



life.augmented

A night-time photograph of a city skyline, likely Singapore, with a river and bridges. Overlaid on the image is a network diagram with glowing blue nodes and white connecting lines, symbolizing connectivity.

Connectivity Case Studies

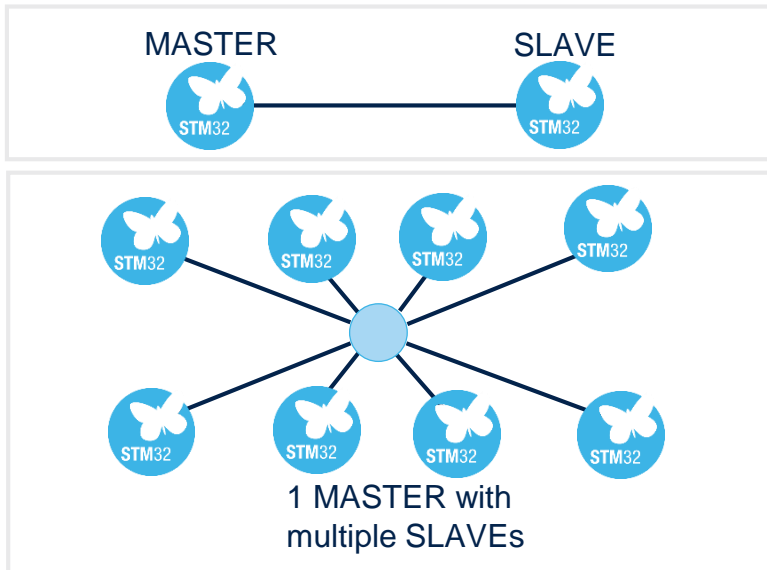


life.augmented

Bluetooth Mesh

Bluetooth Low Energy networking

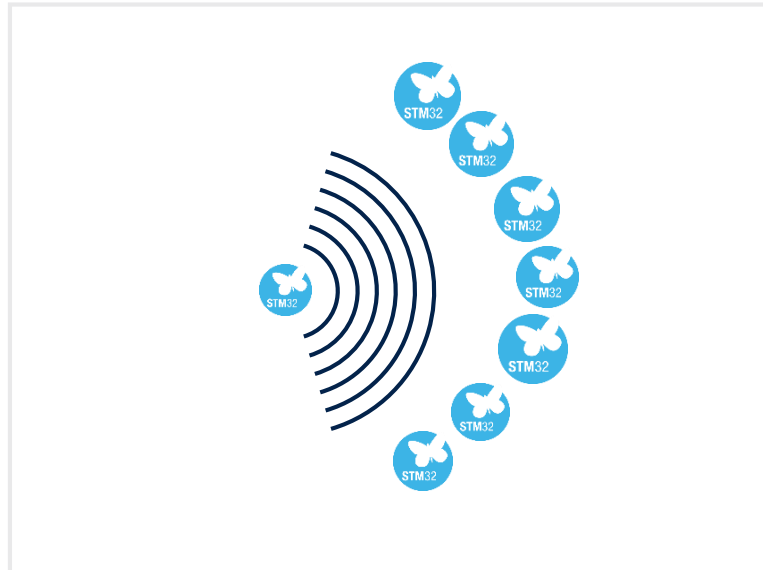
PAIRING one-to-one



DATA TRANSFER

- Sports & fitness devices
- Health and wellness devices
- Peripherals and accessories

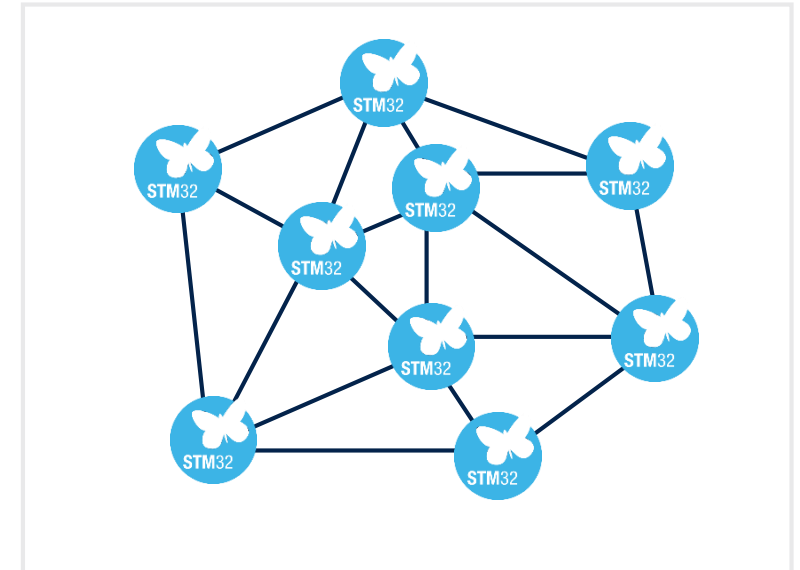
BROADCASTING one-to-many



LOCALIZED INFORMATION

- Point of interest beacons
- Item finding beacons
- Way finding beacons

MESH Many-to-many

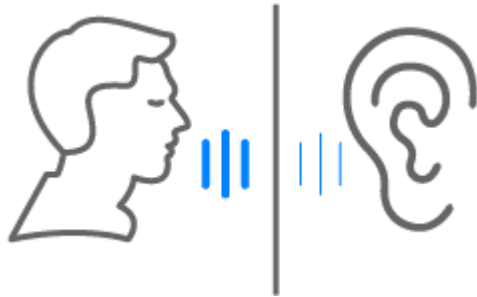


LARGE DEVICE NETWORKS

- Building automation
- Wireless sensor networks
- Indoor navigation & tracking

Range Limitation

Why do we need Mesh communication?



Path loss

Reduction in signal strength

Occurs naturally over distance

Obstacles between the transmitter and the receiver

Made of glass, wood, metal, or concrete, including metal towers or panels that reflect and scatter radio waves.

Radio spectrum:

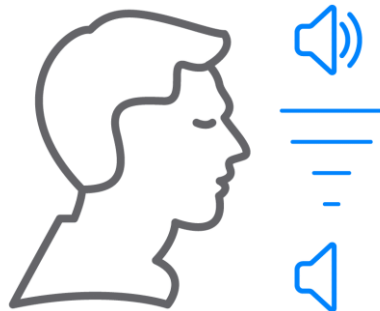
Lower the frequency the longer the range

However, the lower the frequency the lower the data rate it can support

Bluetooth Spectrum Band

2.4 GHz ISM

(2400 to 2483.5 MHz)



Transmit power level

Increase in power consumption

Transmit powers from -20 dBm (0.01 mW) to +20 dBm (100 mW).

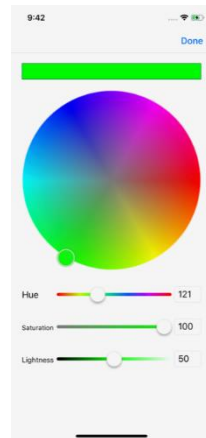
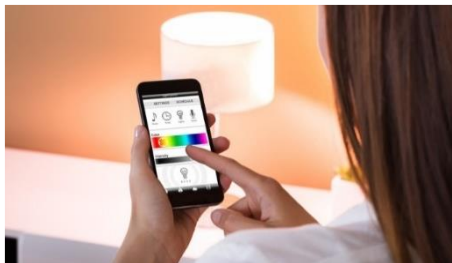
Bluetooth Mesh applications

Bluetooth SIG MESH extends the capabilities of Bluetooth smart chips to answer more **complex application needs in smart lighting**

- Lighting



- ST's STM32WB Cube Firmware package contains a Lighting demonstration: Lighting Model and Vendor Model
- Cool-Warm lighting control
- Light Color, Hue, Saturation control



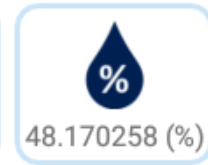
- Smart Home and Building automation
 - Heater/Fan control over generic On/Off model
 - Temperature / Shutter control over Sensor & generic On/Off models
- Wireless sensor networks
 - Demo included in STM32WB Cube Firmware package



25.02 (°C)



999.09 (bar)

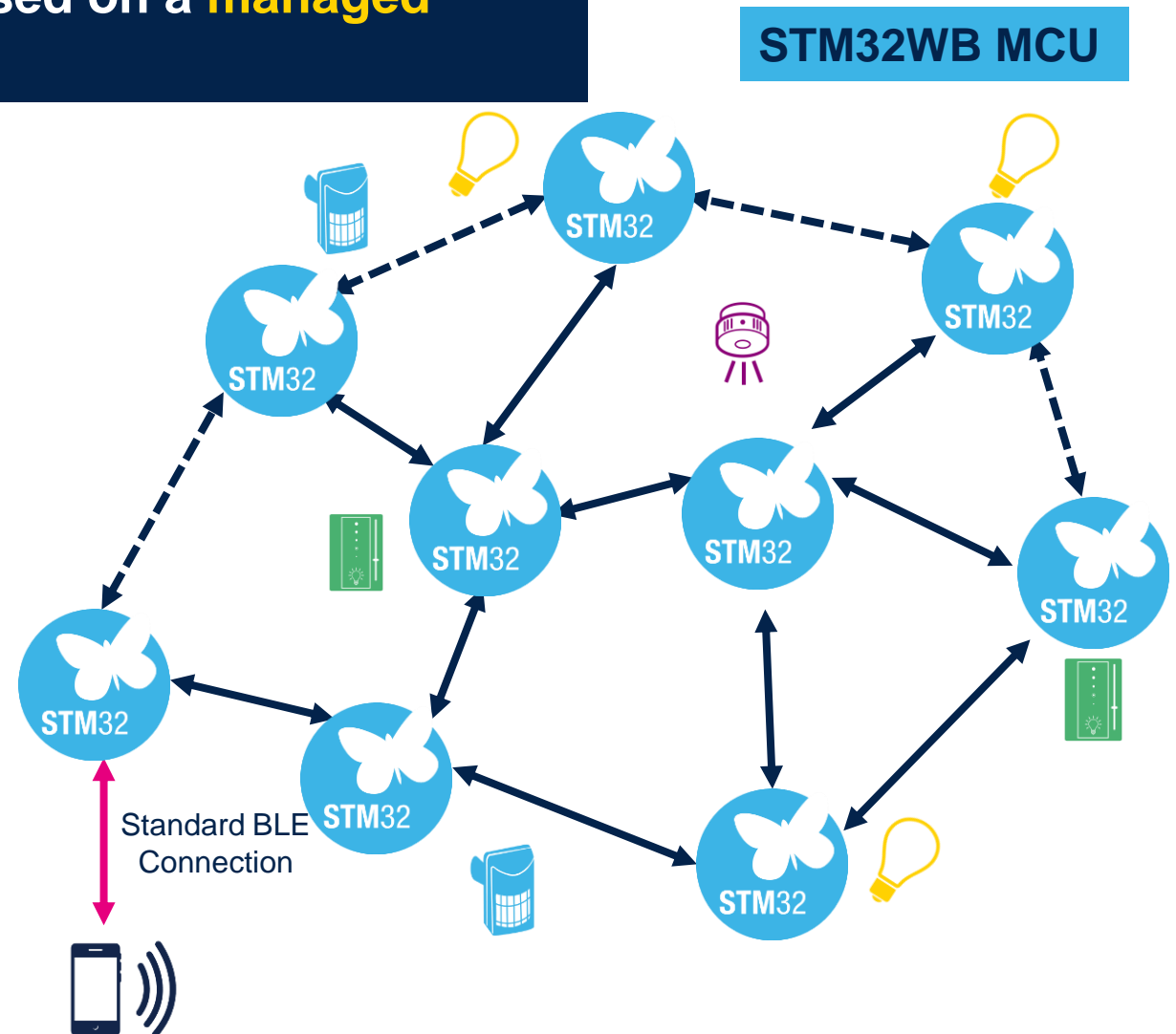


48.170258 (%)

Bluetooth Mesh topology managed flooding

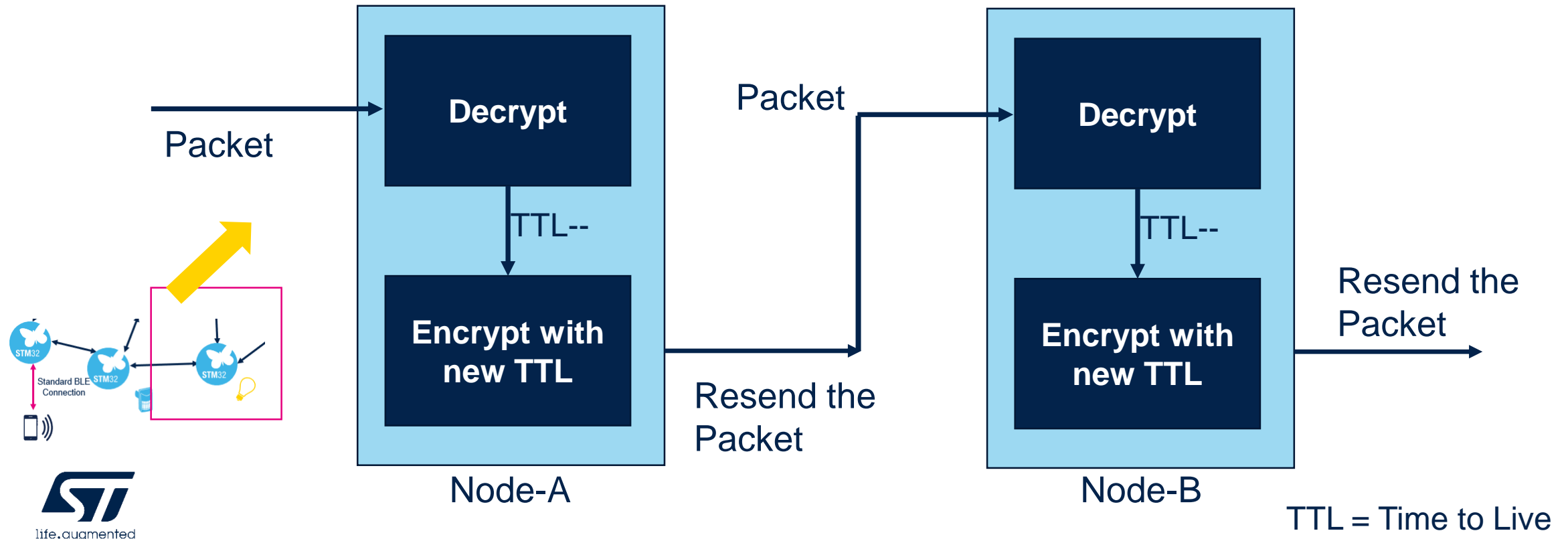
The Bluetooth Mesh network mechanism is based on a **managed flooding protocol**.

- Messages are relayed to extend the range of communication (Multi-hop data transmission)
- No single point of failure: self healing
- Direct communication between adjacent nodes
- Messages contain a Sequence Number to optimize the network usage and protect against replay attacks.
 - Reject already received messages.
- TTL (Time To Live) method:
 - Limit the number of times a message is relayed



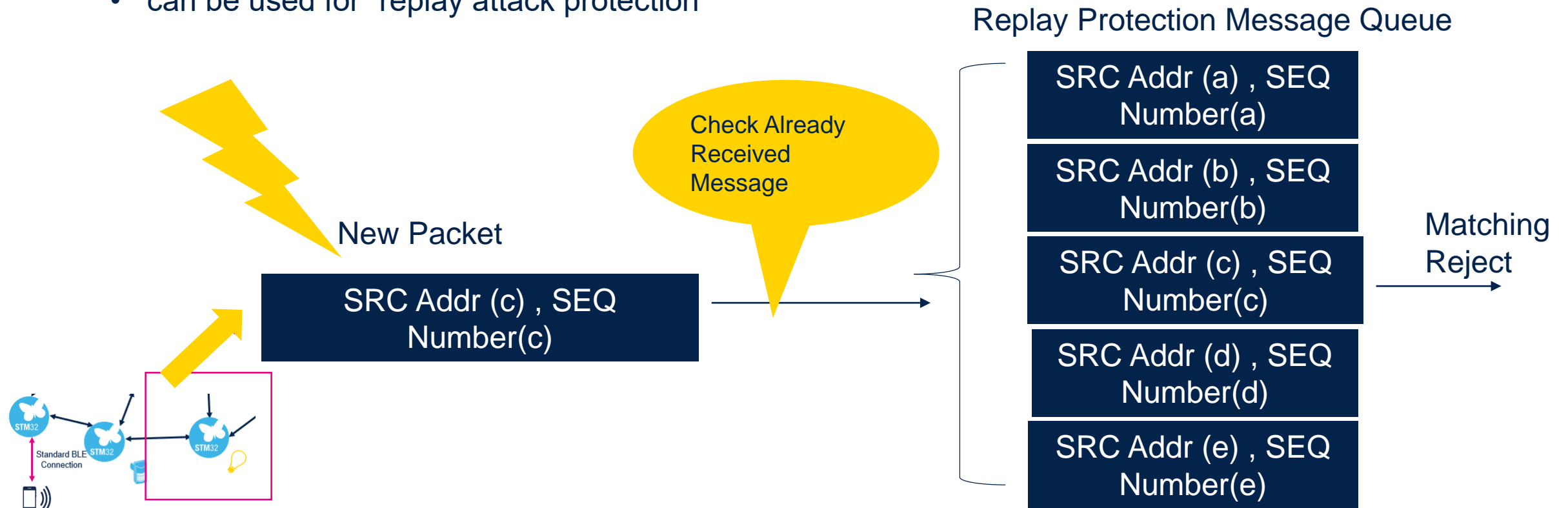
“Managed flooding” using TTL

- Time To Live (TTL): message processing for managed flooding for relayed packets
- Whole packet is decrypted at Network Layer => Decrement the TTL => Encrypt again and send



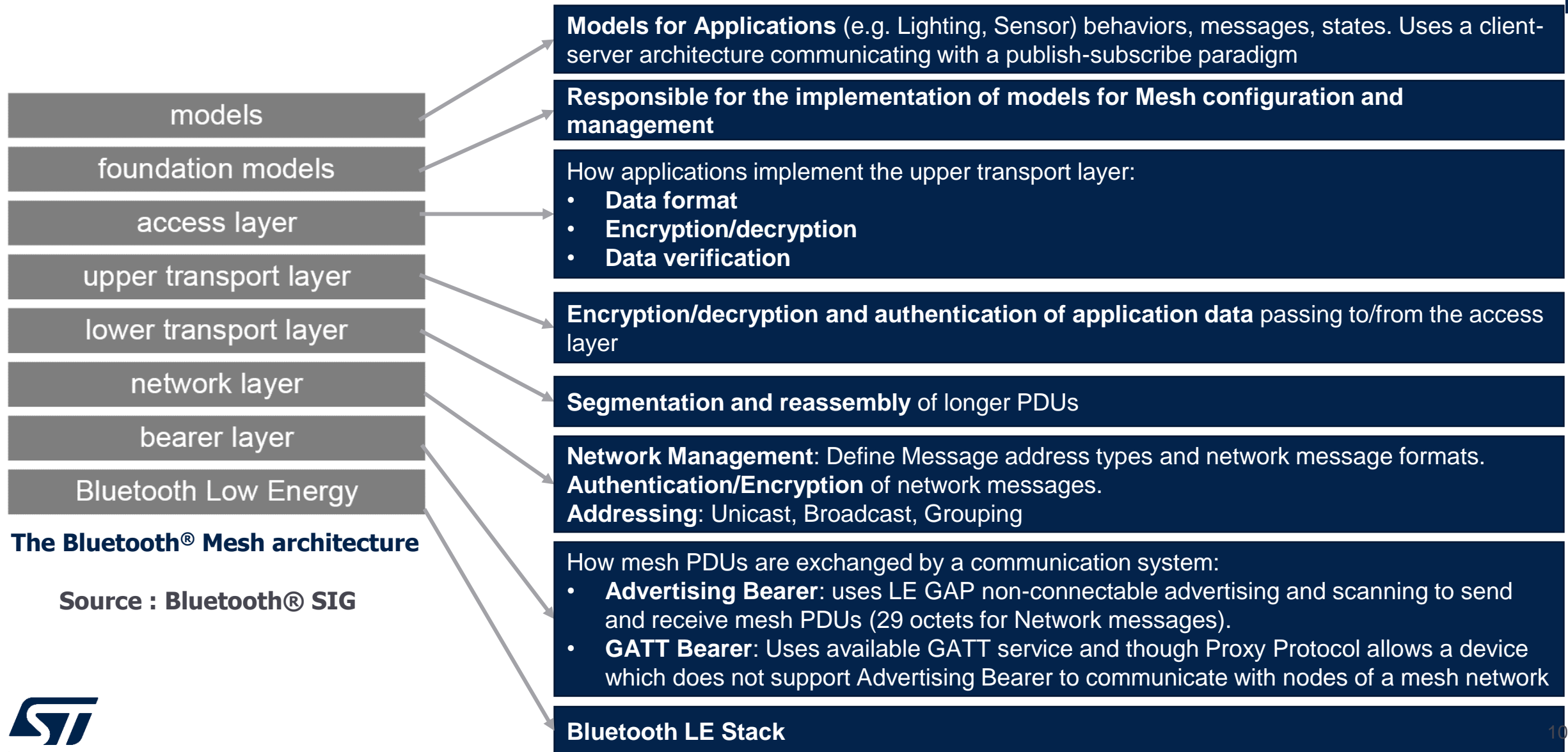
“Managed flooding” using sequence numbers

- SEQ – Sequence Number
 - Messages have a unique 24-bit Sequence Number
 - Together with SRC (Source address of the Message), uniquely identifies the message
 - can be used for “replay attack protection”



Architecture & Security

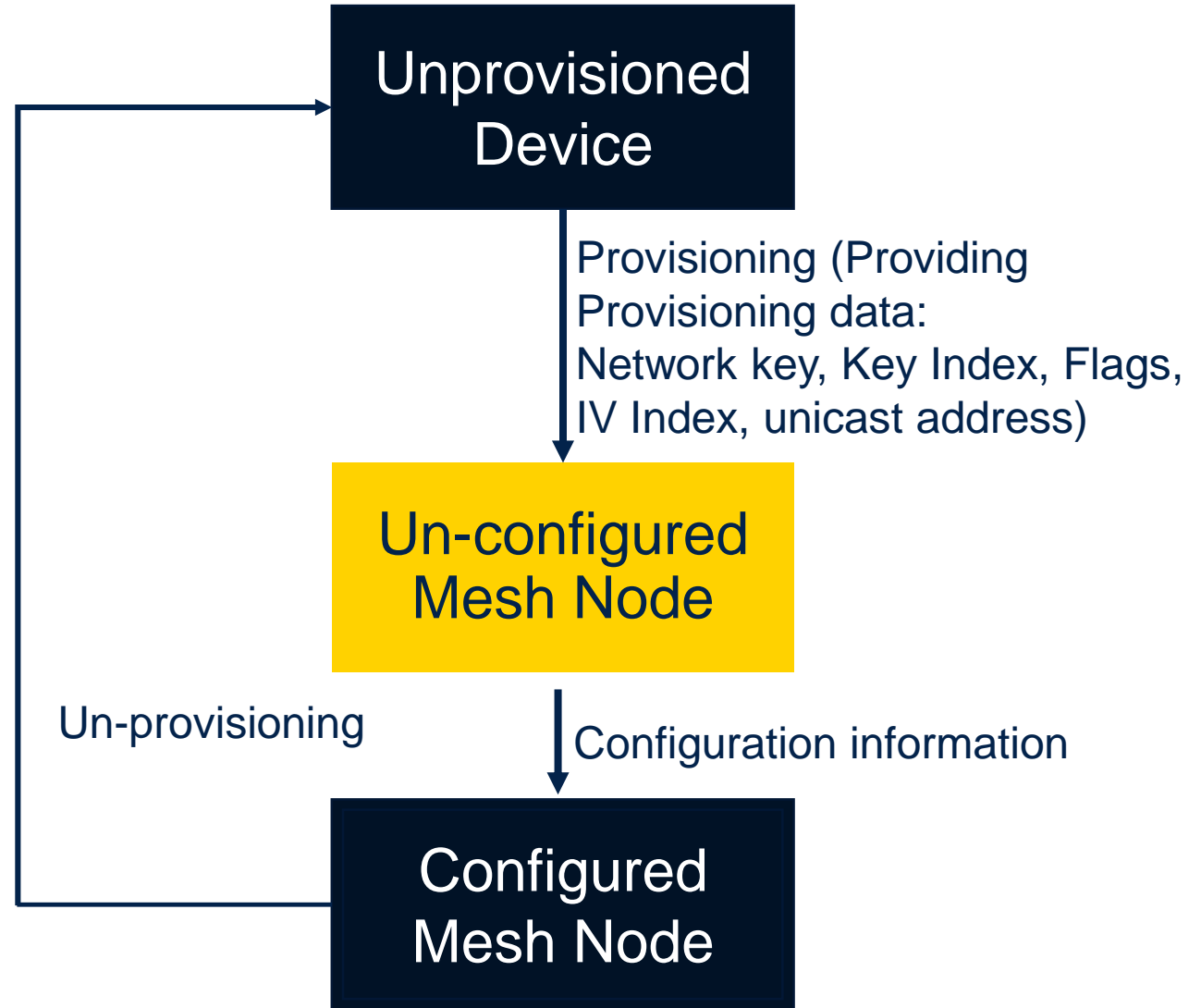
Bluetooth Mesh system architecture



Creating Mesh Network

Provisioning and configuring mesh nodes

- Provisioning is the process of adding an un-provisioned device to a mesh network
- Managed by a Provisioner
- The provisioner is typically a smartphone or other mobile computing device
- Device can be identified from a Provisioner by its Device UUID



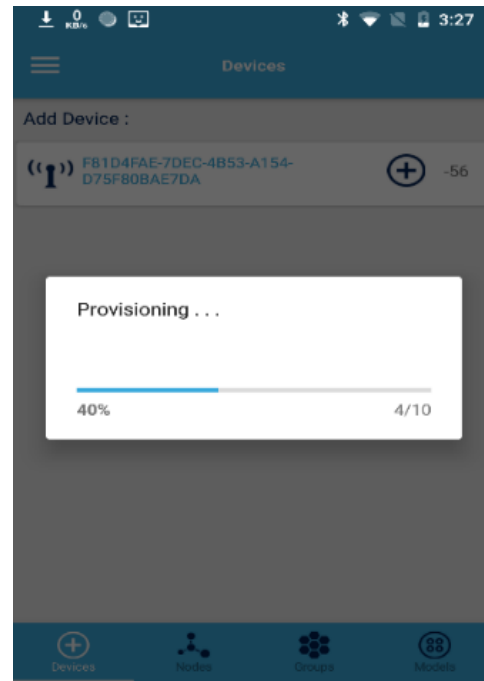
Provisioning of the nodes

Provisioning

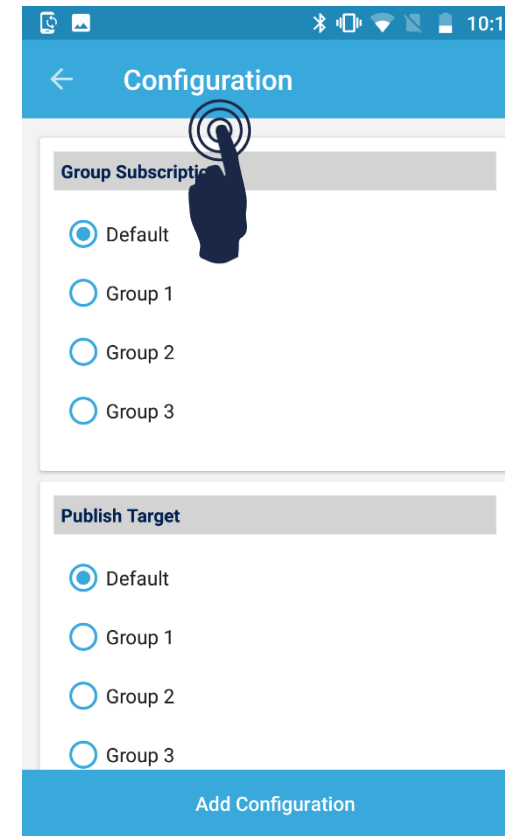


Before the provisioning the ones listed are called “**devices**”

Progress bar

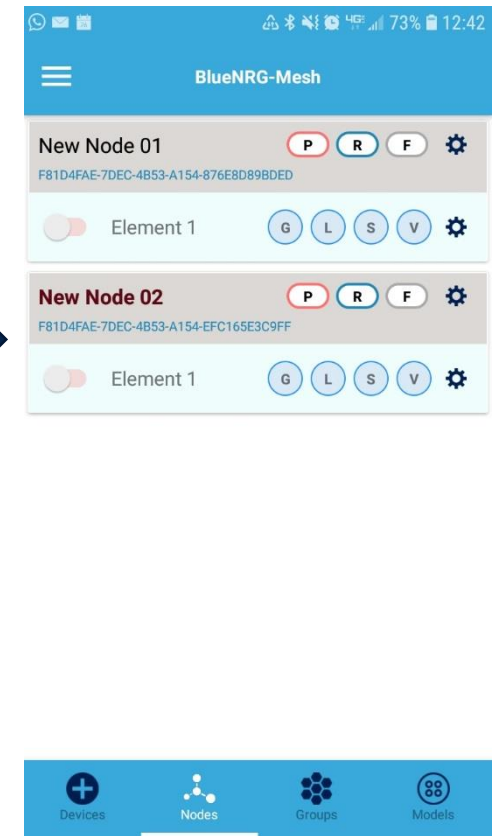


Address configuration

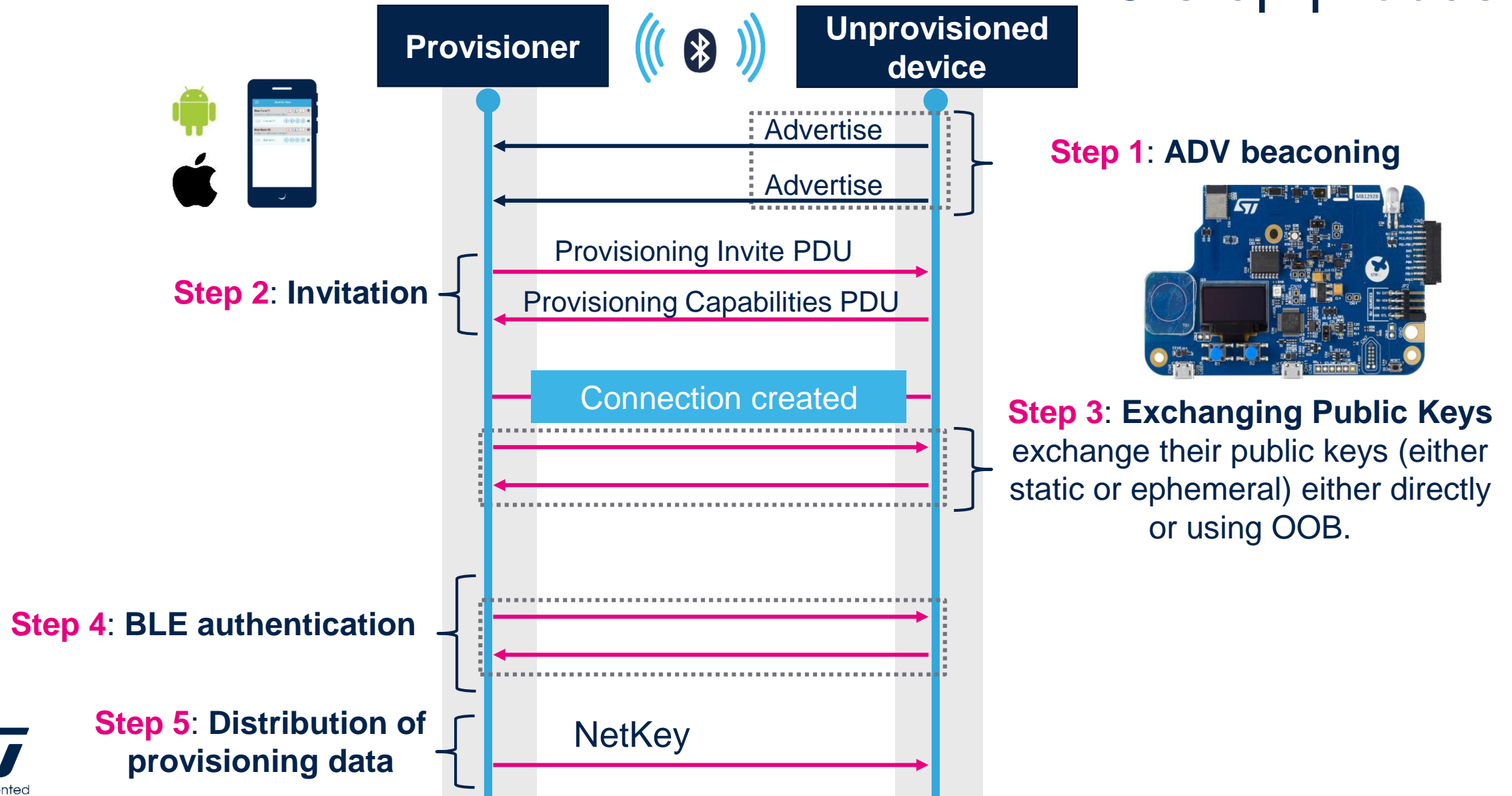


The Node can be added to a specific group of elements

List of provisioned nodes



Provisioning 5-step process





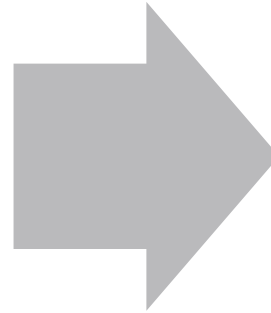
Built-in Security

Unconfigured device

Provisioning

- Set a **unique address** for the device
- 256-bit ECDH* algorithm (public/private keys)
- Exchange several **security keys**

Device added
to the
network



Configured node

Mesh communications

- Multiple layers security thanks to the network/application keys
- Encryption with 128-bit AES-CCM ** ***
- **Privacy though obfuscation**
- **Protection from multiple types of attack:**
 - Replay attack
 - Bit-Flipping attack
 - Eaves Dropping attack
 - Man-in-the-middle attack
 - Trashcan attack

* ECDH - Elliptic Curve Diffie-Hellman

** AES - Advanced Encryption Standard

*** CCM - Counter with CBC-MAC

Bluetooth Mesh Keys

Device Key: never transmitted over air

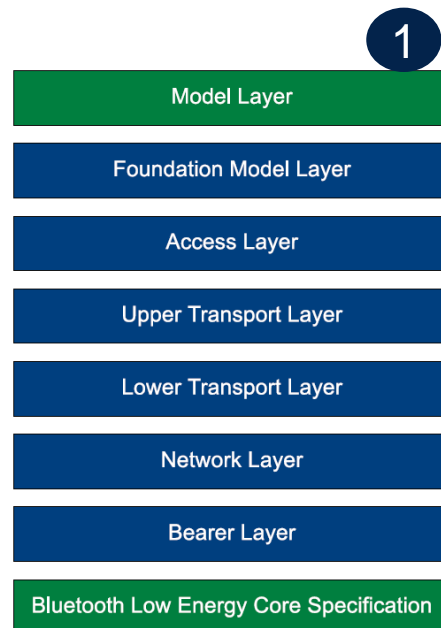
Unique key for each single device, only known by the Provisioner (i.e. smartphone) and the device, used for provisioning, configuration and key management. Calculated using the shared secret derived from the ECDH (Elliptic Curve Diffie-Hellman) key agreement between the Provisioner and the device being provisioned.



Device key



Provisioning
ECDH key
agreement



Application Key: provided by Provisioner

Used to encrypt/decrypt message payload

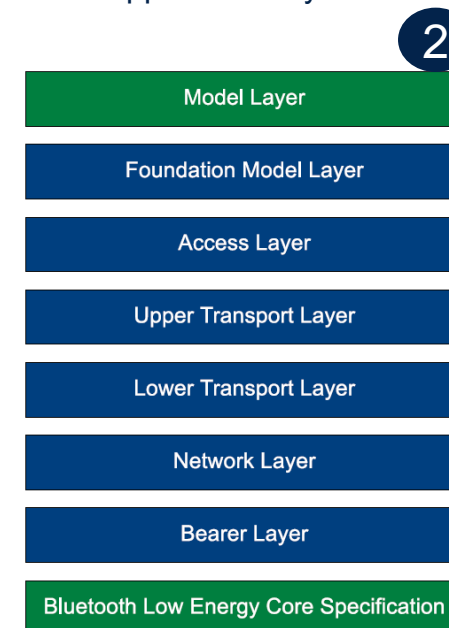
A network may run multiple applications: lights, sensors and switches may co-exist

Different applications have a different "Application key"

Application Key



Network Key



Network Key: provided by Provisioner

Network Key (NetKey) secures the communication at Network Layer

Shared across all the nodes in the network, i.e. the possession of a given NetKey is what defines the membership of a given mesh network.

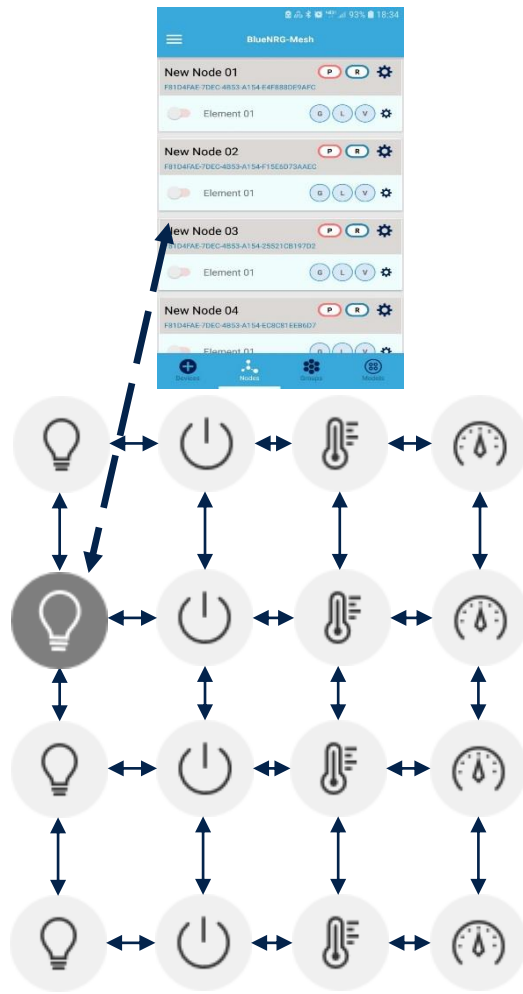
NetKey allows a node to decrypt message header, authenticate up to the Network Layer and to relay messages through a network

Note:

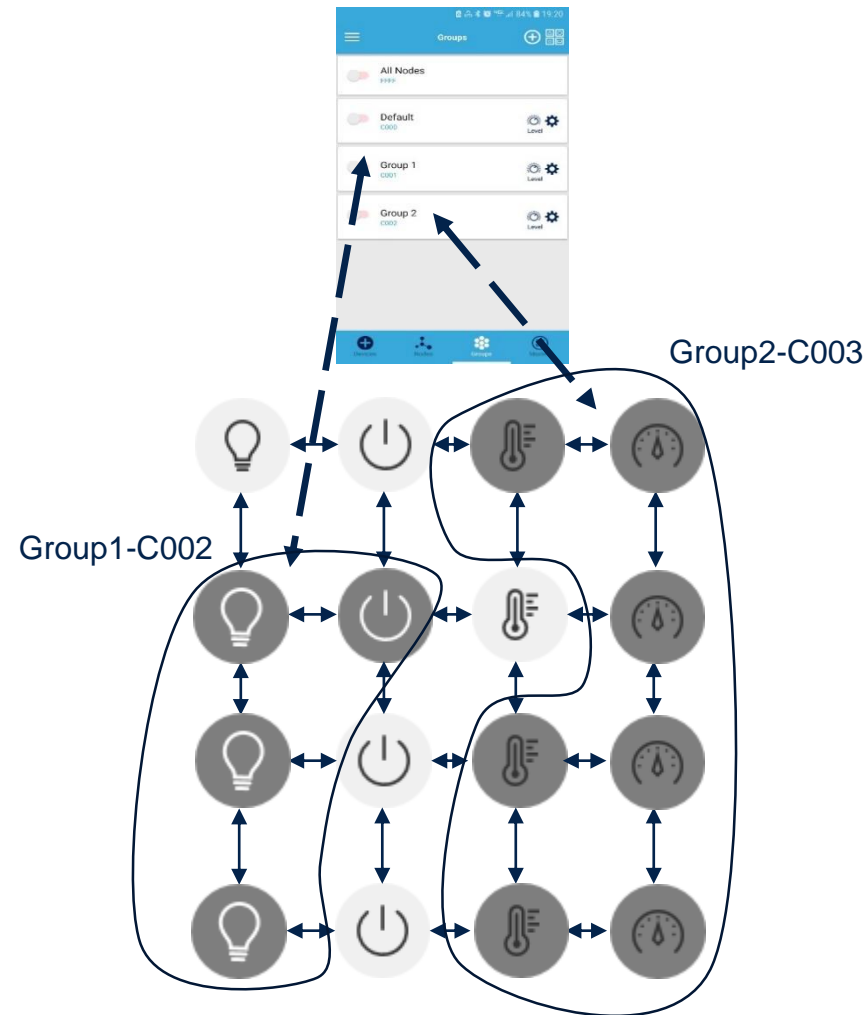
- ECDH: (Elliptic Curve Diffie-Hellman) key agreement

Addressing, Node Types

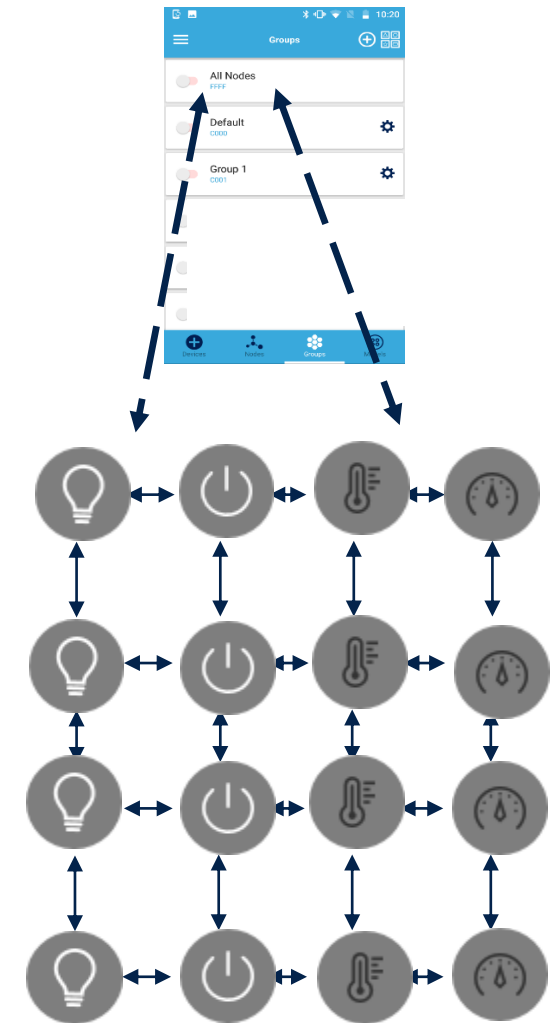
Mesh addresses



Unicast Address



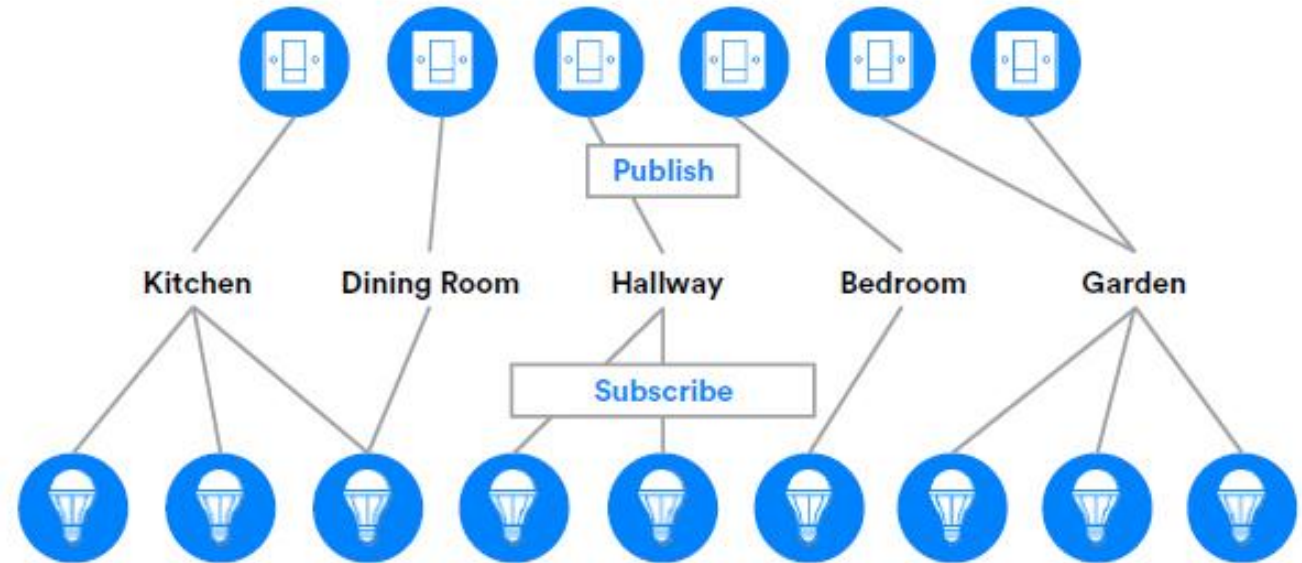
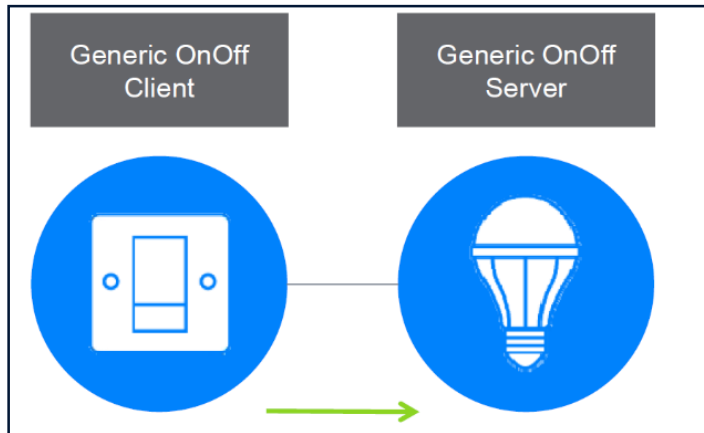
Group Address



Broadcast

Mesh Messaging Model

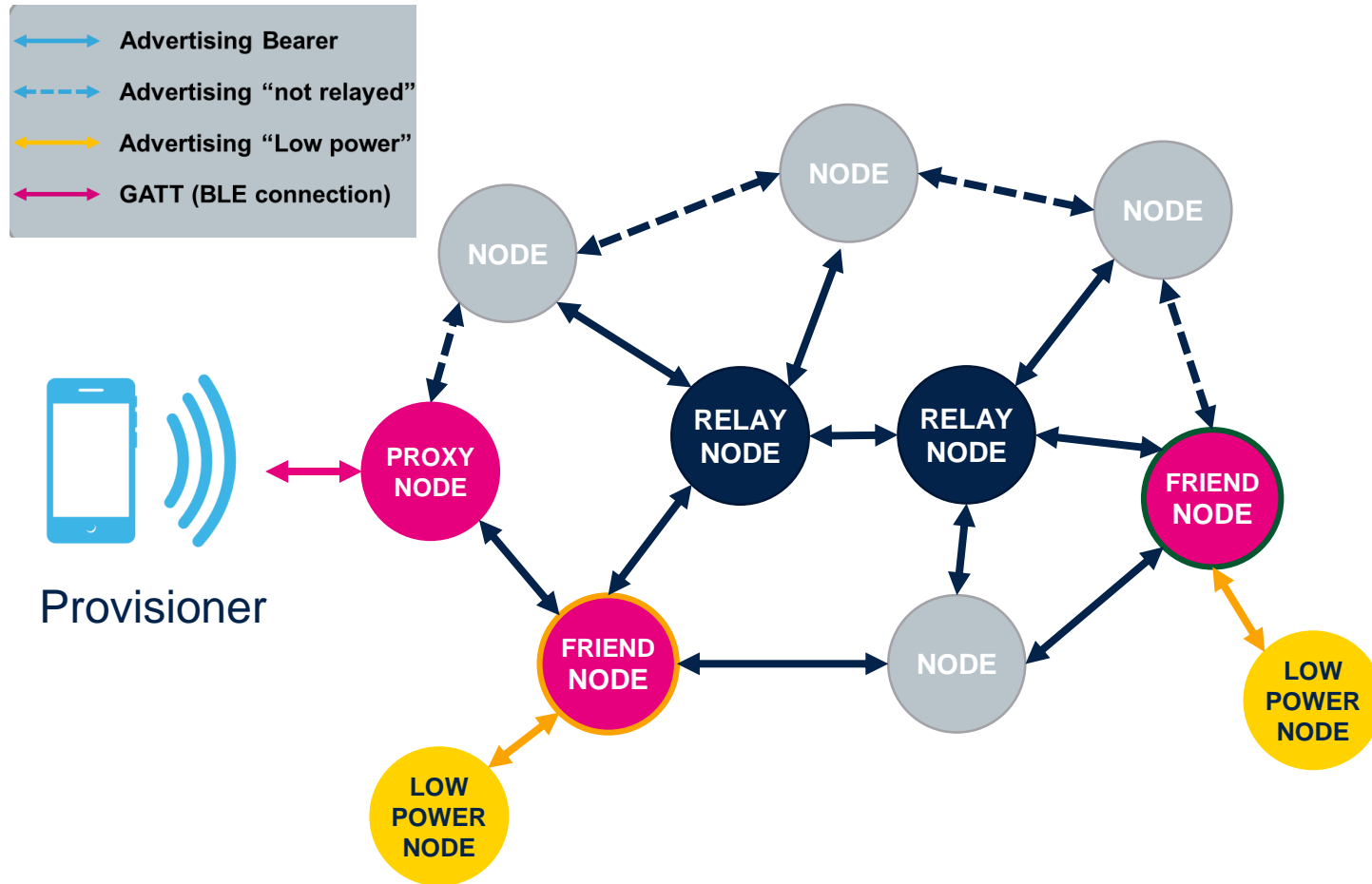
Publish and Subscribe



- Example: **client device** (switch) can post messages and **server device** (light bulb) can be notified about new command arrival.
- Different nodes can subscribe to the same address, but also subscribe to Multiple Groups: the nodes (e.g. Lights) configure themselves to receive messages sent to specific addresses.

Bluetooth mesh topology

node types

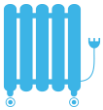


- PROXY NODE**
 - Expose the interface for Smartphone/Tablet to interact with a mesh network
- NODE**
 - Simple leaf node which cannot relay messages (Legacy nodes or Resource constrained nodes)
- RELAY NODE**
 - Able to retransmit received messages
 - Enables multiple "hops" in the network
- LOW POWER NODE**
 - Battery operated devices
 - Primarily send but Rarely receive messages
 - No need of 100% duty cycle
- FRIEND NODE**
 - Stores messages addressed to LPNs and delivers them whenever the LPN polls for "waiting messages"

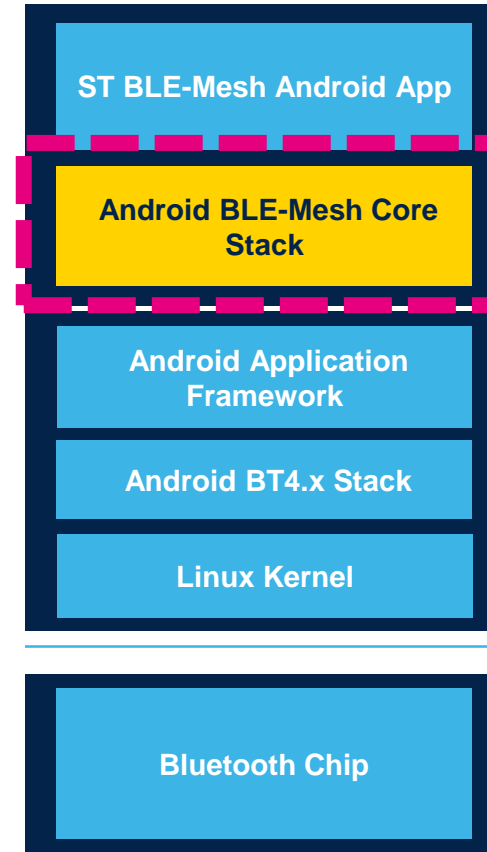
ST's Bluetooth Mesh Solution

STM32WB Cube Firmware package for embedded, Android and iOS

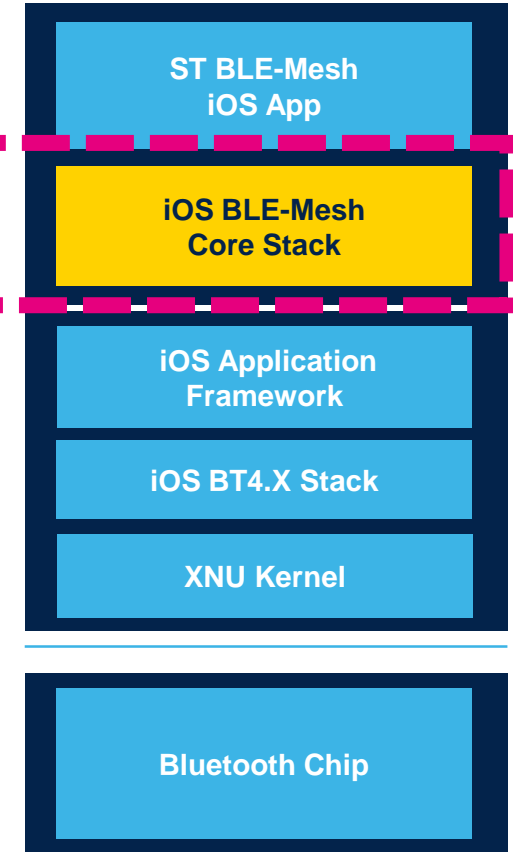
Bluetooth-Mesh SDK



Android SDK



iOS SDK



Available on SoC and network processor

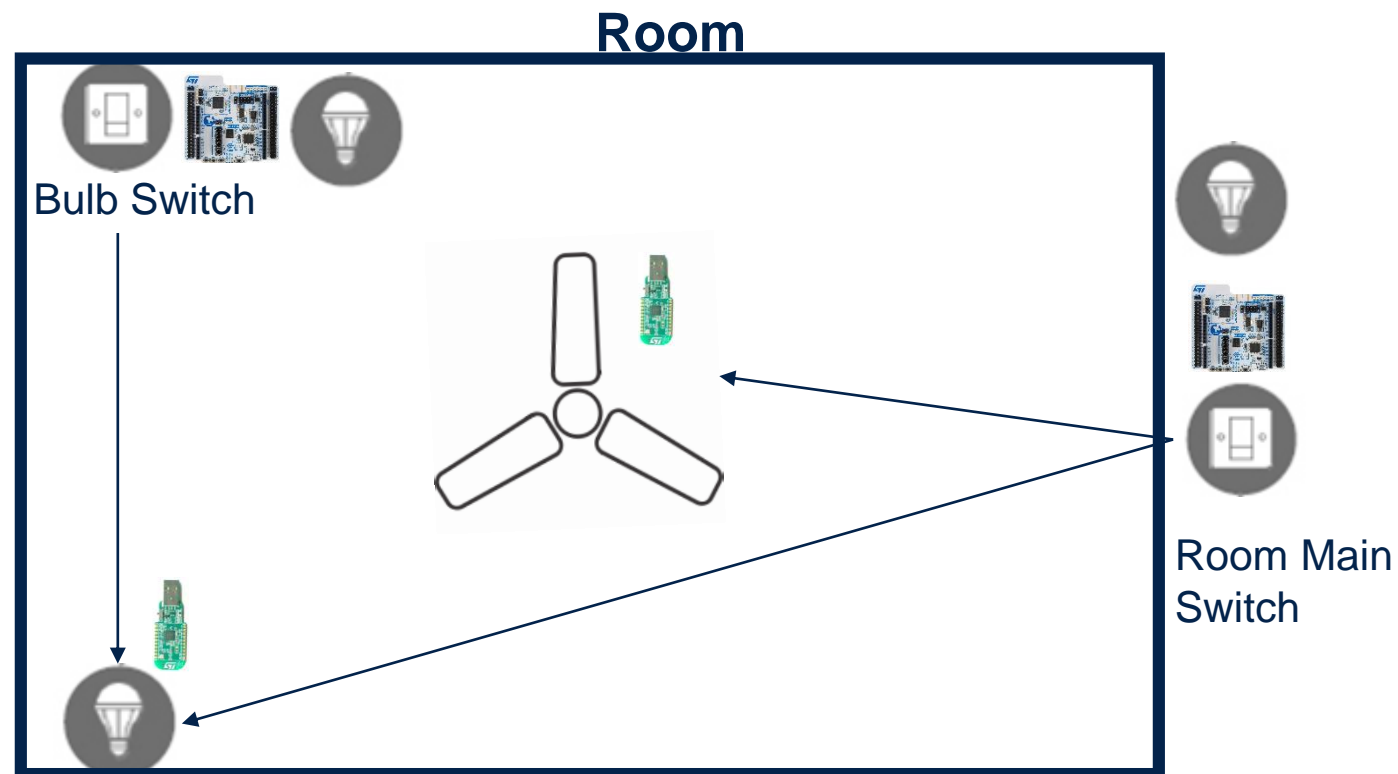
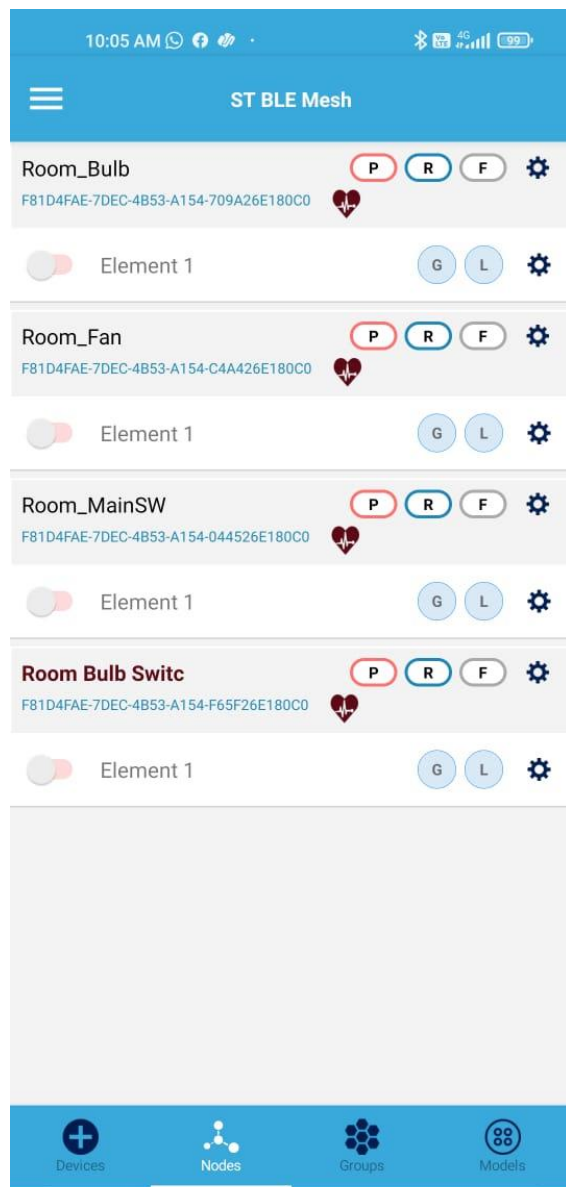
ST's Bluetooth Mesh (STM32WB-Mesh) brings smart-home to your fingertip

Easily connecting appliances to iOS/Android, out-of-the-box

- Bluetooth **Mesh 1.0.1** certified **Profile Library**, **Server Model**, and **Bluetooth LE stack**
- **Two-layer security** (128-bit AES-CCM and 256-bit ECDH protocol)
- **Low-power** and **Friendship** supported
- Provisioned node **database transfer** among smartphones via Email and Cloud application
- **Embedded** and **Mobile SDK** to build both your Android and iOS Apps
- Reduces development costs and accelerates time-to-market



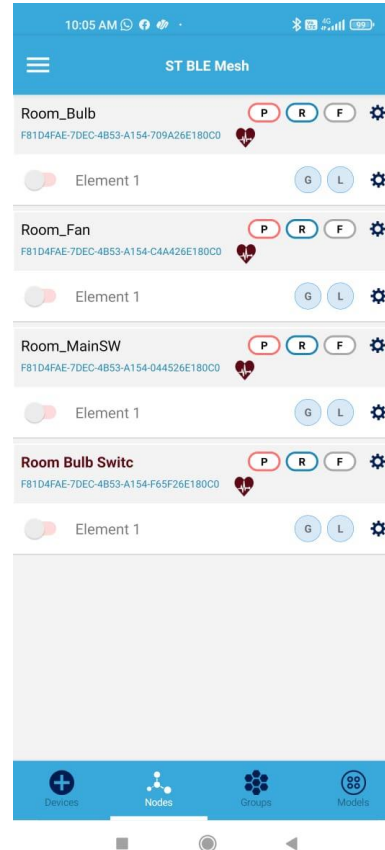
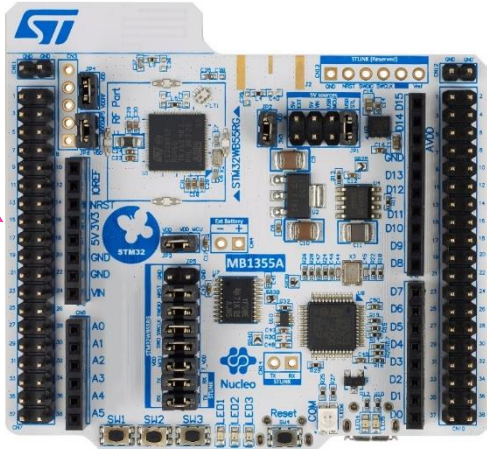
Target



Publisher → Subscriber

STM32WB BLE Mesh - How To

- ▼ STM32Cube_FW_WB_V1.12.1
 - _htmresc
 - Documentation
 - > Drivers
 - > Middlewares
 - ▼ Projects
 - > NUCLEO-WB15CC
 - ▼ P-NUCLEO-WB55.Nucleo
 - ▼ Applications
 - ▼ BLE
 - > BLE_Beacon
 - > BLE_BloodPressure
 - > BLE_CableReplacement
 - > BLE_Custom
 - > BLE_DataThroughput
 - > BLE_HealthThermometer
 - > BLE_HeartRate
 - > BLE_HeartRate_ANCS
 - > BLE_HeartRate_ota
 - > BLE_HeartRateFreeRTOS
 - > BLE_HeartRateFreeRTOS_ANCS
 - > BLE_Hid
 - > BLE_MeshLightingLPN
 - ▼ BLE_MeshLightingPRFNode
 - > Core
 - > EWARM
 - MDK-ARM
 - > STM32_WPAN
 - > STM32CubeIDE
 - > BLE_MeshLightingProvisioner



- ▼ STM32Cube_FW_WB_V1.12.1
 - _htmresc
 - Documentation
 - > Drivers
 - > Middlewares
 - ▼ Projects
 - > NUCLEO-WB15CC
 - > P-NUCLEO-WB55.Nucleo
 - ▼ P-NUCLEO-WB55.USB Dongle
 - ▼ Applications
 - ▼ BLE
 - > BLE_HeartRate
 - > BLE_MeshLightingLPN
 - ▼ BLE_MeshLightingPRFNode
 - > Core
 - > EWARM
 - MDK-ARM
 - > STM32_WPAN
 - > STM32CubeIDE
 - > BLE_p2pClient

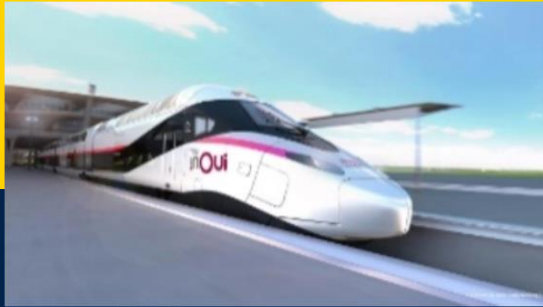
- Flash another Nucleo Board and The USB Dongle Board with the Example code “**BLE_MeshLightingPRFNode**” available in cube repository.
- Provision the node using “**ST BLE Mesh**” Mobile App for Android and IOS

Condition monitoring and predictive maintenance - Context & ST ecosystem



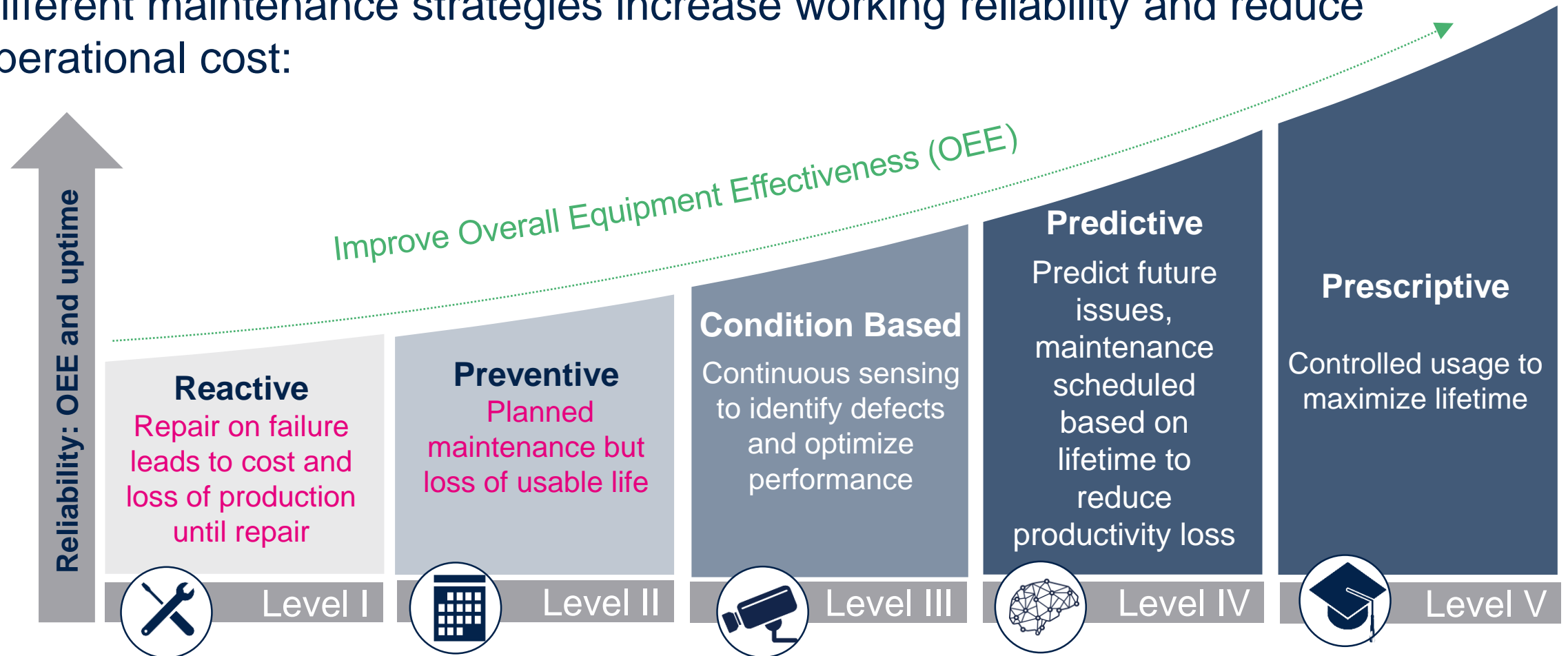
Why do machines need to be maintained?

We are surrounded by many machines,
which can break and generate quality issues
if not maintained properly

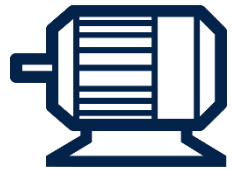


Why do machines need to be maintained?

- Different maintenance strategies increase working reliability and reduce operational cost:



Preventive, condition monitoring, & predictive maintenance



Preventive Maintenance (scheduled)



Condition Based Maintenance (CBM)

(performed at the exact moment when measured parameters reach unacceptable levels)



Predictive Maintenance (PdM)

(scheduled in the future based on analysis of sensor measurements and formulas)



Markets and application segments

New equipment (greenfield)



Integration possible
with power supply
and existing sensors

In-field maintenance (retrofit)



Battery-powered
simplifies
installation



Industrial

- Manufacturing and Process Automation
- Power and energy
- Smart Building Automation



Automotive and Transportation

- Vehicles
- Railways
- Infrastructures



Home

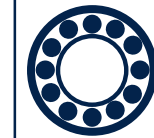
- Washing Machine
- Vacuum cleaner, Air conditioning

Focus on

Vibration monitoring
Temperature and Environmental
Ultrasound detection



Industrial
motor vibration
monitoring



Bearing's
ultrasound
monitoring



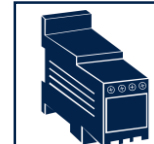
Motor current
monitoring



Crankshaft
rotation
monitoring



Pipe flow
monitoring



Temperature,
humidity, gas
monitoring



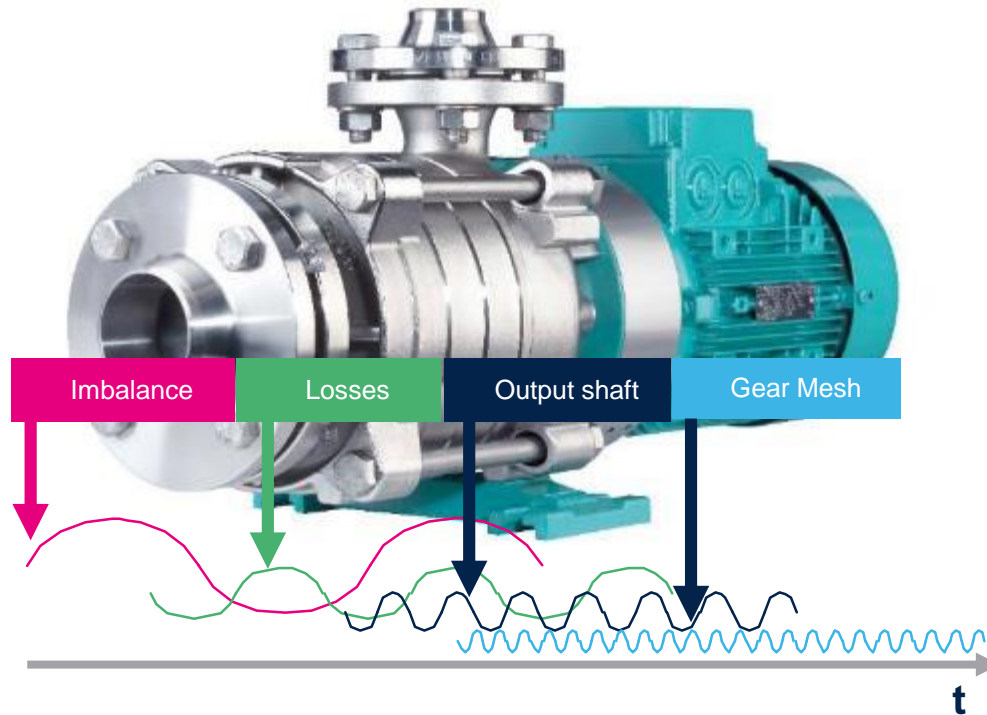
acoustic
monitoring

Typical use case industrial motor monitoring

Any parameter deviation is an indicator of potential failure

Mechanical vibration

- Displacement
- Speed
- Acceleration
- Acoustic noise
- Angular speed
- Torque



Functions to enable monitoring

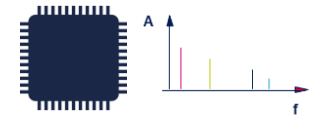
Vibration
Capture



Connectivity



Processing



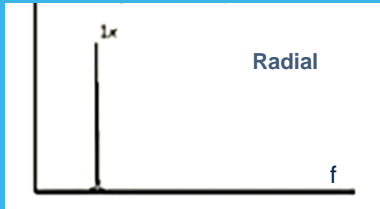
Secure
Connections



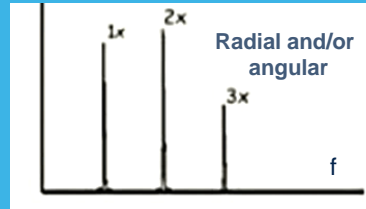
Processing at the edge vibration analysis use case

FFT Spectrum Plot identifies a wide variety of use cases

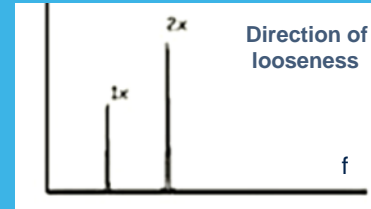
Unbalance



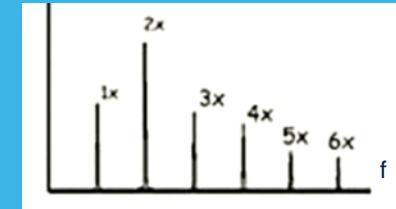
Misalignment



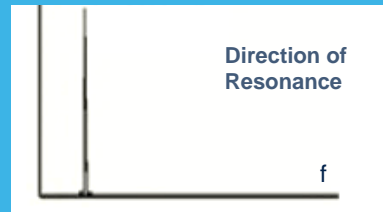
Structural Looseness



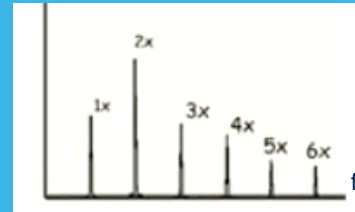
Bearing Looseness



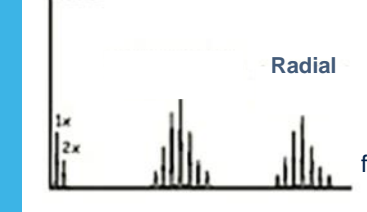
Structural Resonance



Sleeve Bearing Looseness

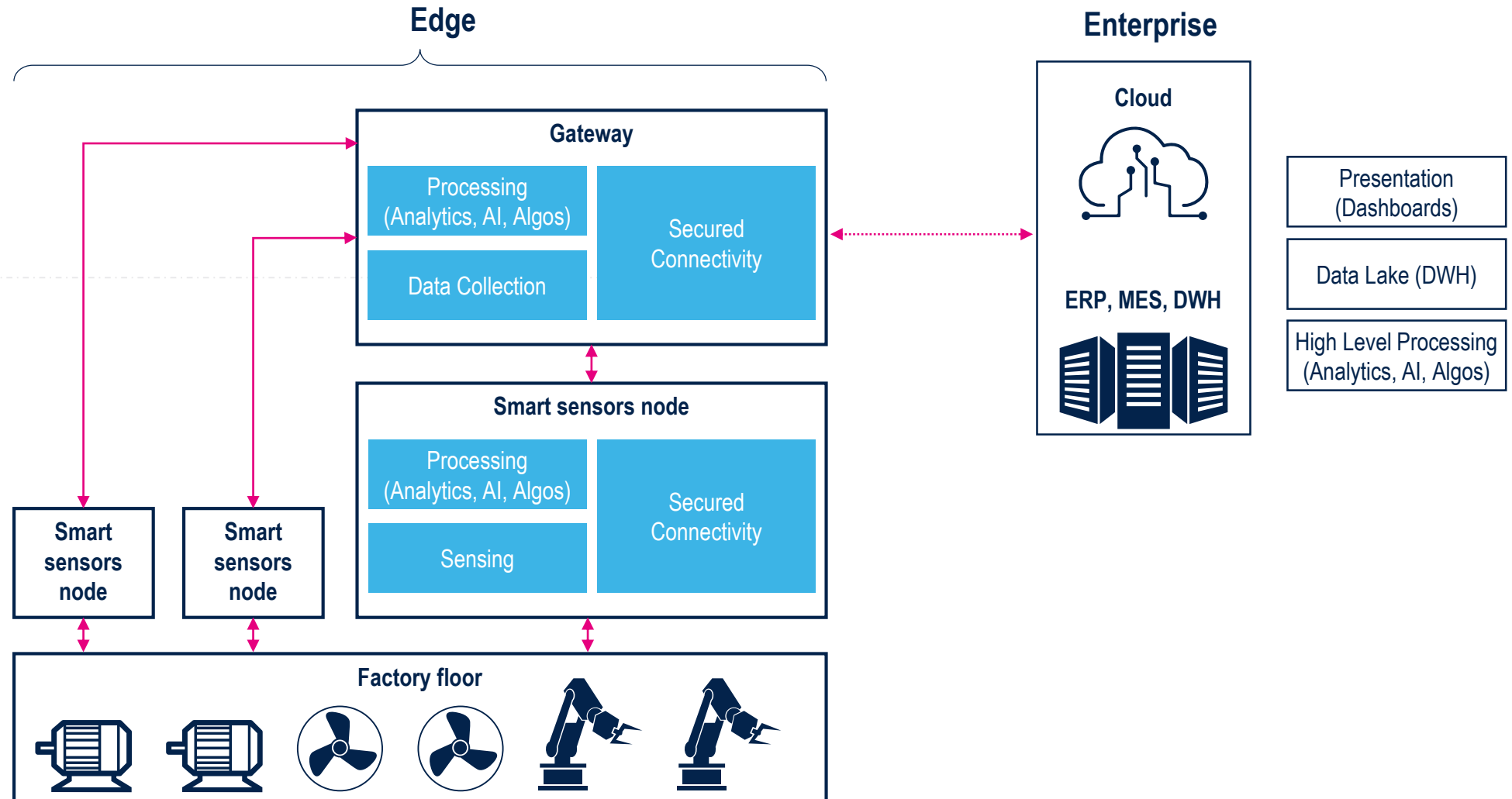


Gear Problem Misalignment

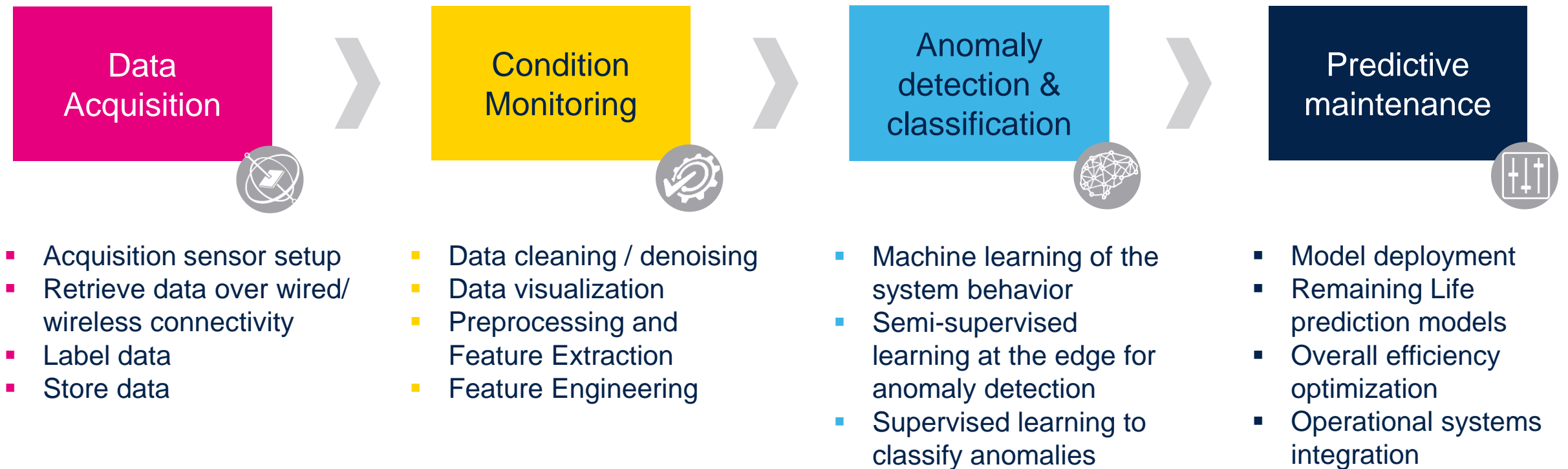


An optimized FFT
library is part of our
software package

Condition monitoring and predictive maintenance Architecture



Key steps

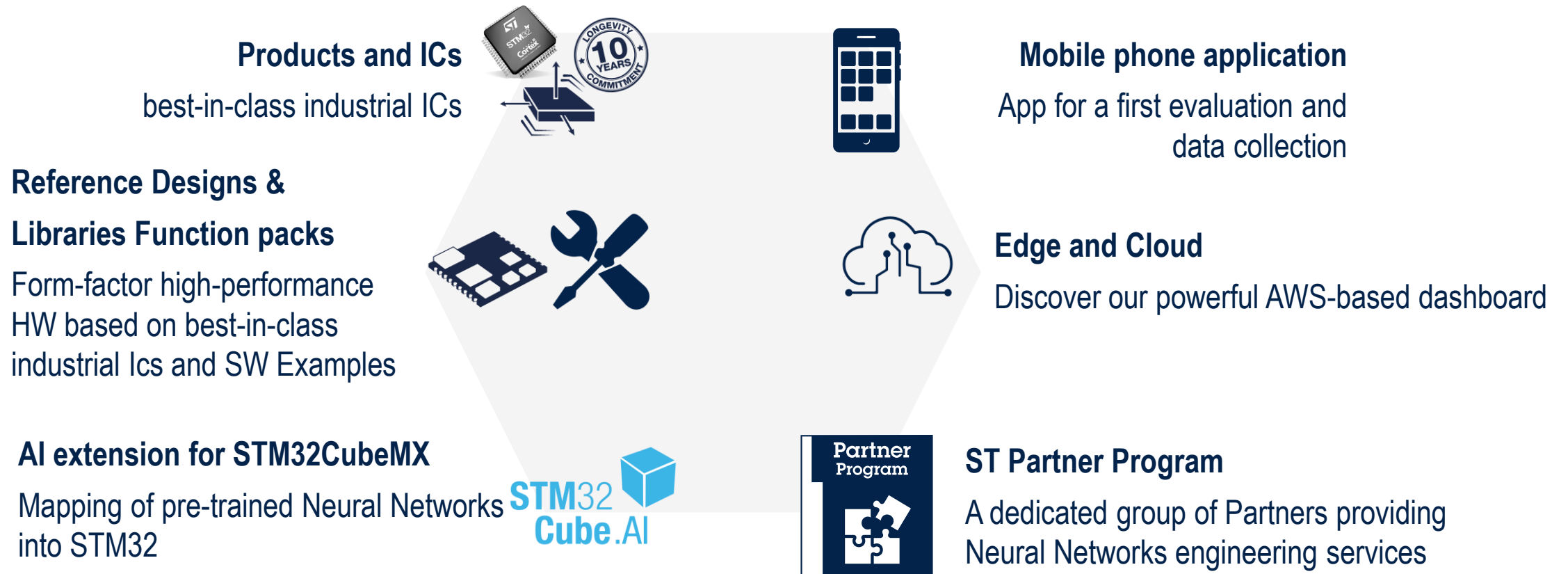


Edge - Factory Level (processed sensors data)

Company Level (ERP, etc.)

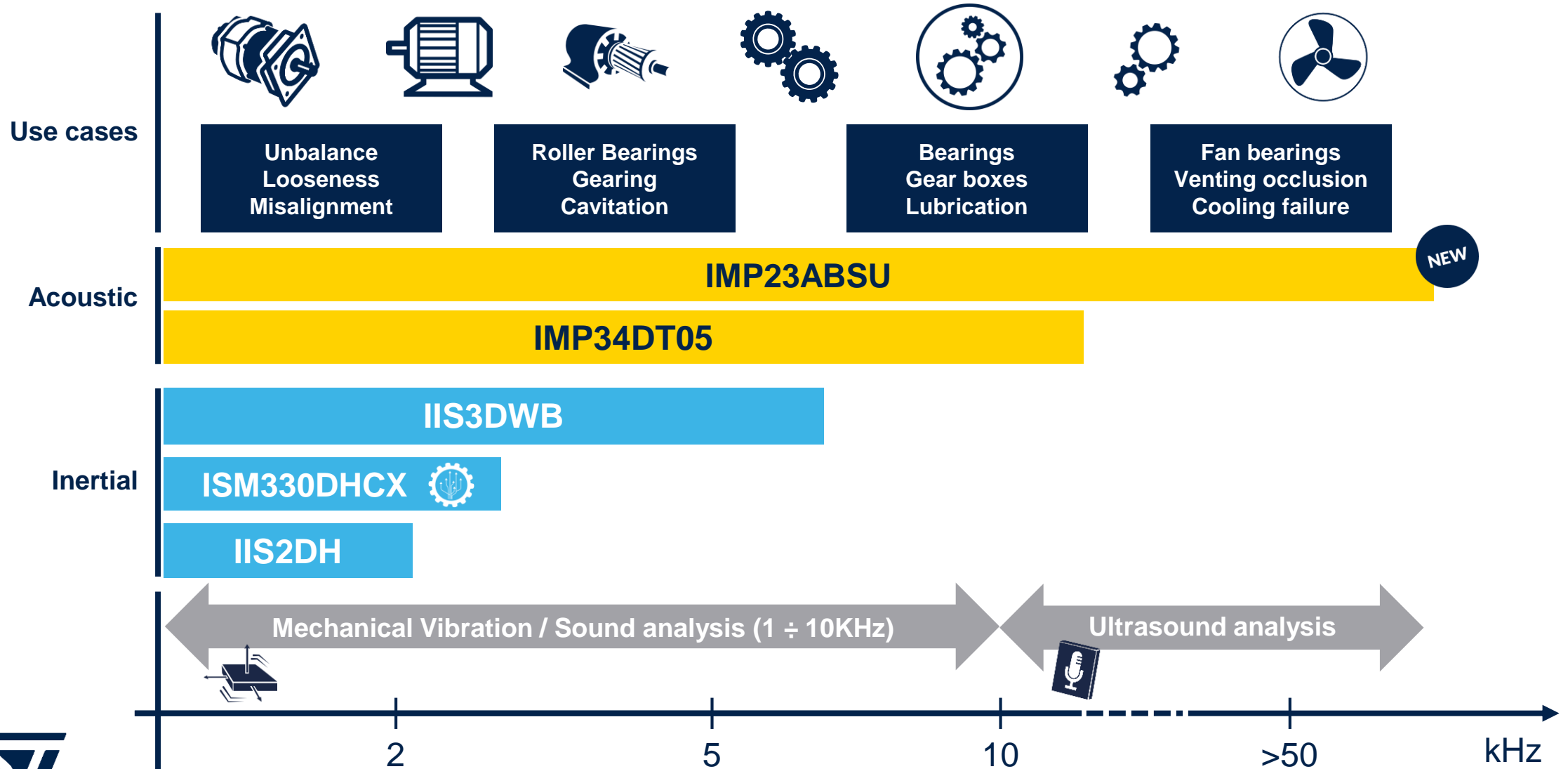
Solutions and tools ecosystem for predictive maintenance

ST's offering covers a wide range of applications






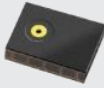





Industrial sensors for vibration analysis sensors and defects over bandwidth



Industrial sensors for CbM and PdM

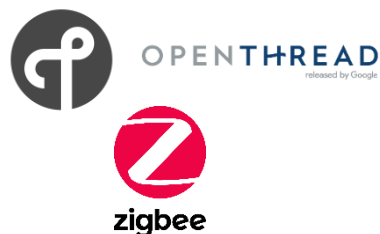
Function	IC	Description	Package	Features
Vibration	 IIS3DWB 	Ultra-wide bandwidth (up to 6kHz), low-noise 3-axis digital Vibration sensor	LGA-14, 2.5 x 3 mm 	<ul style="list-style-type: none"> 3D Accelerometer – 16g Full Scale Digital Output Ultra Wide Bandwidth (up to 5 kHz) Ultra Low Noise + up to 105°C operating Temp
	ISM330DLC ISM330DHCX 	Wide Bandwidth Accelerometer + Gyroscope		<ul style="list-style-type: none"> 3D Accelerometer + 3D Gyro - Digital Output 3 kHz bandwidth accelerometer Ultra Low Power + Smart Features
	 IIS2DH 	Wide Bandwidth, Ultra-low-power Accelerometer	LGA-12, 2 x 2 mm 	<ul style="list-style-type: none"> 3D Accelerometer – Digital Output Up to 2.3 kHz bandwidth Ultra Low Power – Ultra Compact
	IIS2MDC 	Low-Noise, Low Power Magnetometer		<ul style="list-style-type: none"> 3D Magnetometer – Digital Output AMR Technology - Up to 50 Gauss Full Scale Ultra Low Noise, Low Power
Acoustic	 IMP23ABSU 	Analog bottom port microphone with frequency response up to 80kHz for Ultrasound analysis	RHLGA metal cap 5-L, 3.5 x 2.65 x 0.98 mm	<ul style="list-style-type: none"> Bottom port Microphone Wide Acoustic Bandwidth (up to 80 kHz) Wide Dynamic Range (AOP up to 130 dB SPL)
	IMP34DT05 	Digital Top Port Microphone	3 x 4 x 1 mm 	<ul style="list-style-type: none"> Top port Microphone with Digital Output Wide dynamic range (AOP up to 122 dB SPL) ESD up to ±15kV
Environmental	LPS22HH	High Accuracy – Compact Size Absolute Pressure Sensor	HLGA-10-L, 2 x 2 x 0.76 mm Ultra Compact full molded	<ul style="list-style-type: none"> 260 to 1260 hPa Range - Digital Output High Accuracy (±1 hPa) Low noise (0.75 Pa RMS)
	LPS27HHW LPS33HW	Water Resistant Absolute Pressure Sensor	2.7 x 2.7 x 1.7 mm 3.3 x 3.3 x 2.9 mm 	<ul style="list-style-type: none"> 260 to 1260 hPa Range - Digital Output High Accuracy (±2.5 hPa) + Low noise (0.8 Pa RMS) Water resistant up to 10 atm
	STTS22H 	Digital Temperature Sensor	2 x 2 x 0.50 mm 6-lead UDFN	<ul style="list-style-type: none"> Operating temperature -40 °C to +125 °C Accuracy: ±0.5 °C max (-10 °C to +60 °C) Programmable threshold, One-shot mode
	STLM20	Analog Temperature Sensor	SOT323-5L, UDFN-4L	<ul style="list-style-type: none"> Accuracy ±0.5 °C (typ.) Operating Temp -55 °C to +130 °C
	HTS221	Relative humidity and temperature Sensor	2 x 2 x 0.9 mm HLGA package	<ul style="list-style-type: none"> Humidity accuracy: ± 3.5% rH, 20 to +80% rH Temperature accuracy: ± 0.5 °C, 15 to +40 °C SPI and I²C interfaces



Multiprotocol and open radio



- Fully certified Bluetooth® LE 5.2 radio
- 2x faster speed with 2 Mbps capable mode
- Extend network coverage with Bluetooth Mesh



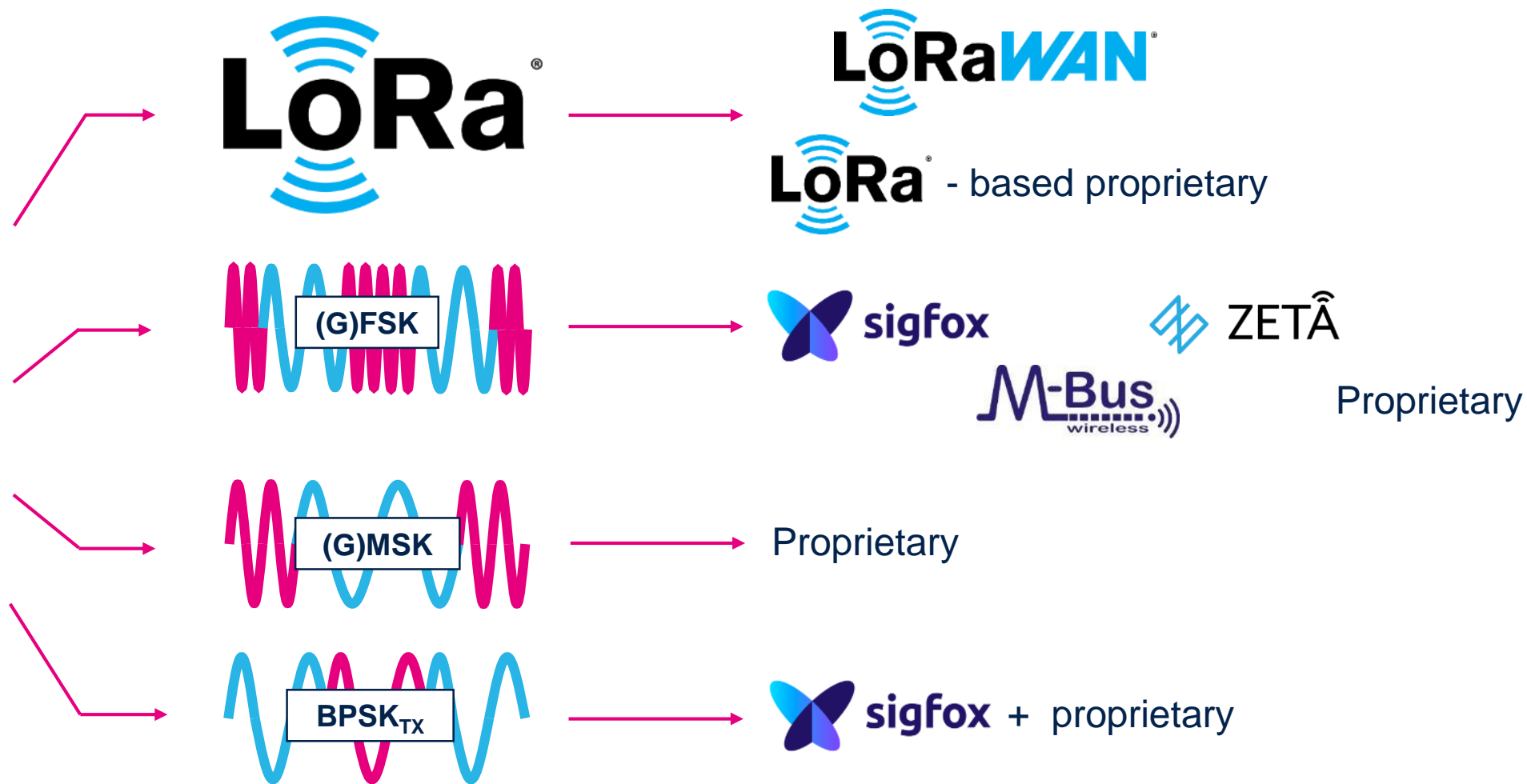
- Last IEEE 802.15.4 standard ready
- OpenThread, Zigbee 3.0
- Bluetooth 5.2 and 802.15.4 protocols in Static and Dynamic concurrent mode

2.4 GHz
Open

- Proprietary protocol capable (Bluetooth Low Energy like or 802.15.4)
- Best-in-class RF with up to +6dBm output power and 102 dB link budget
- Energy sensitive application with only 4.5mA in RX and 5.2mA in TX (@ 0dBm)
- BOM cost reduction thanks to Integrated balun

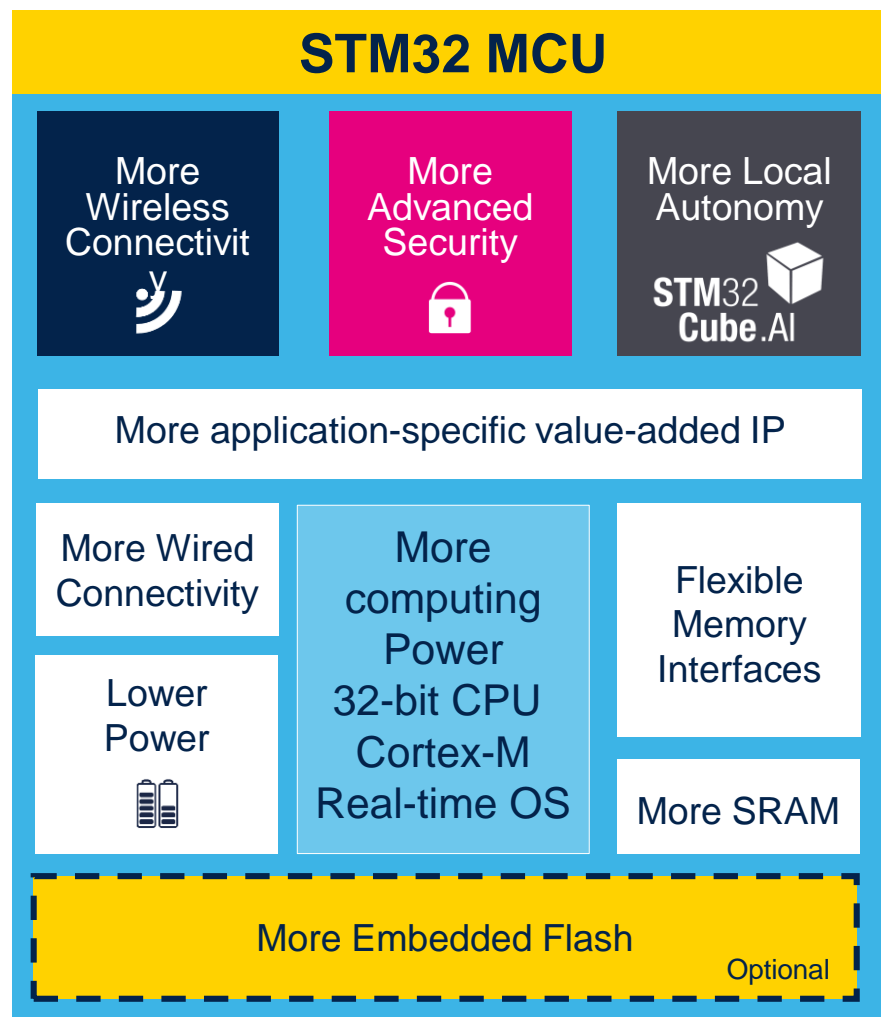


4 modulations - many protocols

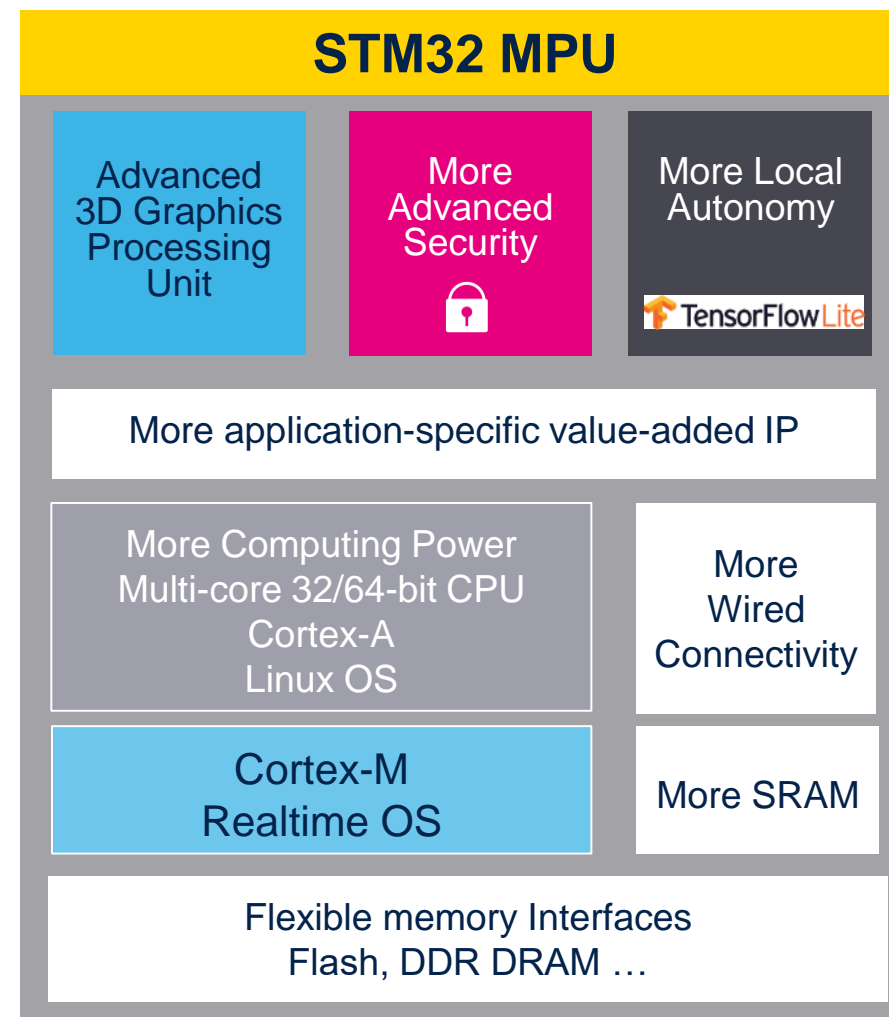




STM32 product family embedded processing at the core of the application



Advanced Non-Volatile Memory technology ... 18nm FD-SOI



Advanced Digital technology ... 16nm FinFET

Solutions and tools



life.augmented



How wireless connectivity changes the game STWIN is the answer

STWIN: SensorTile wireless industrial node



STEVAL-STWINKT1B kit is made of:

- Hardware Board
- Battery + plastic case for field testing
- STLink-V3MINI + cable for programming



For improved security implementation,
STEVAL-STWINKT1B is provided with **STSAFE**



STWIN1B modular expansions

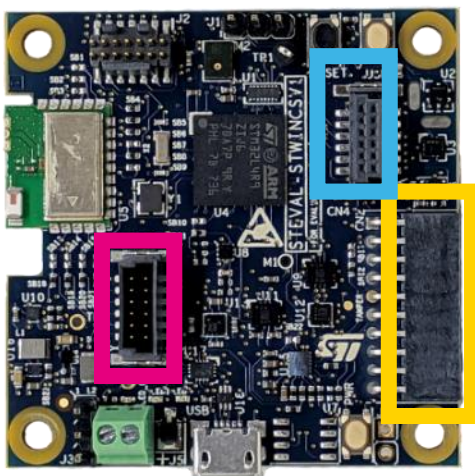
STMOD+ connector + STWIN expansions

The **STMOD+ connector** available on the latest STM32 expansion boards, offers STWIN a world of possibilities:

LTE,
LoRa,
Ind. Ethernet, ...



Example: STWIN + LTE



LTE
P-L496G-CELL02

STEVAL-STWINWV1



Wi-Fi
Wi-Fi Expansion
Inventek Wi-Fi Module



STEVAL-STWINMAV1

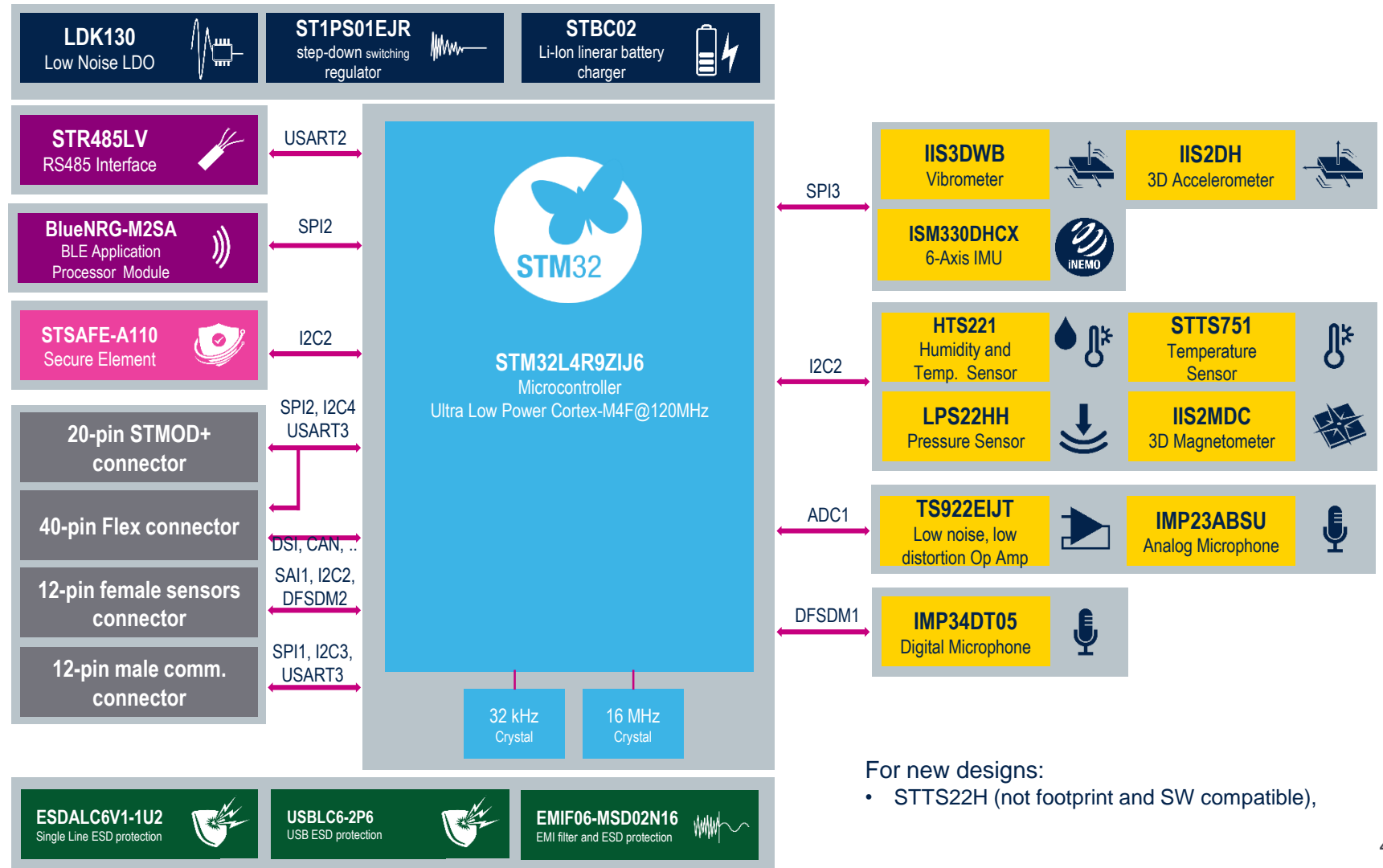


Analog Mic-Array
4x MP23ABS1



STEVAL-STWINKT1B diagram, ICs and STM32CUBE Function Packs

- Best-in-class Industrial Grade Sensors
- Multiple algorithms running on the STM32L4+
- Secure Connection and Authentication with STSAFE-110
- Out-of-the-box BLE Connectivity
- Connectivity and sensor expansions support
- Smart Power to increase battery life (Li-Po battery, USB or ext. 5V)
- [FP-IND-PREDMNT1](#) IoT sensor node for condition monitoring
- [FP-CLD-AZURE1](#) connect an IoT sensor node to Microsoft Azure
- [FP-SNS-DATALOG1](#) High speed Datalog
- [FP-AI-NANOEDG1](#) AI Condition monitoring application



For new designs:

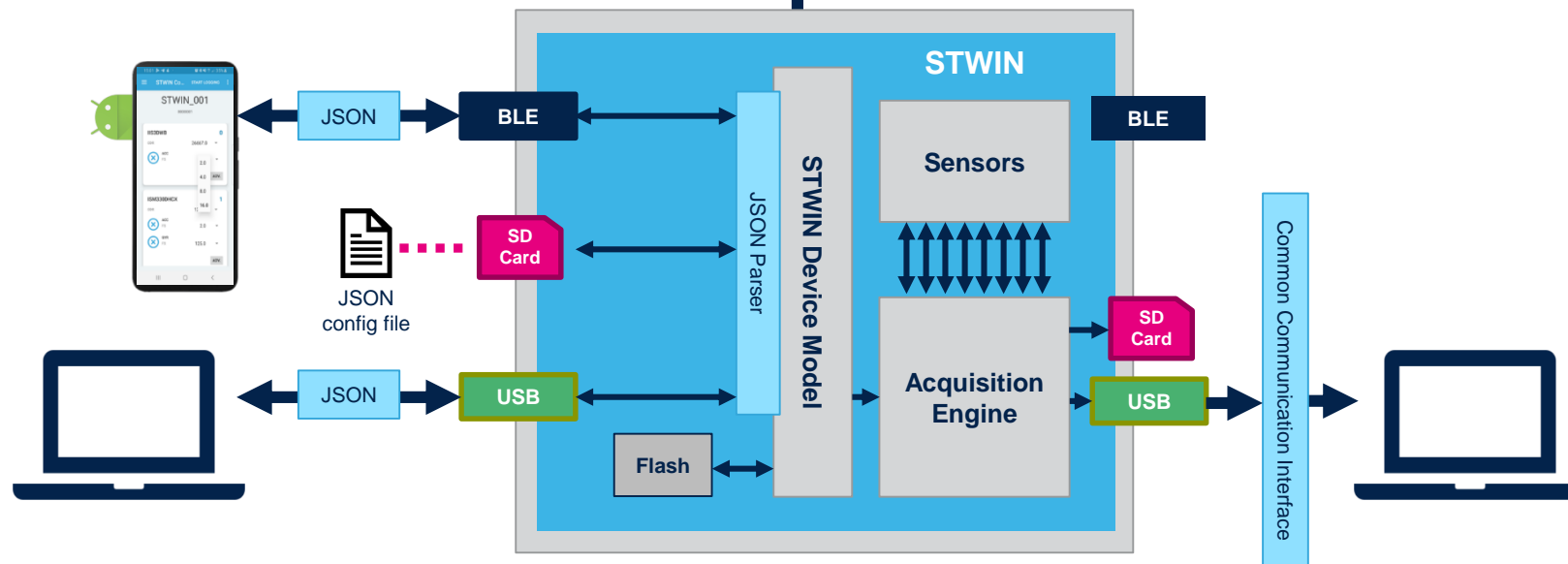
- STTS22H (not footprint and SW compatible),

Introducing High Speed Data logging FP-SNS-DATALOG1

Optimized STM32 SW support streaming all sensors at full data rate

Device configuration

Data streaming



Online at:
<https://bit.ly/2EU9pHT>

- USB WCID class and PC DLL
- SD Card
- Full control of acquisition via BLE app

Soon to be available:

- Support for Wi-Fi streaming



Vibration analysis: MotionSP library

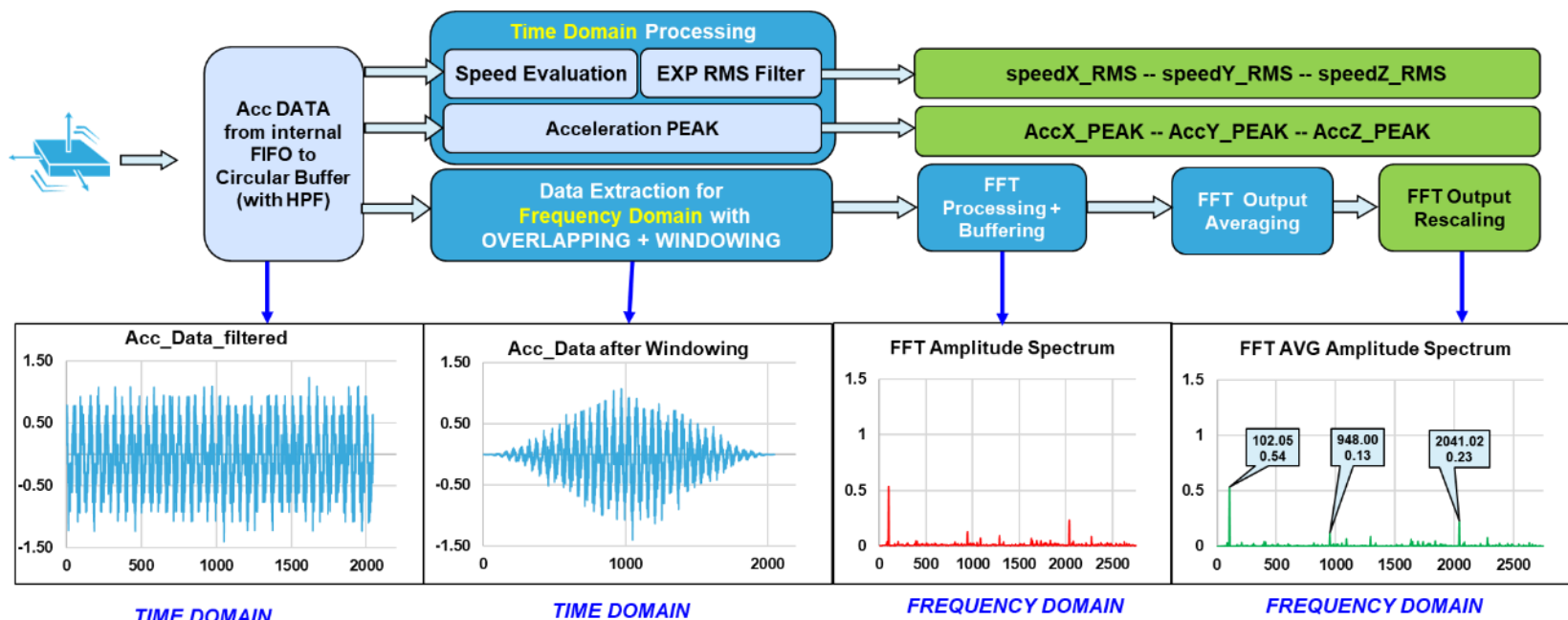
Middleware for advanced time & frequency domain signal processing

Middleware Description

Middleware including algorithms for advanced time and frequency domain signal processing for vibration analysis*.

Key features

- Programmable FFT size (256, 512, 1024, 2048 points)
- Programmable FFT overlapping
- Programmable acquisition time window
- FFT averaging during acquisition time
- Programmable windowing (Flat Top, Hanning, Hamming)
- Speed RMS moving average, acceleration max peak.
- Developed for STM32F4, STM32L4+ with easy portability across different MCU families
- Agnostic to sensors
- Available in source code
- Integrated and available in:
 - STSW-BFA001V1
 - X-CUBE-MEMS-XT1 (not all features available)
 - FP-IND-PREDMNT1





Condition monitoring software package FP-IND-PREDMNT1

Test Condition-based Monitoring Examples with 3 hardware options

1

STM32 Nucleo + Expansions

NUCLEO-F446RE + X-NUCLEO-CCA02M1 + X-NUCLEO-IDB05A1 + X-NUCLEO-IKS01A2 + STEVAL-MKI182V2



2

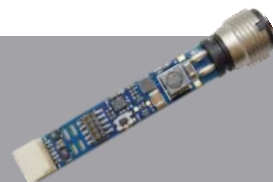
STEVAL-STWINKT1B



3

STEVAL-BFA001V2B

With its STEVAL-UKI001V1 and one STM32 Nucleo board



MotionSP
output
+
parameters
settings

Data
logging

Data
Logging

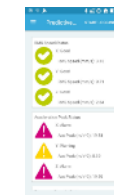
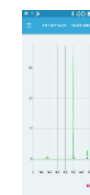


1 / 2 - use both
ST BLE Sensor App

2- Support
Wi-Fi connection to
DSH-PREDMNT
dashboard



3 Serial
connection to PC



Parameter	Value
Frequency	1000.000
Amplitude	0.000
Phase	0.000
...	...

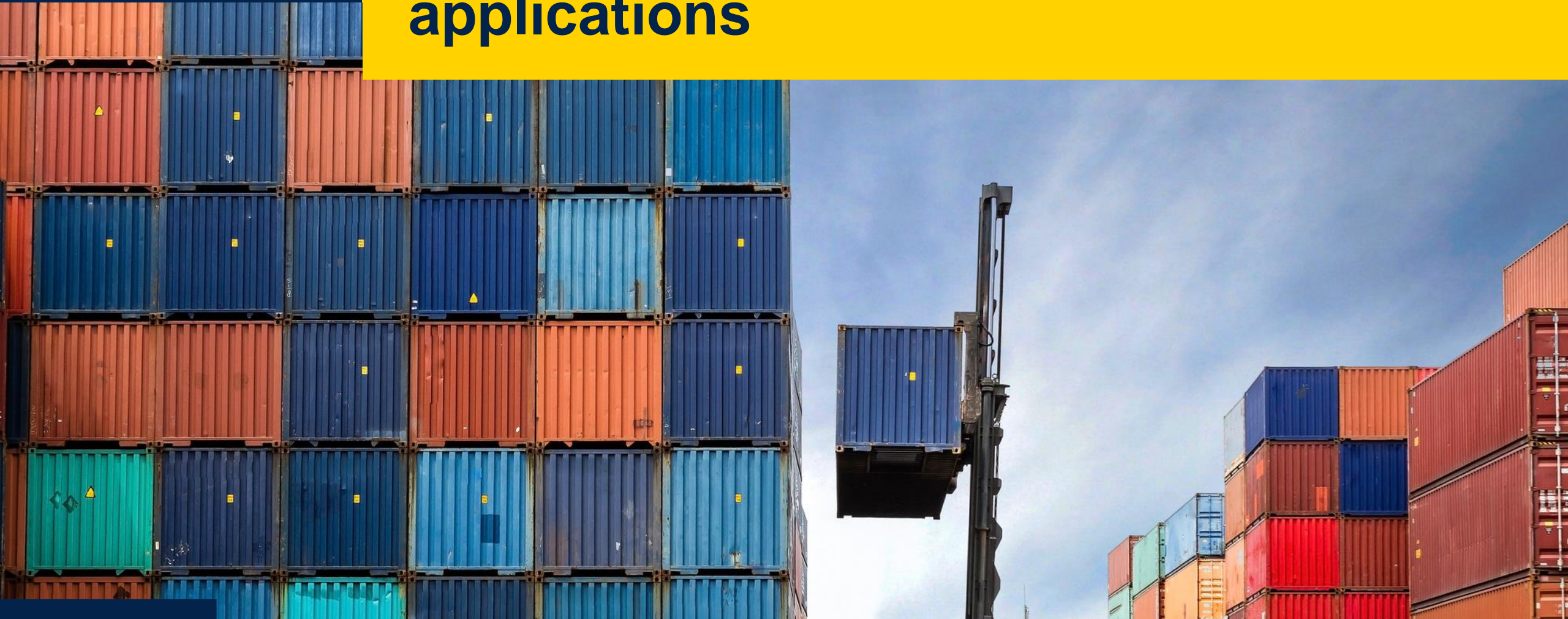
From left to
right:
FFT amplitude,
details and
settings



```
ISM330DLC (Accelerometer): Initialized Enabled  
ISM330DLC (Accelerometer): real ODR 6645.00 Hz  
  
*** Time Domain Data ***  
Speed [mm/s] | X | Y | Z | RMS[tau] [mm/s] |  
|-0.015| -0.053| -0.002| 0.028| 0.101| 0.126|  
|-0.033| 0.214| 0.211| 0.026| 0.111| 0.131|  
|-0.013| 0.174| 0.224| 0.027| 0.149| 0.156|  
| 0.013| 0.142| 0.224| 0.025| 0.149| 0.170|  
| 0.021| 0.080| 0.032| 0.024| 0.145| 0.170|
```

Any terminal emulator
(i.e. TeraTerm) for
data monitoring

Solutions for asset tracking applications



Asset Tracking Applications and segmentation

IoT tracking



Luxury & fashion goods



Personal devices



Social distance



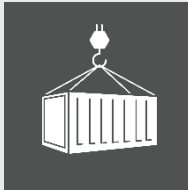
Pet tracking



People tracking



Outdoor real-time monitoring



Containers



Fleet management



Livestock monitoring



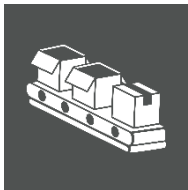
Tractor



Mobility sharing



Indoor localization & Warehouse logistics



RTLS



Mobile assets



pallet



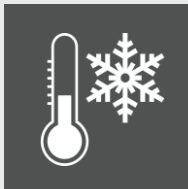
Smart parcels



Employee Safety



Good guarantee



Cold chain



Food tracing



Medical



Letters



































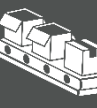





































Packages



Parcels



Asset tracking – Needs per applications

		Processing & security	Sensing	Connectivity	Power management	
IoT tracking Personal devices, pet, child and held people, social distance		 Dedicated MCU  Dedicated secure chip	 	         	 	<div>Real-time tracker</div> <div>Complexity (# of sensors, connectivity)</div> <div>Logger 50</div>
Outdoor real-time monitoring Containers, livestock monitoring, Mobility sharing, fleet management, pet, tractor		 Dedicated MCU  Dedicated secure chip	 	       	 	
Indoor localization & Industrial logistics Pallets, racks, Real Time Localization, Smart Parcels, Employ safety		 Dedicated MCU  Embedded security	 	      		
Good guarantee Cold chain, food tracing, medical		 Dedicated MCU  Embedded security	 	      		
Disposable Letters, packages, parcels		 Sensor with processing  Embedded security		      		

Asset tracking

ST's 360° portfolio delivers 100% flexibility

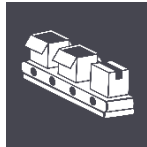
IoT tracking



Outdoor real-time monitoring



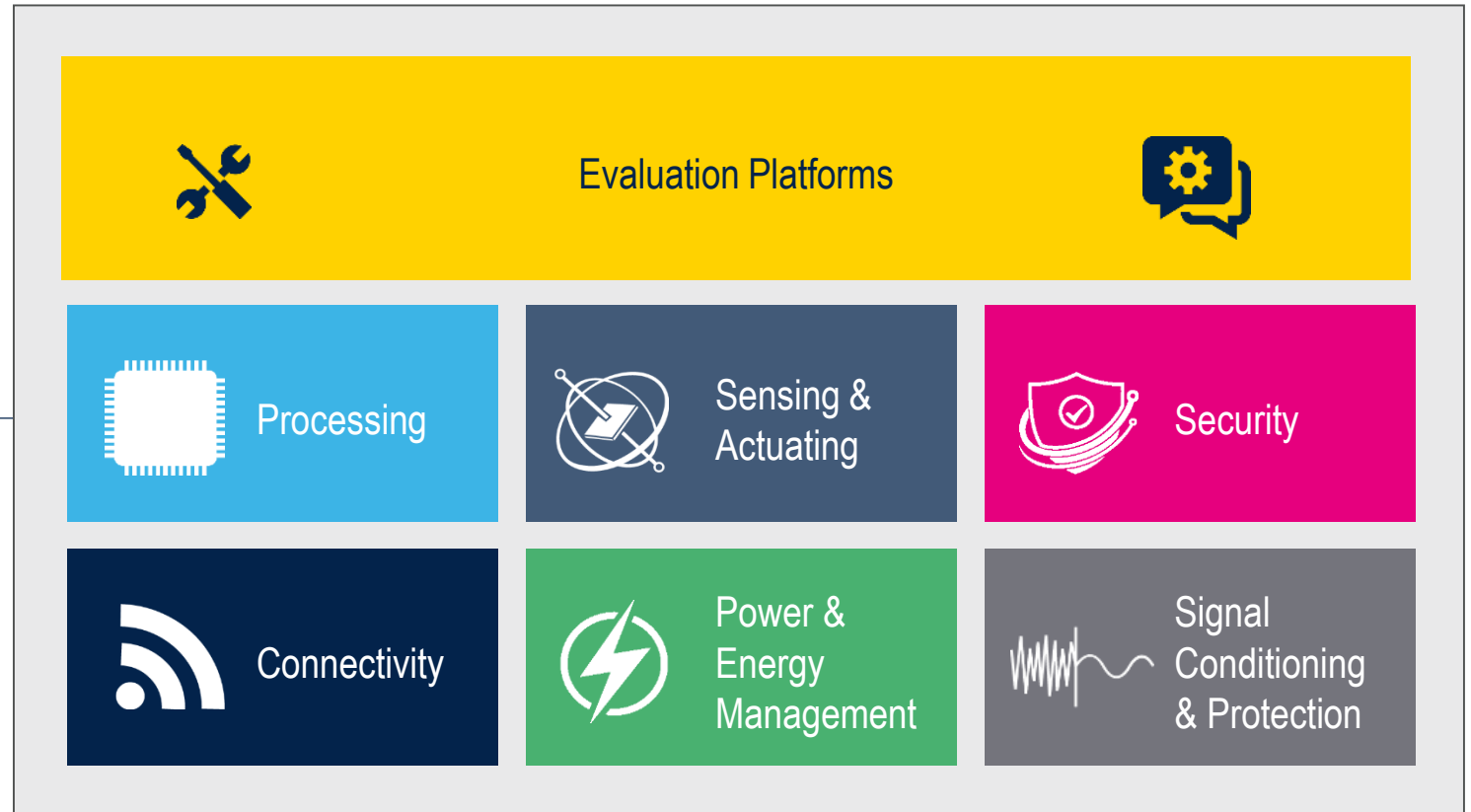
Indoor localization & Warehouse logistics



Good guarantee



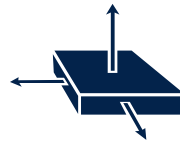
Disposable



Sensors for asset tracking



Temperature, Humidity sensors to monitor environmental changes/activate the de-humidification system, check sealing, consistency of cold chain



Accelerometer to detect motion/wake-up, vibration, crash/shocks, freefall, upright and orientation



Proximity and Light Sensor for container door open/close monitoring and shipment security



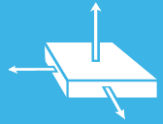
Pressure airplane Take off and landing detection or altitude detection



Microphones for security and emerging applications.



ST sensors for asset tracking



Accelerometers

High-g shock accelerometer	H3LIS331DL
Vibration	IIS3DWB
Ultra-low power	LIS2DW12 LIS2DH12
With embedded temperature sensor	LIS2DTW12
Inclinometer	IIS3DHHC IIS2ICLX



iNEMO® Inertial Module

6x IMU	LSM6DSOX LSM6DSO32
--------	-------------------------------------



Magnetometer

Magnetometer	LIS2MDL
--------------	----------------



Pressure Sensors

Precision pressure sensor	LPS22HH
Waterproof pressure sensor	LPS27HHW LPS27HHTW * LPS33W



Temperature & Humidity Sensors

Humidity & temperature sensor	HTS221
Digital temperature sensor	STTS751 STTS22H
Analog temperature sensor	LM235 STLM20



MEMS Microphones


Digital high-performance Microphone	MP34DT05-A MP23DB01HP
Analog high-bandwidth Microphone	MP23ABS1 IMP23ABSU

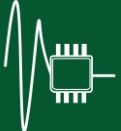



FlightSense Time-of-Flight sensor


Proximity sensor (with ALS)	VL6180/80X
Ranging sensor	VL53L0X
Long distance ranging sensor	VL53L1X
Extra-long distance & Multi-target	VL53L1CB

Complementary products for asset tracking

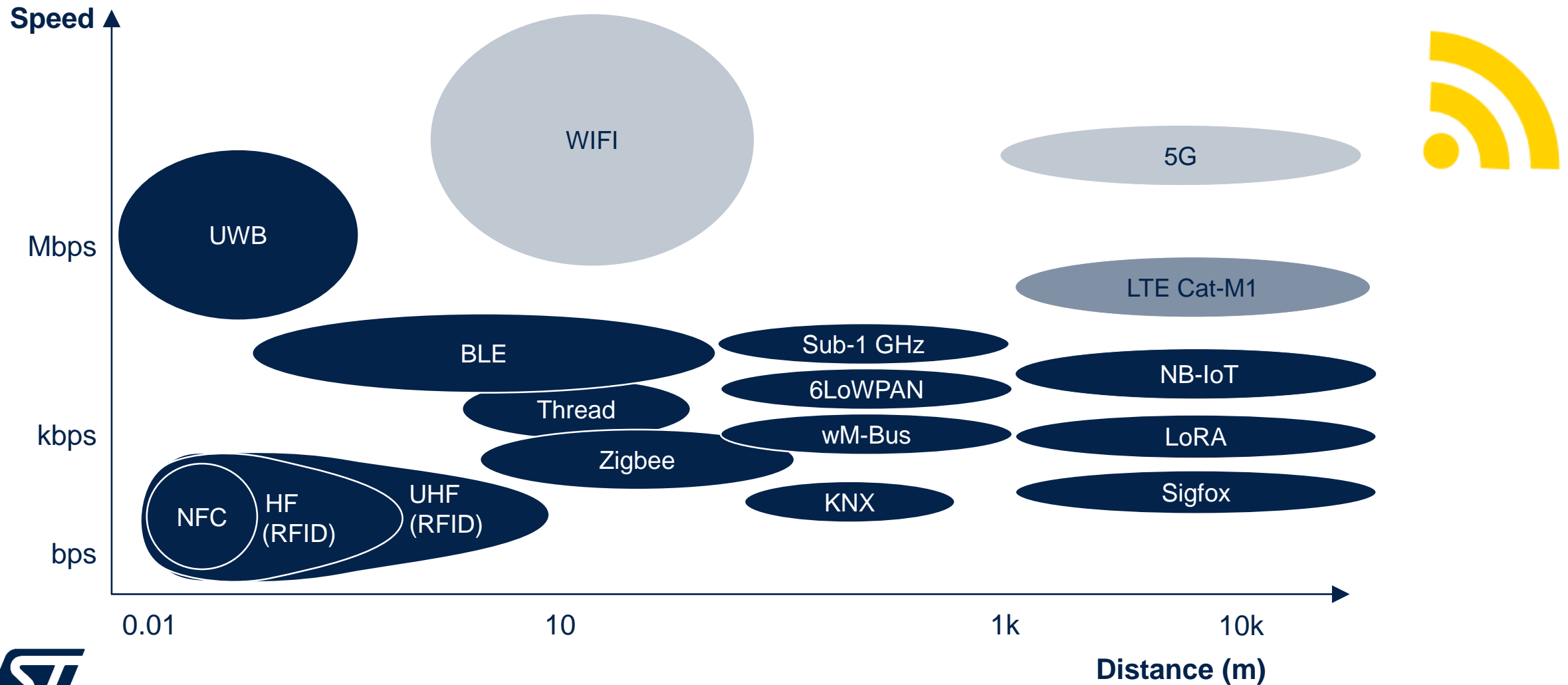
 DC/DC converters	
Synchronous converter, Output voltage flexibility, 400 mA output current, Nano-quiescent current (500 nA) for extended sensors battery life	ST1PS01/02

 Voltage regulators	
200 mA ultra-low quiescent current LDO	STLQ020
Low Iq, ultra low noise 300 mA LDO with power good	LDLN030
Low Iq, ultra low noise 250 mA LDO	LDLN025
Low Iq, ultra low drop 300 mA LDO	LD59030

 Operational amplifiers	
Zero Drift CMOS amplifier <ul style="list-style-type: none"> • Very low offset 5 μV max • Very low drift in temperature 30 nV/$^{\circ}\text{C}$ 	TSZ12 Series
Zero Drift & Speed Amplifier <ul style="list-style-type: none"> • Very low offset 25 μV max • Very low drift in temperature 0.1 $\mu\text{V}/^{\circ}\text{C}$ • Excellent speed/power ratio 3 MHz/1 mA 	TSZ18 Series
Nano-power amplifiers - Zero Drift <ul style="list-style-type: none"> • 900 nA current consumption • Only 150 μV max input offset voltage • Operating from 1.5 V 	TSU11 Series
Nano-power amplifiers <ul style="list-style-type: none"> • 580 nA current consumption • Operating from 1.5 V 	TSU10 Series
Nano-power comparator <ul style="list-style-type: none"> • 200 nA current consumption • Operating from 0.9 V • Push Pull & Open Drain 	TS88 Series

 Protection devices	
SD card protection	EMIF06-MSD02N16
USB 2.0 dataline	ECMF02-4CMX8
DC-DC protection	ESDA7P120-1U1M
ESD protection	USBULC6-2M6
USB TYPE-C Power Delivery protection	TCPP01-M12

IoT wireless connectivity



ST connectivity for asset tracking



NFC & RFID

NFC / RFID tags	ST25TV
Dynamic NFC / RFID tags	ST25DV-I2C
NFC Readers	ST25R
NFC Readers for UHF	ST25RU



Bluetooth Low Energy

Multi-protocol (Bluetooth 5.0 / 802.15.4) Wireless SOC with integrated balun	STM32WB55 / 50 / 35 / 30
Multi-protocol Module (Bluetooth 5.0 / 802.15.4)	STM32WB5MMGH
Highly energy-efficient Bluetooth 5.x Wireless SoC	BlueNRG-2 BlueNRG-LP
Bluetooth 5.0 Modules	BlueNRG-M2
Balun & Filter	BALF-NRG-02D3 MLPF-NRG-01D3 MLPF-WB55-0xE3



Sub-1 GHz

Sub-1 GHz Transceiver/Transmitter Sigfox compatibility	S2-LP S2-LPTX
Balun for S2-LP	BALF-SPI2-01D3
STM32 Sub-1 GHz SOC LoRa/Sigfox compatibility	STM32WL



WPAN

Bluetooth LE 5, Zigbee, Thread, proprietary Wireless SOC (integrated balun)	STM32WB
Balun for UWB	BAL-UWB-01E3
Ultra wideband connectivity	STM32x*



Positioning

GNSS Module	TESEO-LIV3x
GNSS Multi-Bands Module	TESEO-LIV4x*



Cellular

Cellular connectivity	STM32x*
eSIM	ST4SIM



Asset tracking reference design by connectivity



NFC & RFID



NFC Sensor Tag
STEVAl-SMARTAG1
FP-SNS-SMARTAG1
DSH-ASSETTRACKING
ST Asset Tracking



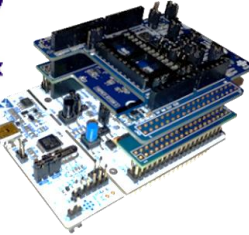
Bluetooth®
Low Energy



SensorTile.box
STEVAl-MKSBOX1V1
FP-ATR-BLE1
DSH-ASSETTRACKING
ST Asset Tracking



Sub-1 GHz



Sigfox™ Tracker
FP-ATR-SIGFOX1
DSH-ASSETTRACKING



Wi-Fi



STWiN
STEVAl-STWINKT1B
FP-CLD-AWS
DSH-ASSETTRACKING



Sub-1 GHz



LoRa® Tracker
STEVAl-STRKT01
FP-ATR-LORA1
DSH-ASSETTRACKING



Cellular & GNSS



LTE™ Tracker
FP-ATR-LTE1
DSH-ASSETTRACKING



Ecosystem

From technology to final products

Technology

Low power, small form factor, high performance & smart chip



Firmware

Fast, affordable development & prototyping

SW compatibility across our product portfolio



STEVAL/DEMO

Wide range of Reference designs

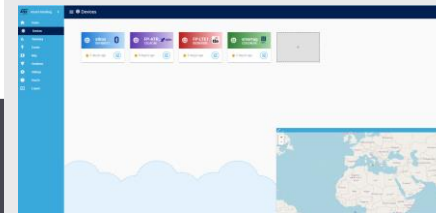
System solutions optimized for key application design



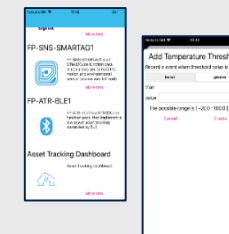
Software Tools

Solutions Design & SW Tools

Cloud dashboard



Mobile App



Partner Program



Service Integrator

Cloud and Service Provider

Network Provider

System Integrator

RF expert and Module Makers

HW/FW products

End-to-end Proof of Concepts Asset Tracking

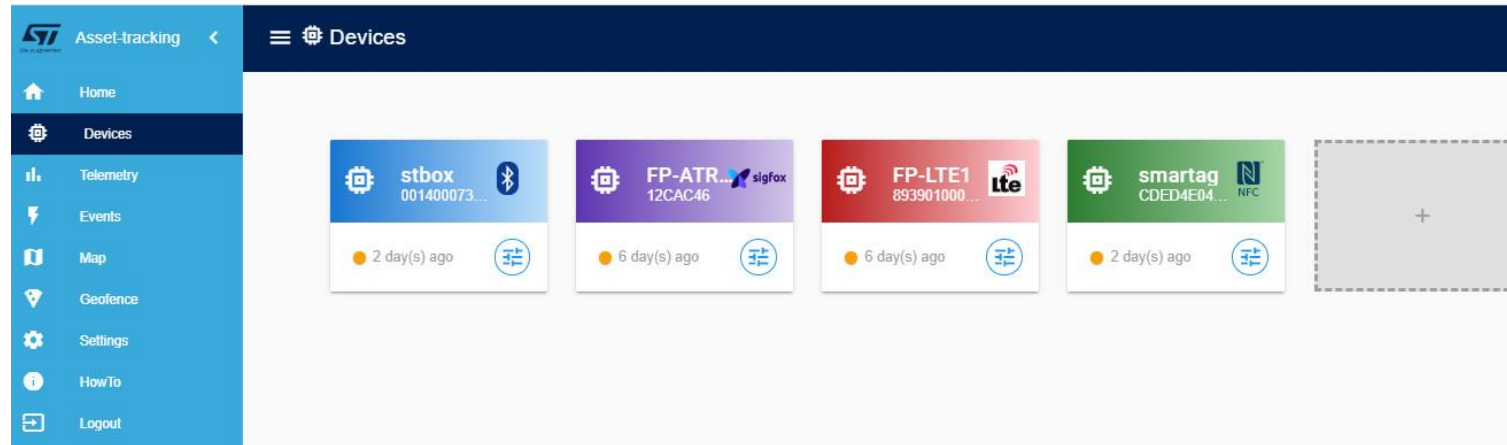


ST asset tracking Cloud dashboard

DSH-ASSETTRACKING



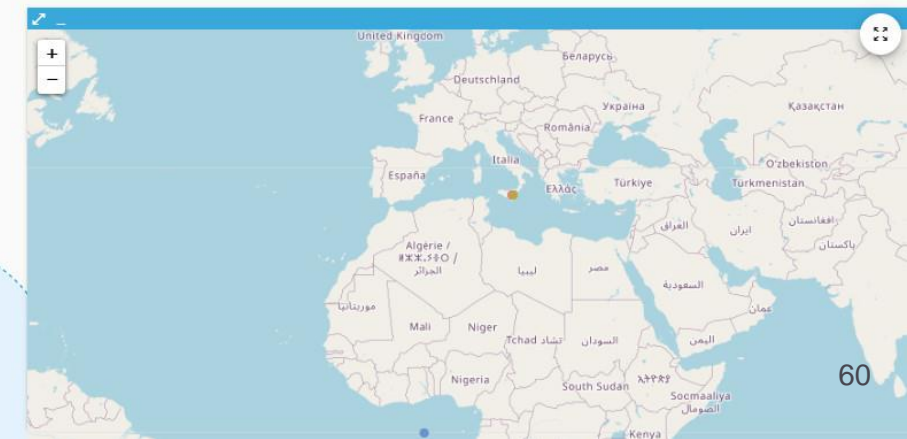
<https://dsh-assettracking.st.com/>



Alert on custom event

Geo-localization

Plotting on chart the data telemetry coming from a selected device



Our technology starts with You

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