LPWAN (LTE & LoRa®) IoT Solutions

Marc Hervieu
Marketing Manager
• 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 Market Overview
Communication Technologies - Overview

- **Baud rate**
  - Mbps
  - Kbps
  - bps

- **Range**
  - 10 m
  - 100 m
  - 1 km
  - 10 km

- **WiFi / BT**
  - Short Range
  - 2.4 GHz

- **Cellular**
  - Cellular
  - 850/1900 MHz
  - 900/1800 MHz

- **LPWAN**
  - LoRa™
  - Sub-GHz
  - 850/1900 MHz
  - 900/1800 MHz

- **Protocol**
  - Thread
  - BLE
  - Zigbee
  - USB

- **Technology**
  - Linux
  - Wi-Fi Direct

- **Network**
  - 802.11
  - Bluetooth
  - Zigbee
North America – LPWAN Market Trends

Applications driving LPWAN growth

- **LTE-M**
  - Asset Tracking
  - People / Pet Tracking
  - Home Auto.
  - Metering
  - Street Lighting

- **NB-IoT**
  - Asset Tracking
  - Metering
  - People / Pet Tracking

- **LoRa**
  - Agriculture
  - Asset Tracking
  - Home Monitoring
  - Metering

- **Sigfox**
  - Agriculture
  - Asset Tracking
  - Home Monitoring

Others
- Home Automation

Source: ABI research: LPWAN Market Data – Q2 2018
Communication Technologies - Overview

Emerging Technologies

- Long Range Low Power

- **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

<table>
<thead>
<tr>
<th>Coverage (BS Sensitivity)</th>
<th>sigfox: -142 dBm</th>
<th>LoRa: -138 dBm</th>
<th>LTE-M: -124 to -138 dBm</th>
<th>NB-IoT: -142 dBm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Consumption</td>
<td>Low</td>
<td>Medium(^4)</td>
<td>Optimized for rich traffic Models (several K Bytes/day)</td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td>AES128 No IP</td>
<td>AES128</td>
<td>eSIM</td>
<td>eSIM</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>0.1 - 0.6 kHz</td>
<td>0.3 - 50.0 kHz</td>
<td>10.0 - 100.0 kHz</td>
<td>0.2 - 10.0 kHz</td>
</tr>
<tr>
<td>2-Way</td>
<td>Device triggered</td>
<td>Class A only</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Data Rate</td>
<td>100 - 600 bps</td>
<td>11 Kbps</td>
<td>300 Kbps</td>
<td>50 Kbps</td>
</tr>
<tr>
<td>Daily Traffic per device</td>
<td>1.6 Kbyte</td>
<td>10 Kbytes</td>
<td>Several 100 Kbytes</td>
<td>Several 100 Kbytes</td>
</tr>
</tbody>
</table>
ST IoT & Operator Strategy
Supporting IoT Movement

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

>17 Billion ST MEMS
WW Top #1 #2

Industrial WW Top #3

>3 Billion ST MCU
WW Top #2

>60,000 Customers

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

Debug solutions
Simulation and analysis tools
On-line design tools
STM32 portfolio positioning

Largest Market Offering with ~1000 STM32 Part Numbers

<table>
<thead>
<tr>
<th>High-performance</th>
<th>Mainstream</th>
<th>Ultra-low-power</th>
<th>Wireless</th>
</tr>
</thead>
<tbody>
<tr>
<td>STM32 F2</td>
<td>STM32 F1</td>
<td>STM32 L0</td>
<td>Cortex-M0</td>
</tr>
<tr>
<td>STM32 F4</td>
<td>STM32 F3</td>
<td>STM32 L1</td>
<td>Cortex-M0+</td>
</tr>
<tr>
<td>STM32 F7</td>
<td>STM32 F7</td>
<td>STM32 L5</td>
<td>Cortex-M3</td>
</tr>
<tr>
<td>STM32 F7</td>
<td>STM32 F7</td>
<td>STM32 L4</td>
<td>Cortex-M33</td>
</tr>
<tr>
<td>STM32 N7</td>
<td>STM32 N7</td>
<td>STM32 L4+</td>
<td>Cortex-M4</td>
</tr>
<tr>
<td>STM32 MP1</td>
<td></td>
<td></td>
<td>Cortex-M7</td>
</tr>
</tbody>
</table>

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

More than 60,000 customers
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

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

- **WiFi / BT**: Short Range
  - Mbps
  - Kbps
  - Bps
  - 10 m
  - 100 m

- **Cellular**
  - GSM
  - LTE
  - 5G
  - UMTS
  - LTE-M
  - NB-IoT
  - No Gateway
  - Low power
  - Low Cost
  - Coverage
  - Mobility

- **LPWAN**
  - Weightless
  - LoRa
  - Sigfox
  - 1 km
  - 10 km

**Legend**

- **Baud rate**
- **Range**
VERIZON LTE Starter Kit
Targets IoT Embedded Developers

IoT Enabler
Sensor to Cloud
Simply Cellular
IoT STM32 LTE Starter Kit

- ST LTE Modem
- X-Nucleo Expansion Board
- STM32L4 Discovery Kit IoT Node

Features:
- Accelerometer
- Gyroscope
- Magnetometer
- Humidity
- Temperature
- Pressure
- Time of Flight
- Proximity Sensor
- 2x MEMS Microphone
- Bluetooth Low Energy
- Sub GHz
- LTE Cat-M
- NB-IoT
- NFC
STM32L475 Discovery Kit IoT Node

- **B-L475E-IOT01A**

- **Components:**
  - Wi-Fi
  - USB OTG
  - ARDUINO
  - LED
  - ST LINK
  - User Button
  - Reset Button
  - NFC/EEPROM
  - Time of Flight Proximity Sensor
  - Humidity Temperature
  - Accelerometer Gyroscope
  - Pressure
  - Sub GHz
  - STM32L4
  - MEMS Microphone
  - Bluetooth ® Low Energy
  - Magnetometer
  - MEMS Microphone

- **Features:**
  - IoT Node
  - STM32L475
  - Multiple Sensing Capabilities
  - Development Board for IoT Applications
STMod+ Connector Board & Modem

ST Mod+ Connector
20 Pins

ARDUINO

Quectel
BG96
Multi-band
LTE Cat-M
NB-IoT

ST LTE Modem
B-CELL-LTENB1

Note: Jumpers set by default for
Discovery IoT Kit Node
Key Links & Resources

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

B-L475E-IOT01A


X-NUCLEO-STMODA1


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

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

Application Example
Http Client, Ping, Config Menu, Console Commands

ST Cellular Driver Middleware
- Simplify Application (BSD API, generate AT Cmd)
- More Robust (Communication, Error Mgt)
- Cellular Certification features

ST Driver / STM32CubeMx

STM32L4 Discovery Kit IoT Node

Modem Production FW

ST LTE Modem

FreeRTOS

AT Commands
UART

X-Nucleo Expansion Board

www.st.com/x-cube-cellular
STM32 LTE Starter Kit
x-cube-cellular

Web Browser

LTE IoT DK Dashboard

Accelerometer

Current Environmental Sensors

Current Environmental Sensors

LDE on board

LTE Cat-M Signal Strength (dBm)
Amazon FreeRTOS

ST Cellular Driver Middleware
- Simplify Application (BSD API, generate AT Cmd)
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STM32L4 Discovery Kit IoT Node

Application Example
AWS SDK: MQTT Client (Sensors…)

Modem Production FW

ST Driver / STM32CubeMx

AT Commands
UART

X-Nucleo Expansion Board

ST LTE Modem
Microsoft Solution Azure IoT Central

Application Example
Azure SDK: MQTT client, TLS

ST Cellular Driver Middleware
- Simplify Application (BSD API, generate AT Cmd)
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ST Driver / STM32CubeMx

STM32L4 Discovery Kit IoT Node

AT Commands
UART

X-Nucleo Expansion Board

Modem Production FW

ST LTE Modem
Microsoft Azure IoT Central Experience

STM32 LTE Starter Kit

Web Browser
Azure IoT Central Dashboard
STM32 Verizon – How to Get Access

- Verizon ThingSpace Cloud connectors: 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:
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

1GB
$20/year
$1/device/month

- 1GB data/year
- Share up to 20 Verizon certified devices
- 1200 SMS per year per line of service
- Automatically renew (you can opt out at any time)

Subscribe

10MB
$5/year
$1/device/month

- 10MB data/year
- Share up to 20 Verizon certified devices
- 1200 SMS per year per line of service
- Automatically renew (you can opt out at any time)

Subscribe

https://thingspaceportal.verizon.com/ccapp/#/home
STM32 – Software Resources

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

IoT Enabler
Sensor to Cloud
Simply Cellular
LTE-M
NB-IoT capable

TRUPHONE
STMicroelectronics
SEQUANS
IoT STM32 LTE Starter Kit

- ST LTE Modem
- ST SIM-Card
- X-Nucleo Expansion Board
- STM32L4 Discovery Kit IoT Node

- 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**

*Data brief, User Guide, Schematics, Gerber, Manufacturing, Technical Notes…*

**B-L475E-IOT01A**


**X-NUCLEO-STMODA1**


**B-CELL-GM01Q**


**TG.08.0113**

Application Example
Http Client, Ping, Config Menu, Console Commands

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ST Driver / STM32CubeMx

STM32L4 Discovery Kit IoT Node

AT Commands
UART

X-Nucleo Expansion Board

Modem Production FW

ST LTE Modem

www.st.com/x-cube-cellular
IoT STM32 LTE Starter Kit

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- Sub GHz
- LTE Cat-M
- NB-IoT

STM32L4 Discovery Kit IoT Node

Avnet – Modem Board

STM32L4

WNC

AT&T

LTE-M

LTE-1
STM32 AT&T – How to Get Access

• AT&T market place
  • Solution: $139, 150 MB / 6 Months Per Device included, 90 Days

• Avnet resources
  http://cloudconnectkits.org/product/att-stm32-iot-starter-kit
**LTE-M IoT Starter Kit Breakdown**

- **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

*Suggested Resale: $139 USD*

* Also includes LTE-M and GPS antennas from Taoglas
Telus Solution

https://www.telus.com/lpwa

http://cloudconnectkits.org/product/telus-lte-m-iot-starter-kit

- Cost – $139 USD
- Data Plan – 150 MB / 6 Months
ST IoT LPWAN LoRa
Communication Technologies - Overview

Baud rate

- Mbps
- Kbps
- bps

Range

- 10 m
- 100 m
- 1 km
- 10 km

WiFi / BT

Cellular
  - GSM
  - UMTS
  - LTE
  - 5G
  - LTE-M
  - NB-IoT

Short Range

LPWAN
  - LoRa
  - Weightless

LoRa

Low bitrate
Low power
Small Factor
Low Cost
Key Verticals

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

...
LoRaWAN™ NETWORKS

83
Network Operators

56
Alliance Member Operators

Operating in 49 Countries

~100 Countries With LoRaWAN Deployments
• 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

https://MachineQ.com/st-lora-dev-kit/
ST LoRa Dev Kit Hardware

base board B-L072Z-LRWAN1

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

Murata® Module
All-in-one Open

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

3D Accel. + 3D Gyro. (LSM6DSL)
3D Accel. + 3D Magno. (LSM303AGR)
Pressure (LPS22HB)
Temperature + Humidity (HTS221)

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

Published on www.st.com
Search for STEVAL-MK*
ST LoRa Dev Kit Firmware

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

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

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

http://www2.keil.com/stmicroelectronics-stm32/mdk
ST LoRa Dev-Kit Deal

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

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

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

Published on www.st.com
Search for FP-ATR-LORA1
ST LoRa Asset Tracking Dev-Kit

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
ST LoRa Asset Tracking Ref Design

Published on www.st.com
Search for STEVAL-STRKT01
Asset Tracker Solution – Tago.io UI

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
Wrap-Up

Come see the demos…

Contact: Marc.Hervieu@st.com
Thank you!
BACKUP
SigFox

ST
life augmented
Communication Technologies - Overview

Baud rate

Mbps

Kbps

bps

Range

10 m 100 m 1 km 10 km

WiFi / BT

Cellular

Short Range

LPWAN

Very-Low bitrate

Very-Low power

Small Factor

Low Cost

WiFi

4G LTE

Cat 1-6

5G

GSM

UMTS

4G LTE-NB-IOT

Cat-M

LoRa

sigfox

Weightless

Thread

Bluetooth

BT

Bluetooth

スマート

Microchip

sigfox

Very-Low bitrate

Very-Low power

Small Factor

Low Cost

89
• Use Cases
  • Asset Tracking / Monitoring
  • Predictive Maintenance
  • Regulatory Compliance
  • Operational Efficiency
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.