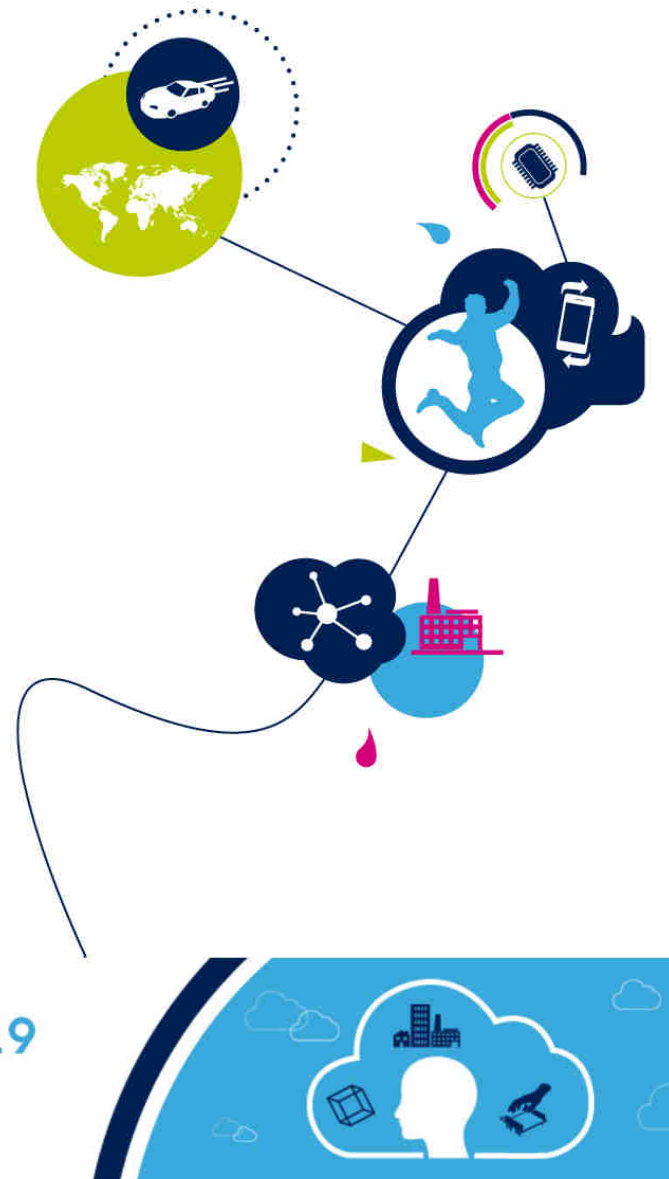


LPWAN (LTE & LoRa®) IoT Solutions

Marc Hervieu
Marketing Manager



Technology Tour 2019
Minneapolis, MN | October 24

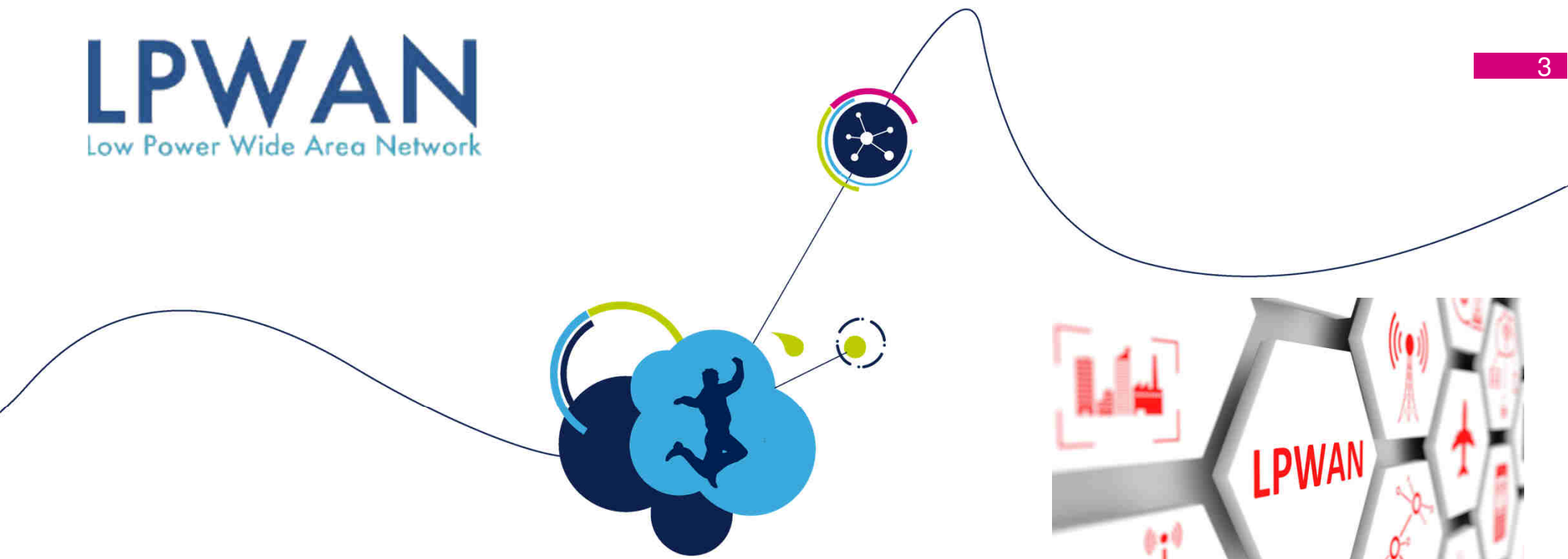


- LPWAN Market Overview
- ST IoT & Operator Strategy
- ST IoT LPWAN Cellular
 - Verizon, Truphone, AT&T, Telus Dev-Kits
- ST IoT LPWAN LoRa
 - MachineQ Dev-Kits
 - GNSS LoRa Tracker Dev-Kits & Ref. Design
- Wrap-Up

LPWAN

Low Power Wide Area Network

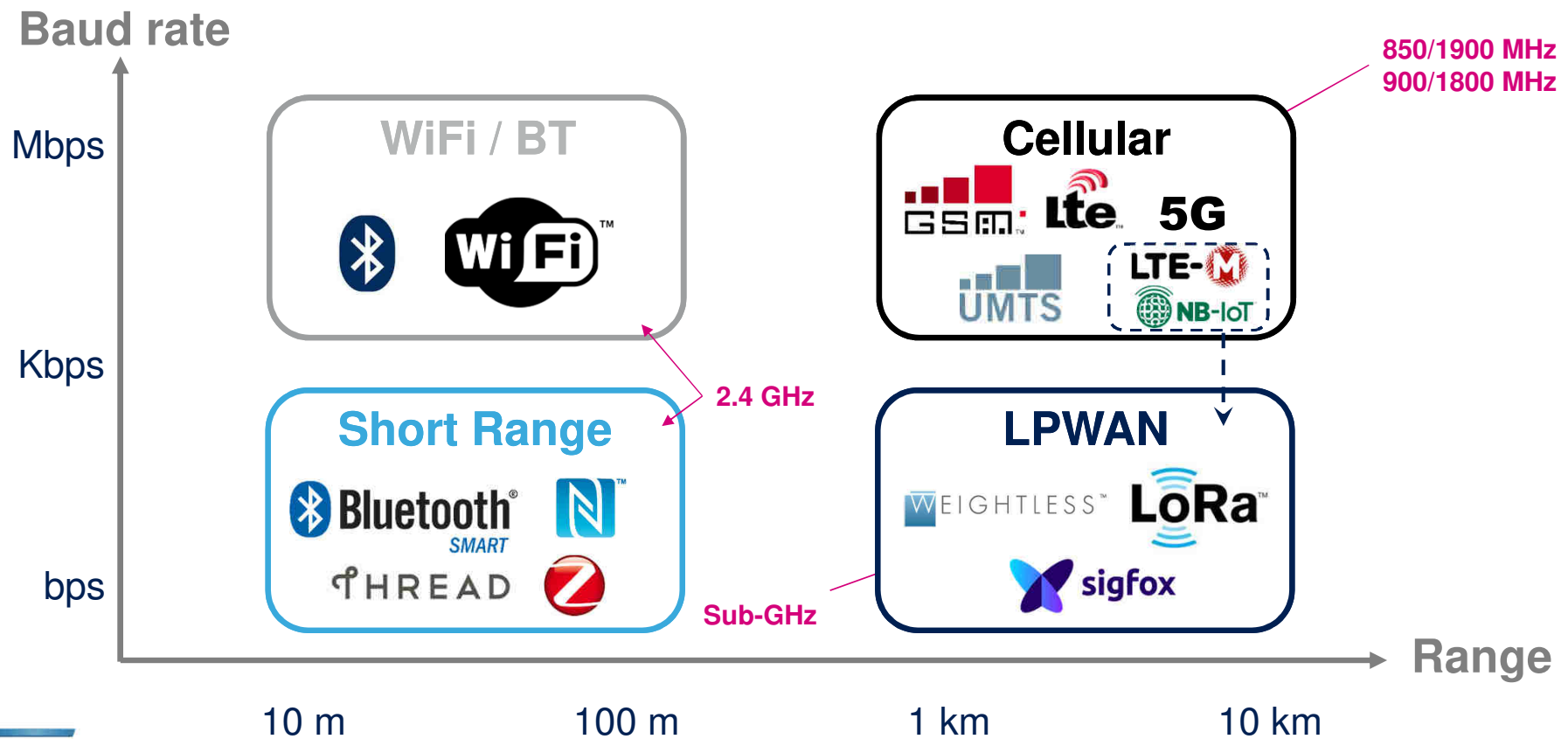
3



LPWAN Market Overview

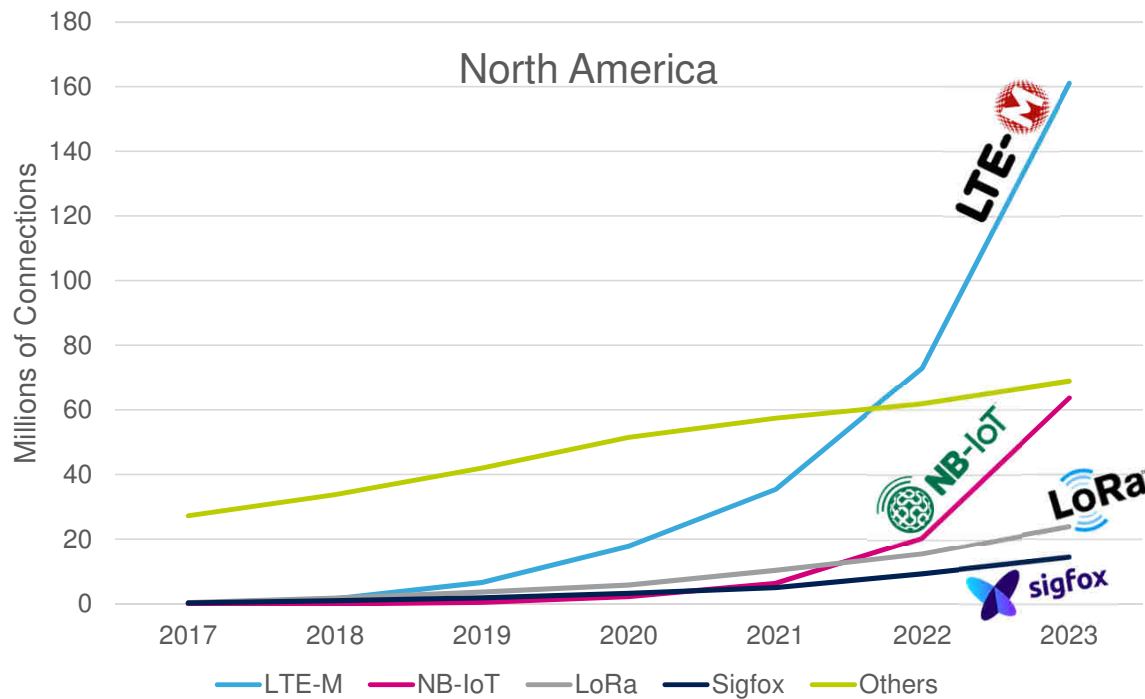
Communication Technologies - Overview

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

Americas Operators – LPWAN Activity

8

LTE-M



NB-IoT



LoRa

machineQTM
A COMCAST SERVICE

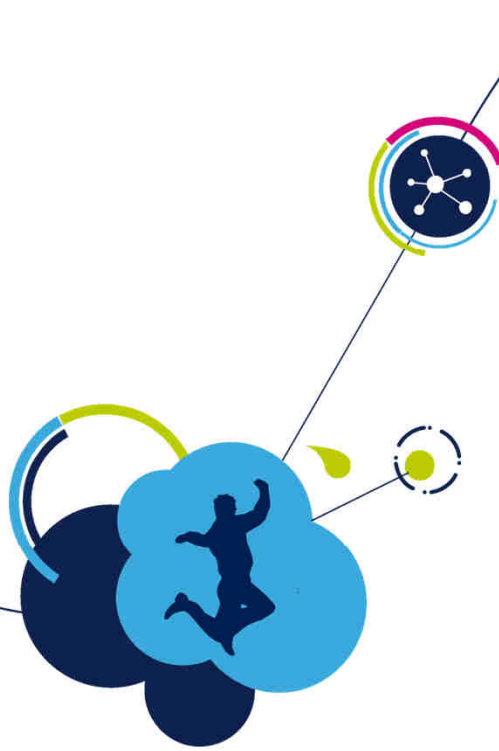
senet

COX

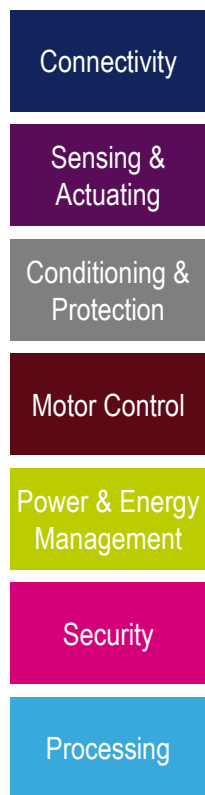
Sprint

U.S. Cellular

sigfox



ST IoT & Operator Strategy



>17 Billion
ST MEMS



WW Top
#1 #2



Industrial
WW Top #3

>4 Billion
ST MCU



WW Top #2
>60,000 Customers

SensorTile



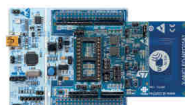
BlueCoin



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



IDE
Development
environments



Debug
solutions



Simulation
and analysis tools



On-line
design tools



STM32 portfolio positioning

11

Largest Market Offering with ~1000 STM32 Part Numbers



Note ● : Cortex-M0+ Radio Co-processor, ● : Cortex-M4 Co-processor

More than
4 Billion shipped & **60,000** customers



MEMS Sensors and Actuators

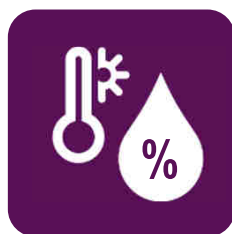
12

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



Targets:

- Embedded Developers
- IoT evangelist
- OEMs
- Mass market

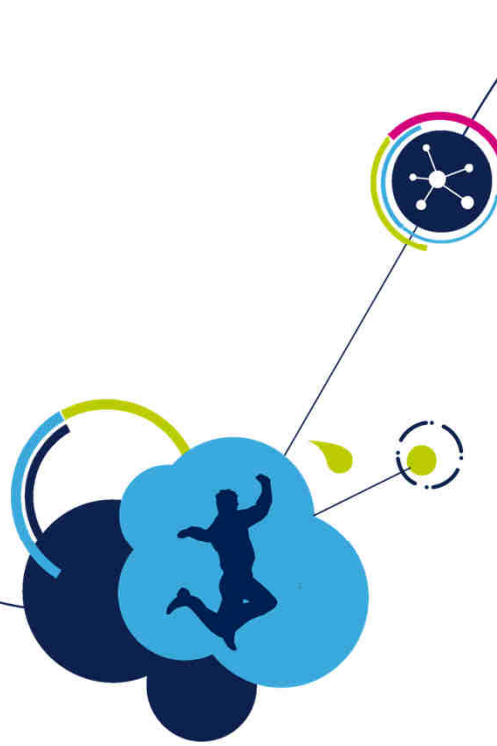
Return On Investment:

- Use ST products
- Use Operator service



New Products on
the market

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

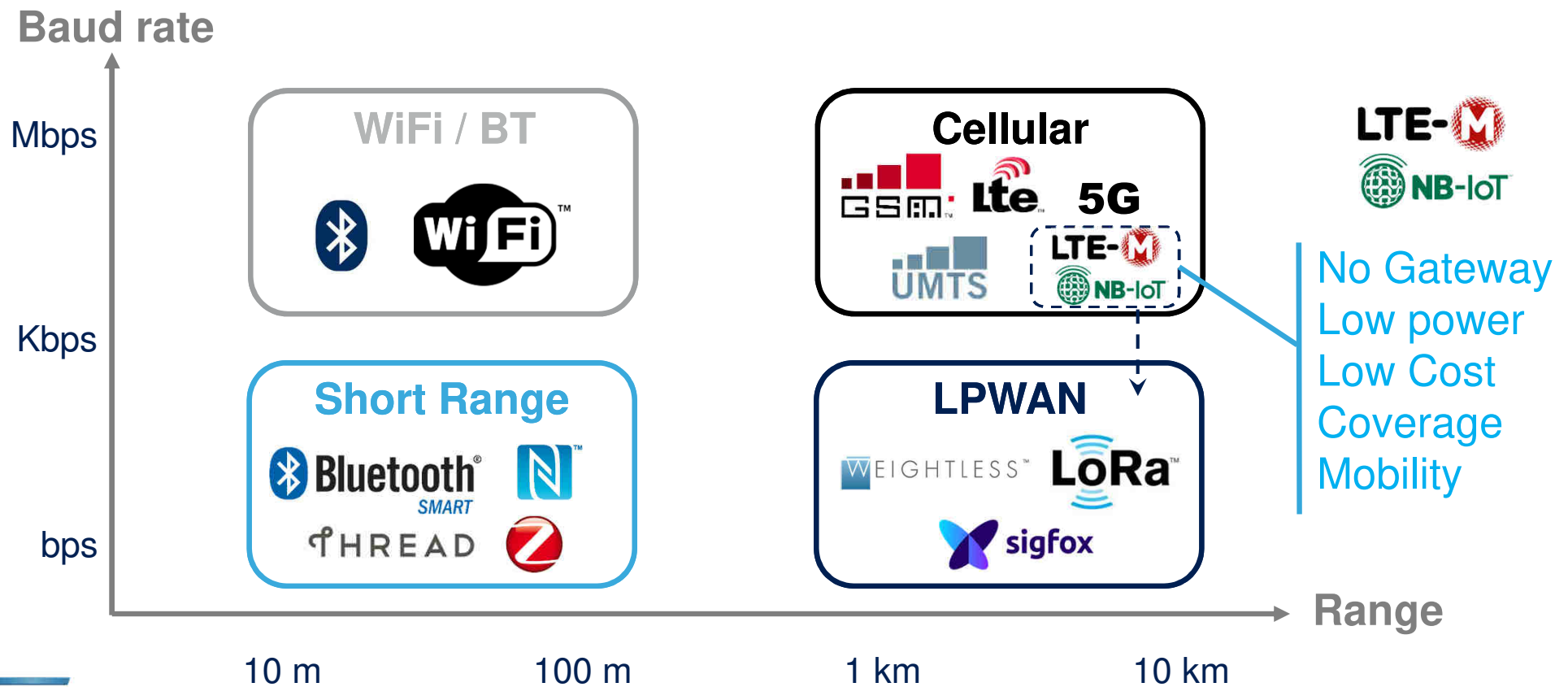


ST IoT LPWAN Cellular



Communication Technologies - Overview

16

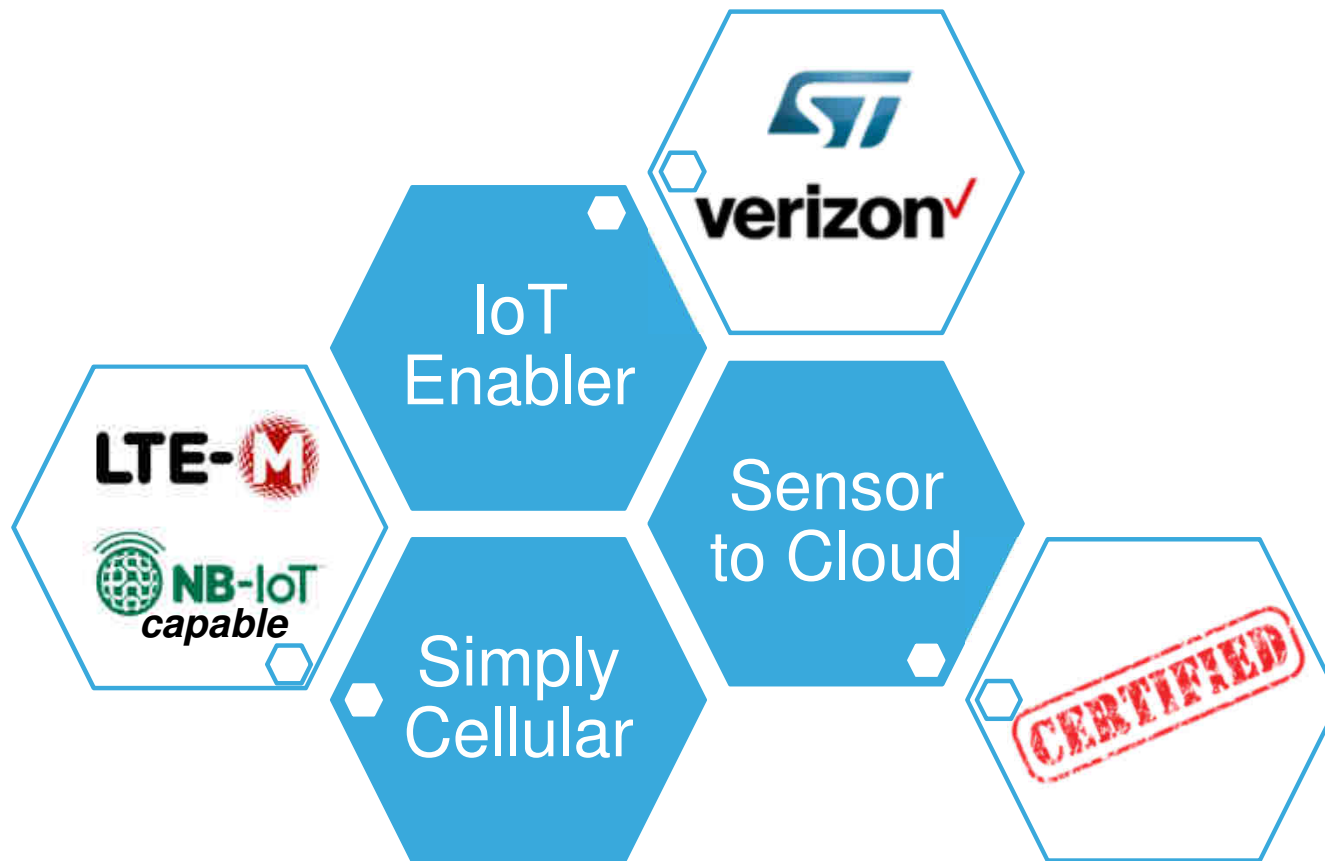




VERIZON LTE Starter Kit

Targets IoT Embedded Developers

17



IoT STM32 LTE Starter Kit

18



LTE-M **NB-IoT**

STM32 **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

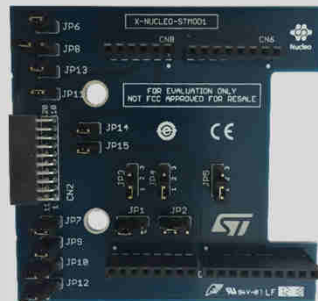


ST LTE Modem

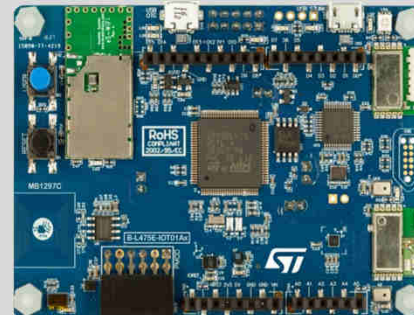


verizon✓

ST SIM-Card



X-Nucleo
Expansion Board

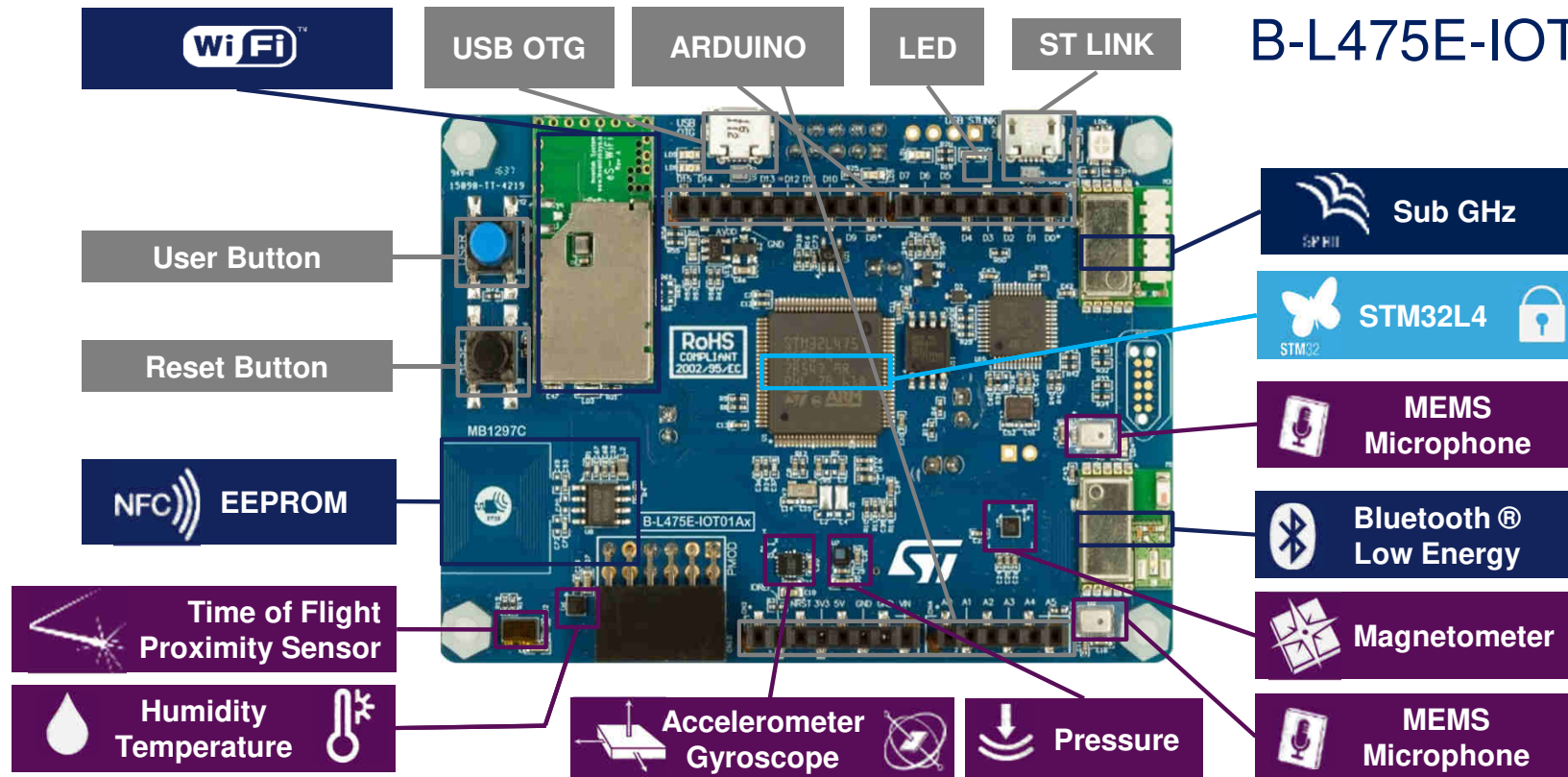


STM32L4 Discovery
Kit IoT Node

STM32L475 Discovery Kit IoT Node

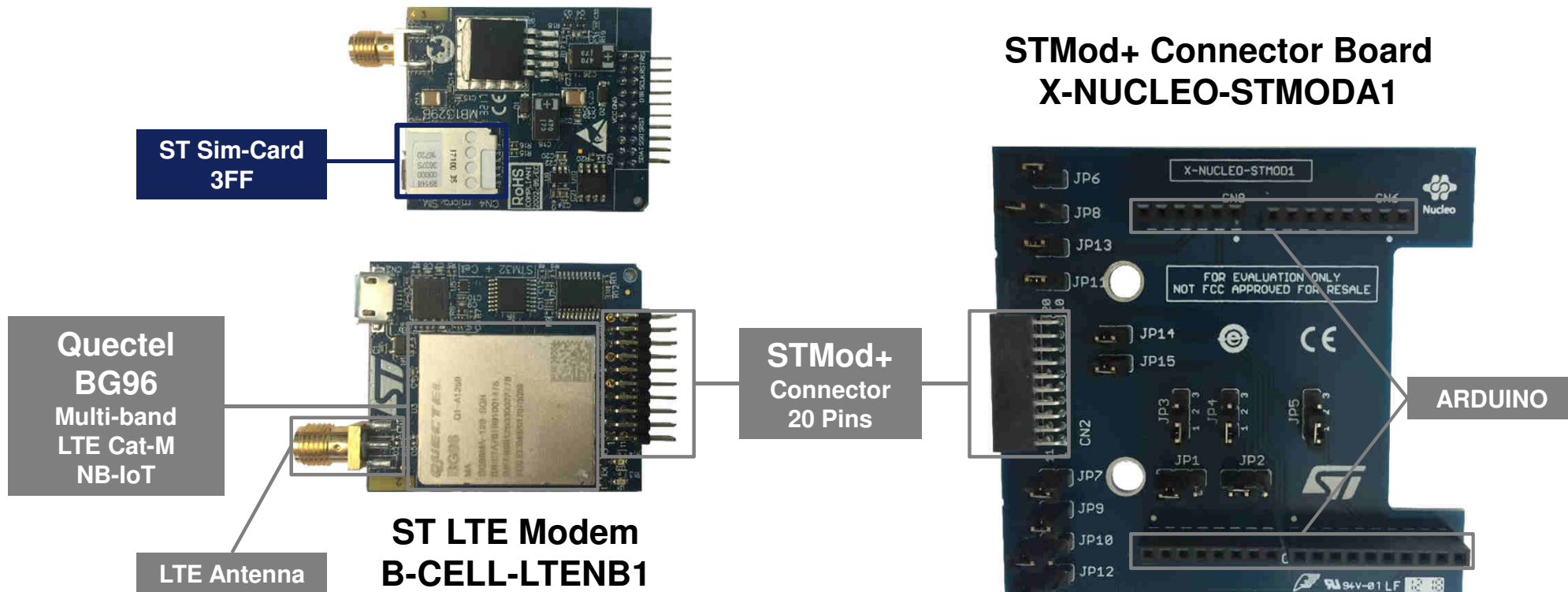
19

B-L475E-IOT01A



STMod+ Connector Board & Modem

20



Note: Jumpers set by default for Discovery IoT Kit Node

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



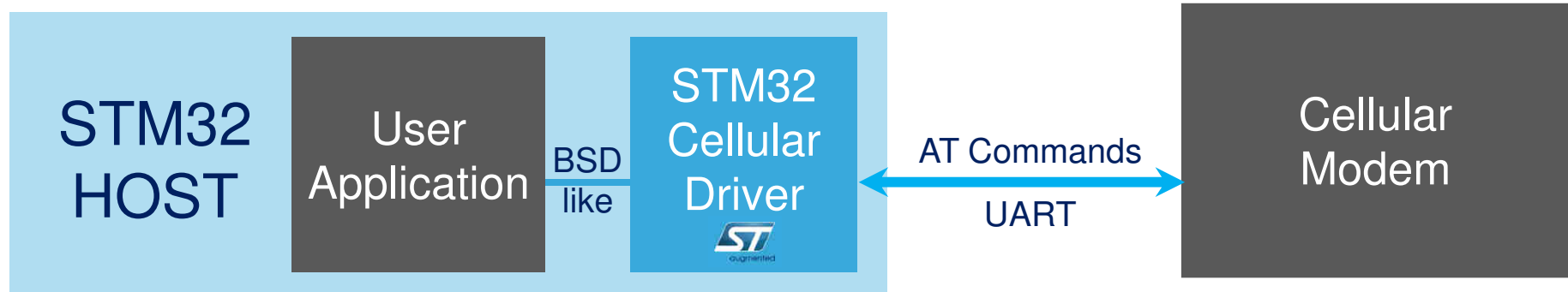
<https://www.st.com/en/evaluation-tools/p-l496g-cell02.html>

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

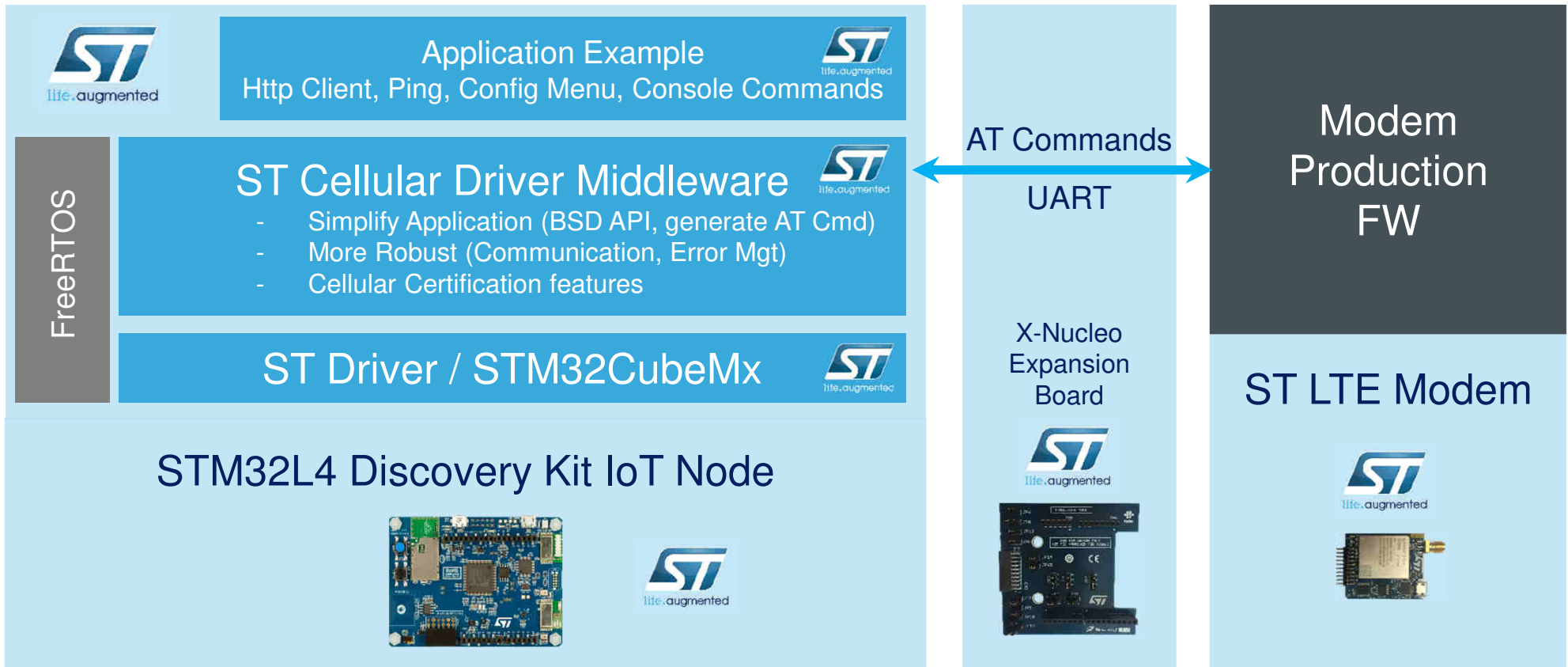
- No need to be a Cellular expert
- Simple Application
 - BSD like Socket APIs → Data Plane
 - HAL → Abstract all key Cellular AT commands
 - Control various modem vendors
 - Error Management (Device, Network)
- Certification added value
 - Partial GSMA TS34/35 compliance



Released done with:

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

ST Solution X-CUBE-CELLULAR

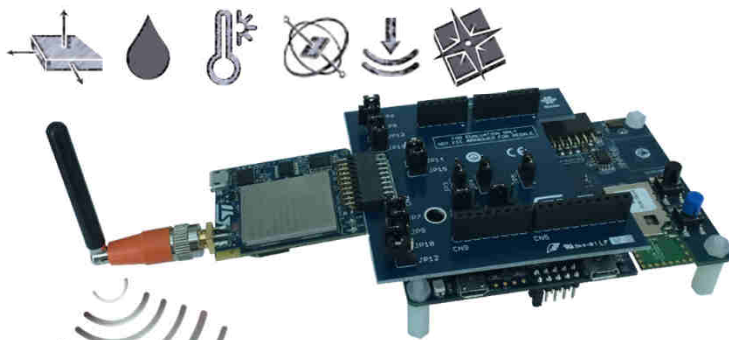


verizon[✓]

X-CUBE-CELLULAR

24

STM32 LTE Starter Kit x-cube-cellular

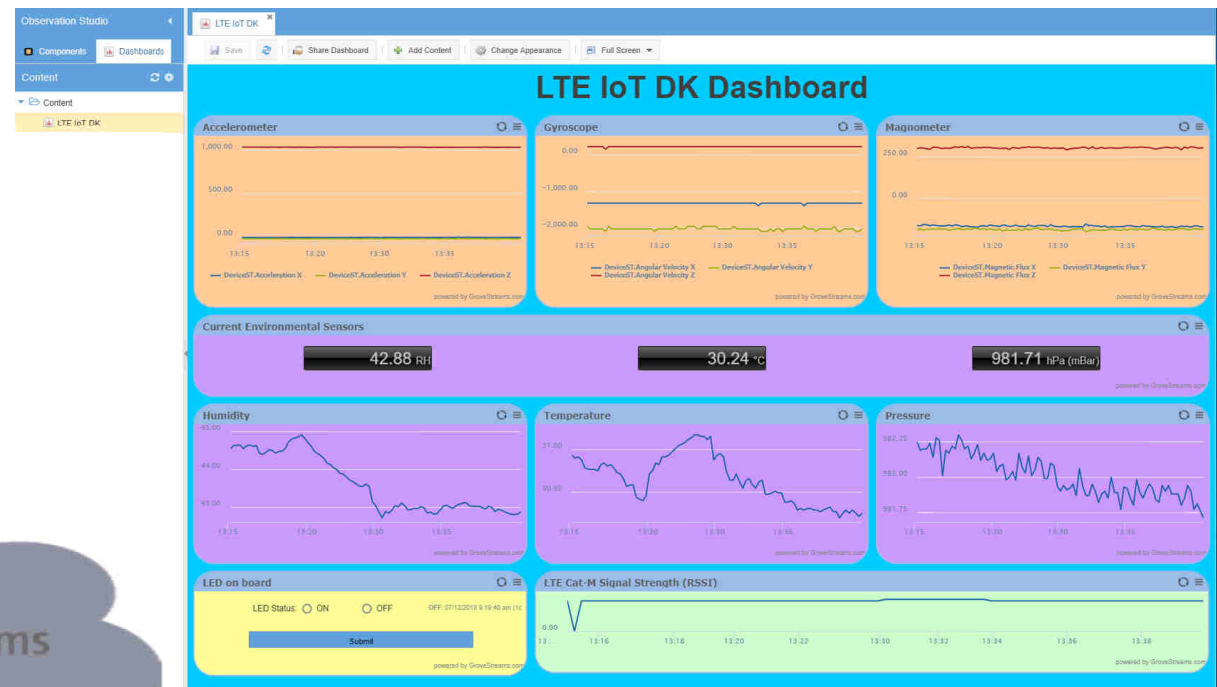


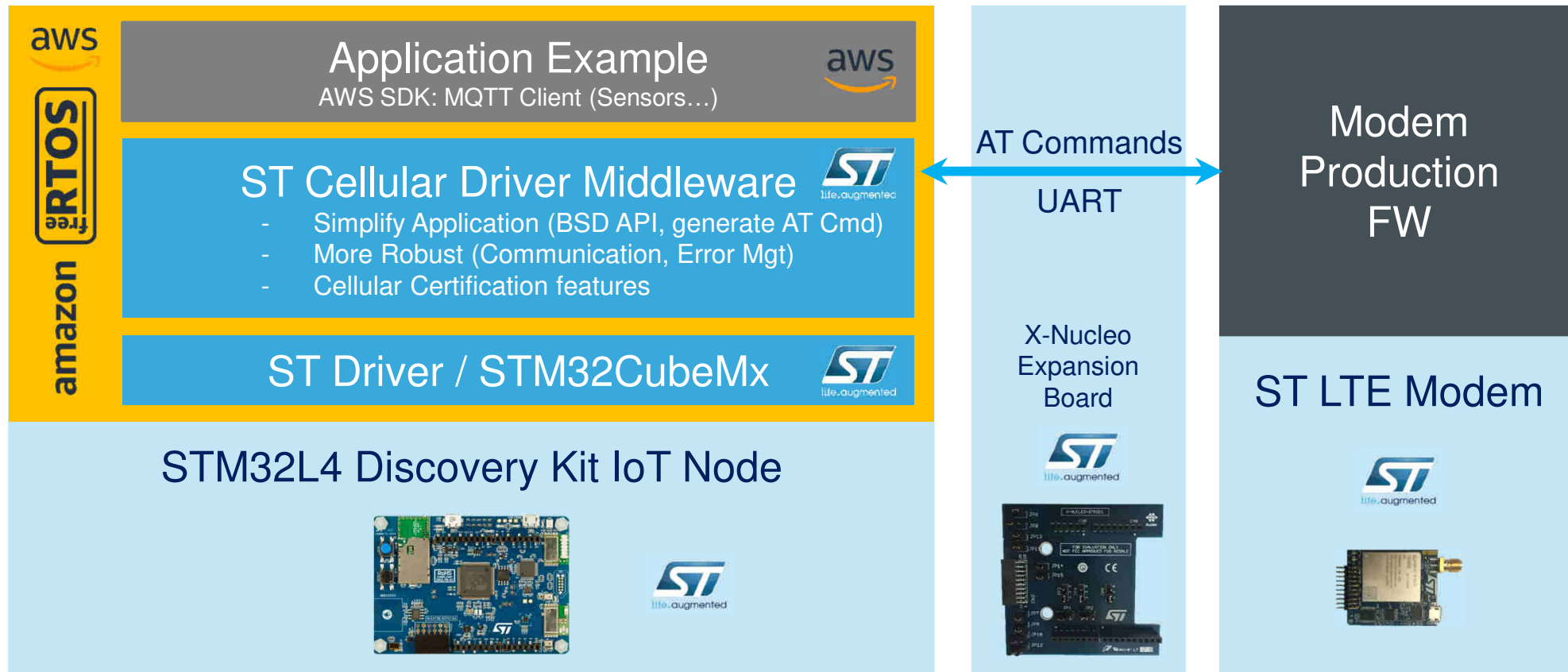
verizon[✓]
LTE-M

GroveStreams

ST
life.augmented

Web Browser





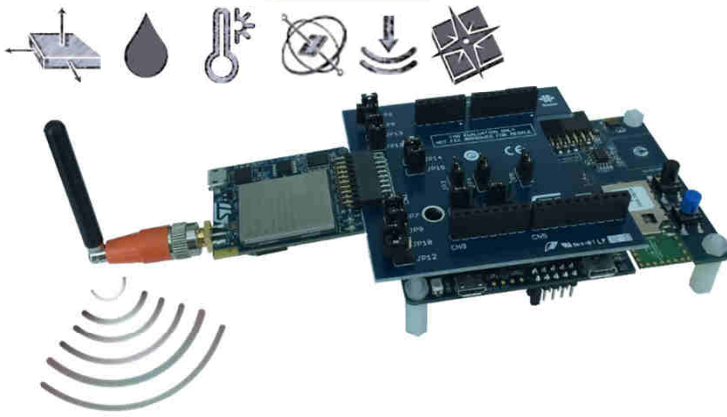
verizon✓

Amazon FreeRTOS

26

STM32 LTE Starter Kit

amazon **freeRTOS**



verizon✓
LTE-M

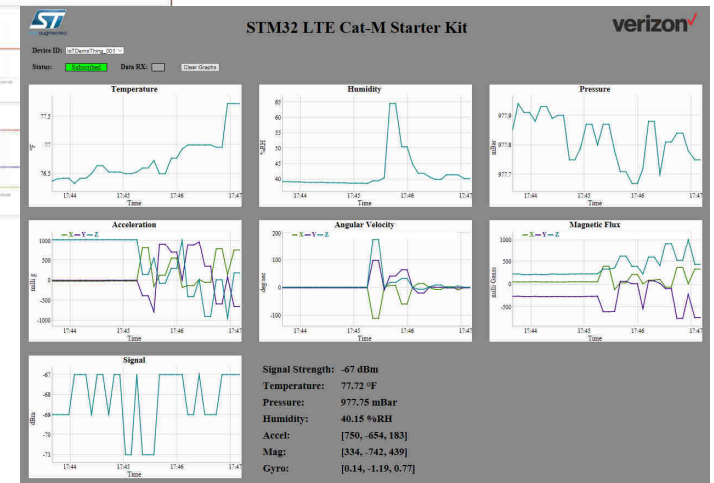
ST
life.augmented



Web Browser AWS – KIBANA Dashboard

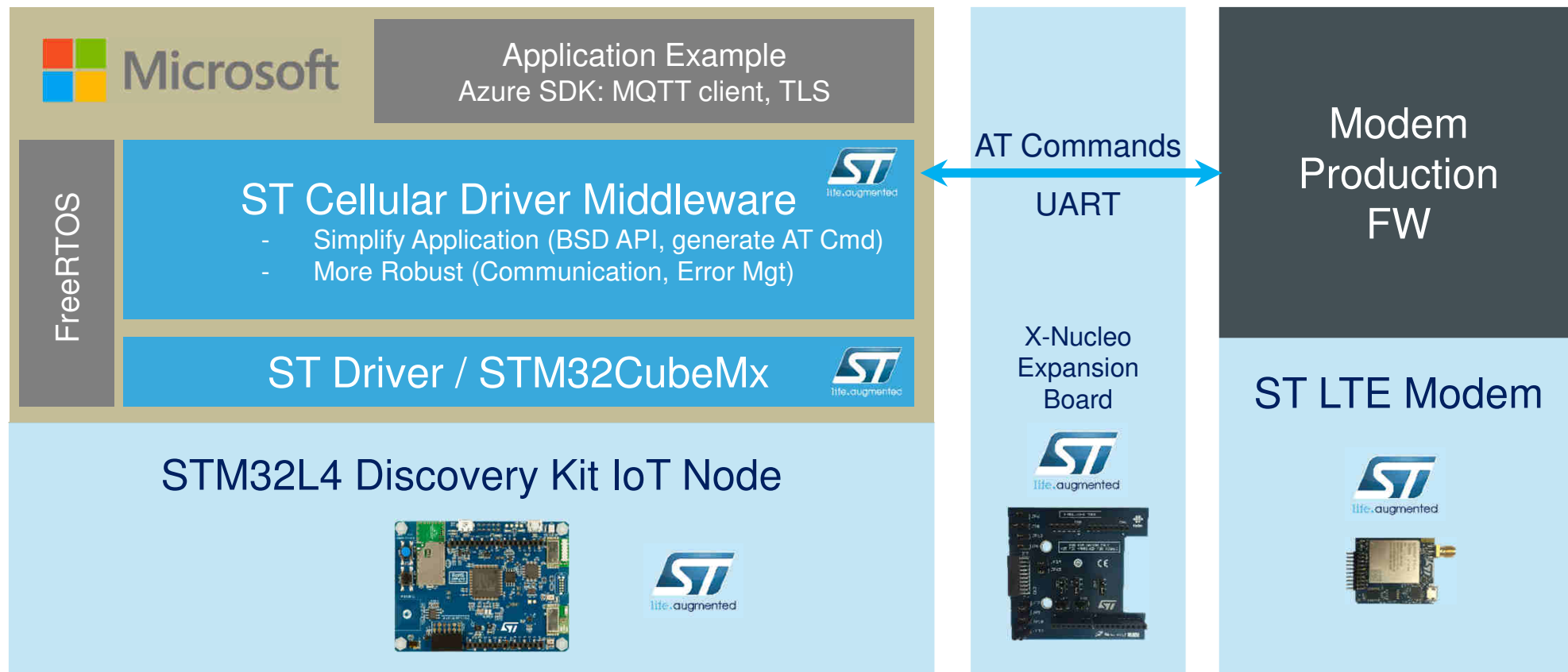


Web Browser ST JavaScript Dashboard



Microsoft Solution Azure IoT Central

27

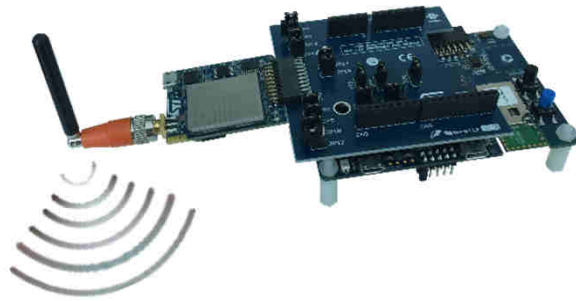




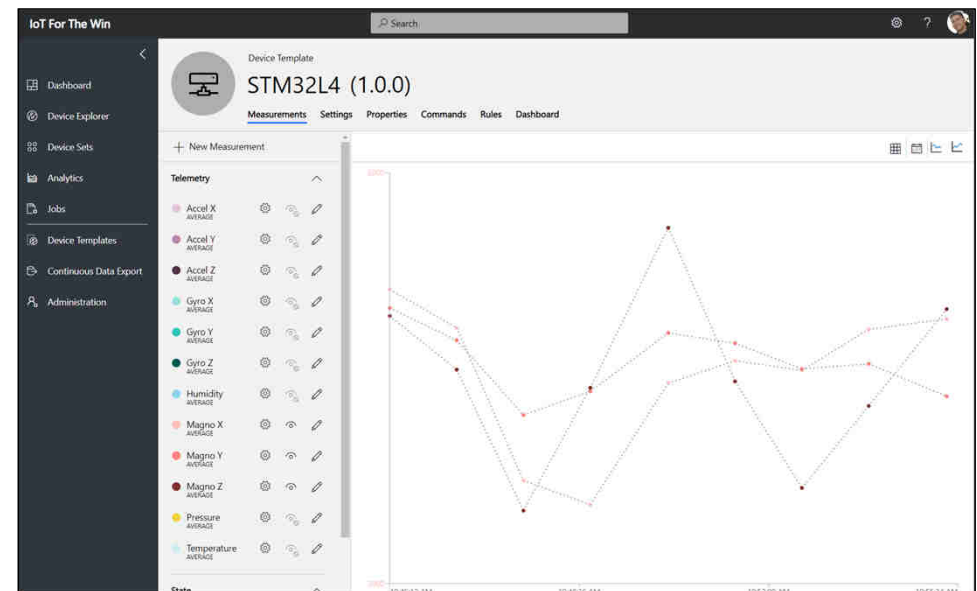
Microsoft Azure IoT Central Experience

28

STM32 LTE Starter Kit



Web Browser Azure IoT Central Dashboard



STM32 Verizon – How to Get Access

29

- Verizon ThingSpace Cloud connectors



Click on “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>



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

verizon✓

STM32 – Software Resources

31



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

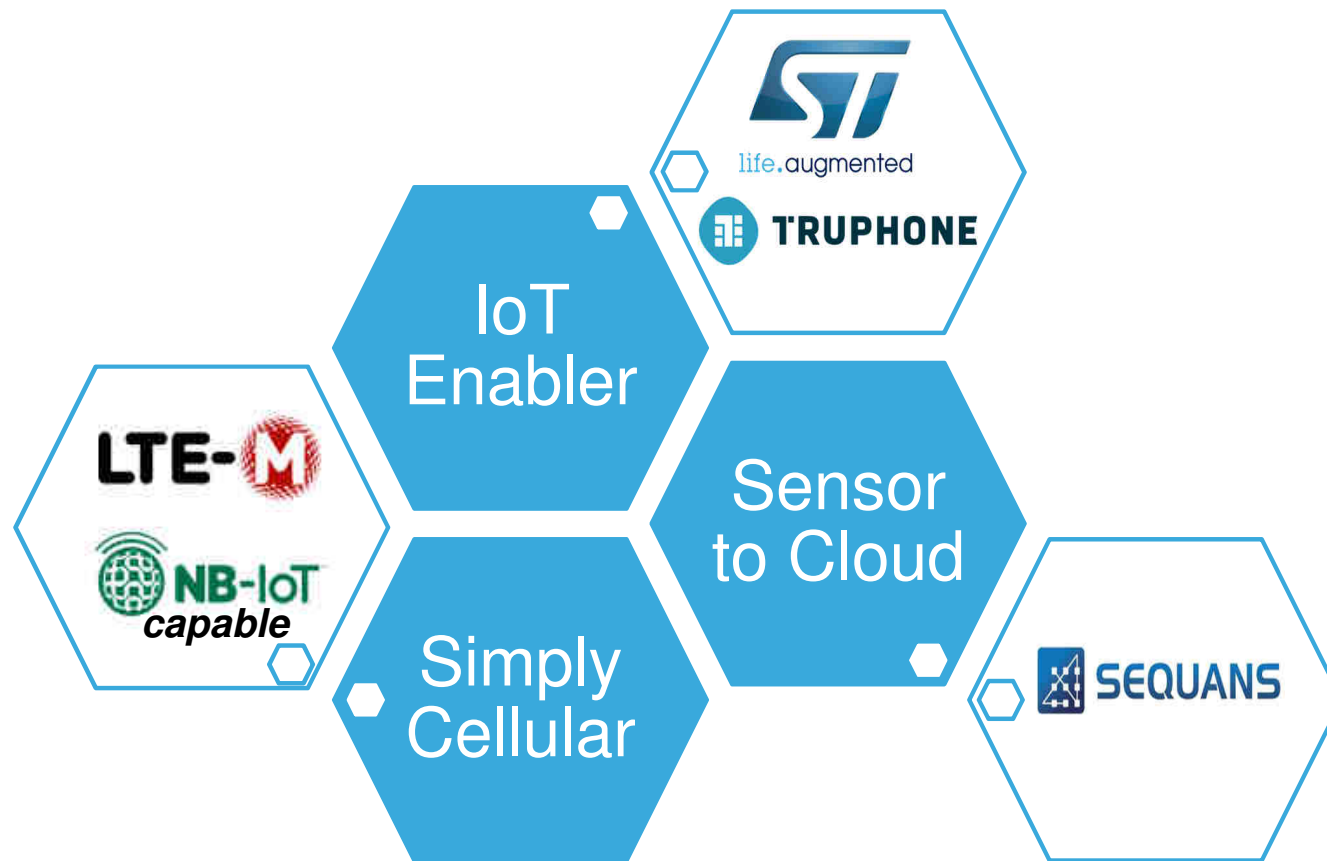
<https://github.com/Azure/iot-central-firmware/tree/master/freeRTOS/b-l475e-iot01a1-bg96-verizon>



Worldwide LTE-M Starter Kit

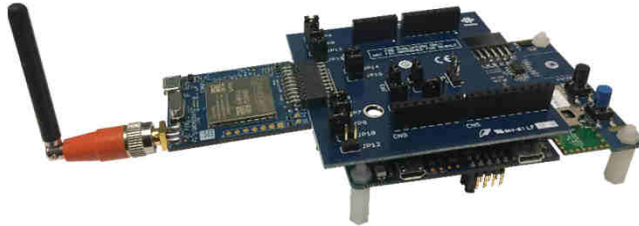
Targets IoT Embedded Developers

32



IoT STM32 LTE Starter Kit

33



LTE-M **NB-IoT**

STM32L4

Accelerometer
Gyroscope

Magnetometer

Humidity
Temperature

Pressure

Time of Flight
Proximity Sensor

2x MEMS
Microphone

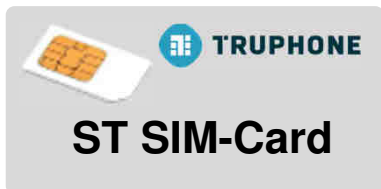
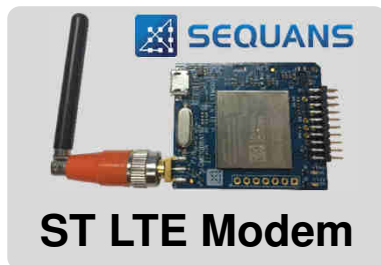
NFC EEPROM

Bluetooth®
Low Energy

Sub GHz

WiFi™

LTE Cat-M
NB-IoT



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



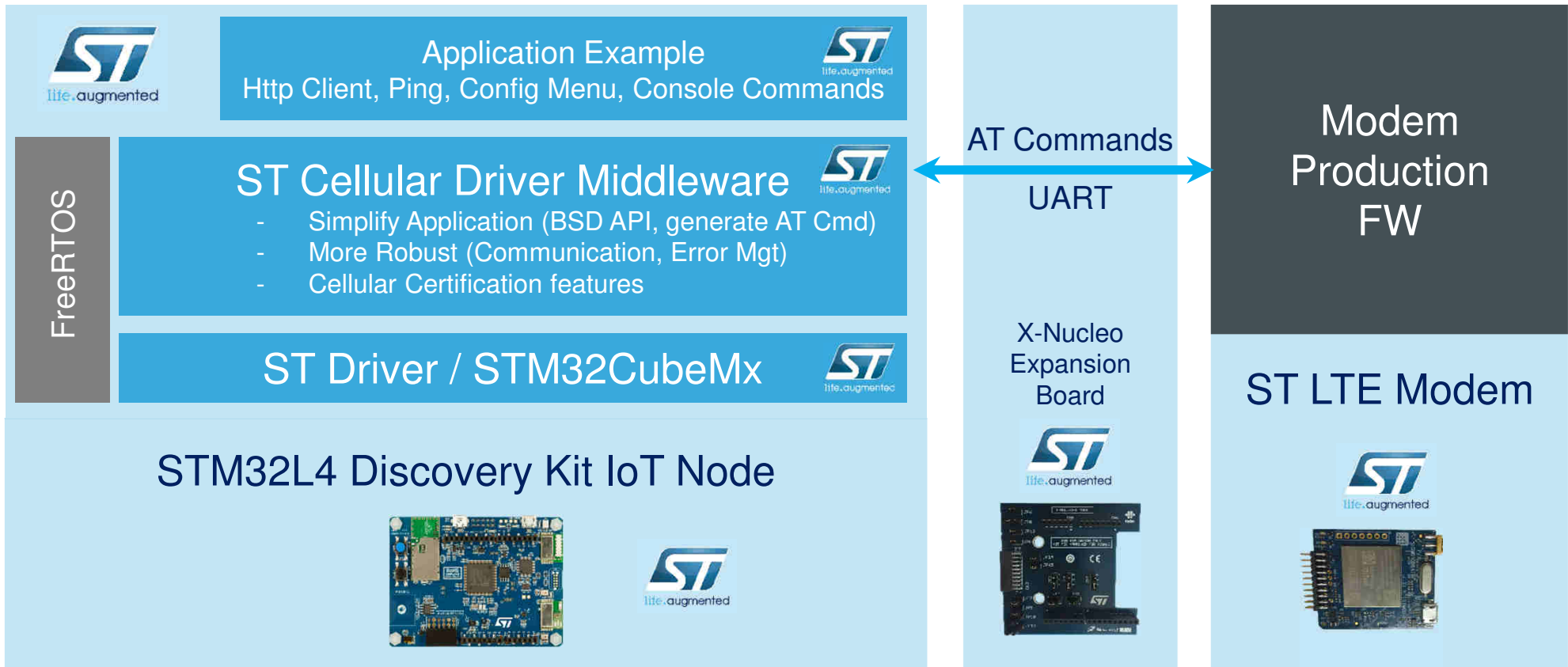
<https://www.taoglas.com/product/tg-08-cellulargpsglonass-beidou-monopole-antenna-2/>



TRUPHONE

ST Solution X-CUBE-CELLULAR

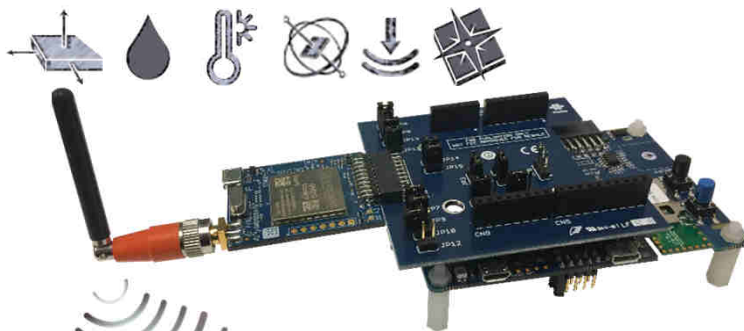
35



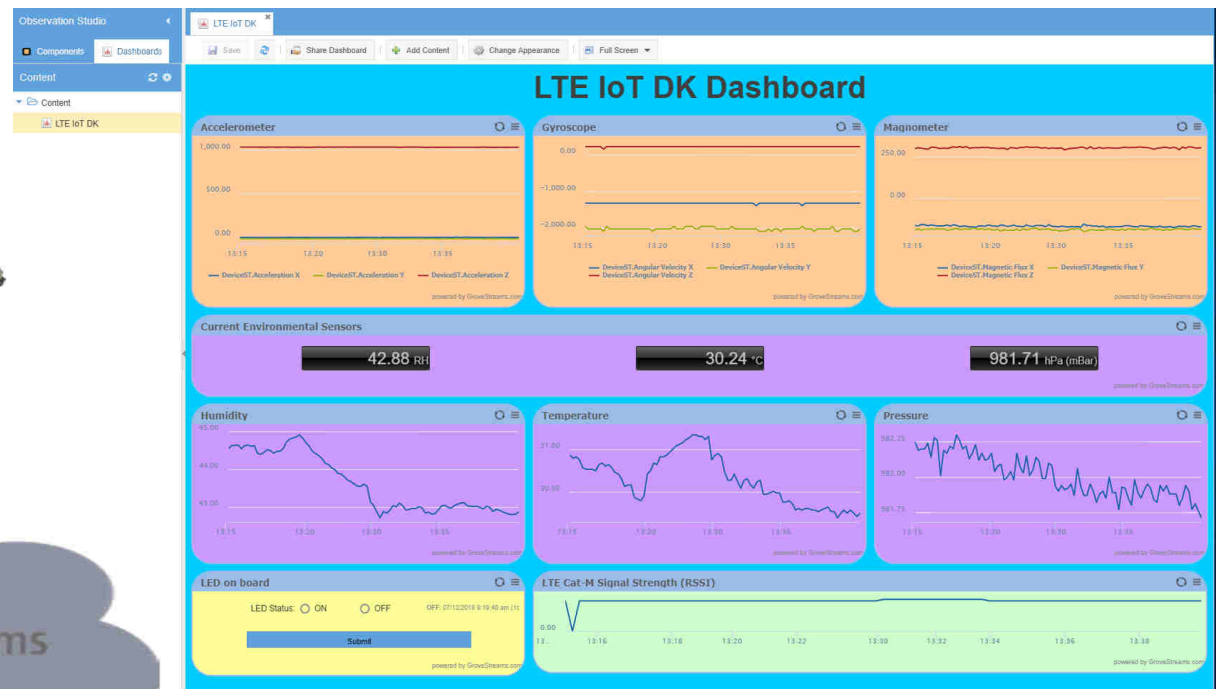
www.st.com/x-cube-cellular



STM32 LTE Starter Kit x-cube-cellular



Web Browser





AT&T Starter Kit

37

STM32 based Development Kits with AT&T



LTE-M
LTE-I





IoT STM32 LTE Starter Kit

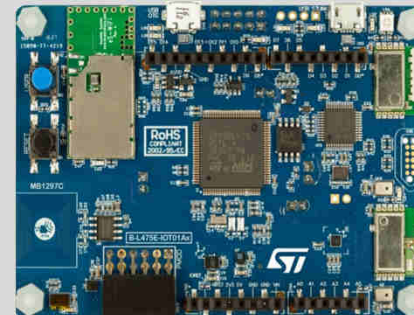
38



LTE-M
LTE-1



Avnet – Modem Board



STM32L4 Discovery
Kit IoT Node





Avnet- AT&T Solution

39

STM32 LTE Starter Kit

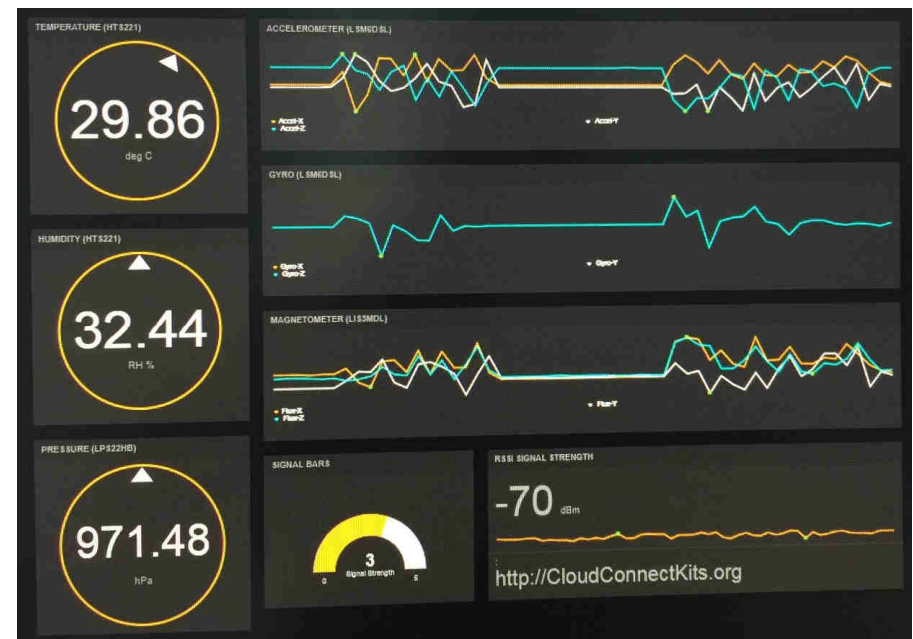


LTE-M

AT&T Flows



Web Browser



STM32 AT&T – How to Get Access

40

- 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

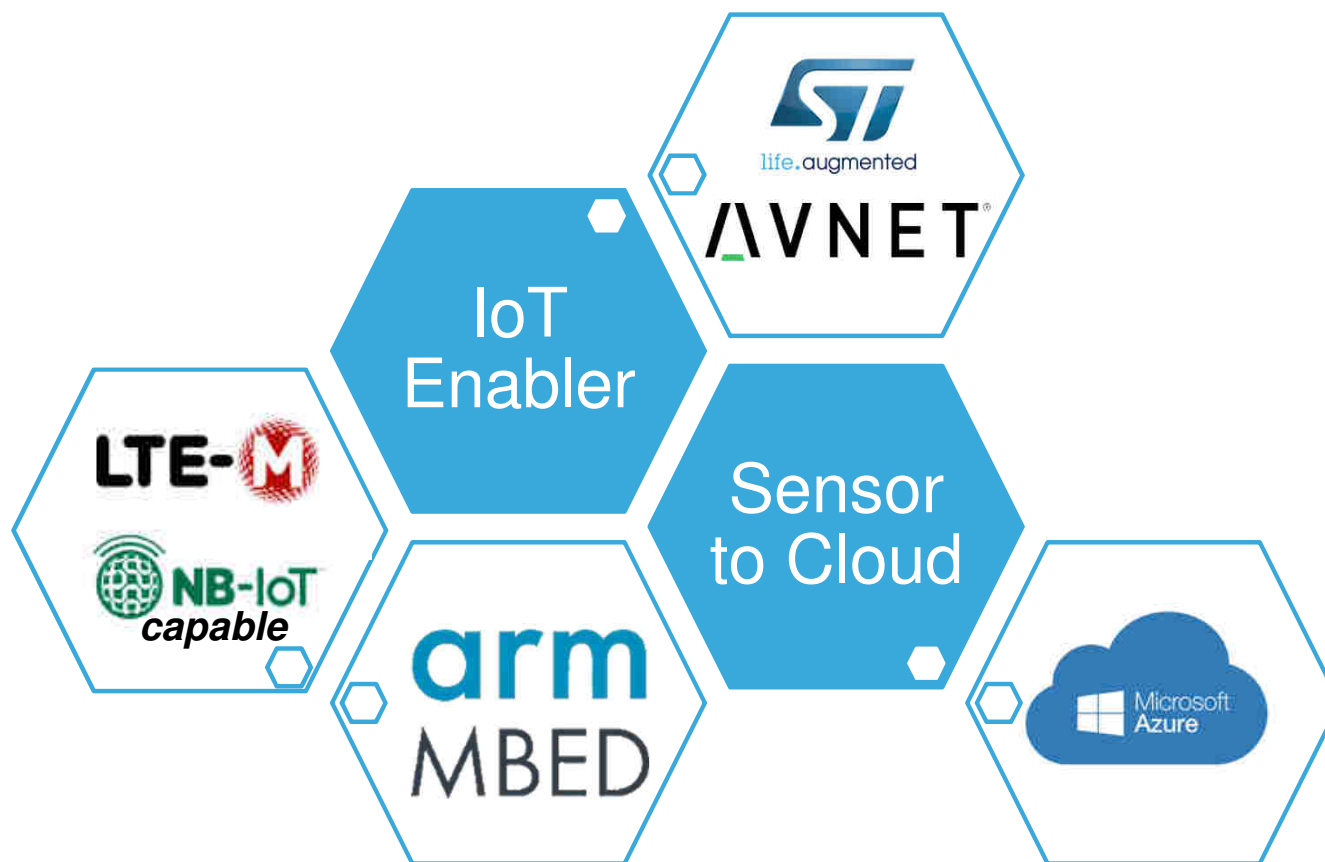


<http://cloudconnectkits.org/product/att-stm32-iot-starter-kit>

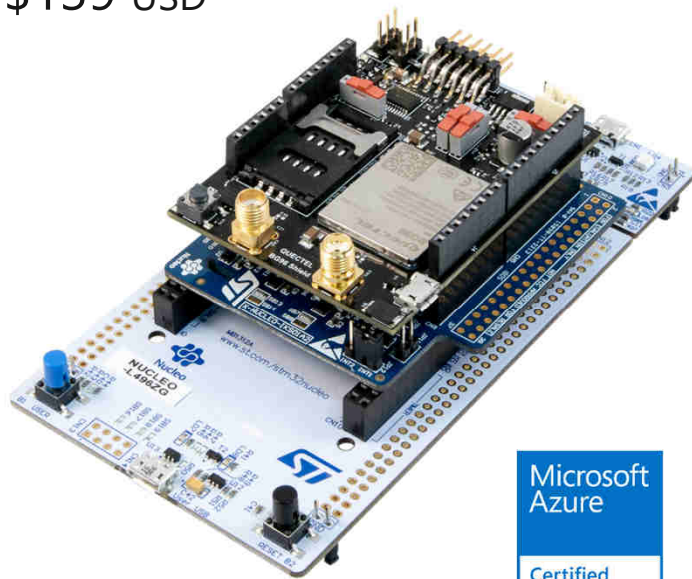
Telus LTE-M Starter Kit

Targets IoT Embedded Developers

41



Suggested Resale:
\$139 USD



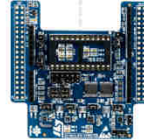
Microsoft
Azure
Certified

* 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

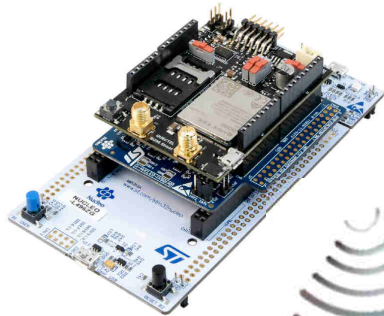
- Avnet designed Arduino shield format
- Based on Quectel BG96 LTE-M / NB-IoT modem
- Supports both SIM and eUICC options



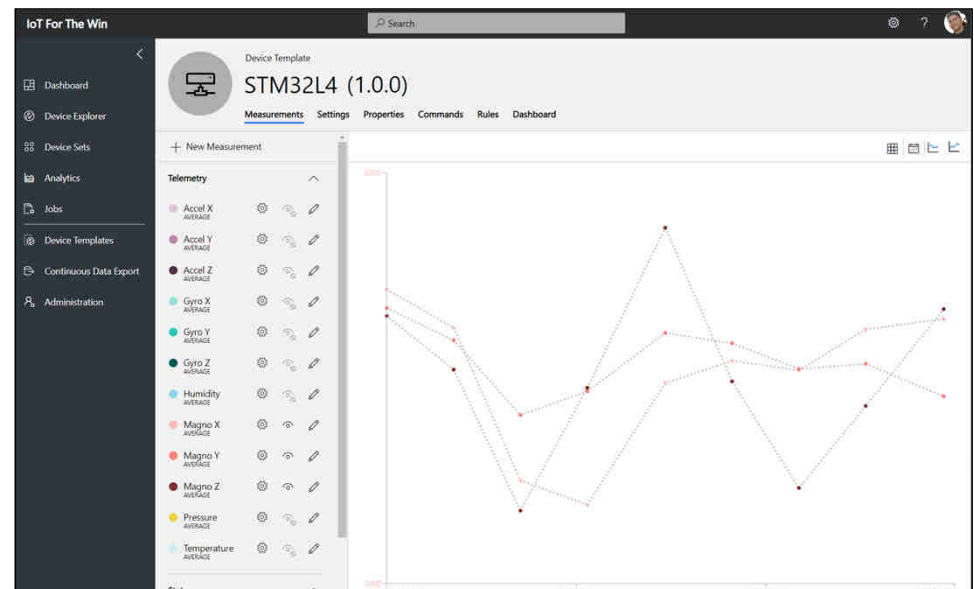
Azure IoT Central Experience

44

STM32 LTE Starter Kit



Web Browser Azure IoT Central Dashboard



Telus Solution

45

 **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

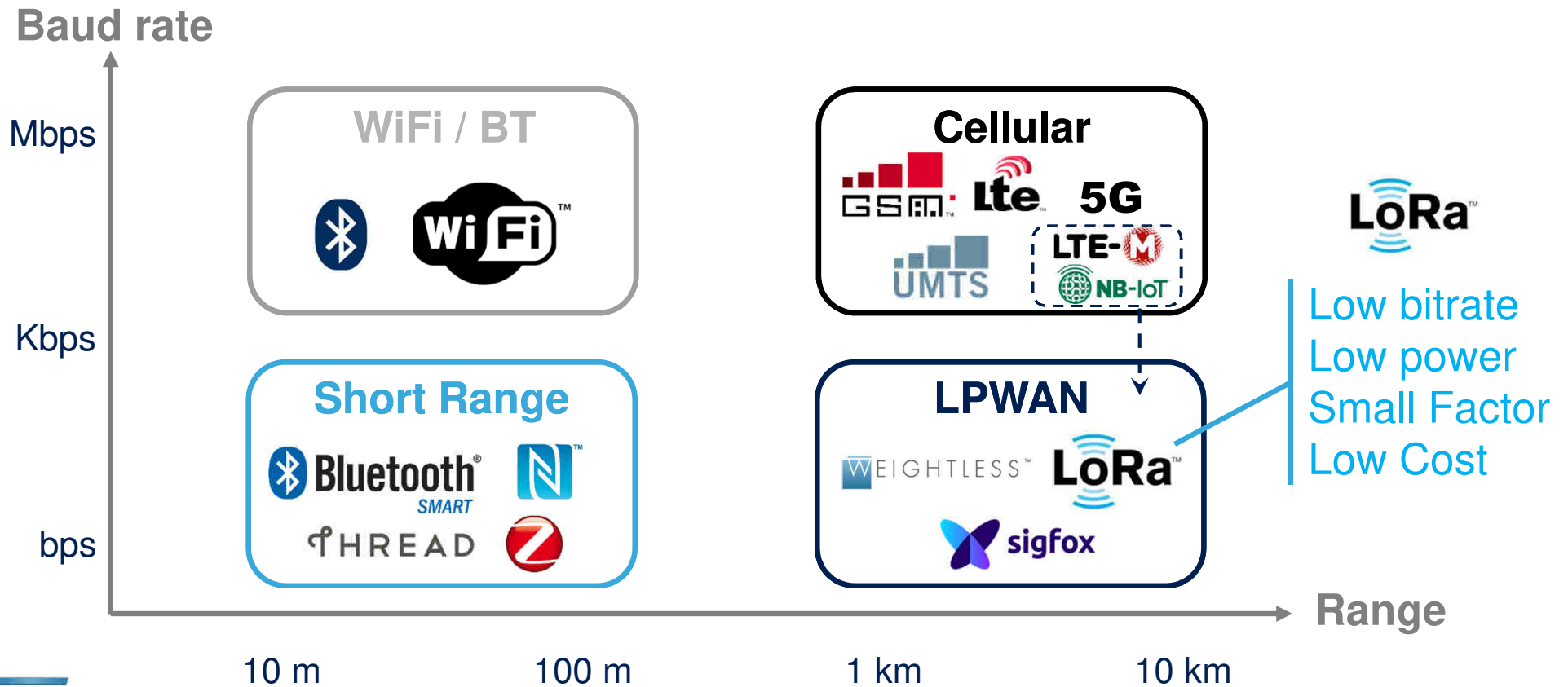




ST IoT LPWAN LoRa

Communication Technologies - Overview

47





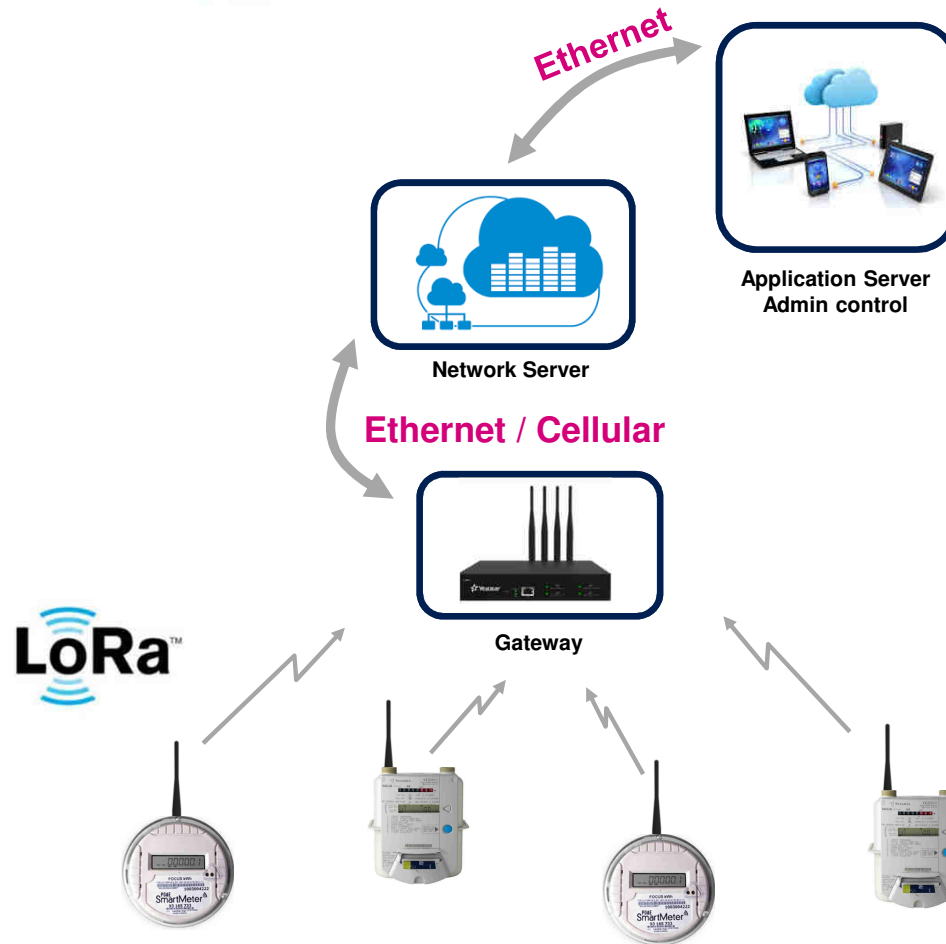
IoT use cases

48

Key Verticals

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

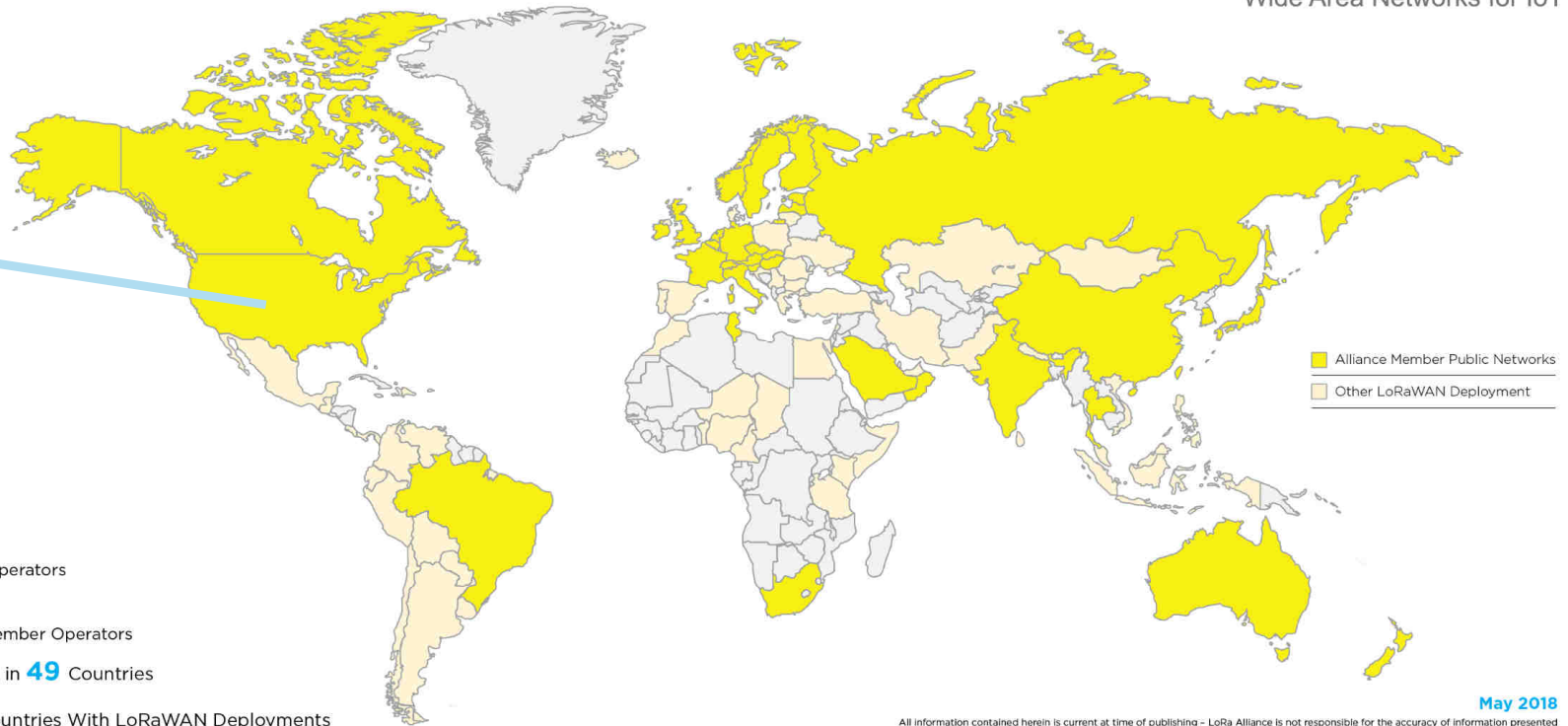
...



LoRa Network Deployments

49

LoRaWAN™ NETWORKS



83
Network Operators

56
Alliance Member Operators

Operating in **49** Countries

~100 Countries With LoRaWAN Deployments



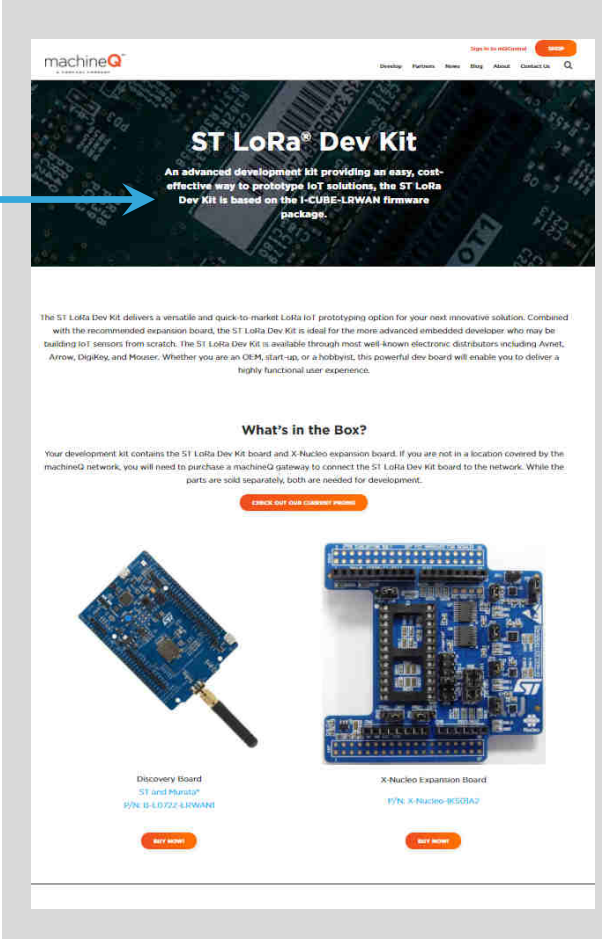
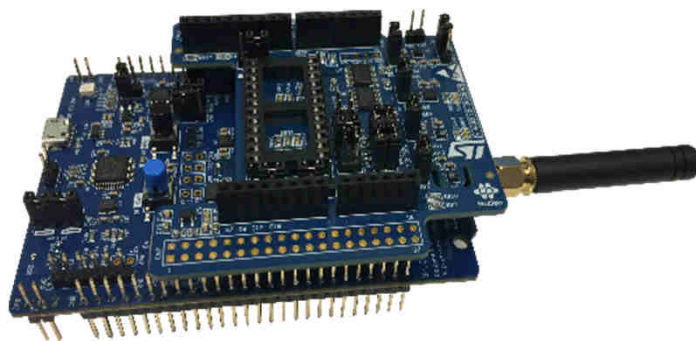
May 2018

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

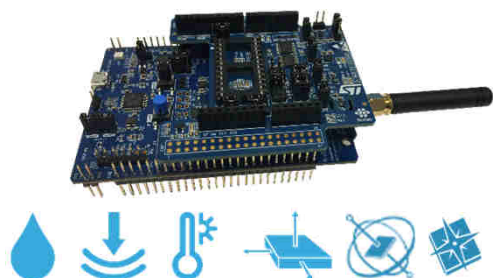
50

- 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



ST LoRa Dev Kit Solution

51



MACHINE QTM
IoT Gateway



MQcentral (SaaS)



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



ST LoRa Dev Kit Hardware

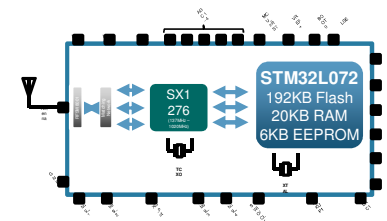
base board B-L072Z-LRWAN1

52

ST-Link
Debugger



Murata® Module
All-in-one Open



Arduino Connector

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



B-L072Z-LRWAN1

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



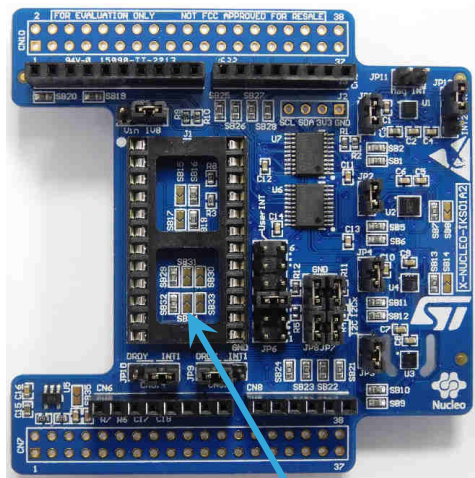


ST LoRa Dev Kit Hardware

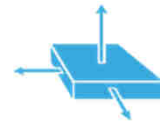
Sensor Shield X-NUCLEO-IKS01A2

53

Published on www.st.com
Search for X-NUCLEO-IKS01A2



DIL-24 Extension



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



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



Pressure (LPS22HB)



Temperature + Humidity (HTS221)

Published on www.st.com
Search for STEVAL-MK*

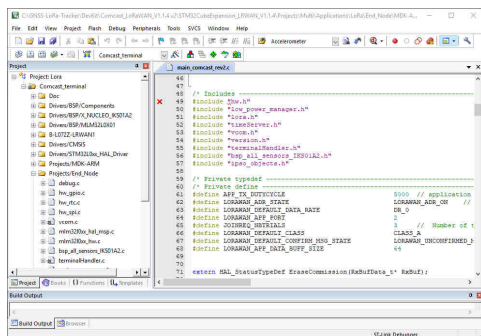


life.augmented

ST LoRa Dev Kit Firmware

54

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

Published on www.st.com
Search for I-CUBE-LRWAN

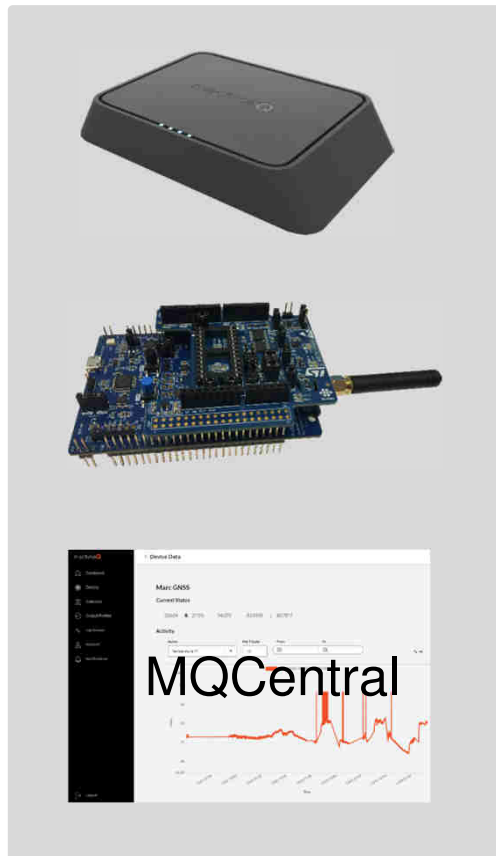
+

Sensors → raw data to the cloud

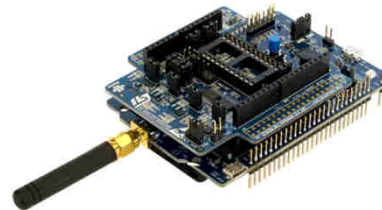
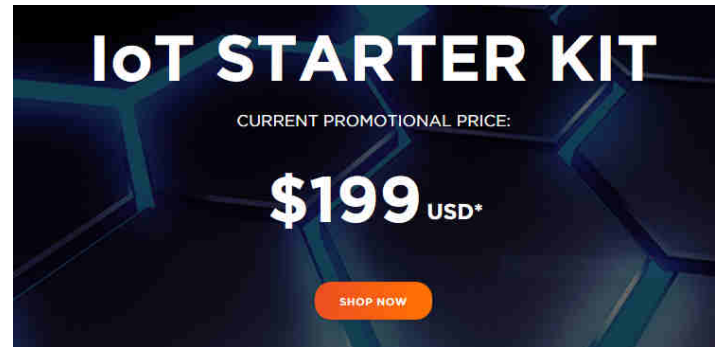
+

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

MACHINEQTM
A COMCAST COMPANY



ST LoRa Dev-Kit Deal



ST LoRa Dev Kit

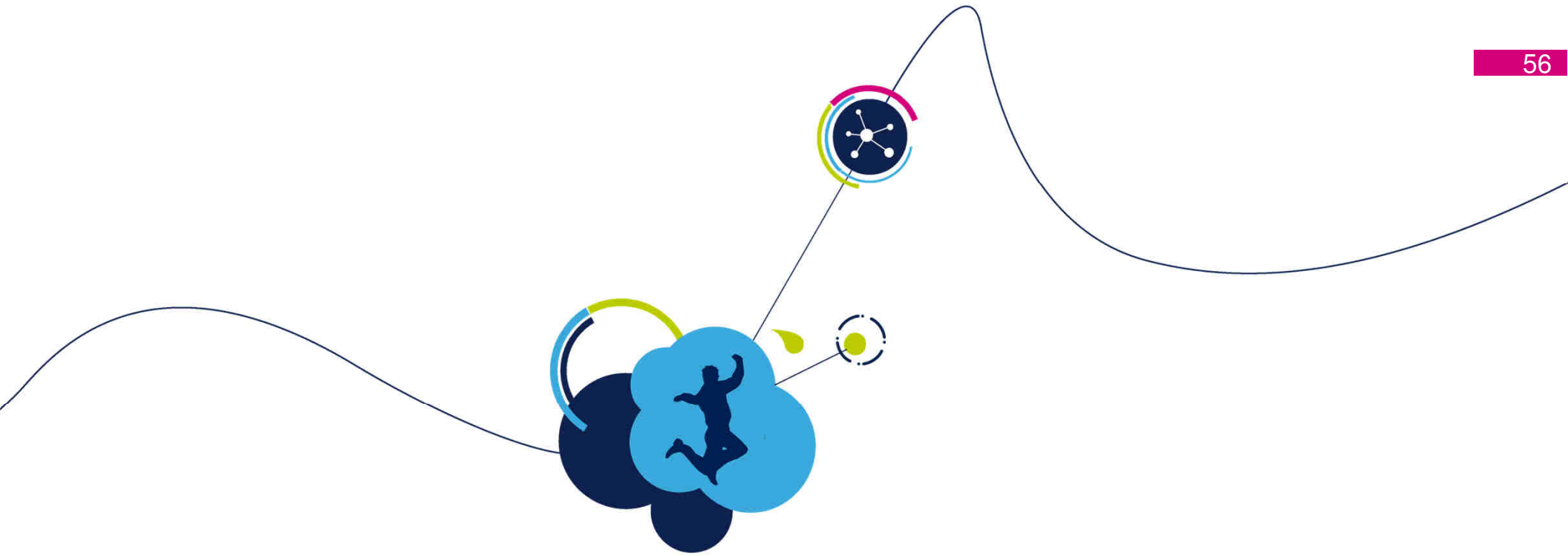
The ST LoRa development board and sensor is an advanced development kit optimized for engineers that are ready to prototype scalable solutions towards a complete IoT implementation.



<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

57

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

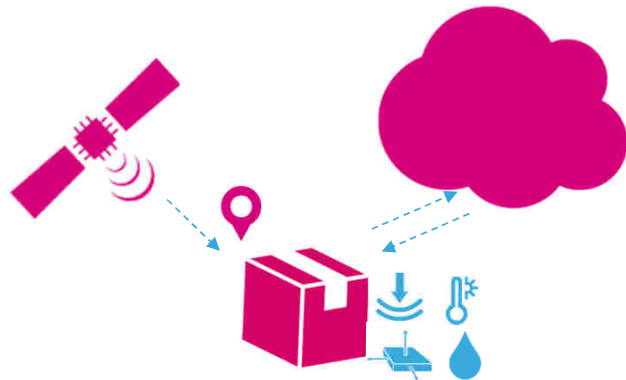
FP-ATR-LORA1

58



Key Features

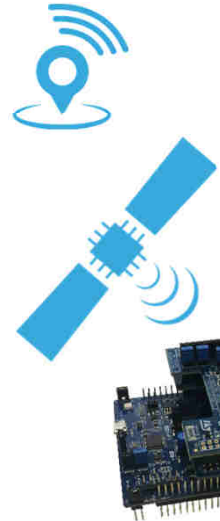
- Complete firmware to connect an IoT node to a LoRaWAN network, sending geo-position coming from GNSS and environmental and sensor data
- Library supporting LoRaWAN 1.0.2 class A and USB
- Teseo-LIV3F based GNSS positioning and Geofencing.
- LoRaWAN keys provisioning via USB
- Power/Battery Management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

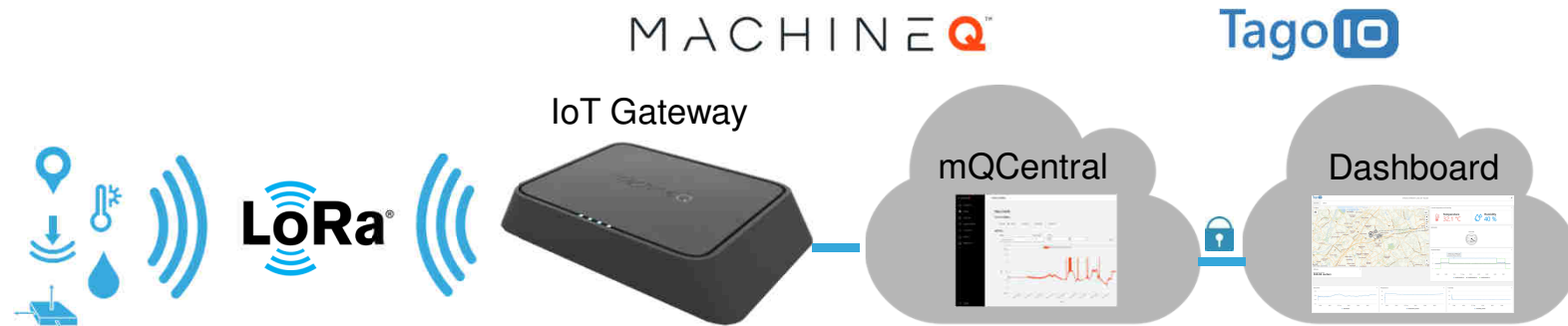


Published on www.st.com
Search for FP-ATR-LORA1



ST LoRa Asset Tracking Dev-Kit

59



<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



GPS



Galileo



GLONASS



Beidou2

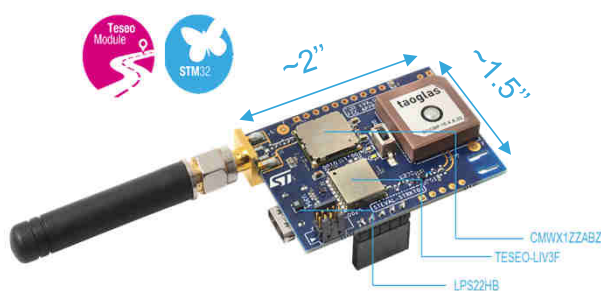


QZSS



ST LoRa Asset Tracking Ref Design

60

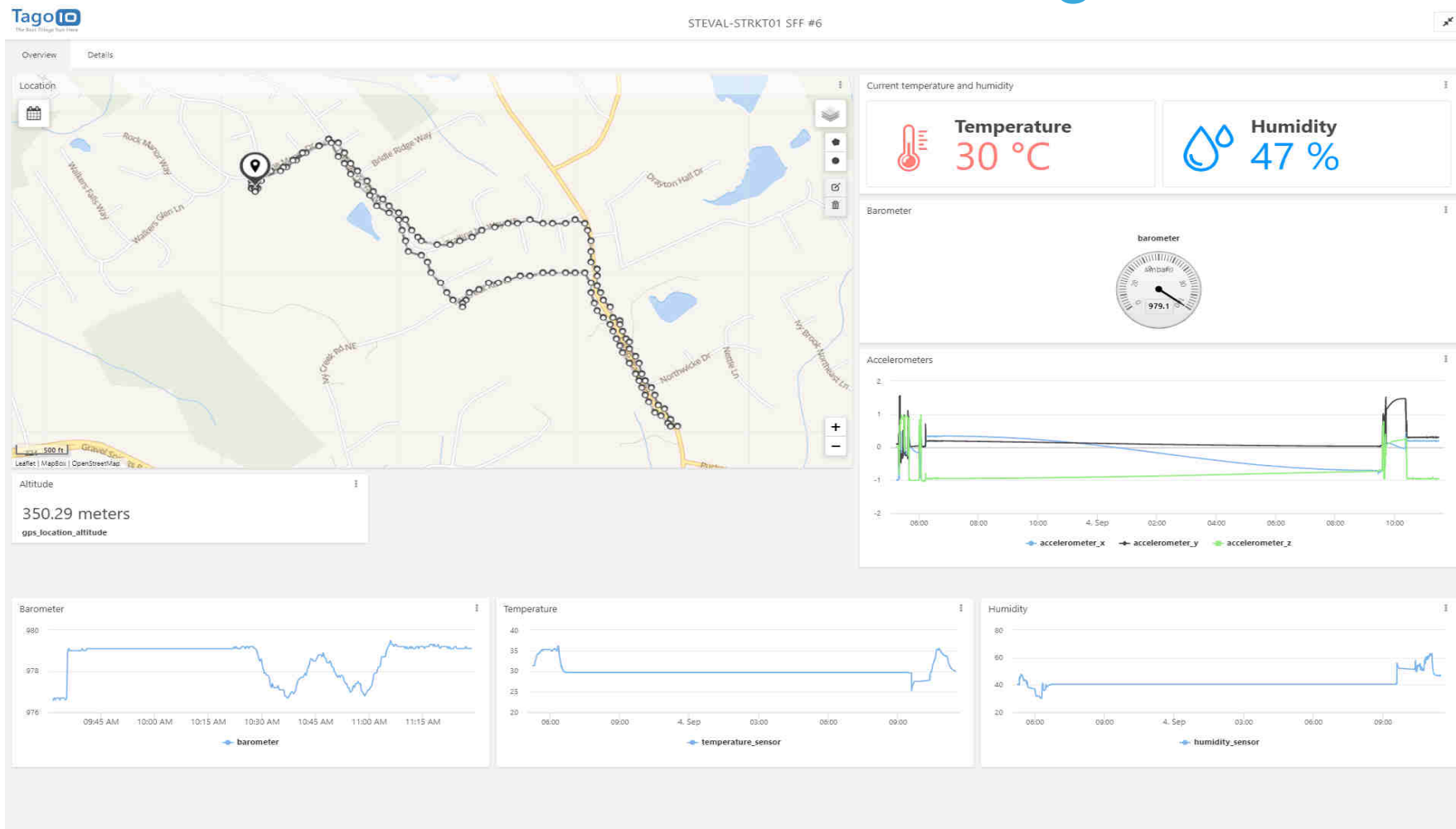


Published on www.st.com
Search for STEVAL-STRKT01



Asset Tracker Solution – Tago.io UI

61



Asset Tracking

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



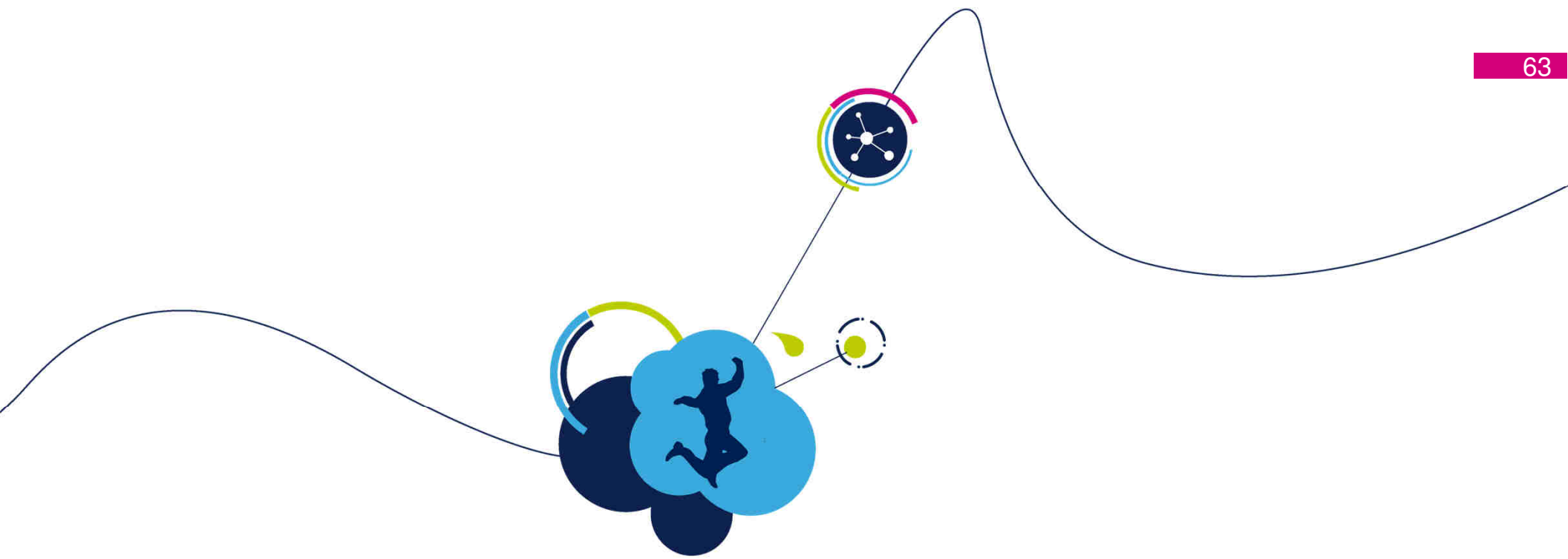


- **Getting it right the first time:
Accelerate your LoRa Implementation**
 - ST Webinar Sponsored by MachineQ & Murata
 - Occurred on **Jan 30th 2019**

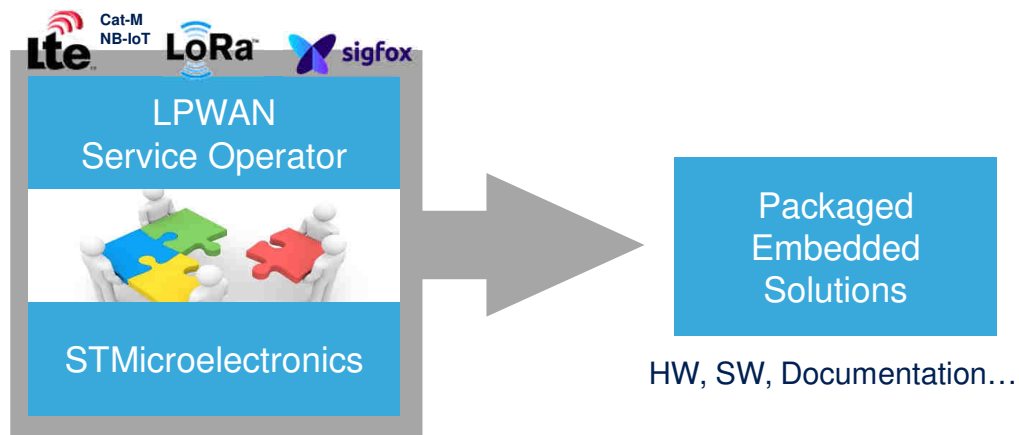


https://www.st.com/content/st_com/en/about/events/events.html/accelerate-your-lora-implementation-webinar.html

Video and Material available on line.

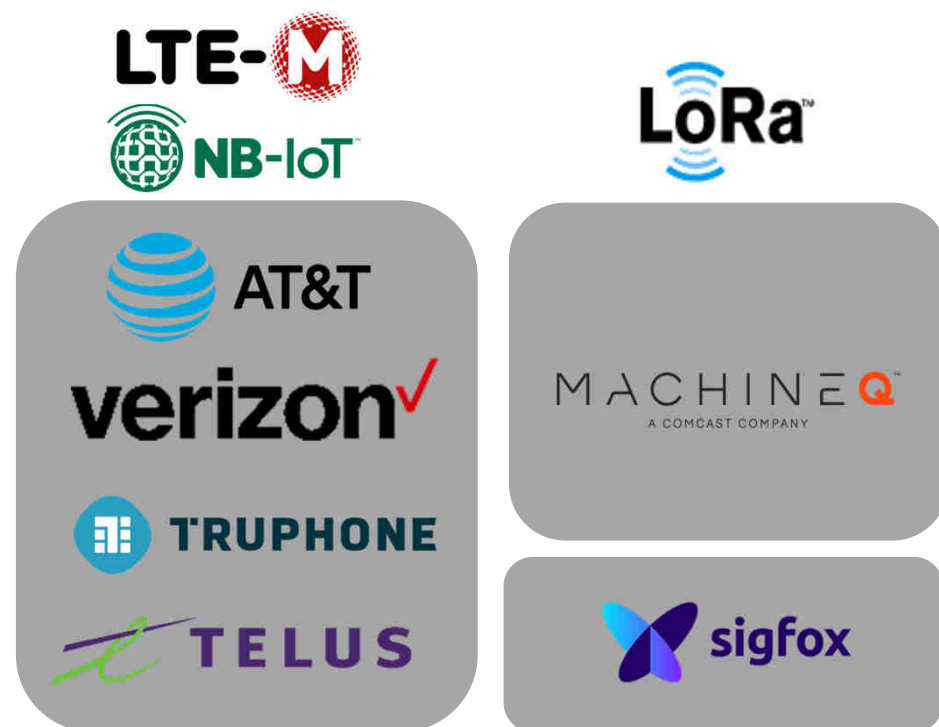


Wrap-Up

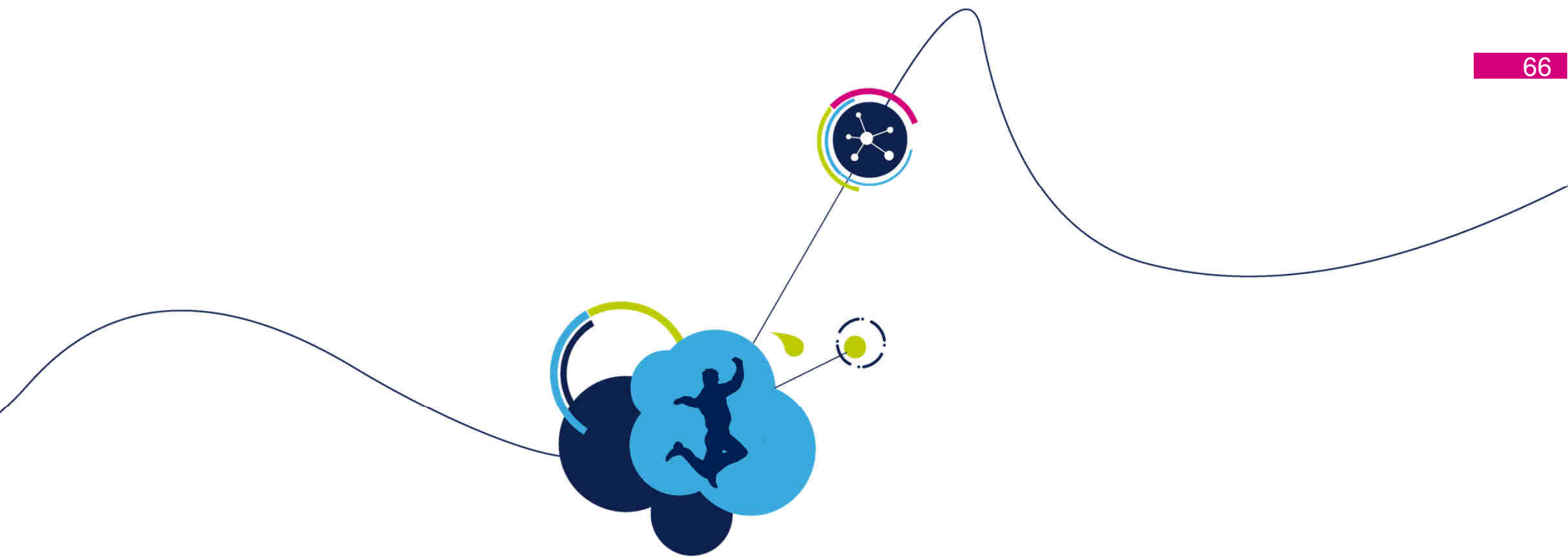


Come see the demos...

Contact: Marc.Hervieu@st.com







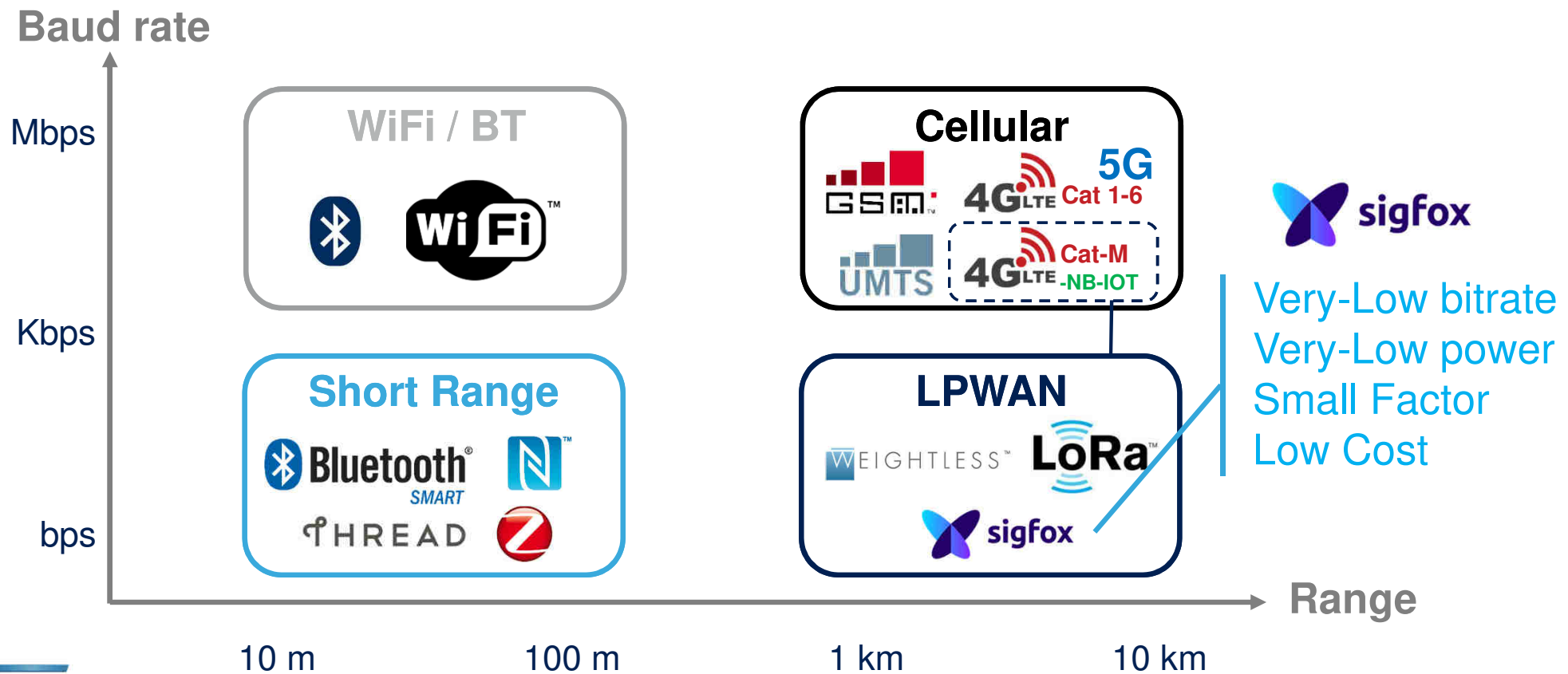
BACKUP



SigFox

Communication Technologies - Overview

68

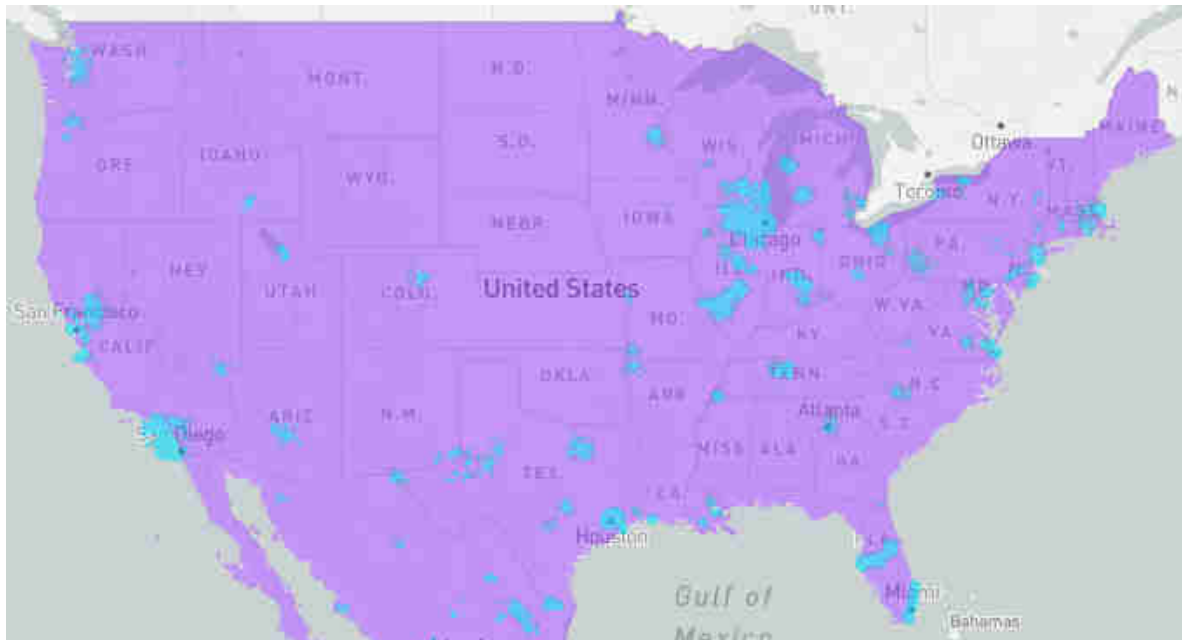




Sigfox USA Service

Feb 2019

69



- Use Cases

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

SIGFOX certified tools

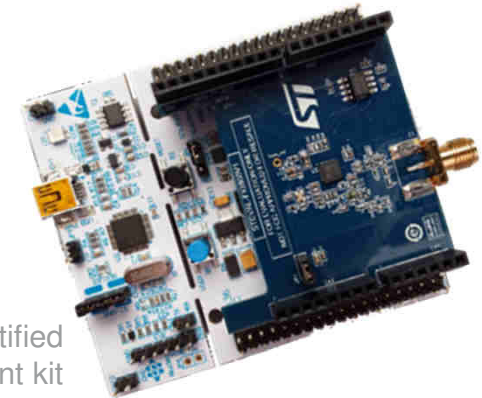
STEVAL-FKI868V1 / FK1915V1

70

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