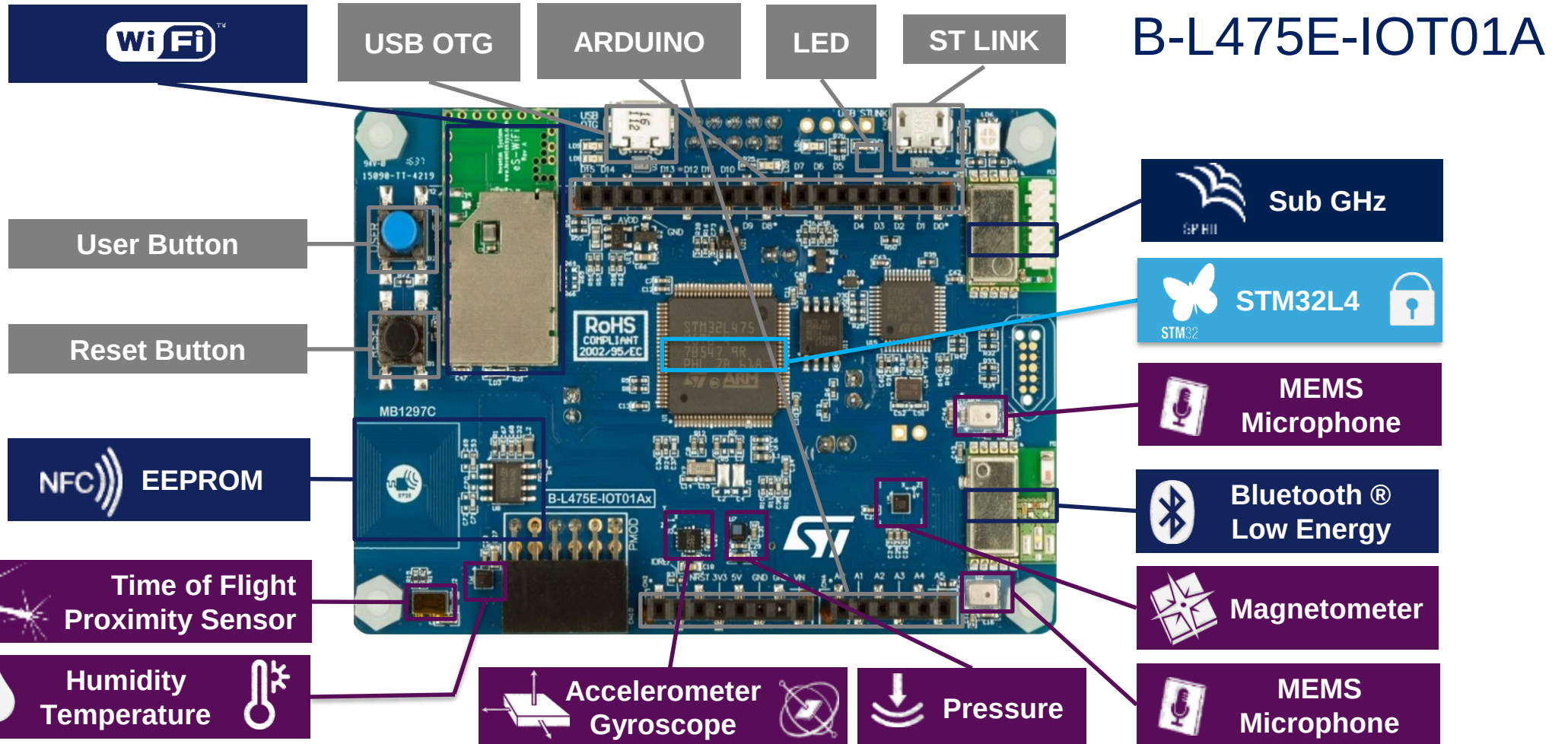
Sub GHz



LTE Cat-M
NB-IoT

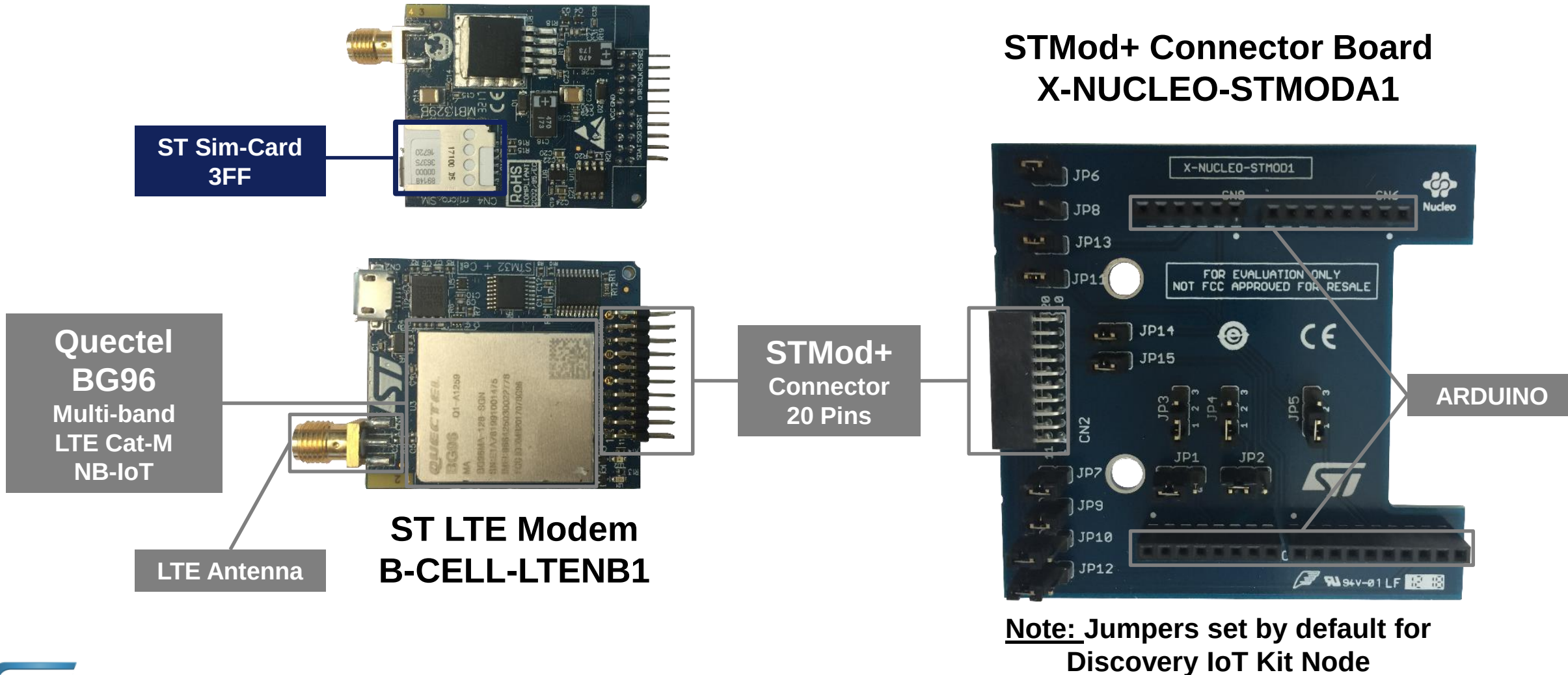
STM32L475 Discovery Kit IoT Node

19



STMod+ Connector Board & Modem

20



Key Links & Resources

21

Data brief, User Guide, Schematics, Gerber, Manufacturing, Technical Notes...

B-L475E-IOT01A



<https://www.st.com/en/evaluation-tools/b-l475e-iot01a.html>

X-NUCLEO-STMODA1



https://www.st.com/content/st_com/en/products/ecosystems/stm32-open-development-environment/stm32-nucleo-expansion-boards/stm32-ode-translate-hw/x-nucleo-stmoda1.html

B-CELL-LTENB1



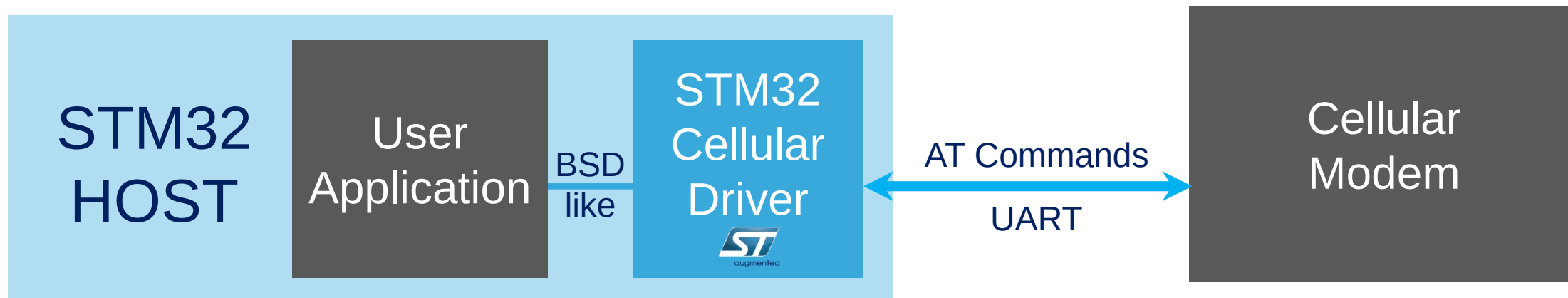
<https://www.st.com/en/evaluation-tools/p-l496g-cell02.html>

Note: This modem is part of another dev-kit (P-L496G-CELL02) under codename **MB1329-B03**

TG.08.0113



<https://www.taoglas.com/product/tg-08-cellulargpsglonass-beidou-monopole-antenna-2/>



STM32 Cellular Driver Middleware

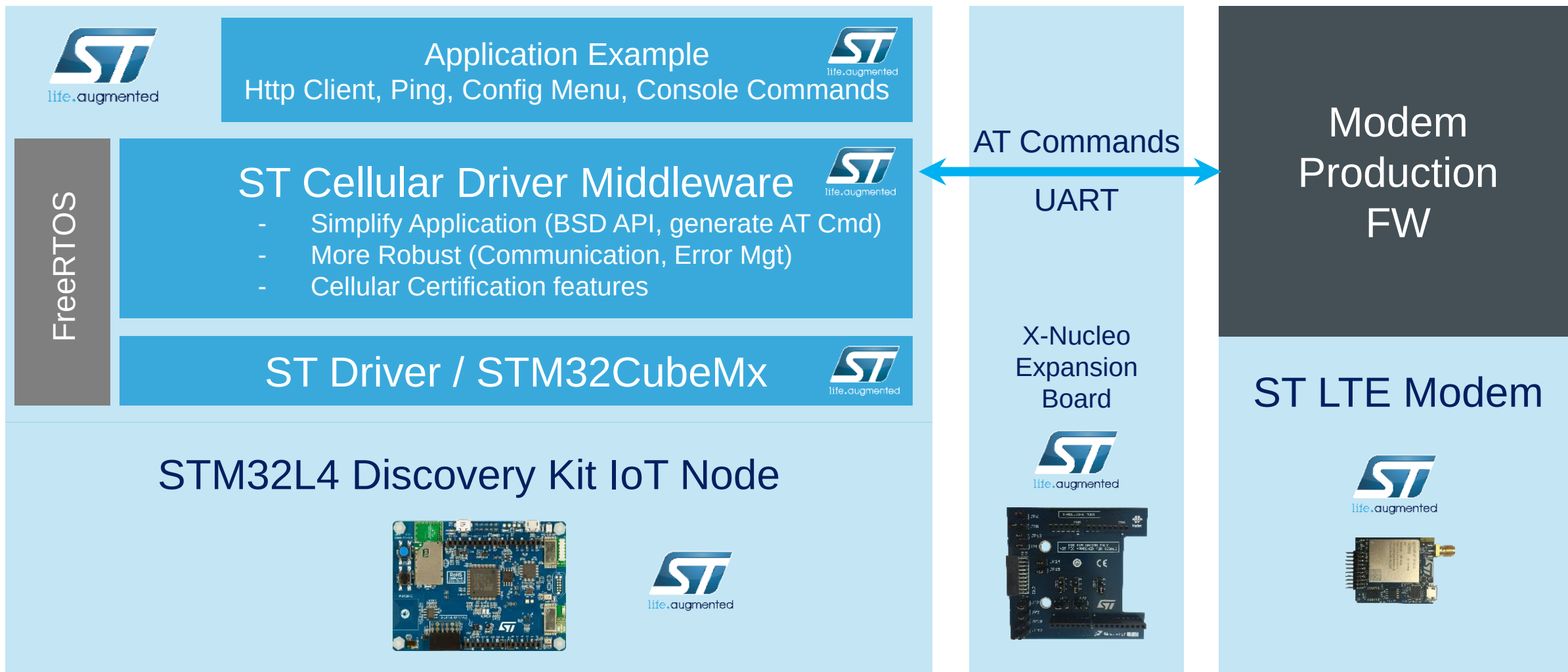
- No need to be a Cellular expert
- Simple Application
 - BSD like Socket APIs → Data Plane
 - HAL → Abstract all key Cellular AT commands
 - Control various modem vendors
 - Error Management (Device, Network)
- Certification added value
 - Partial GSMA TS34/35 compliance

Released done with:

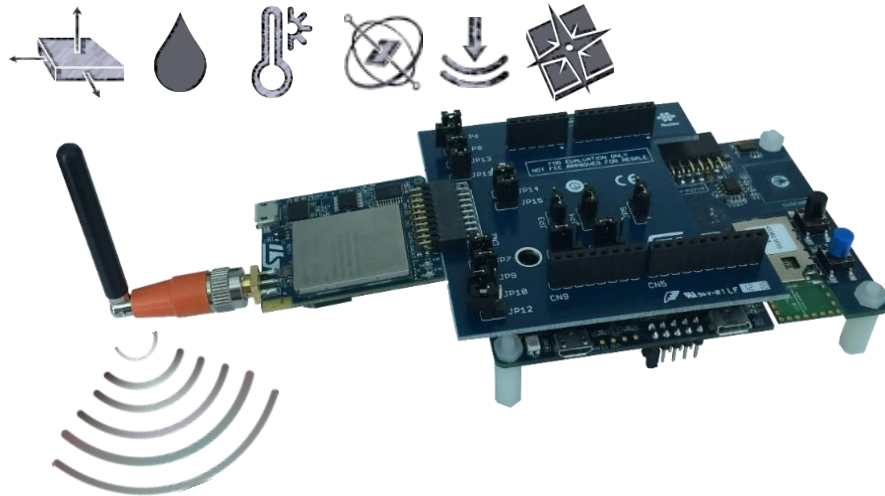
- Quectel BG96
- Sequans VZM20Q
- *User Guide to add more...*

ST Solution X-CUBE-CELLULAR

23



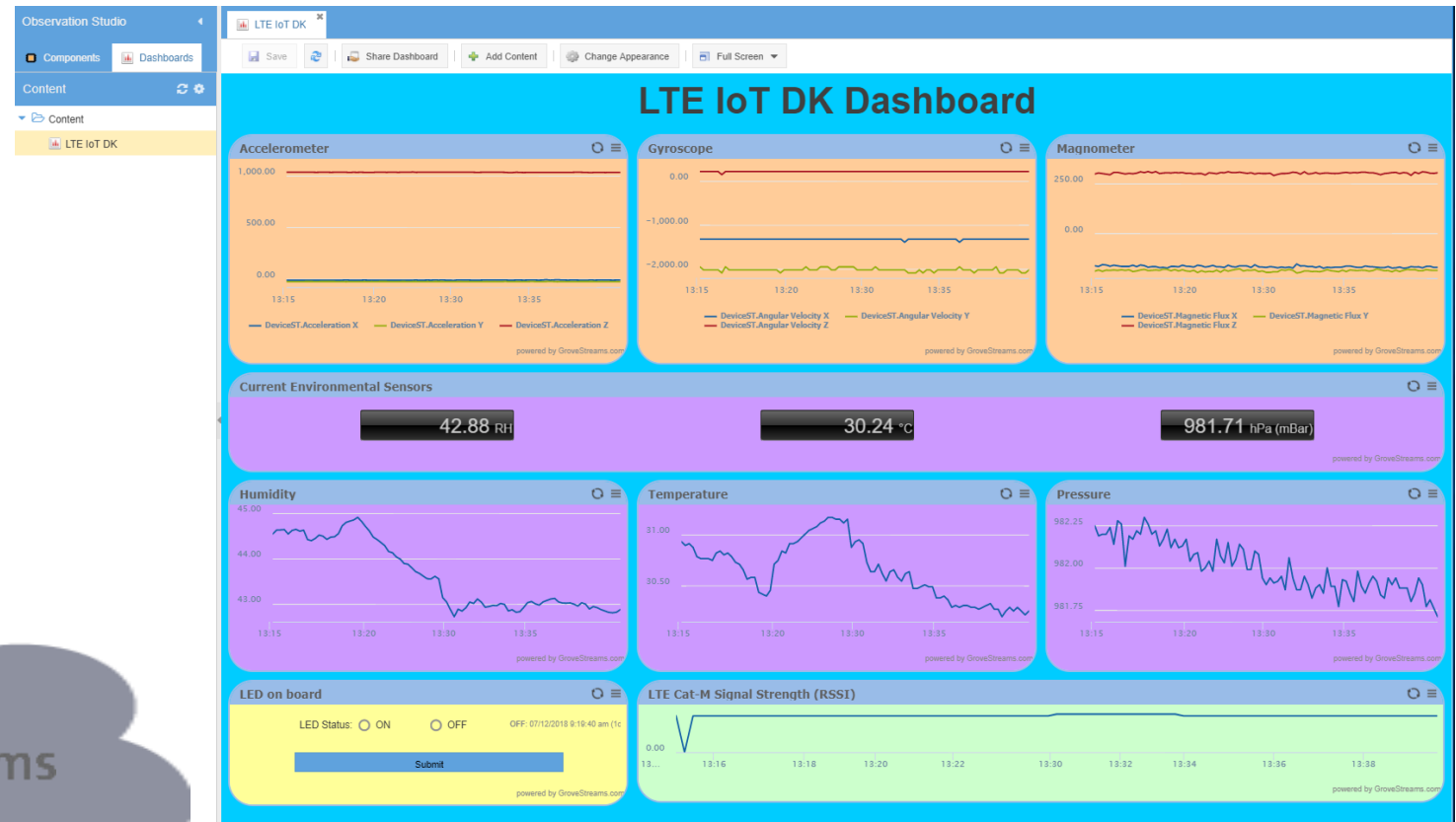
STM32 LTE Starter Kit x-cube-cellular

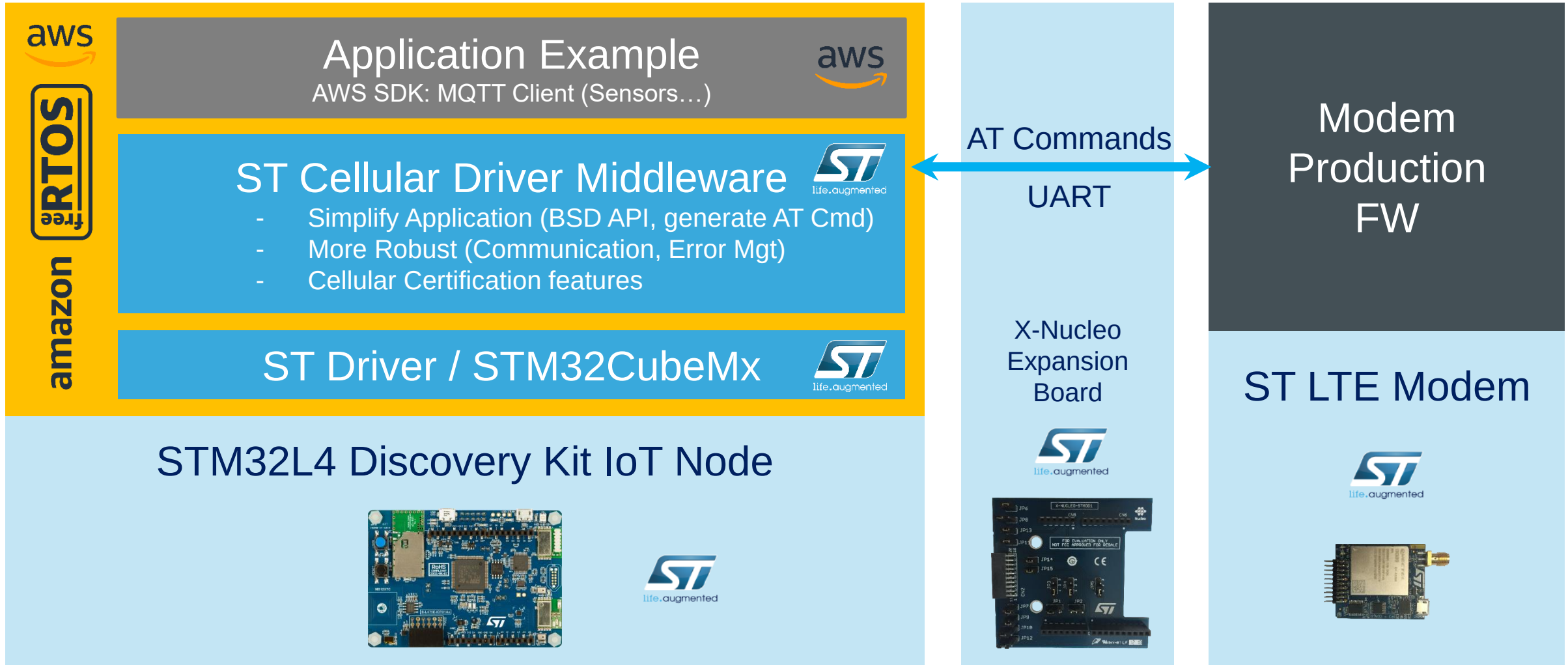


verizon
LTE-M

GroveStreams

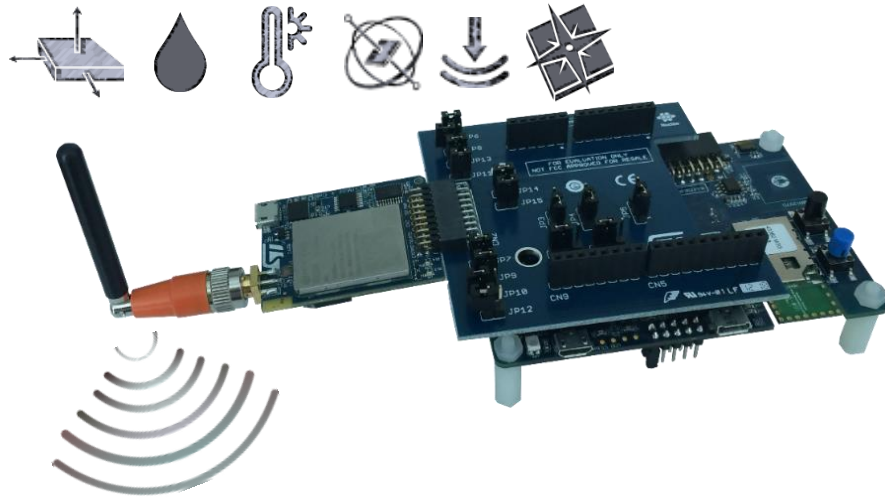
Web Browser





STM32 LTE Starter Kit

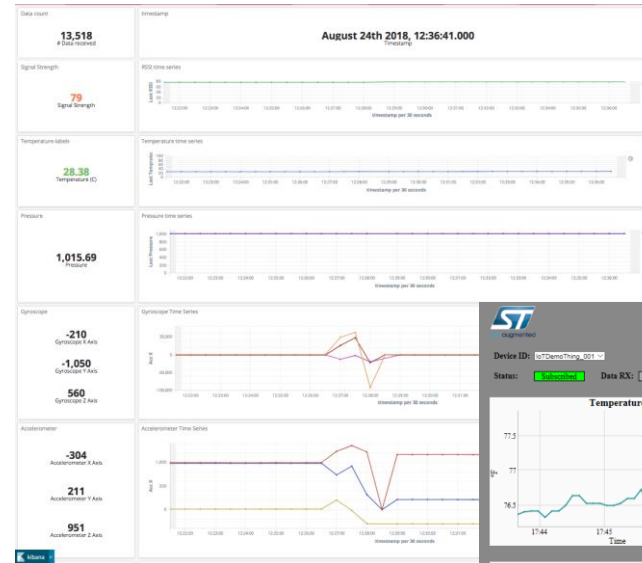
amazon **freeRTOS**



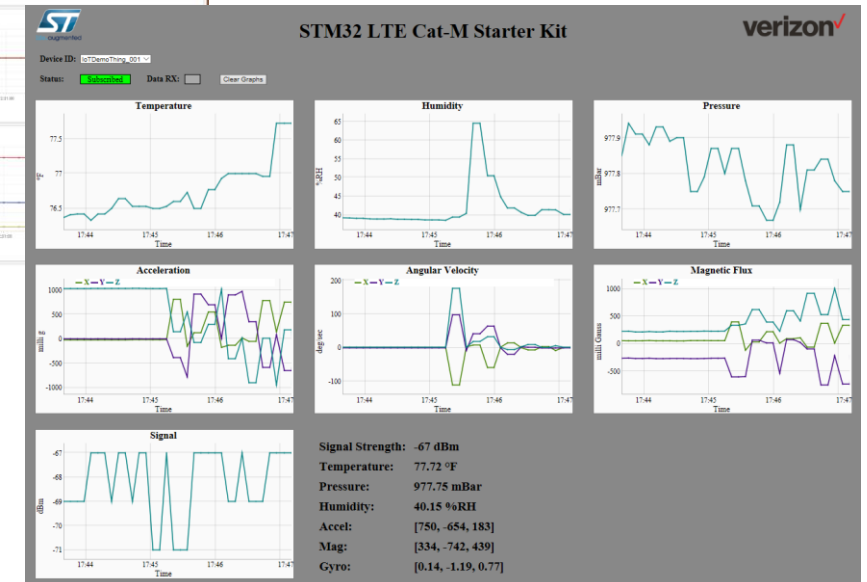
verizon
LTE-M



Web Browser AWS – KIBANA Dashboard

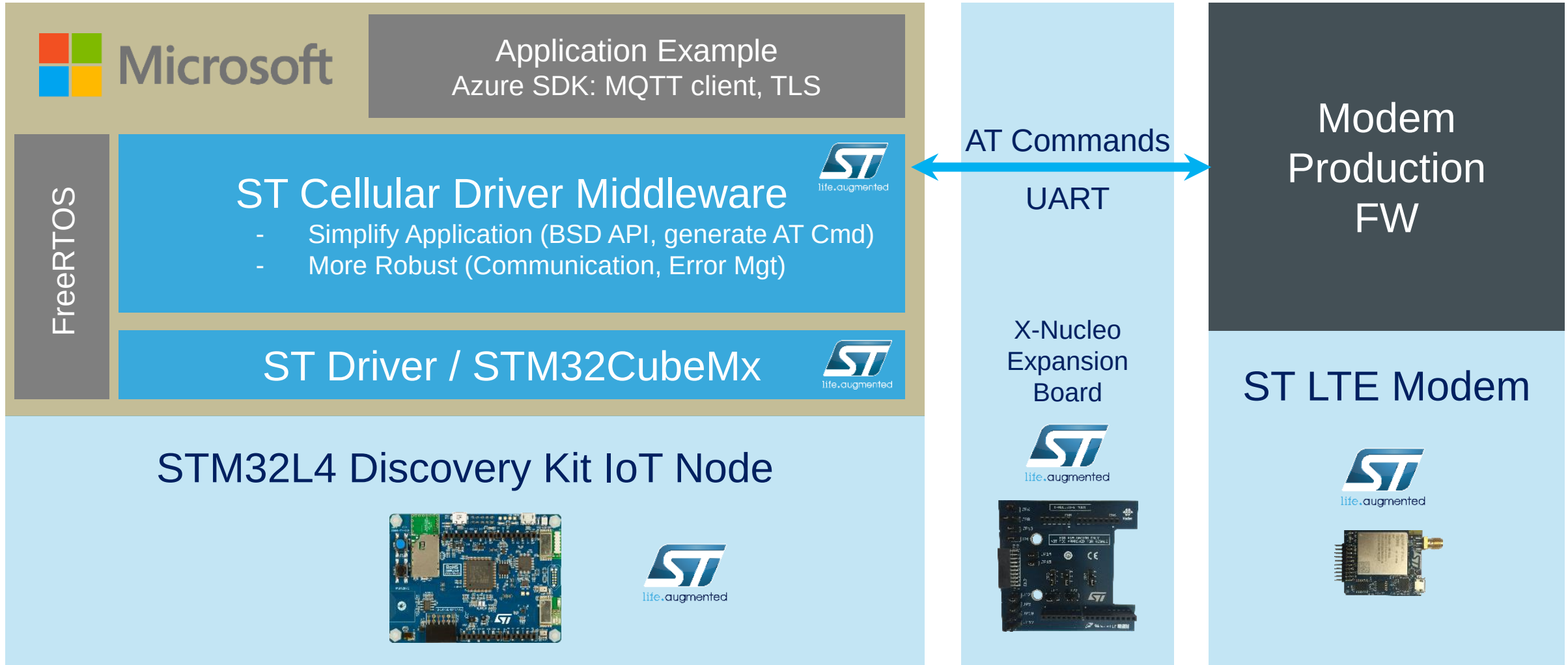


Web Browser ST JavaScript Dashboard



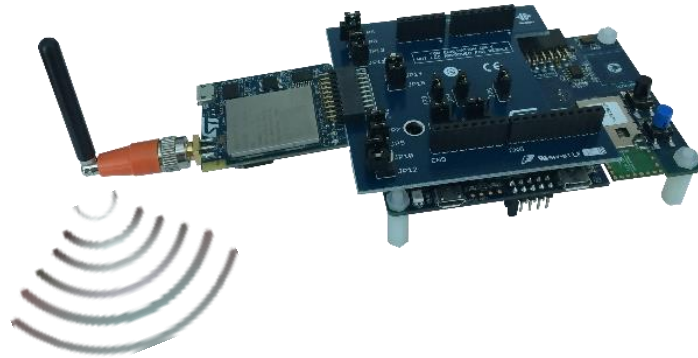
Microsoft Solution Azure IoT Central

27



Microsoft Azure IoT Central Experience

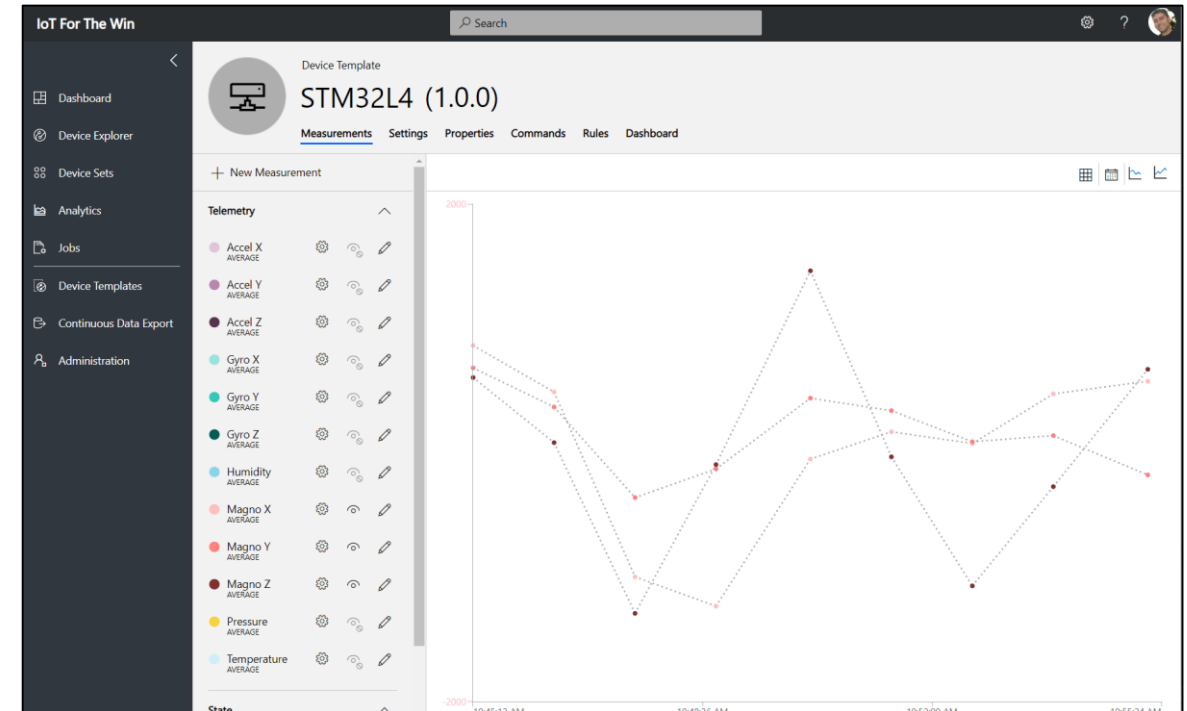
STM32 LTE Starter Kit



verizon
LTE-M



Web Browser Azure IoT Central Dashboard



STM32 Verizon – How to Get Access

29

- Verizon ThingSpace Cloud connectors



Click on “Learn more”

IoT Development Kit
Build, connect and stream to AWS

Learn more



<https://thingspace.verizon.com/connectors>

Data Plan <https://thingspaceportal.verizon.com/ccapp/#/home>



- Amazon Marketplace



<https://devices.amazonaws.com/search?kw=thingspace&page=1>



- To buy the hardware



<https://www.arrow.com/en/products/vz-iot-dev-002/arrow-development-tools>



<http://cloudconnectkits.org/product/st-microelectronics-verizon-lte-m-iot-starter-kit>



life.augmented

Get your devices talking.

Now you can access the award-winning Verizon network and get the data plan you need to bring your IoT solution to life.

ThingSpace IoT Connectivity Plans for Developers

Automatically renew plans.
Cancel at any time.

Plan restricted to Verizon IoT certified devices. International roaming, voice capability and multimedia messaging are not included. No activation fee. Credit card only - no EFT. No subsidies.

1GB

\$20/year
+\$1/device/month

ThingSpace IoT for Developer - 1GB

- 1 GB data/year
- Share up to 20 Verizon certified devices
- 1,200 SMS per year per line of service
- Automatically renews(you can opt out at any time)

[Subscribe](#)

10MB

\$5/year
+\$1/device/month

ThingSpace IoT for Developer - 10MB

- 10MB data/year
- Share up to 20 Verizon certified devices
- 1,200 SMS per year per line of service
- Automatically renews(you can opt out at any time)

[Subscribe](#)


<https://thingspaceportal.verizon.com/ccapp/#/home>

Data Plan

30

STM32 – Software Resources

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X-CUBE-CELLULAR

www.st.com/x-cube-cellular



Amazon FreeRTOS – Verizon GitHub

https://github.com/verizonlabs/vz_aws_st



Azure IoT Central – Microsoft GitHub

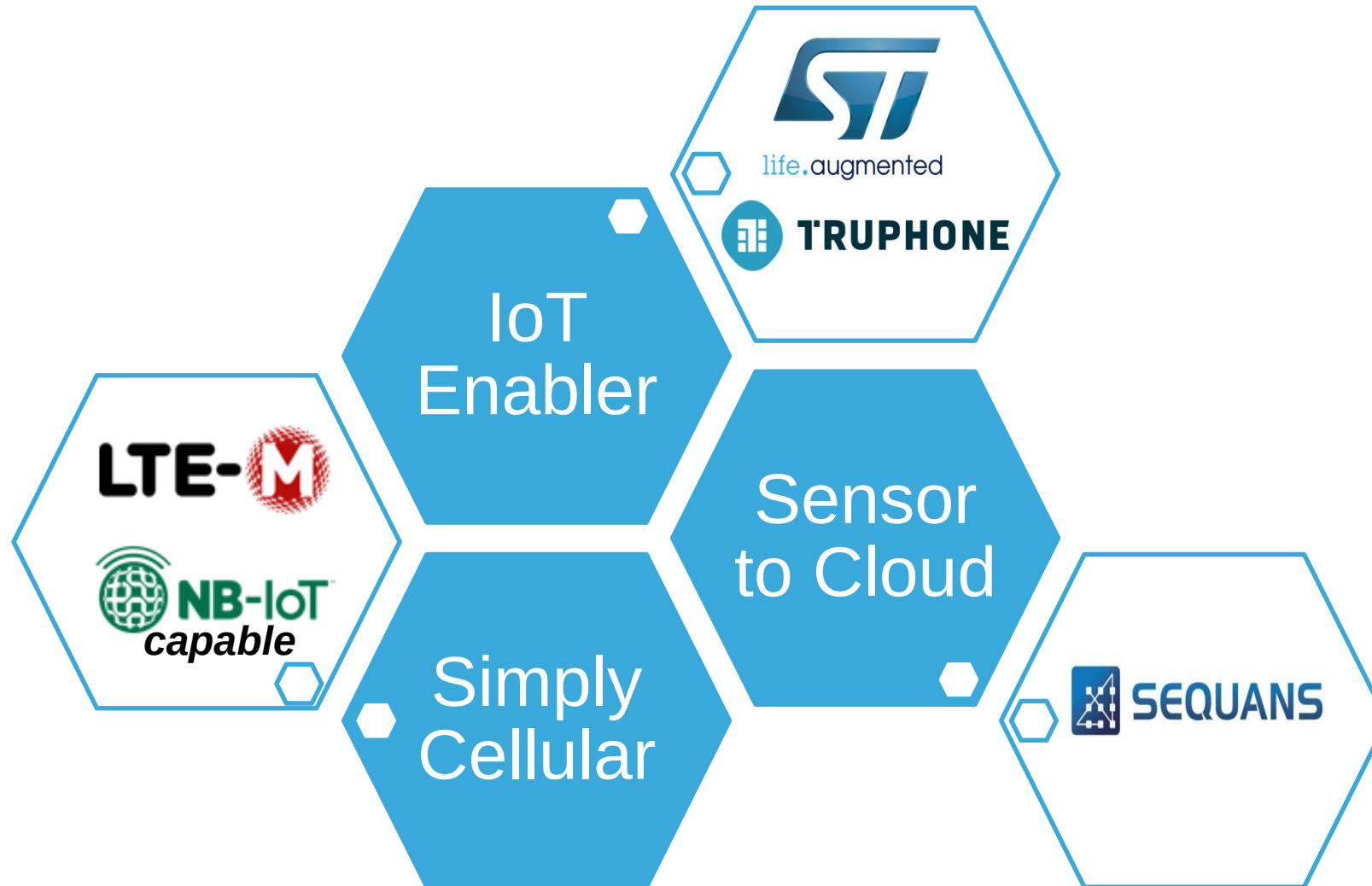
<https://github.com/Azure/iot-central-firmware/tree/master/freeRTOS/b-l475e-iot01a1-bg96-verizon>



Worldwide LTE-M Starter Kit

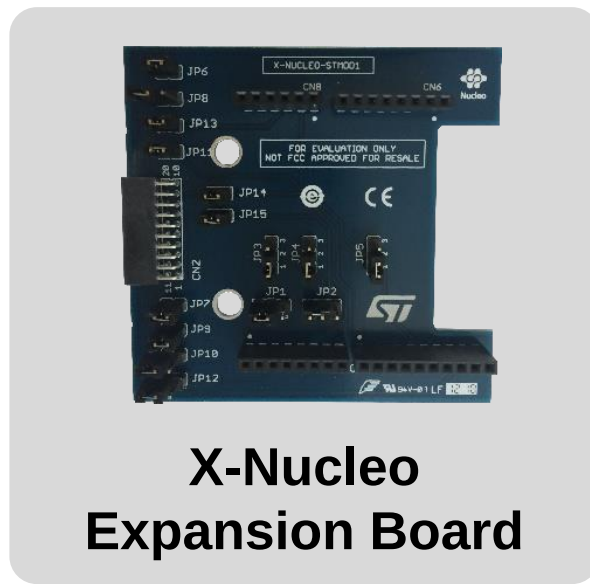
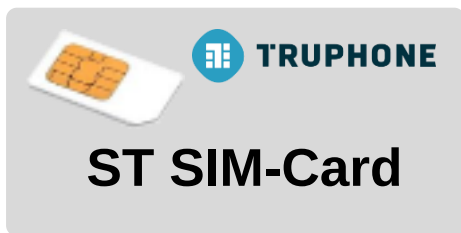
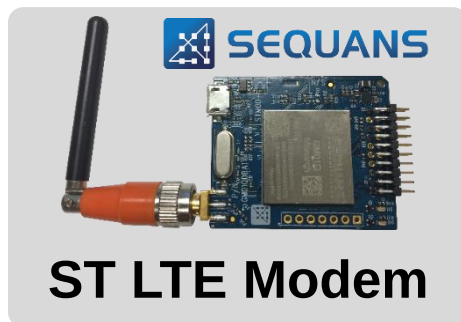
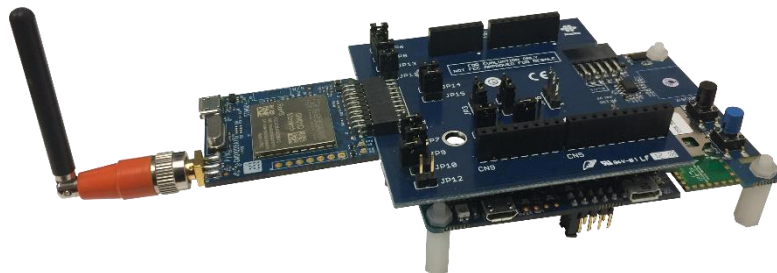
Targets IoT Embedded Developers

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IoT STM32 LTE Starter Kit

33



Key Links & Resources

34

Data brief, User Guide, Schematics, Gerber, Manufacturing, Technical Notes...

B-L475E-IOT01A



<https://www.st.com/en/evaluation-tools/b-l475e-iot01a.html>

X-NUCLEO-STMODA1



https://www.st.com/content/st_com/en/products/ecosystems/stm32-open-development-environment/stm32-nucleo-expansion-boards/stm32-ode-translate-hw/x-nucleo-stmoda1.html

B-CELL-GM01Q



<https://www.st.com/en/evaluation-tools/b-cell-gm01q.html>

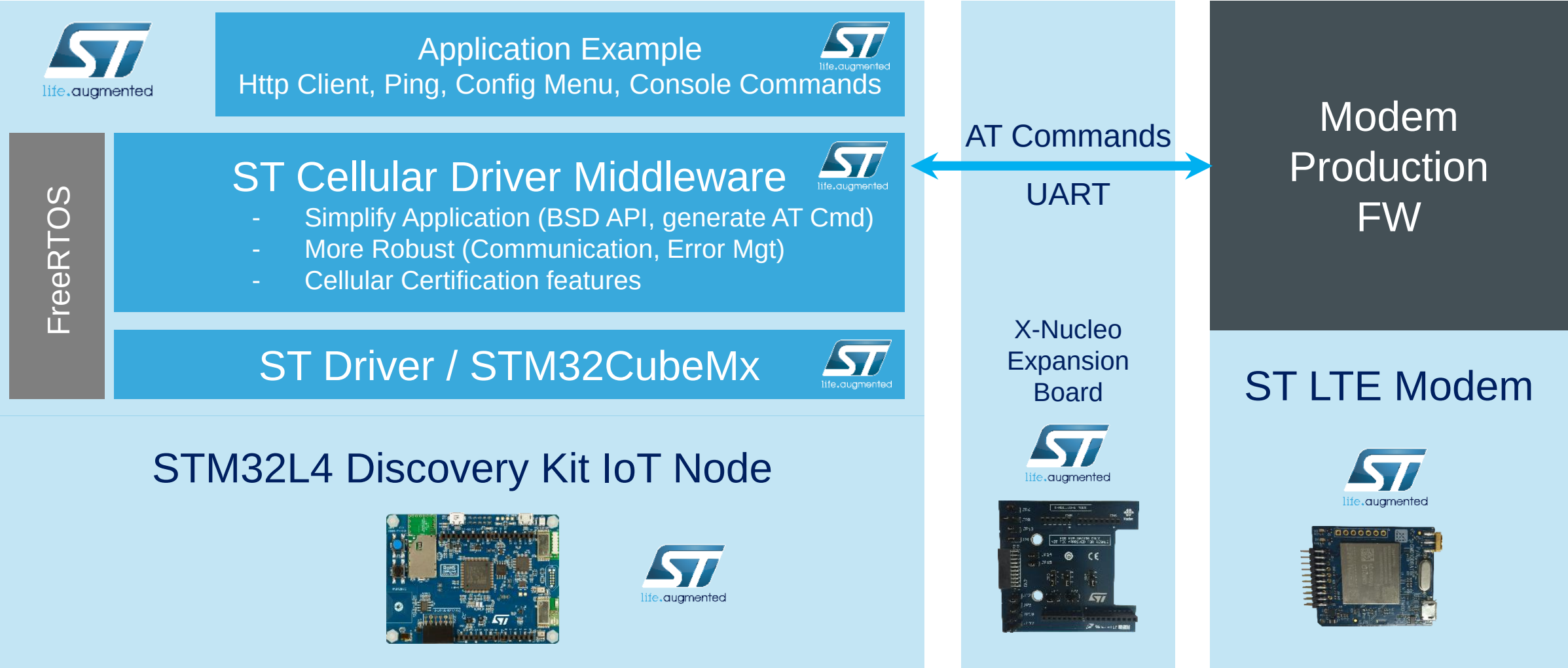
TG.08.0113



<https://www.taoglas.com/product/tg-08-cellulargpsglonass-beidou-monopole-antenna-2/>



ST Solution X-CUBE-CELLULAR



IoT STM32 LTE Starter Kit

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STM32L4



Accelerometer
Gyroscope



Magnetometer



Humidity
Temperature



Pressure



Time of Flight
Proximity Sensor



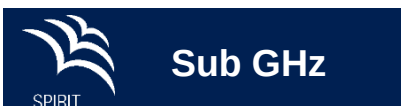
2x MEMS
Microphone



NFC



Bluetooth®
Low Energy



Sub GHz



WiFi

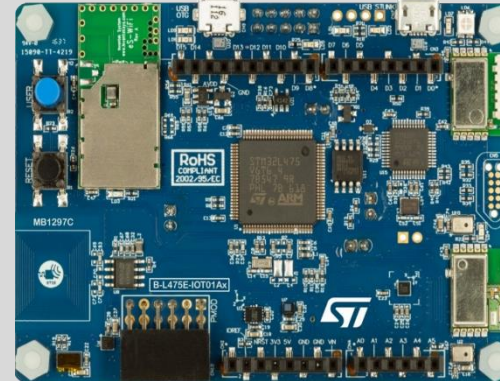


LTE Cat-M
NB-IoT

LTE-M
LTE-1



Avnet – Modem Board



STM32L4 Discovery
Kit IoT Node



STM32 AT&T – How to Get Access

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- AT&T market place



<http://marketplace.att.com/products/att-iot-starter-kit-stm32-lte-m>

- Solution: \$139, 150 MB / 6 Months Per Device included, 90 Days



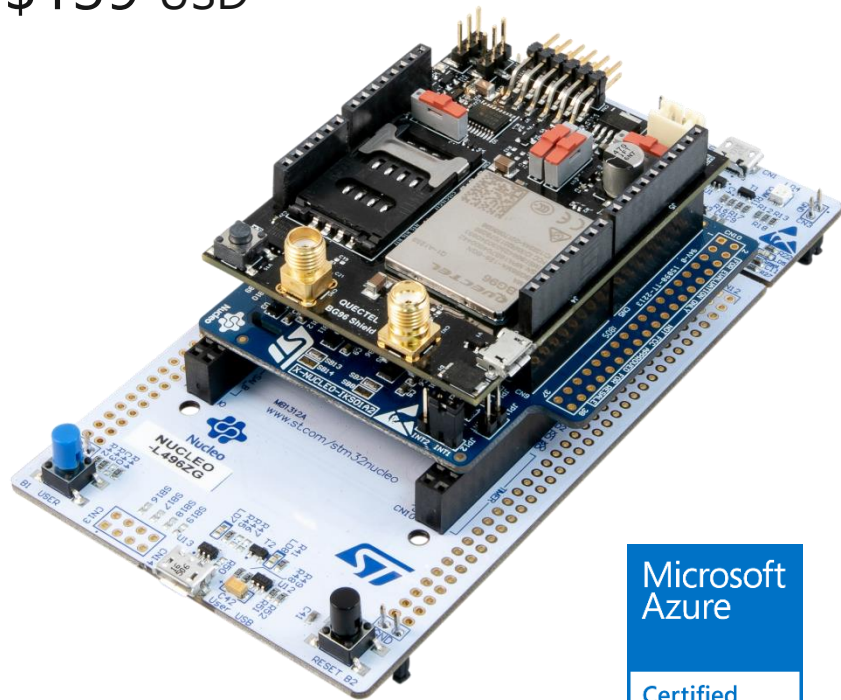
- Avnet resources



<http://cloudconnectkits.org/product/att-stm32-iot-starter-kit>

Suggested Resale:

\$139 USD



Microsoft
Azure

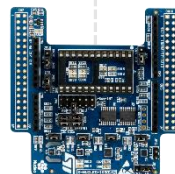
Certified

* Also includes LTE-M and GPS antennas from Taoglas



• Microcontroller Board

- ST Microelectronics L496 Nucleo board
- Arm® Cortex®-M4 MCU @ 80MHz
- Arduino™ Uno R3 expansion
- Supports Arm Mbed™ OS



• Sensor Shield

- Contains six I2C sensors (ST Microelectronics)
- Accelerometer, Gyro, Magnetometer, Temperature, Humidity, Pressure



• LTE-M Modem Shield

- Avnet designed Arduino shield format
- Based on Quectel BG96 LTE-M / NB-IoT modem
- Supports both SIM and eUICC options

 **TELUS** <https://www.telus.com/lpwa>



 **AVNET** <http://cloudconnectkits.org/product/telus-lte-m-iot-starter-kit>



LTE-M  **NB-IoT**

- Cost – \$139 USD
- Data Plan – 150 MB / 6 Months

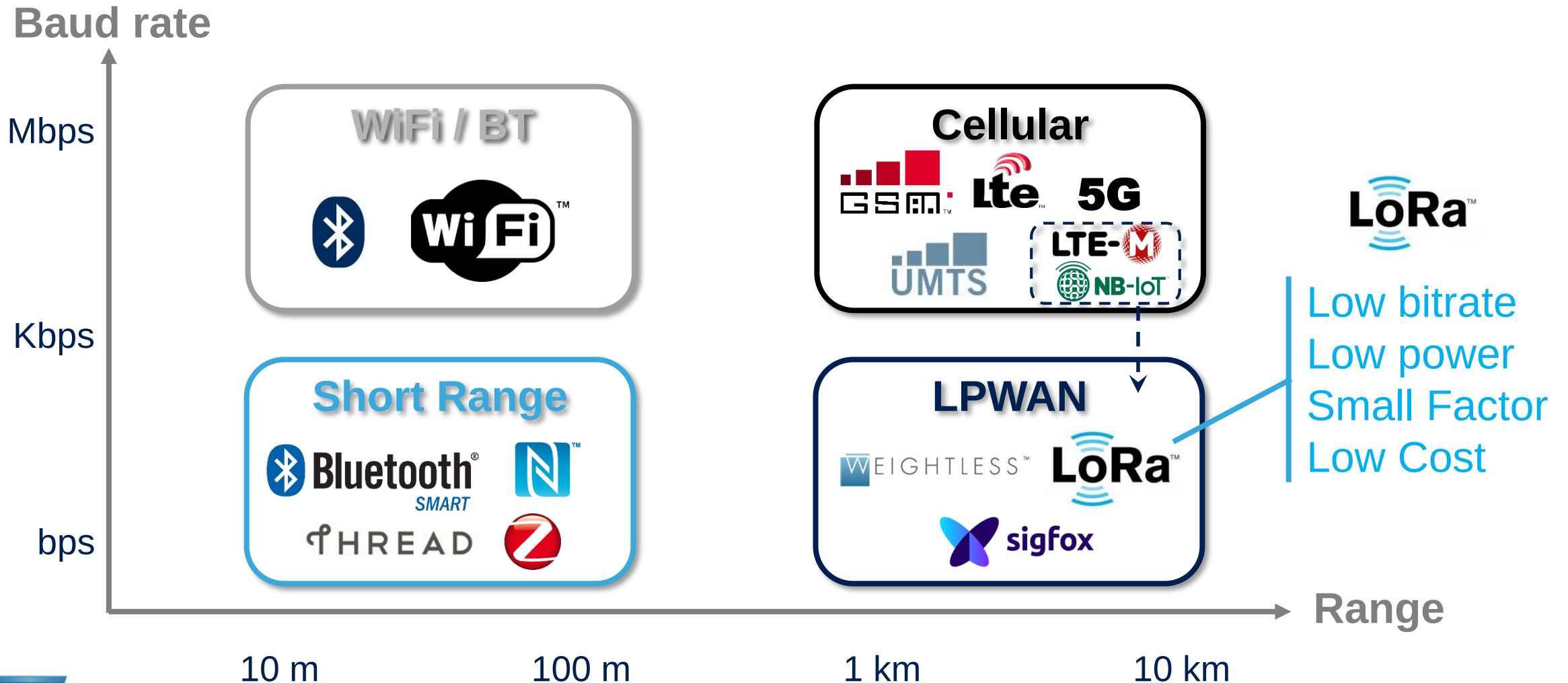




ST IoT LPWAN LoRa

Communication Technologies - Overview

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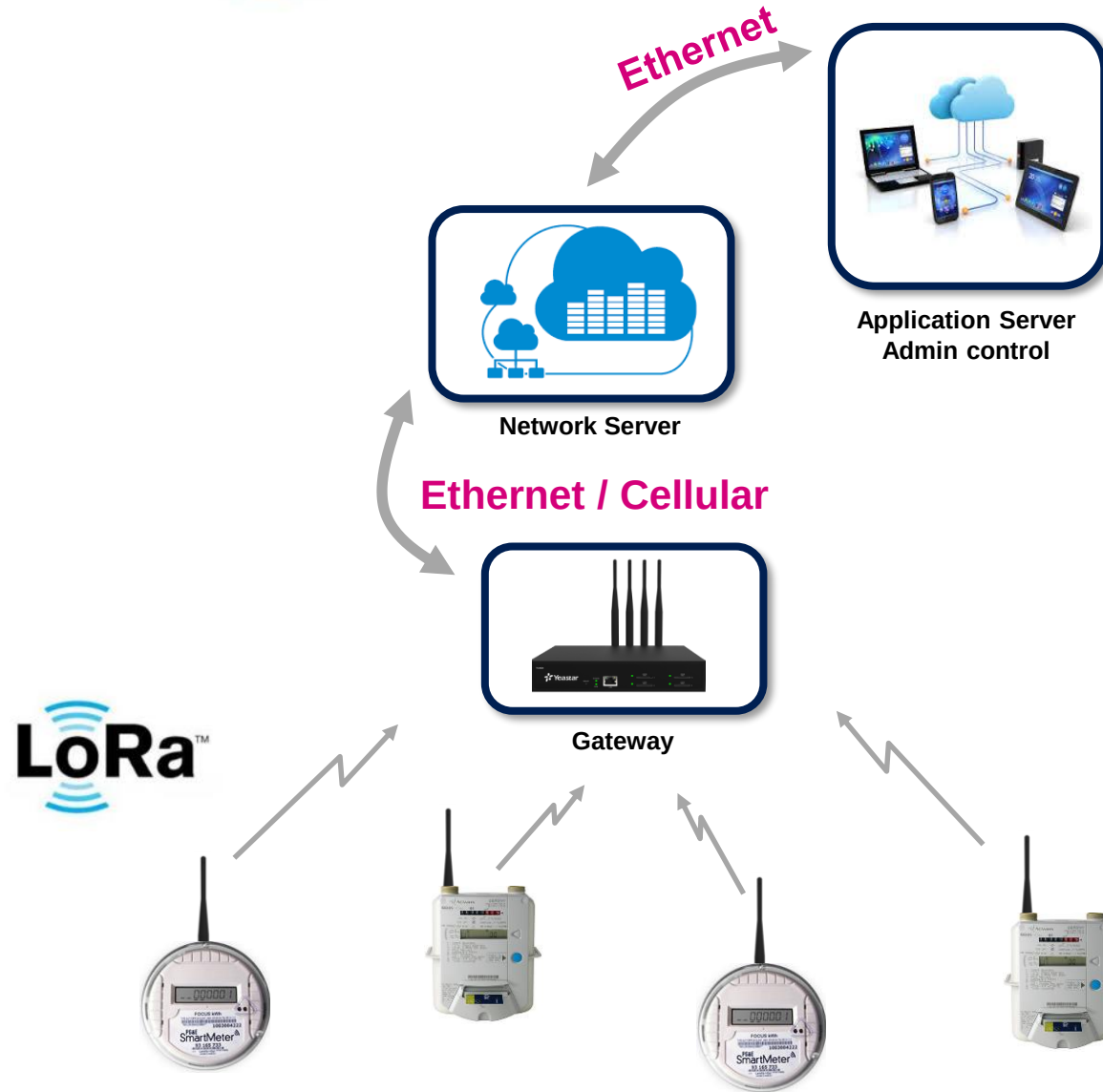
IoT use cases

47

Key Verticals

- Smart Industry
- Smart City
- Smart Metering
- Smart Agriculture
- Smart Building

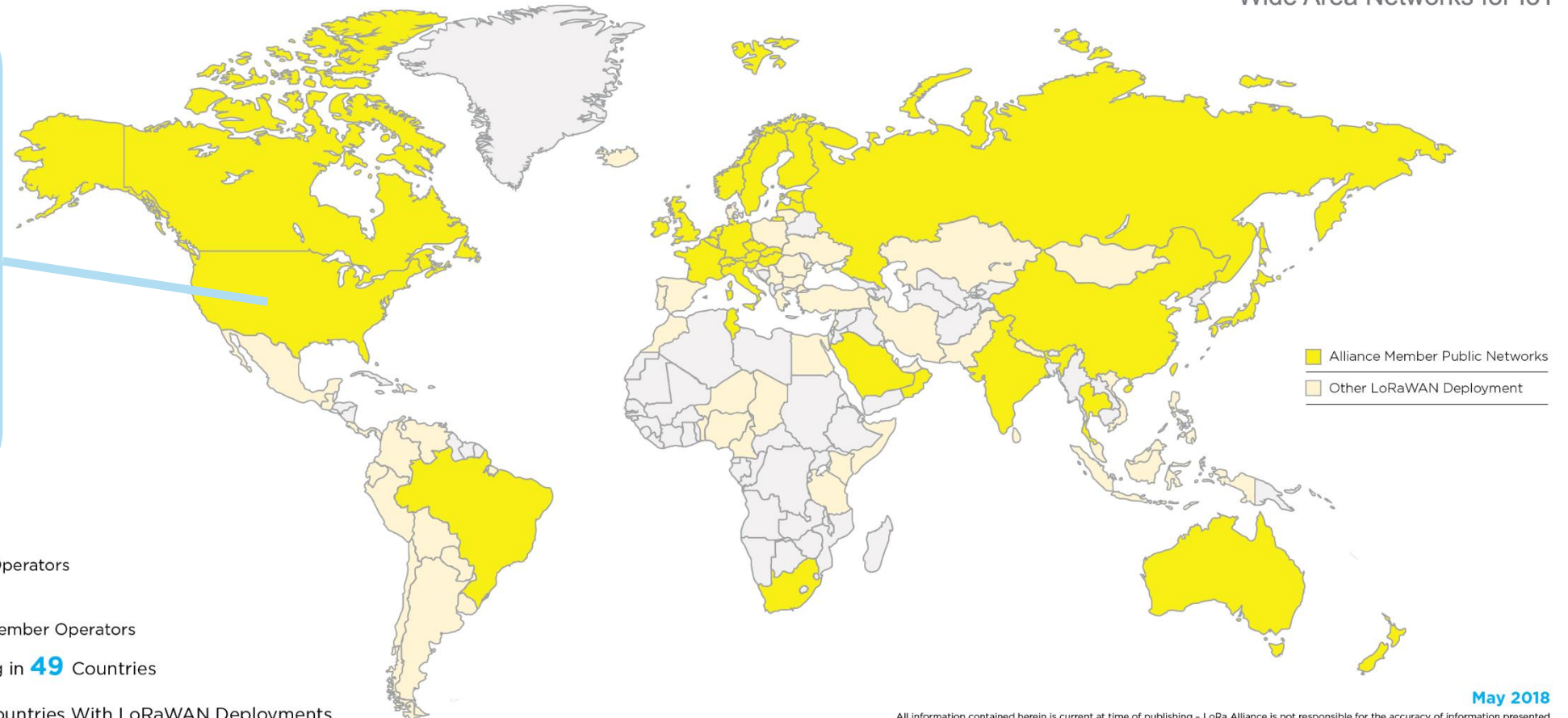
...



LoRa Network Deployments

48

LoRaWAN™ NETWORKS



83

Network Operators

56

Alliance Member Operators

Operating in **49** Countries

~100 Countries With LoRaWAN Deployments

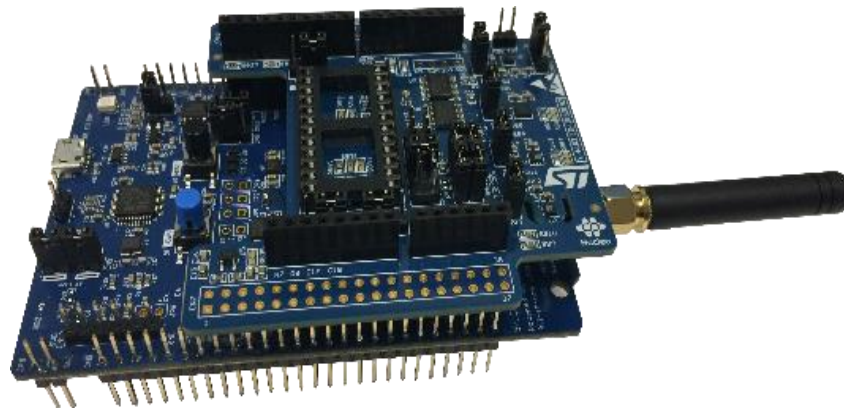
May 2018

All information contained herein is current at time of publishing - LoRa Alliance is not responsible for the accuracy of information presented

ST LoRa Dev Kit

49

- Dev-kit based on STM32 & ST Sensors
 - MachineQ.com: <https://machineq.com/st-lora-dev-kit/>
 - Getting Started Guide
 - Binary & Keil project Source Code
 - HW available from distribution
 - FW and Step by step user Guide provided on machineQ.com



machineQTM
A COMCAST COMPANY

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Develop Partners News Blog About Contact Us

ST LoRa[®] Dev Kit

An advanced development kit providing an easy, cost-effective way to prototype IoT solutions, the ST LoRa Dev Kit is based on the I-CUBE-LRWAN firmware package.

The ST LoRa Dev Kit delivers a versatile and quick-to-market LoRa IoT prototyping option for your next innovative solution. Combined with the recommended expansion board, the ST LoRa Dev Kit is ideal for the more advanced embedded developer who may be building IoT sensors from scratch. The ST LoRa Dev Kit is available through most well-known electronic distributors including Avnet, Arrow, DigiKey, and Mouser. Whether you are an OEM, start-up, or a hobbyist, this powerful dev board will enable you to deliver a highly functional user experience.

What's in the Box?

Your development kit contains the ST LoRa Dev Kit board and X-Nucleo expansion board. If you are not in a location covered by the machineQ network, you will need to purchase a machineQ gateway to connect the ST LoRa Dev Kit board to the network. While the parts are sold separately, both are needed for development.

[CHECK OUT OUR CURRENT PRICING](#)



Discovery Board
ST and Murata[®]
P/N: B-L072Z-LRWAN1

[BUY NOW](#)

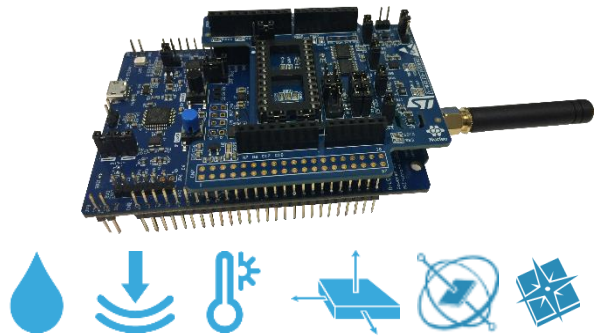


X-Nucleo Expansion Board
P/N: X-Nucleo-0K501A2

[BUY NOW](#)

ST LoRa Dev Kit Solution

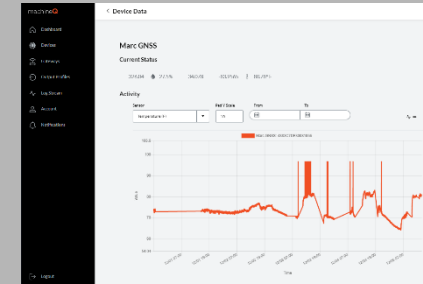
50



MACHINE QTM
IoT Gateway



MQcentral (SaaS)



<https://MachineQ.com/st-lora-dev-kit/>



ST LoRa Dev Kit Hardware

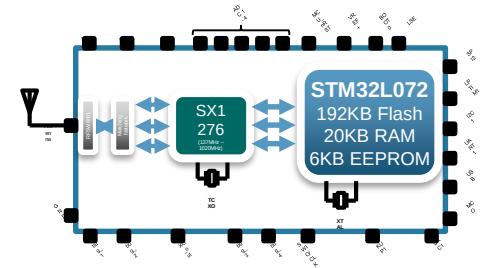
base board B-L072Z-LRWAN1

51

ST-Link
Debugger

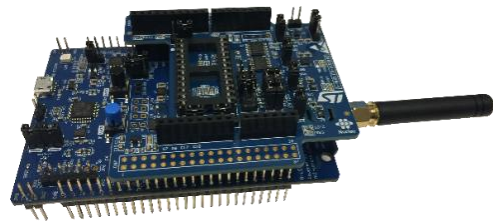


Murata® Module
All-in-one Open



Published on www.st.com
Search for B-L072Z-LRWAN1

Arduino Connector



B-L072Z-LRWAN1

- Murata Module
 - Host: STM32L0
 - 20KB RAM, 192KB Flash, 6KB Eeprom
 - Radio: Semtech SX1276



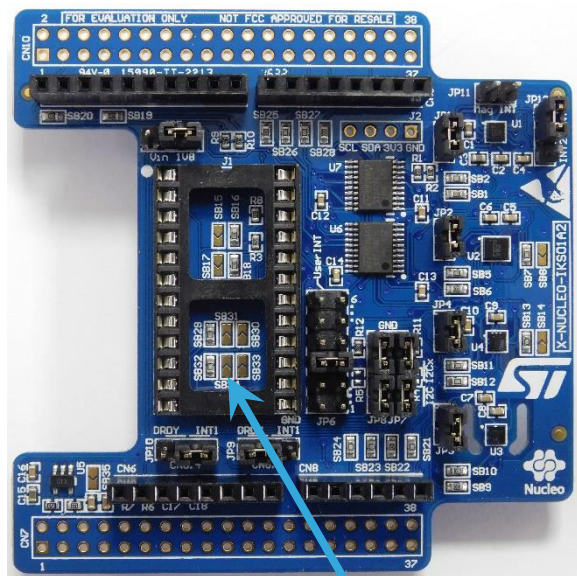


ST LoRa Dev Kit Hardware

Sensor Shield X-NUCLEO-IKS01A2

52

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Search for X-NUCLEO-IKS01A2



DIL-24 Extension

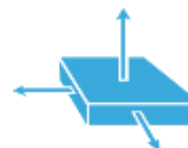
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3D Accel. + 3D Gyro. (LSM6DSL)



3D Accel. + 3D Magno. (LSM303AGR)



Pressure (LPS22HB)

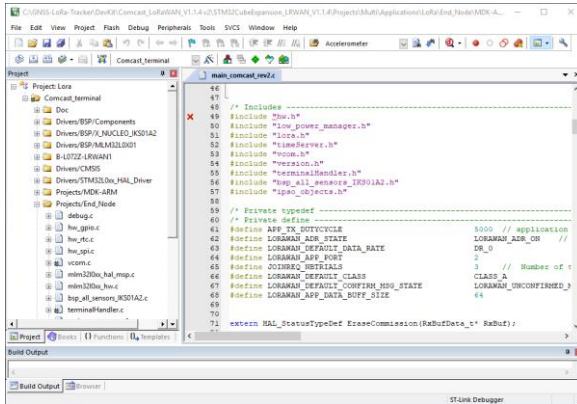


Temperature + Humidity (HTS221)

ST LoRa Dev Kit Firmware

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To download Binary & Source code
go to <https://MachineQ.com/st-lora-dev-kit/>



ARM KEIL

Microcontroller Tools

- Professional grade IDE
- Free for STM32L0
- Debugger / Program



<http://www2.keil.com/stmicro-electronics-stm32/mdk>



ST LoRaWAN stack → I-CUBE-LRWAN

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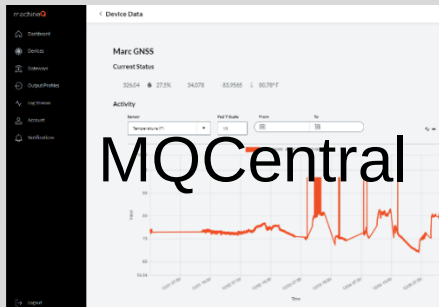
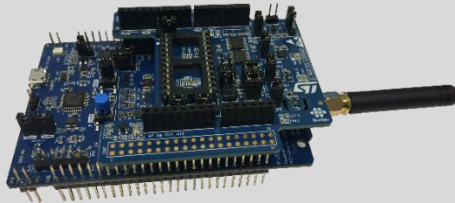
Search for I-CUBE-LRWAN

+

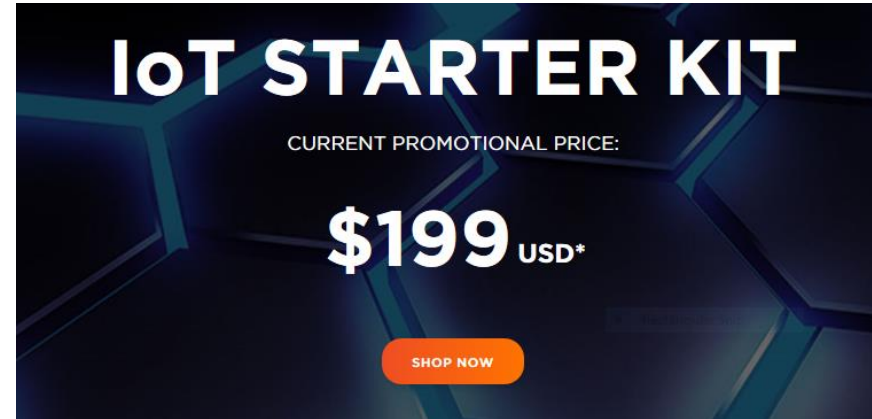
Sensors → raw data to the cloud

+

Menu setup → Stores parameters in NVM
Credentials (DevEUI, AppEUI, AppKey), Duty Cycle



ST LoRa Dev-Kit Deal



ST LoRa Dev Kit

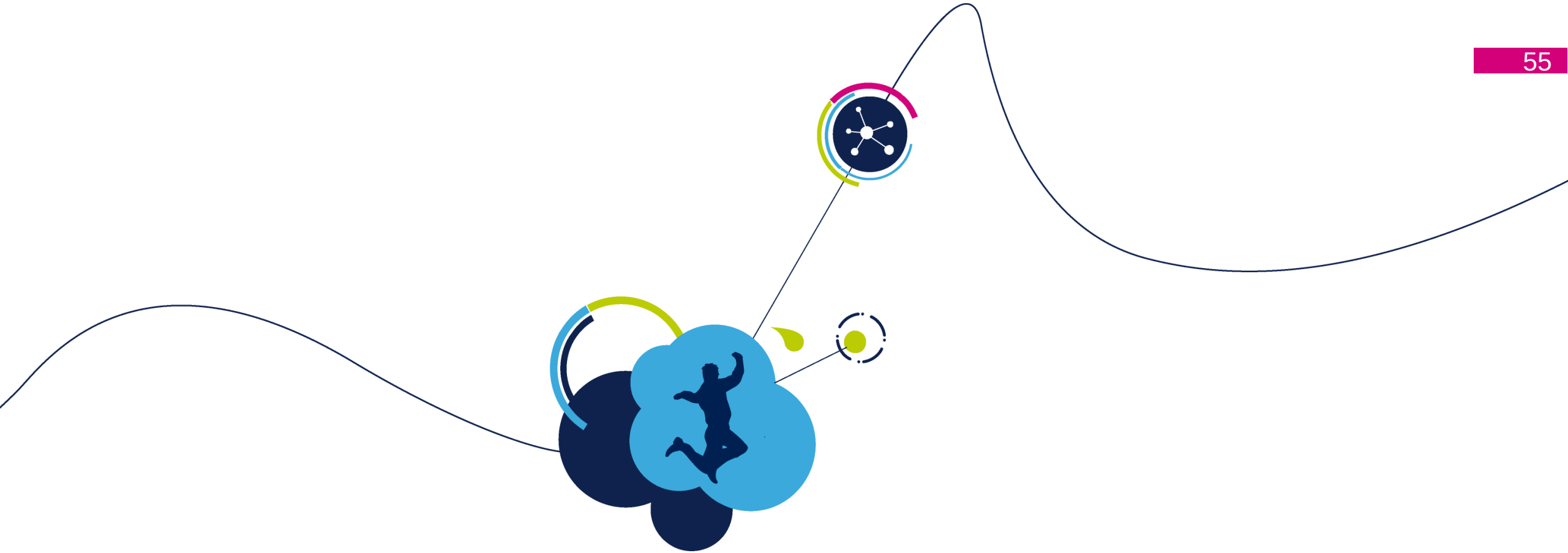
The ST LoRa development board and sensor is an advanced development kit optimized for engineers that are ready to prototype scalable solutions towards a complete IoT implementation.



<https://store.machineq.com/store/products/machineq-starter-kit>

Includes:

- 1** MachineQ Gateway (8 channel)
- 1** ST LoRa Dev Kit (Select "Dev Kit: ST LoRa" in menu)
- 1 Year** MQcentral IoT Management



LoRa Asset Tracker

Asset Tracking Use Case

56

Being able to locate an asset and its environment



- Applications

- Fleet management → For ex. Truck delivery
- Asset / Goods tracking
- Pet/Child tracker

- Use case scenarios

- On-line within LoRa network
 - Real-time location, Send notification when inside geo-fence
- Off-line not connected to any LoRa network
 - Recreate the path history for post analysis

LoRa Asset Tracking Function Pack

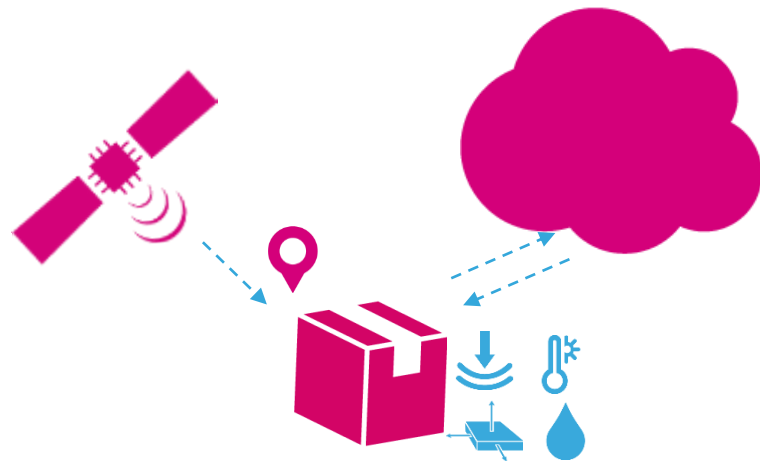
FP-ATR-LORA1

57



Key Features

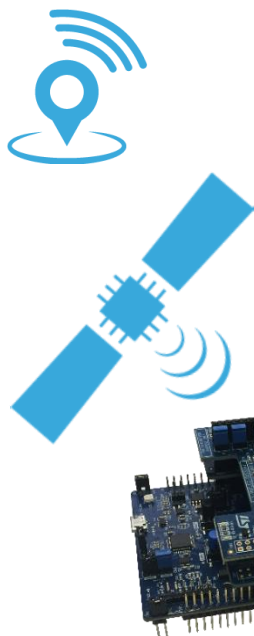
- Complete firmware to connect an IoT node to a LoRaWAN network, sending geo-position coming from GNSS and environmental and sensor data
- Library supporting LoRaWAN 1.0.2 class A and USB
- Teseo-LIV3F based GNSS positioning and Geofencing.
- LoRaWAN keys provisioning via USB
- Power/Battery Management with low-power operating modes
- Data logging on external EEPROM



Application	Asset tracking Application		
Middleware	LoRaWAN Class A	USB	GNSS
Hardware Abstraction	STM32Cube Hardware Abstraction Layer (HAL)		
Hardware	STM32 Nucleo expansion boards X-NUCLEO-GNSSA1 (Connect) X-NUCLEO-IKS01A2 (Sense)		STEVAL-STRKT01 evaluation board
	B-L072Z-LRWAN1 development board		



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ST LoRa Asset Tracking Dev-Kit

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MACHINE Q™

Tago

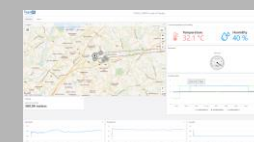
IoT Gateway



mQCentral



Dashboard



<https://MachineQ.com/st-lora-dev-kit/>



ST GNSS Arduino Shield

- ST Teseo-LIV3F Module
- ST Teseo III
 - Multi-constellation:
 - Geo-Fencing...

Published on www.st.com
Search for X-NUCLEO-GNSS1A1



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GPS



Galileo



GLONASS



Beidou2

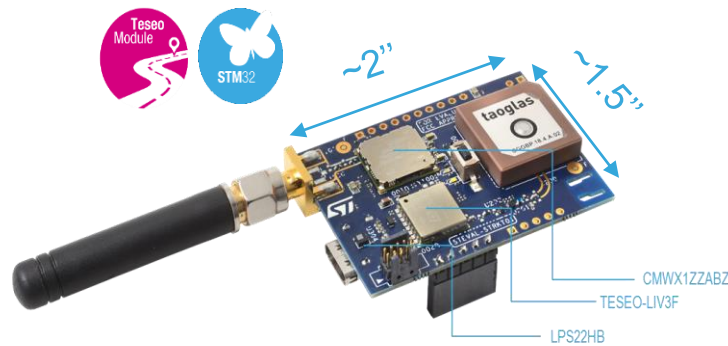
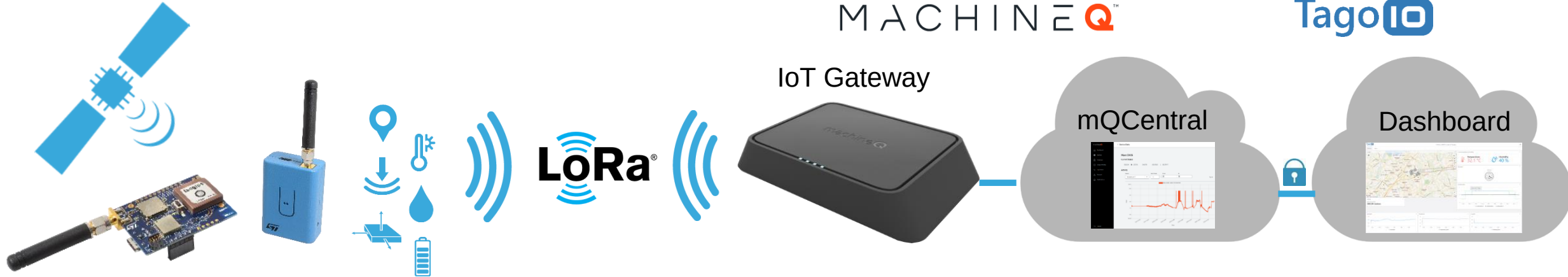


QZSS



ST LoRa Asset Tracking Ref Design

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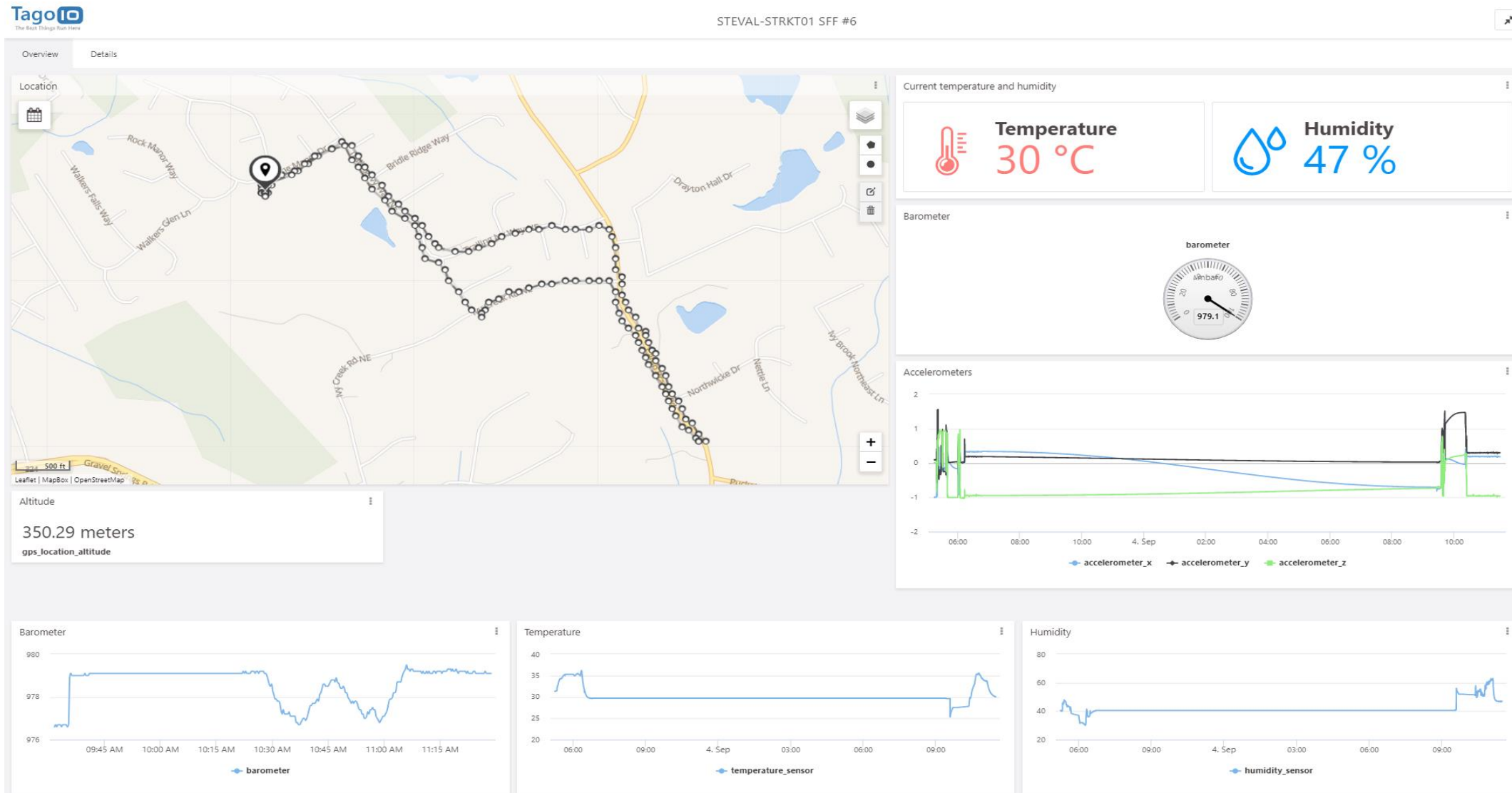


Asset Tracker Solution – Tago.io UI

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Asset Tracking

- Pin on Map
- Sensors
 - Altitude
 - Temperature
 - Humidity
 - Pressure
 - Accel (x,y,z)



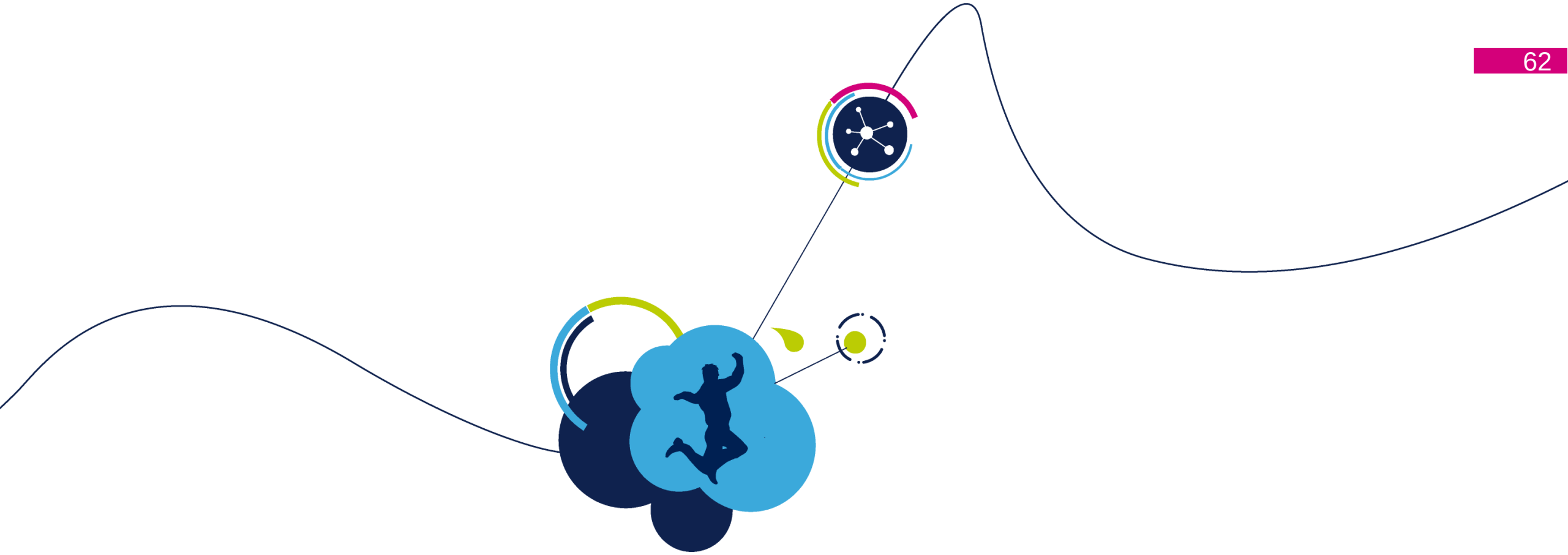


- **Getting it right the first time:
Accelerate your LoRa Implementation**
 - ST Webinar Sponsored by MachineQ & Murata
 - Occurred on **Jan 30th 2019**

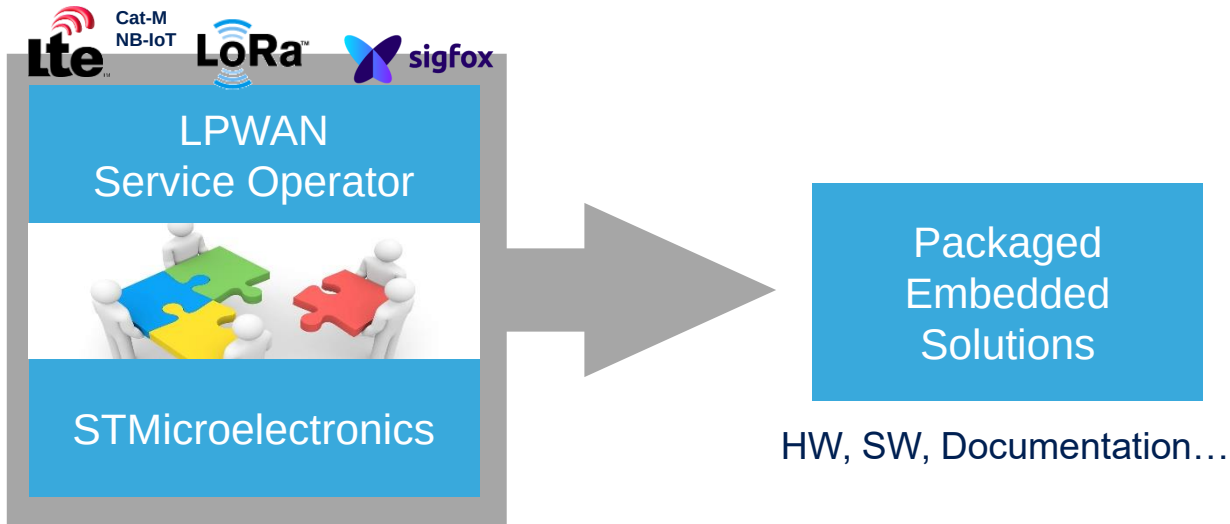


https://www.st.com/content/st_com/en/about/events/events.html/accelerate-your-lora-implementation-webinar.html

Video and Material available on line.

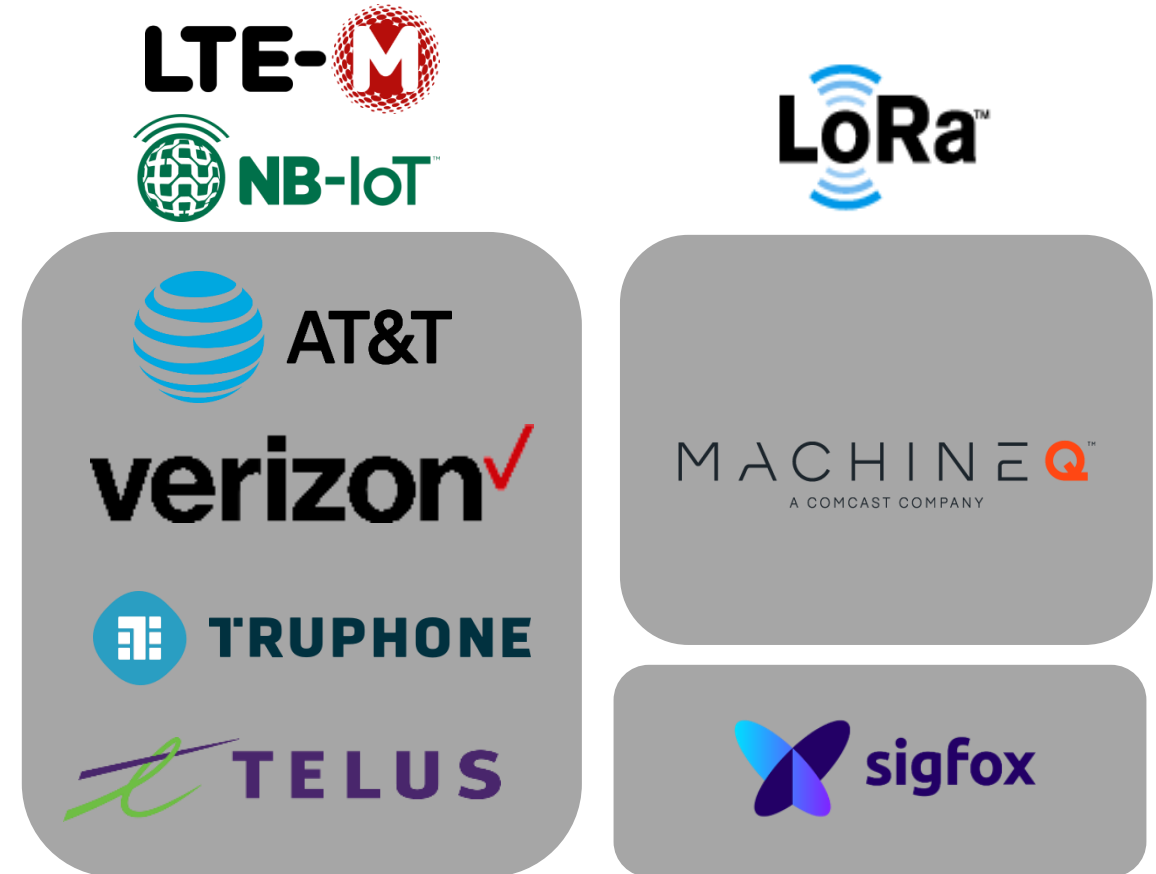


Wrap-Up



Come see the demos...

Contact: Marc.Hervieu@st.com

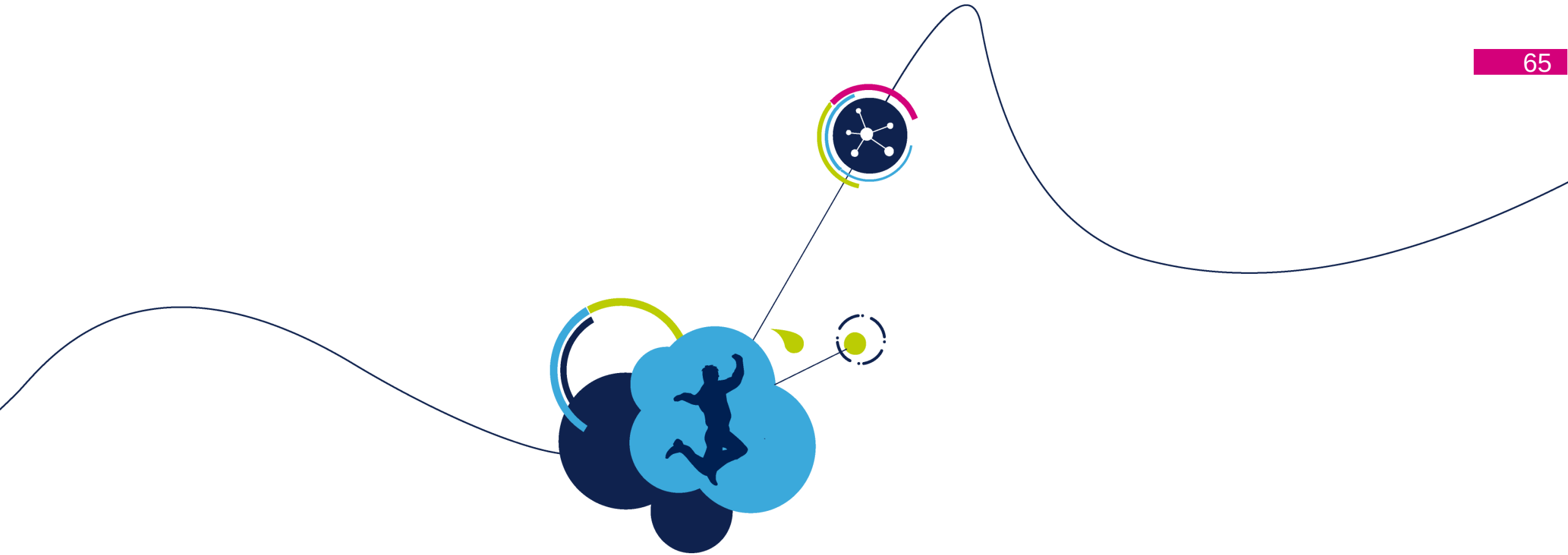




life.augmented

Thank you!





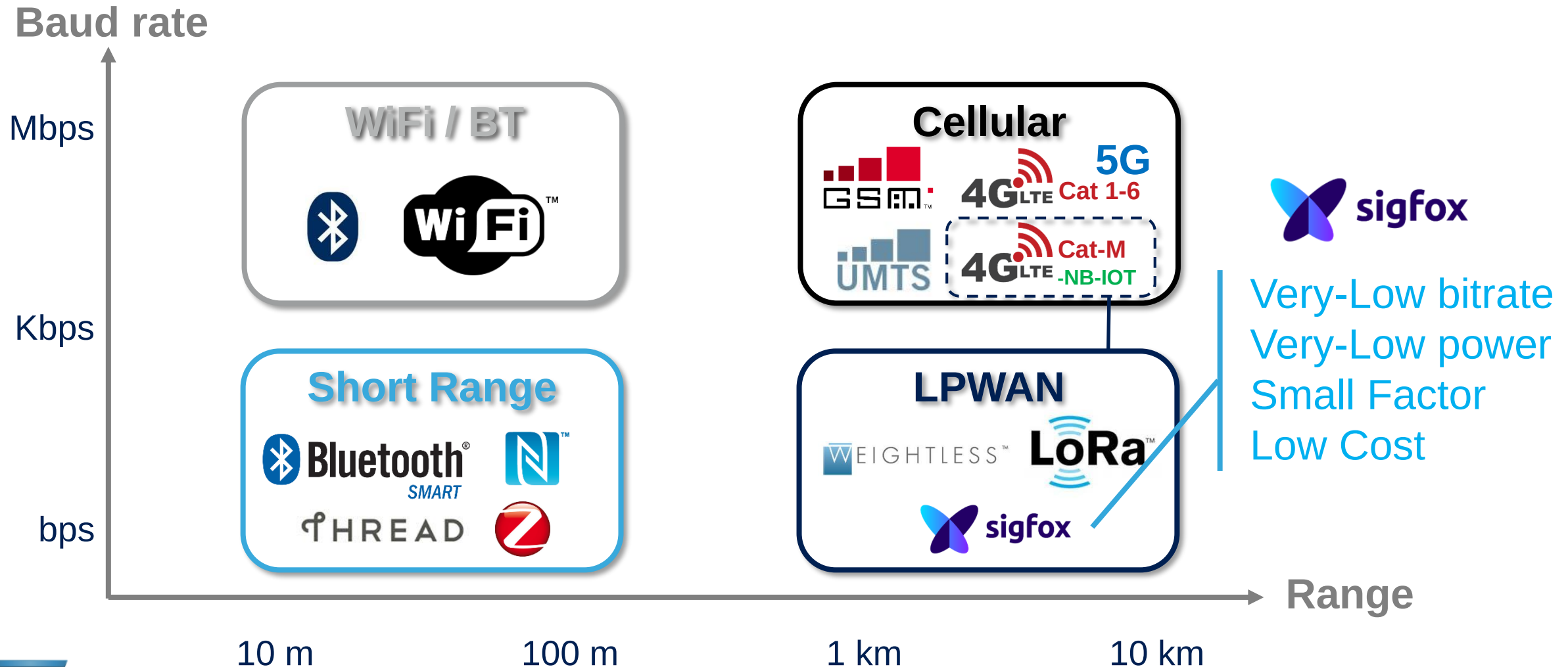
BACKUP

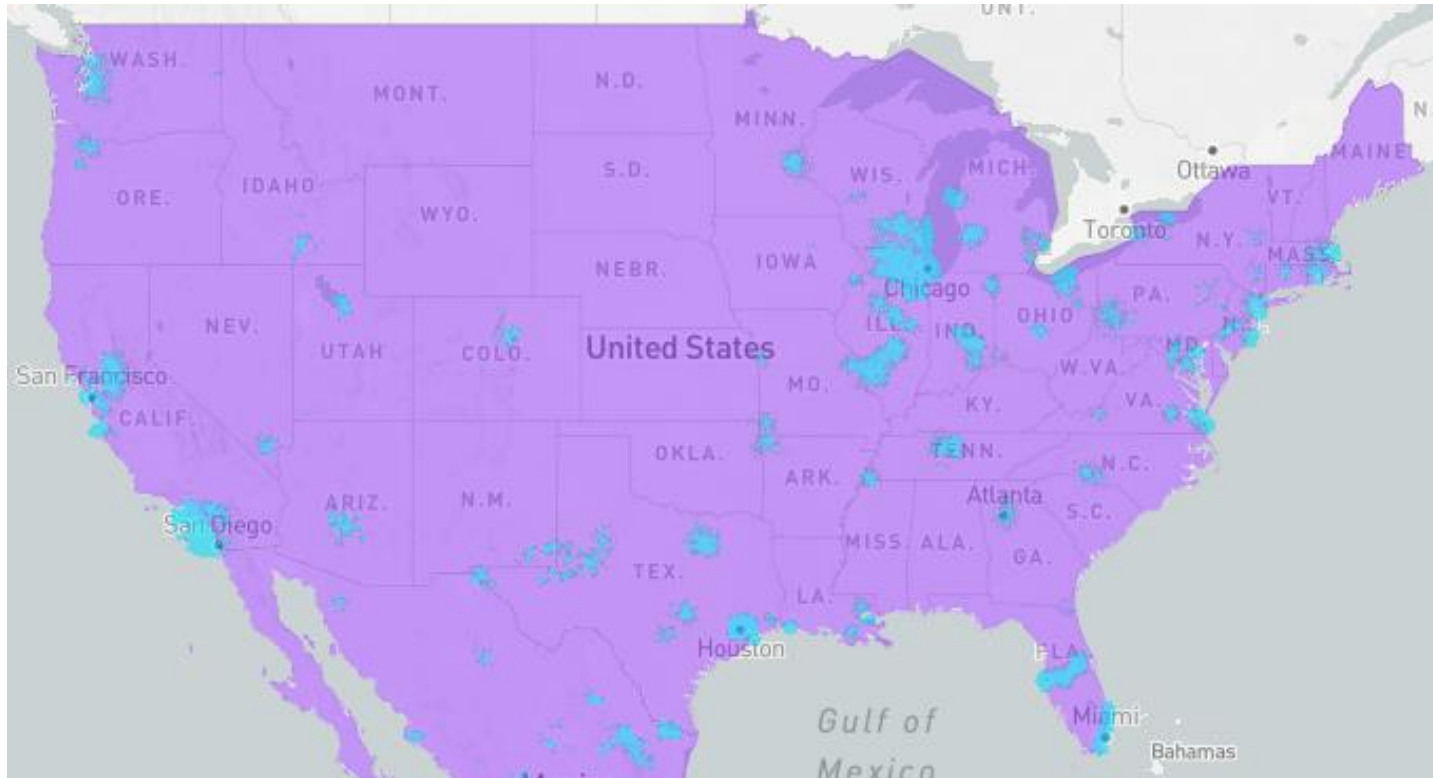


SigFox

Communication Technologies - Overview

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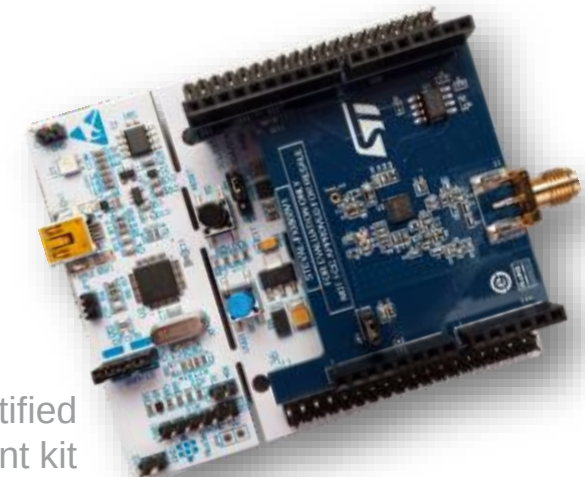


- Use Cases
 - Asset Tracking / Monitoring
 - Predictive Maintenance
 - Regulatory Compliance
 - Operational Efficiency

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.

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



SIGFOX End Product certified
Development kit