Eval kits and Development Platforms for MEMS Sensors: A Comprehensive Environment for Fast Go-to-Market

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Technology Tour 2019

Dallas-Richardson, TX | March 7

This session will explore:

✓ IoT Discovery Kit

✓ SensorTile Development Kit

✓ BlueNRG-Tile: Bluetooth LE-enabled sensor node development kit

✓ STM32 Nucleo Expansion boards

✓ Professional MEMS tool: ST MEMS adapter motherboard

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ST: Products & Ecosystem
to Match IoT Market Trends

Market Trends

Smart Things		Smart Home		Smart City		Smart Industry	

Ultra-low power, Form Factor, Sensors Performance…

Wifi, BTLE, sub-GHz, Sensors, Audio, Touch, Graphics…

LTE, Sub-GHz, Motion Sensors

Longevity, Certification, motion sensors…

ST Offering

Broad Technology Offer

Power

Secure

Translate

Process

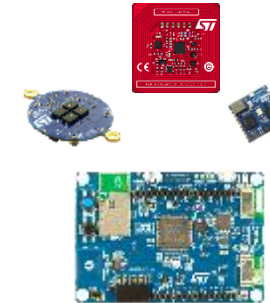Connect

Move / Actuate

Sense

Ecosystem for application development

STM32 Nucleo development kits

STM32 Nucleo expansion boards for connectivity, sensing, actuating

NFC

Starter Kits and Form Factor Boards

STM32 Cube

STM32 Open Development Environment

Partner Program

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...but Their Needs are the Same

	Processing & Security	Sensing & Actuating	Connectivity	Signal Conditioning & Protection	Power & Energy Management
Smart Things	Ultra-Low Power to High Performance

Scalable Security solutions | Full range of sensors and actuators | 10 cm to 10 km | Nano Amps to Kilo Amps | Nano Watt to Mega Watt |
Smart Home					
Smart City					
Smart Industry					

Internet of Things

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MEMS and Analog Empower the IoT

Sense	Actuate	Sensor Interface	Power	Signal Conditioning	Connectivity	Security	Processing

MEMS | **Analog** | **Digital**

Sensors ←——— Sensors to Cloud ———→
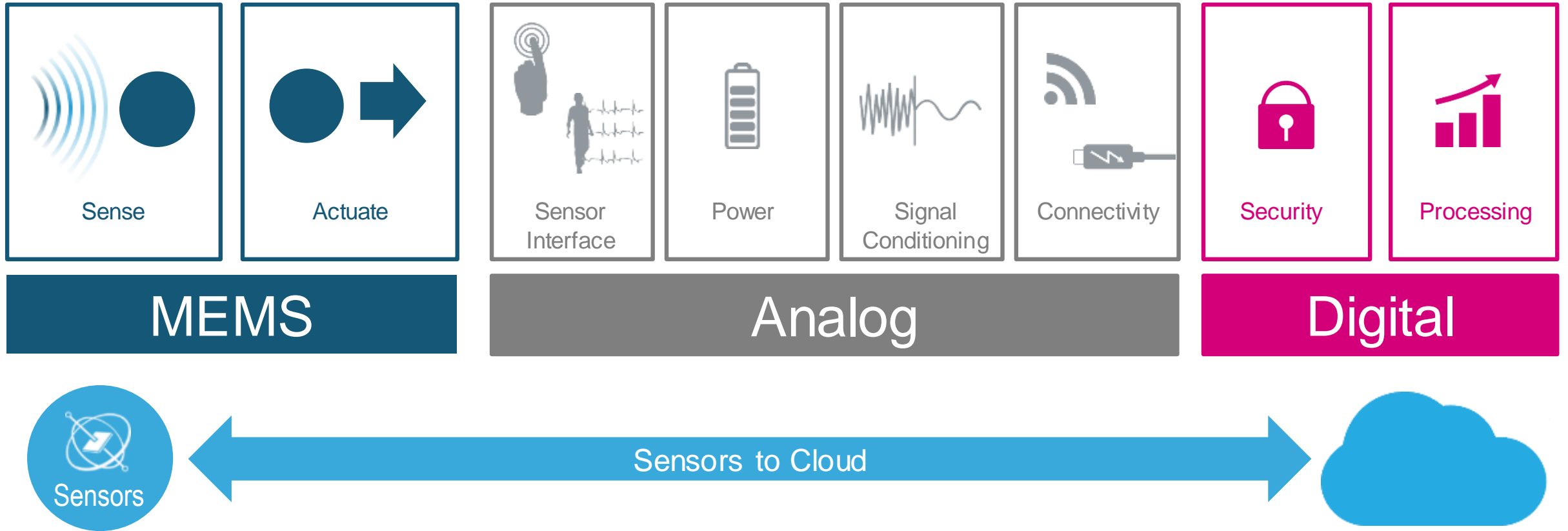
Today only a tiny portion of the sensory data that would be useful is captured, stored and analyzed

…and even smaller part of that is used to carry out actions through actuators

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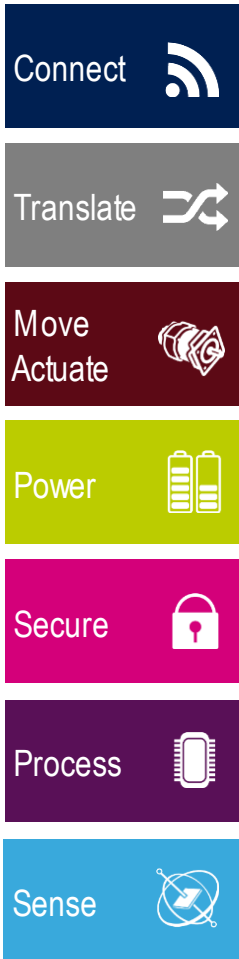# Supporting the IoT Movement

Connect

Translate

Move Actuate

Power

Secure

Process

Sense

SensorTile

BlueNRG-Tile

ProfiMEMS

Discovery Kit IoT Node

STM32 Nucleo Development & Expansion boards

Pre-integrated SW for vertical applications

Smart Things

Smart Home

Smart City

Smart Industry

Development Ecosystem

Code generators

Prototyping software

Development environments

Debug solutions

Simulation and analysis tools

On-line design tools

ST Community

Partner Program

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>150 Partners... and Counting

Cloud | Components and Modules | Embedded Software | Engineering Services | Hardware Development Tools | Software Development Tools | Training

IoT Discovery Kit

Get connected seamlessly!

Smart Nodes

Network Servers
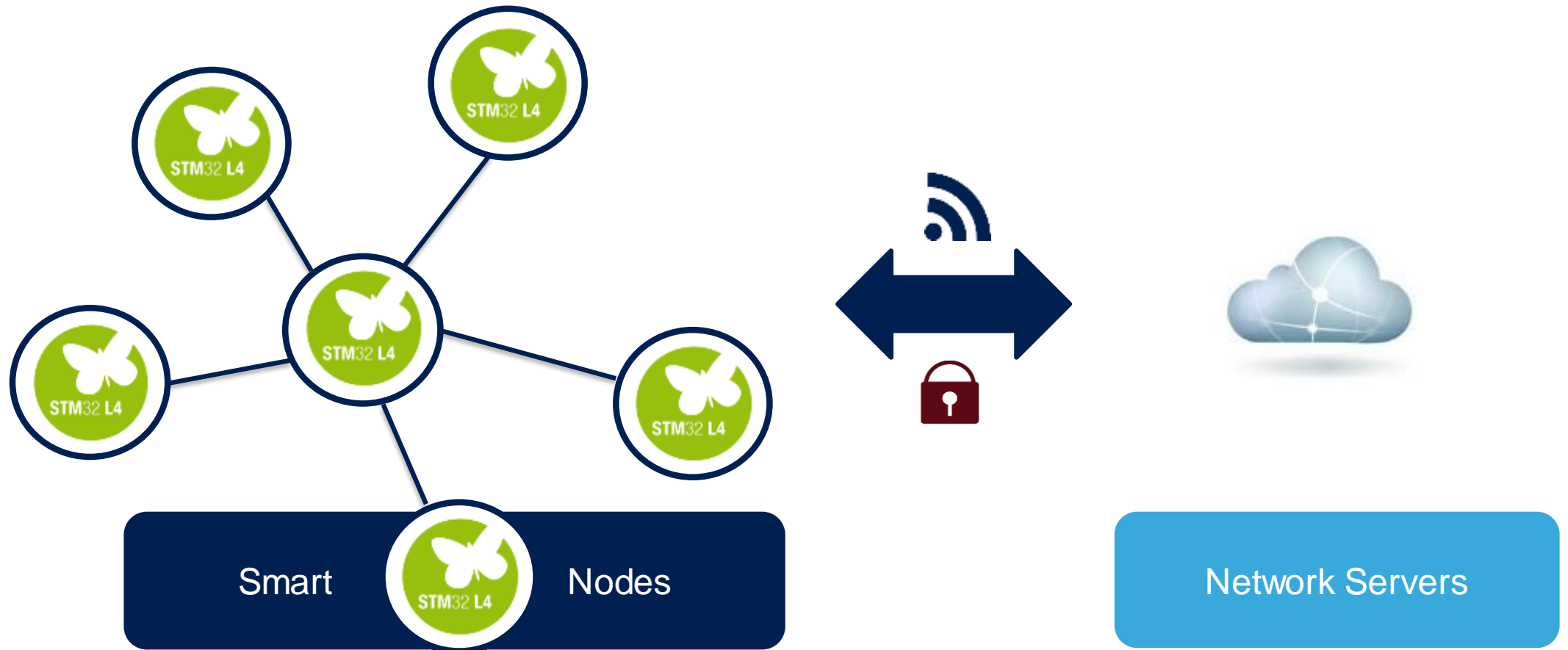
STM32L4 Discovery Kit IoT Node

Open the door to remote services

Direct connection to cloud servers

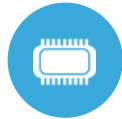Low-power long-range communication

Environmental awareness: humidity, pressure, temp

Detection hub: motion, proximity, audio

All-in-One IoT Development Platform

Motion sensors

Environmental sensors

MEMS Microphones

Proximity sensor

Dynamic NFC Tag

Low Power MCU

Sensors Fusion

Bluetooth Low Energy

Sub 1GHz

Wi-Fi

B-L475E-IOT01A

STM32 L4

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STM32L475 Discovery Kit IoT Node

STM32 L4

Wi Fi

USB OTG

ARDUINO

LED

ST LINK

3GPP Arduino Extensions for LTE Cat-M / NB-IoT

User Button

Reset Button

NFC EEPROM

Time of Flight Proximity Sensor

Humidity Temperature

Accelerometer Gyroscope

Pressure

Sub GHz

STM32L475VG

MEMS Microphone

Bluetooth® Low Energy

Magnetometer

MEMS Microphone

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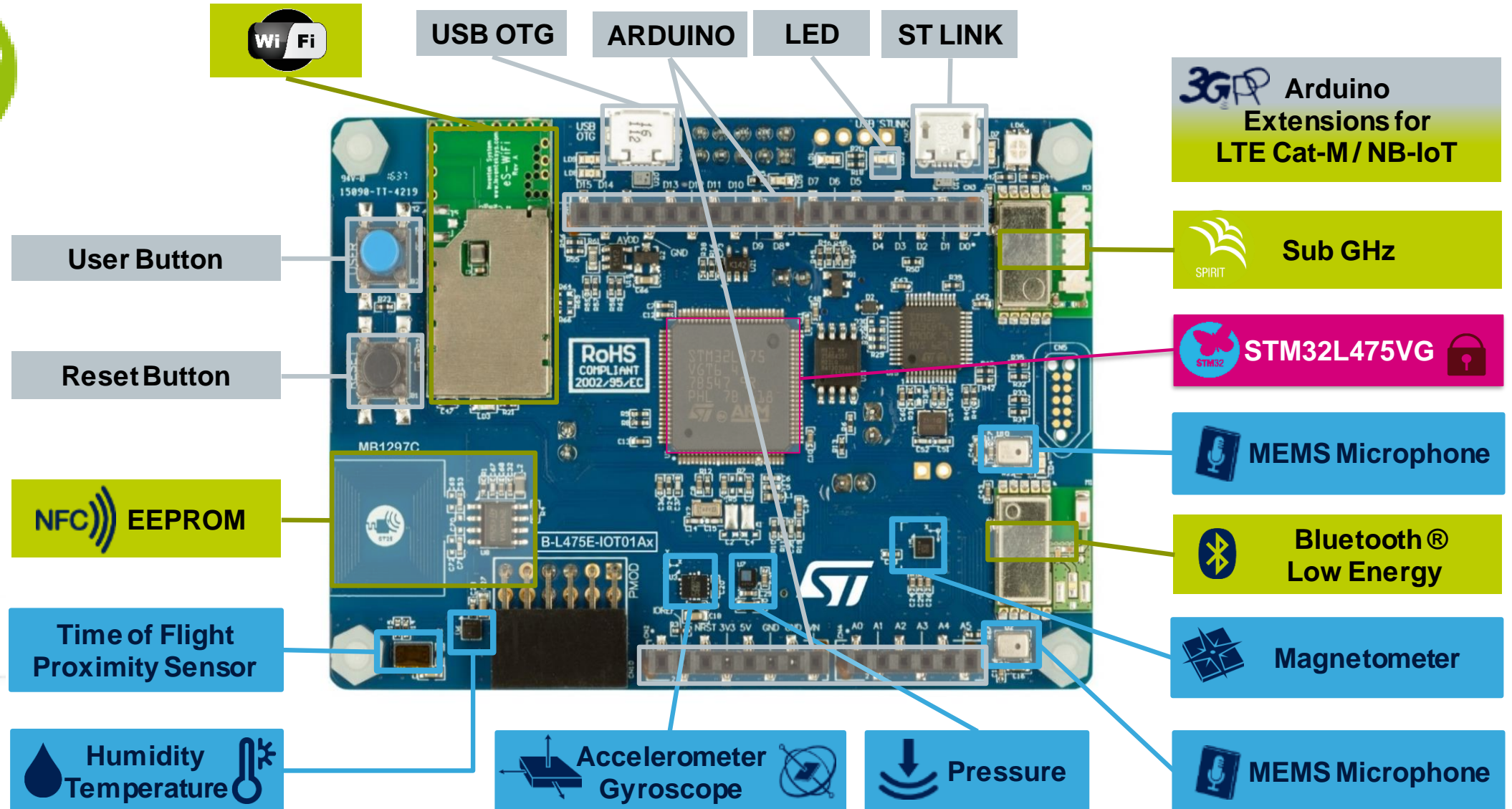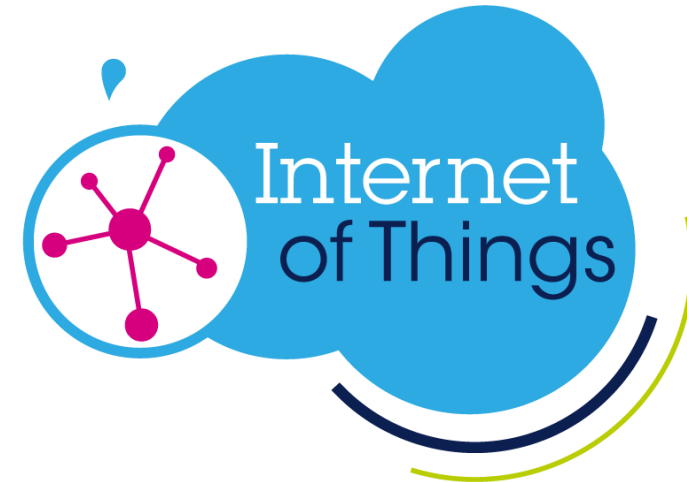
Cloud Connected IoT Sensor Nodes

- Amazon AWS IoT
  - X-CUBE-AWS
  - FP-CLD-AWS and Web Dashboard
  - Amazon FreeRTOS

- Microsoft Azure IoT
  - FP-CLD-AZURE1
  - STM32ODE IoT Web Dashboard
  - X-CUBE-AZURE

- Google Cloud IoT Platform
  - X-CUBE-GCP

- IBM Watson IoT
  - X-CUBE-WATSON
  - FP-CLD-WATSON1

ST provides device kit and FW packages to connect to the major Cloud providers

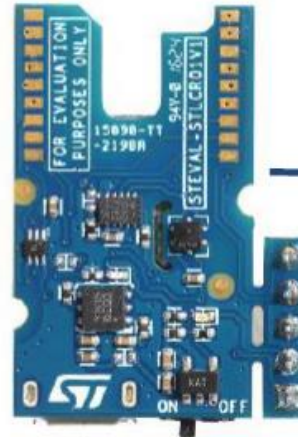# SensorTile

SensorTile
Core System
STLCS01V1

SensorTile
Cradle Board
STLCR01V1
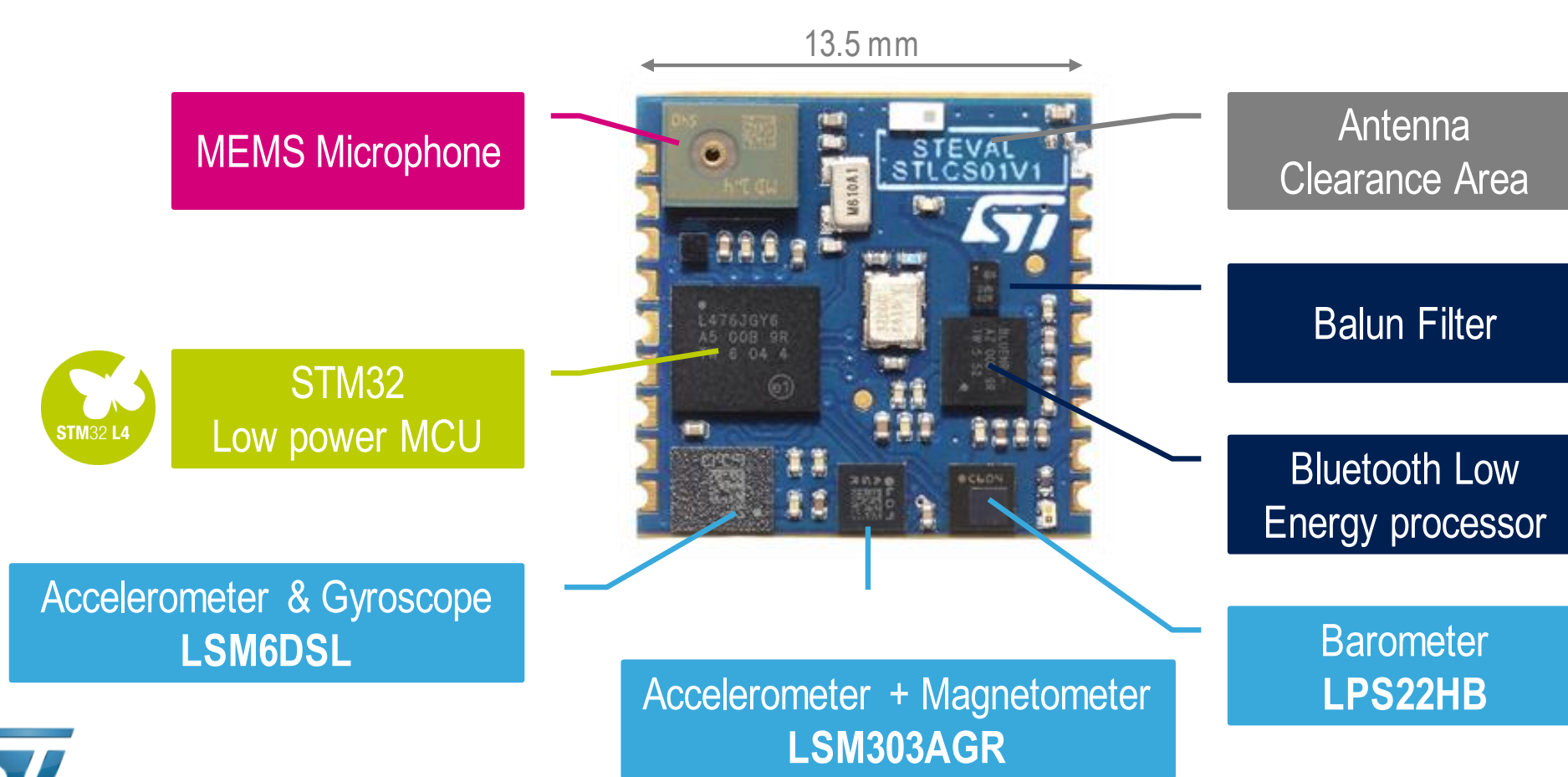
SensorTile
Cradle eXpansion
STLCX01V1

STEVAL-STLKT01V1

SensorTile kit
Connectable sensor node

SENSORTILE

CRADLE

BATTERY

PROGRAMMING CABLE

CRADLE EXPANSION BOARD

PLASTIC CASE

www.st.com/sensortile

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Sensors, MCU, Connectivity

SensorTile Development Kit: STEVAL-STLKT01V1

Bottom View

13.5 mm

MEMS Microphone

STM32
Low power MCU

STM32 L4

Accelerometer & Gyroscope
LSM6DSL

Accelerometer + Magnetometer
LSM303AGR

Antenna
Clearance Area

Balun Filter

Bluetooth Low
Energy processor

Barometer
LPS22HB

BlueNRG

Bluetooth SMART

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Sense
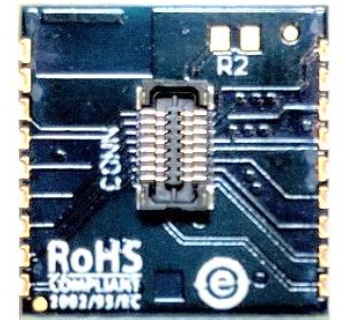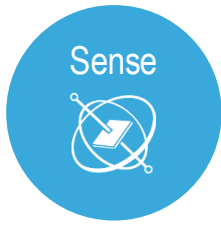
High performance 6-axis IMUs

- 3D accelerometer and 3D gyroscope

- "Always-on" experience with <0.7mA

- Smart features: FIFO, Sensor hub, Pedometer, Motion detection etc.
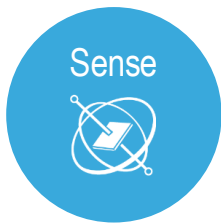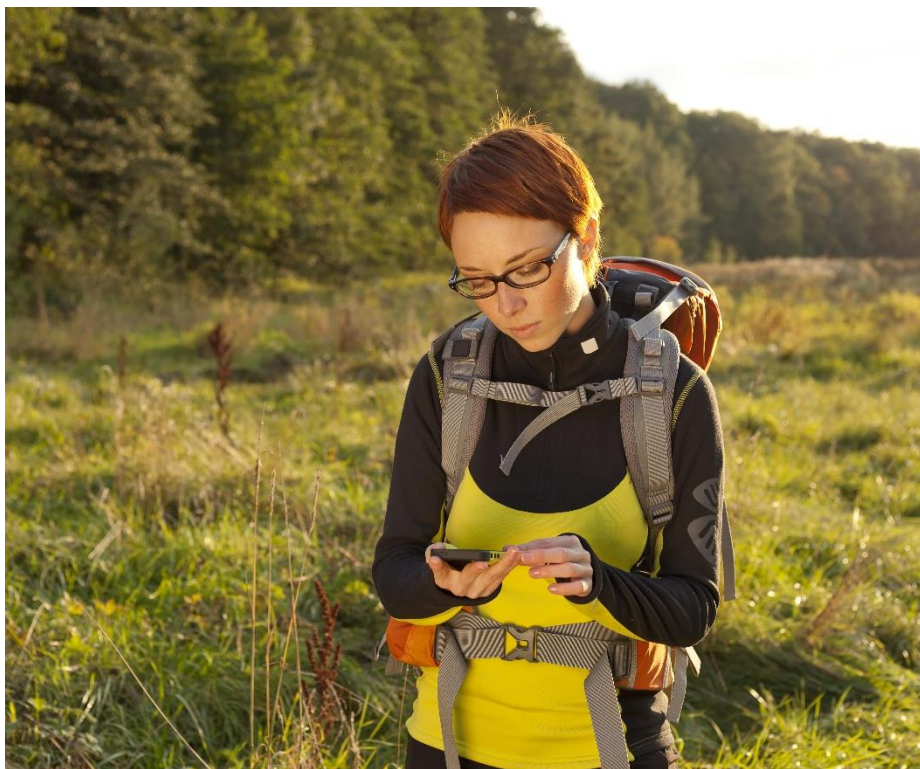
LSM6DSL and LSM6DSM enabling always-on low-power features for an optimal motion experience for the user.
It is a system-in-package featuring 3D accelerometer and 3D gyroscope performing at 0.65 mA in high-performance mode.
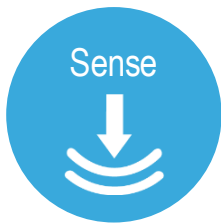
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Ultra-high accurate e-compass / magnetometer

- Extended dynamic range: 50Gauss

- Low power: 200µa @20hz

- Very low noise: 2.5mGauss

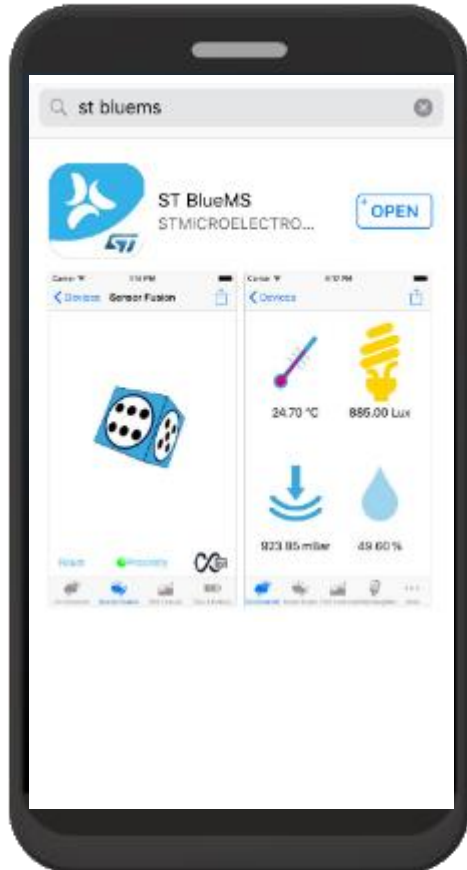**LSM303AGR and LIS2MDL enabling high performance Magnetic field measurement** by offering High Full Scale Magnetometer, Flexibility resolution vs. power consumption, Magnetic offset cancellation embedded in a standard pinout 2 x 2 mm package

High accuracy barometric sensor

- Low noise: down to 20µbar & 7.5µbar (LPF)

- High accuracy: 6cm with OPC

- Reduced current consumption: 12µA (low noise) to 3µA (low power) @1Hz

- High stability vs Temperature: Embedded Quadratic Temperature compensation

LPS22HB enabling high performance pressure measurement by offering Low noise, High accuracy, Reduced current consumption & High stability vs Temperature in a 2 x 2 x 0.76mm package

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SensorTile & ST BLE Sensor App

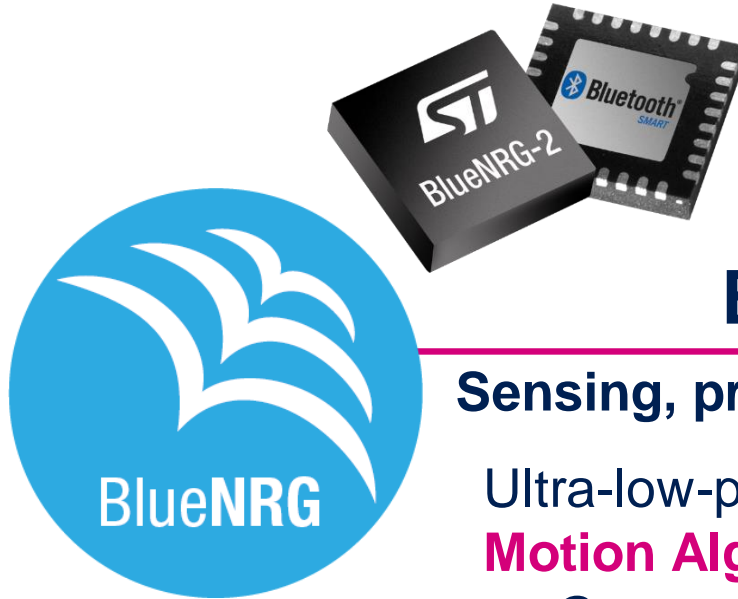**ST BLE Sensor**
(previously ST BlueMS)
STMICROELECTRONICS INC
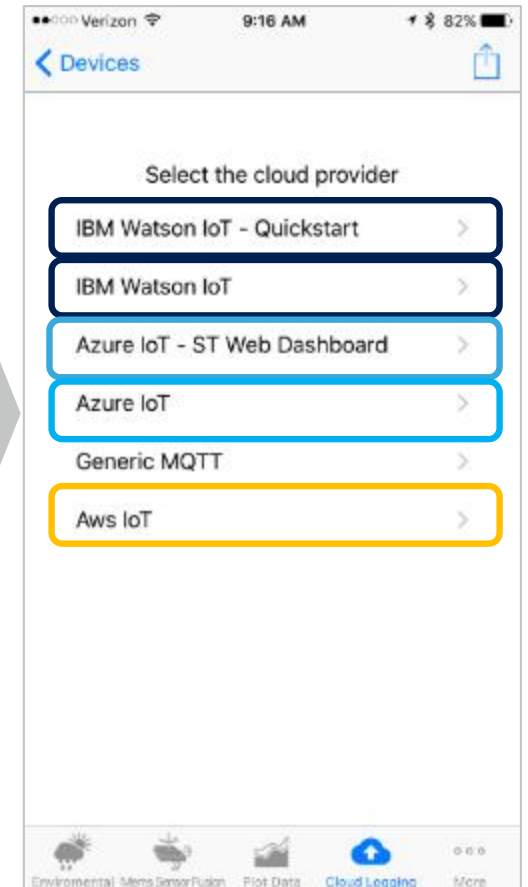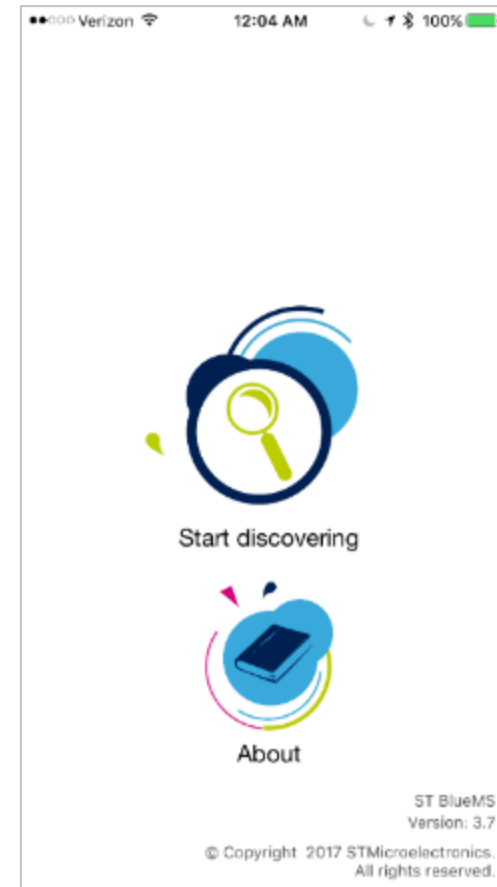
BlueNRG-Tile

STEVAL-BCN002V1B

← 2.5 cm →

BlueNRG SoC

Sensing, processing and streaming

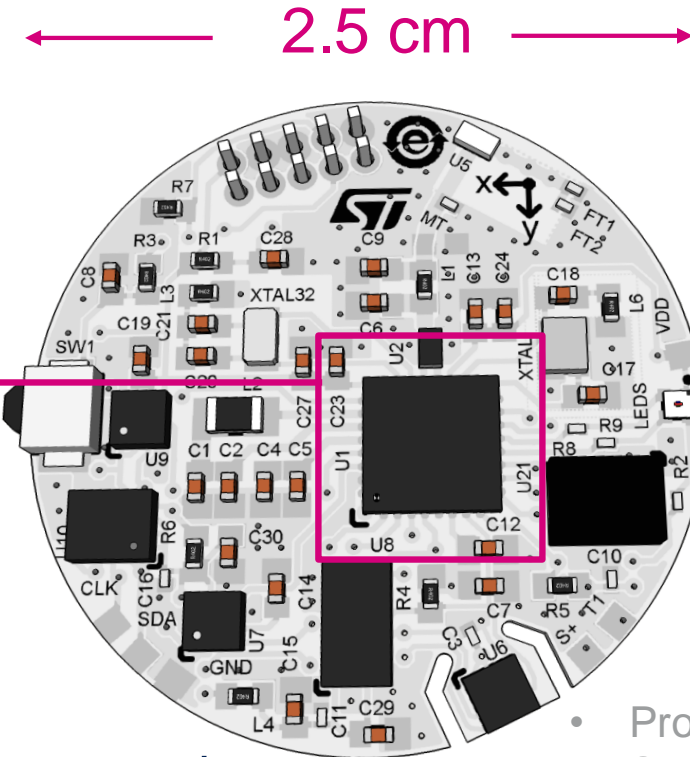Ultra-low-power software libraries for:

Motion Algorithms:
- Gesture and Activity recognition

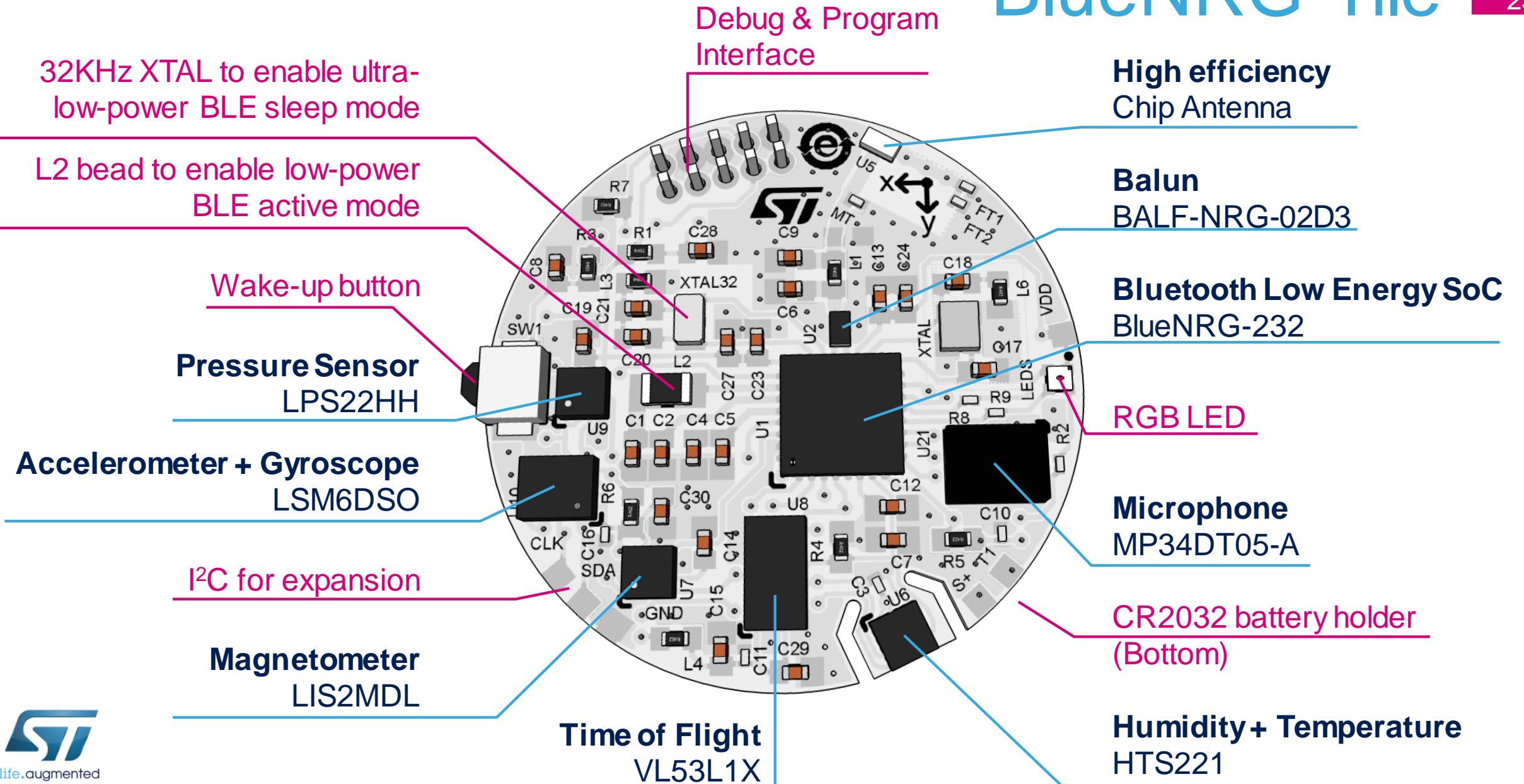**Voice over BLE:**
- High quality voice capturing and compression

BLE Mesh:
- Range-extending networks with duplex communication

- Prototypes available
- Samples in Q3 2018
- Production in Q4 2018

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32KHz XTAL to enable ultra-low-power BLE sleep mode

L2 bead to enable low-power BLE active mode

Wake-up button

Pressure Sensor
LPS22HH

Accelerometer + Gyroscope
LSM6DSO

I²C for expansion

Magnetometer
LIS2MDL

Time of Flight
VL53L1X

Debug & Program Interface

High efficiency
Chip Antenna

Balun
BALF-NRG-02D3

Bluetooth Low Energy SoC
BlueNRG-232

RGB LED

Microphone
MP34DT05-A

CR2032 battery holder (Bottom)

Humidity + Temperature
HTS221

BlueNRG-2 and MEMS Sensors

Ready-to-go Software Libraries for Voice and Motion

VOICE CAPTURE

Mic

MOTION CAPTURE

Sensors

Voice over BLE

High quality voice capturing and compression (ADPCM)
More codec supported through external host
(Speex, Opus, …)

Motion Algorithms

Lightweight 6 or 9 axis sensor fusion (up to 50Hz ODR)
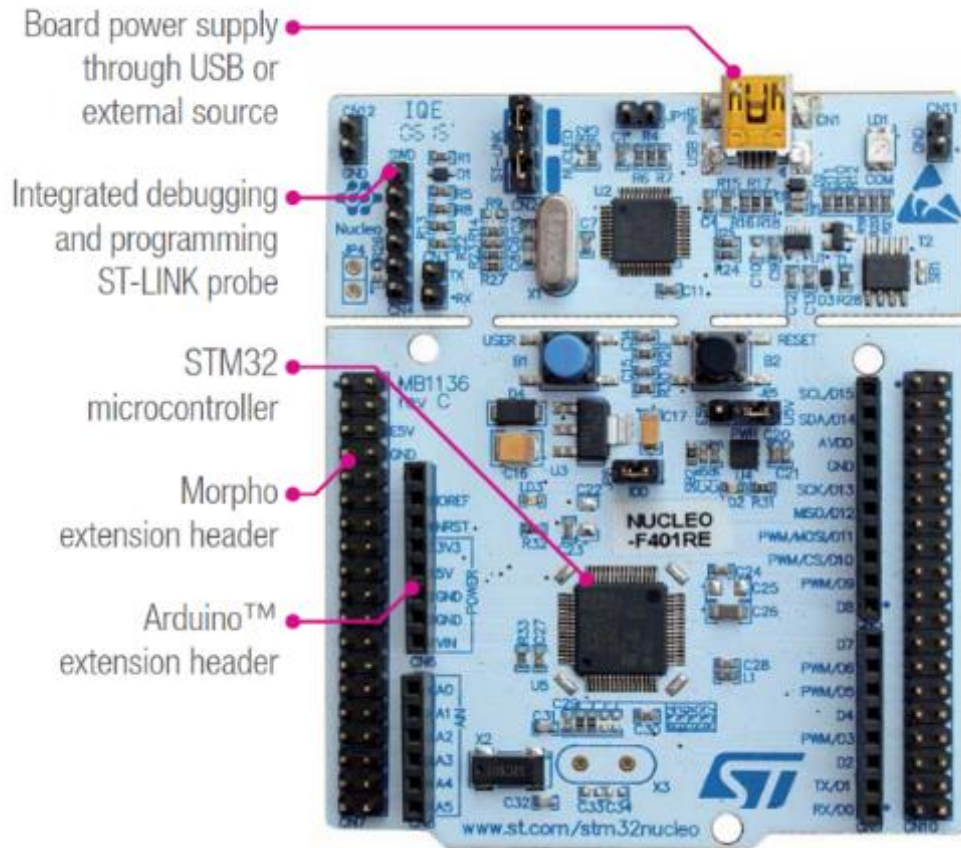and gesture recognition algorithms

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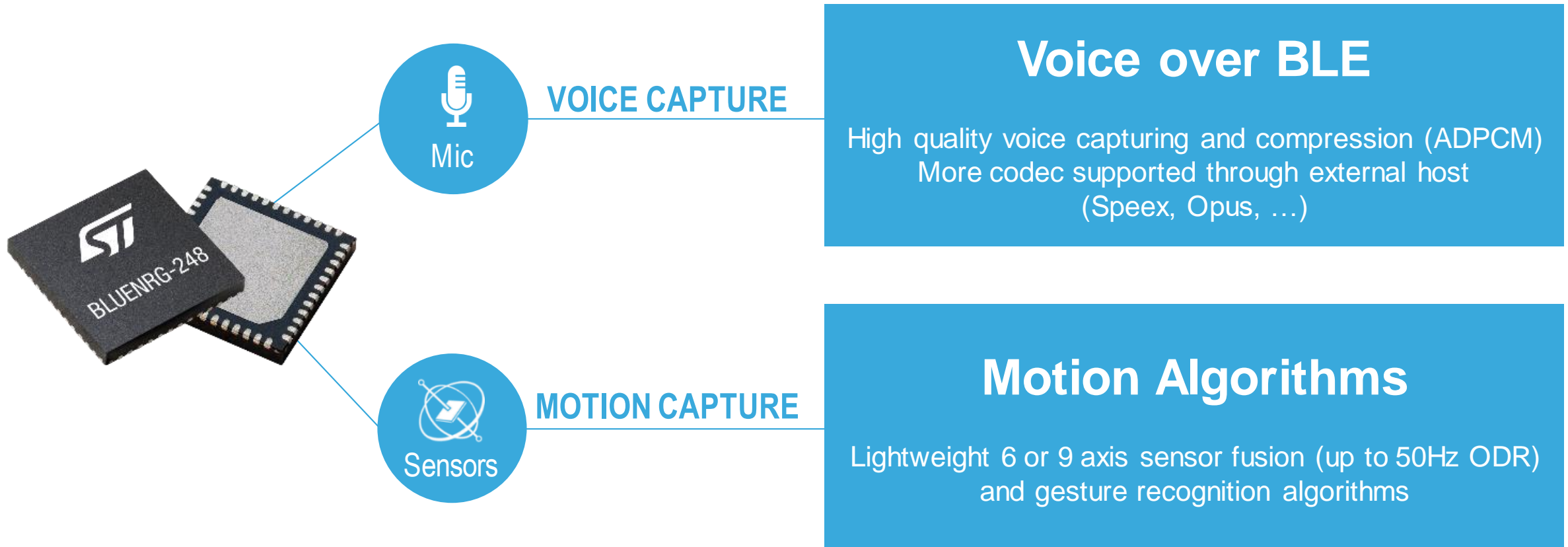
STM32 Nucleo Expansion

STM32 Nucleo Development Boards

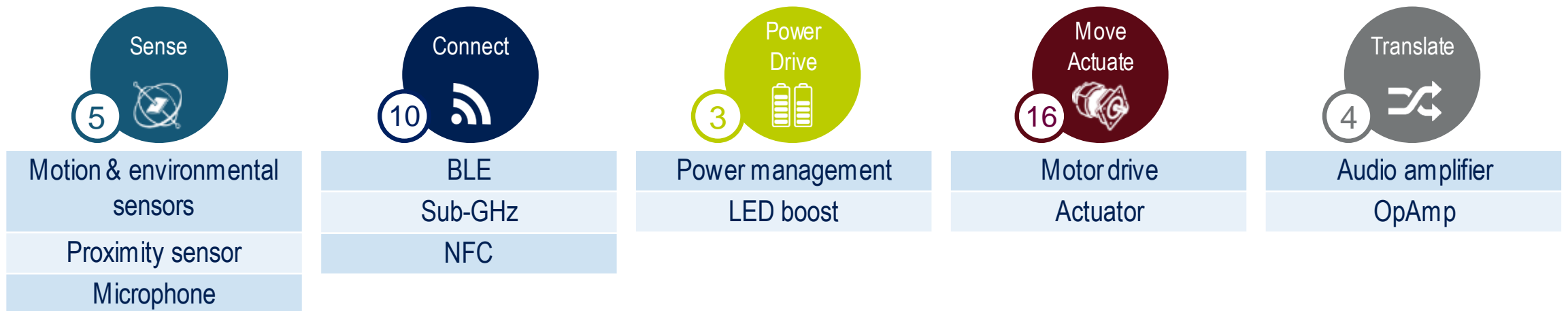27 development boards and growing… in two flavors (Processing & Security)

Board power supply through USB or external source

Integrated debugging and programming ST-LINK probe

STM32 microcontroller

Morpho extension header

Arduino™ extension header

STM32 Nucleo

STM32 complete product range
from ultra-low power to high performance

STM32 F0 | STM32 F1 | STM32 F2 | STM32 F3 | STM32 F4 | STM32 F7

STM32 L0 | STM32 L1 | STM32 L4 | STM32 H7

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38 expansion boards and growing… covering all the key functions

Sense 5

Motion & environmental sensors

Proximity sensor

Microphone

Connect 10

BLE

Sub-GHz

NFC

Power Drive 3

Power management

LED boost

Move Actuate 16

Motor drive

Actuator

Translate 4

Audio amplifier

OpAmp

An Application-Oriented Approach

Your need	The building blocks	Our answer
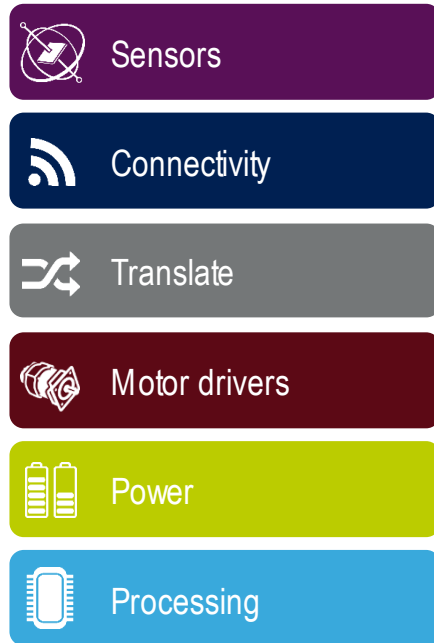
Processor boards (Nucleo 64)
Expansion boards (X-NUCLEO)

Function Packs (FP)

- Sensors
- Connectivity
- Translate
- Motor drivers
- Power
- Processing

- Motion
- Environmental
- Bluetooth LE
- Sub-1GHz
- NFC
- Op Amp
- Motor controller
- Power manager
- Microcontroller
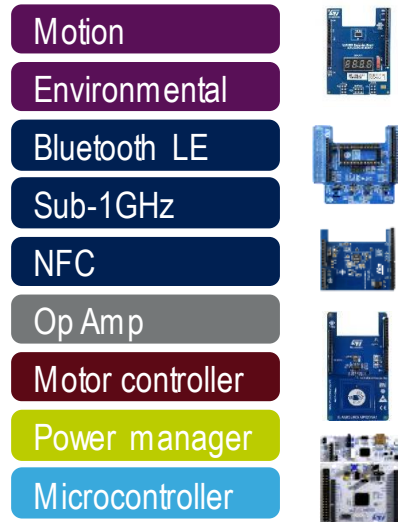
STM32 Cube

Application software and development tools	Integrated Development Environment and middleware	Ready-to-use application-oriented package

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All the Software Needed

to Start Application Coding from Day One

STM32Cube Expansion SW	STM32 ODE Function Pack

- Prototype with a single expansion board
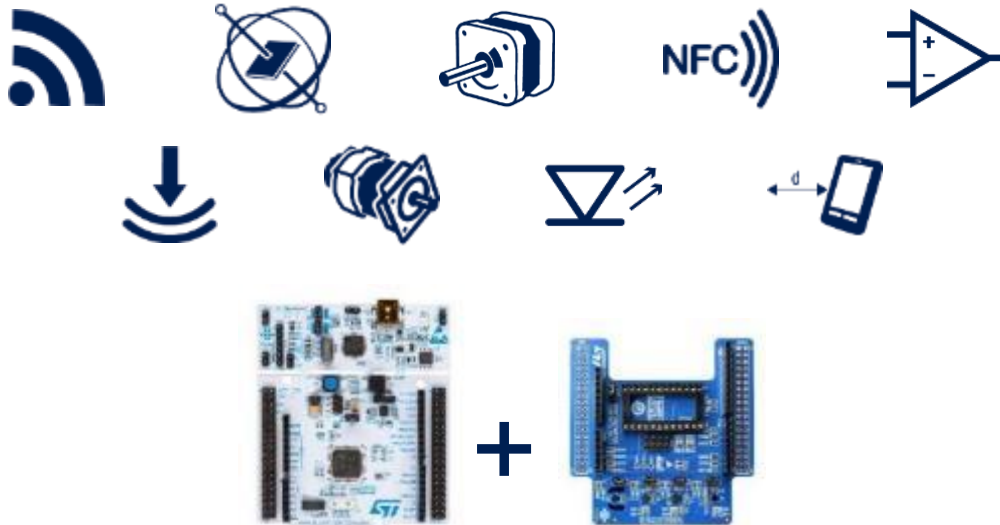
- Create advanced use cases based on multiple expansion boards

Sample applications

Pre-integrated application example

Wearables IoT Smart Things Home applications Building automation
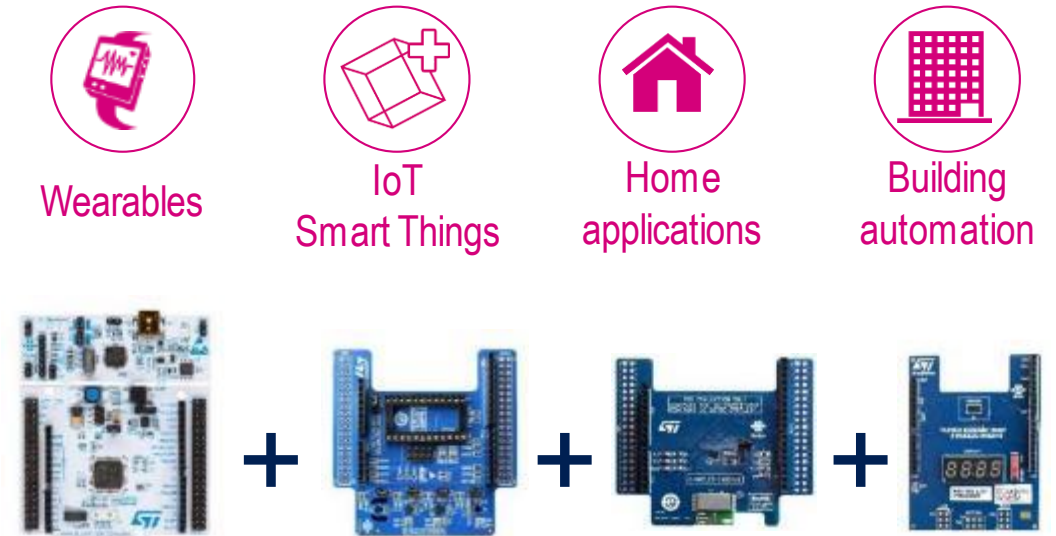
Development Software Architecture
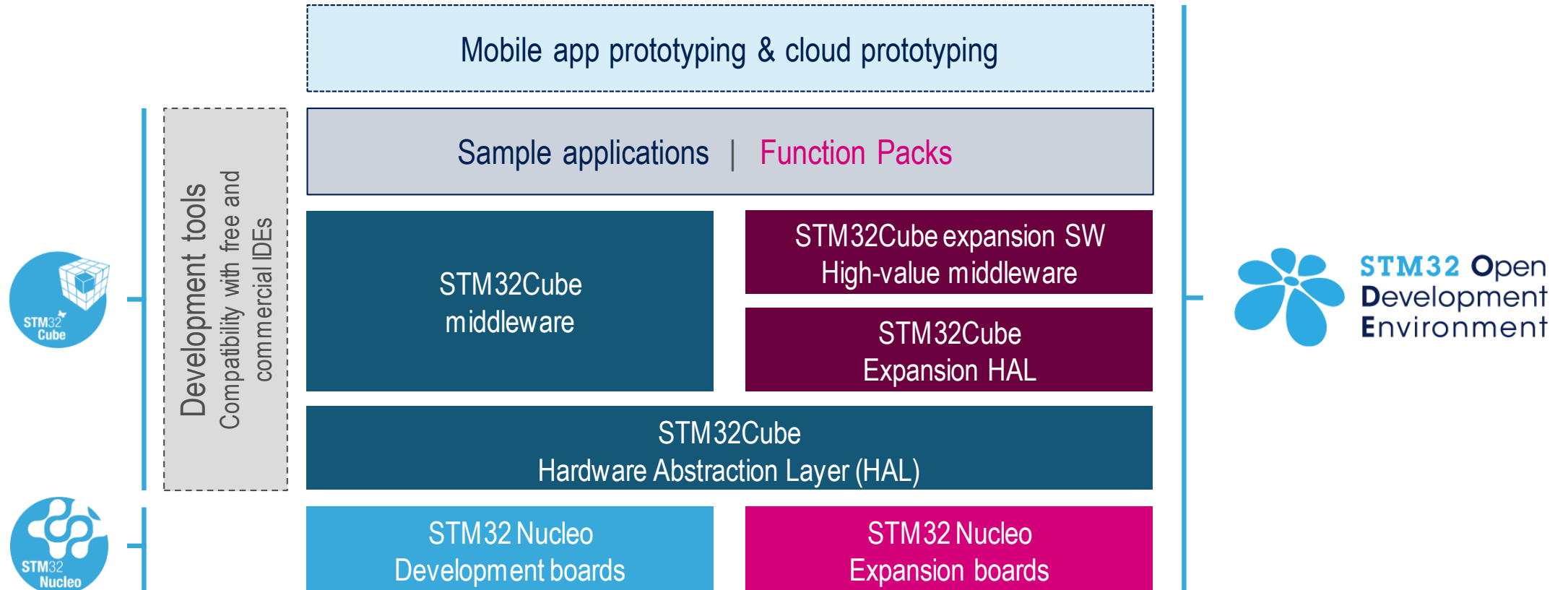
Motion MEMS and environmental sensor expansion board for STM32 Nucleo

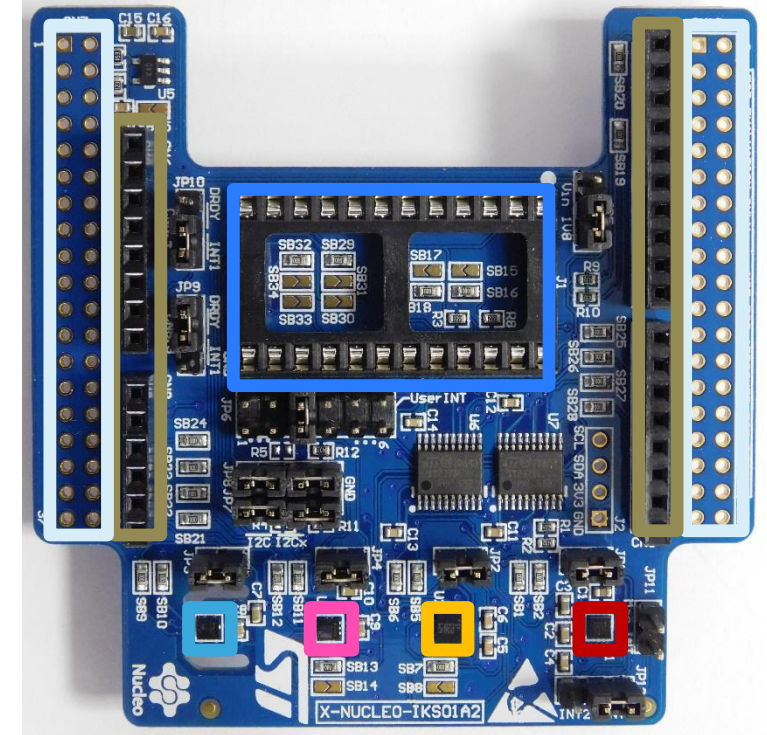- It is compatible with the Arduino UNO R3 connector layout

Key products on board:

LSM6DSL: MEMS 3D accelerometer (±2/±4/±8/±16 g) + 3D gyroscope (±245/±500/±2000 dps)

LSM303AGR: MEMS 3D magnetometer (±50 gauss) + 3D accelerometer (±2/±4/±8 g /±16 g)

LPS22HB: MEMS pressure sensor, 260-1260 hPa absolute digital output barometer

HTS221: Capacitive digital relative humidity and temperature

DIL 24-pin: Socket available for additional MEMS adapters and other sensors

☐ HTS221   ☐ LSM6DSL   ☐ ST Morpho connector**
☐ LPS22HB   ☐ LSM303AGR ☐ Arduino UNO R3 connector
            ☐ DIL 24-pin

** Connector for the STM32 Nucleo Board

Info available at
X-NUCLEO-IKS01A2

Graphical User Interface

X-CUBE-MEMS1

Key features:

- Display output data from connected sensors in various views (**X-NUCLEO-IKS01A1**, **X-NUCLEO-IKS01A2**)
- Display outputs from algorithms
- Save data to comma separated (CSV) or tab separated (TSV) files
- Configure sensor output data rate and full scale
- Direct read from and writes to sensor registers
- Program NUCLEO board with selected FW
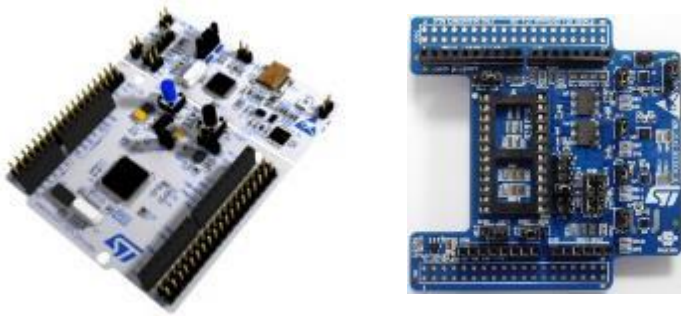- Available also for Sensor Tile & Blue Tile
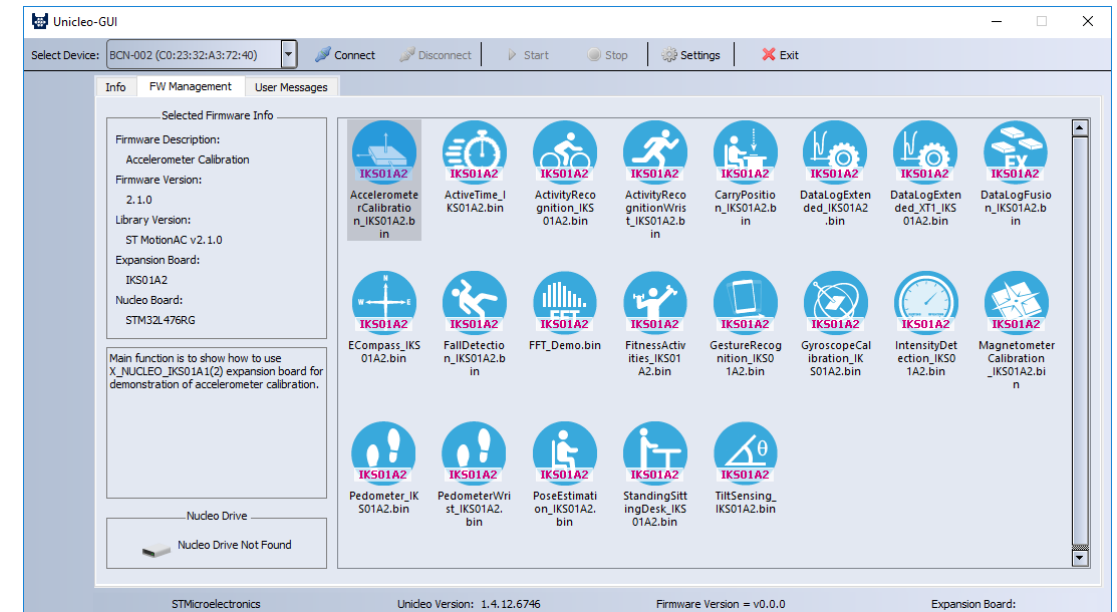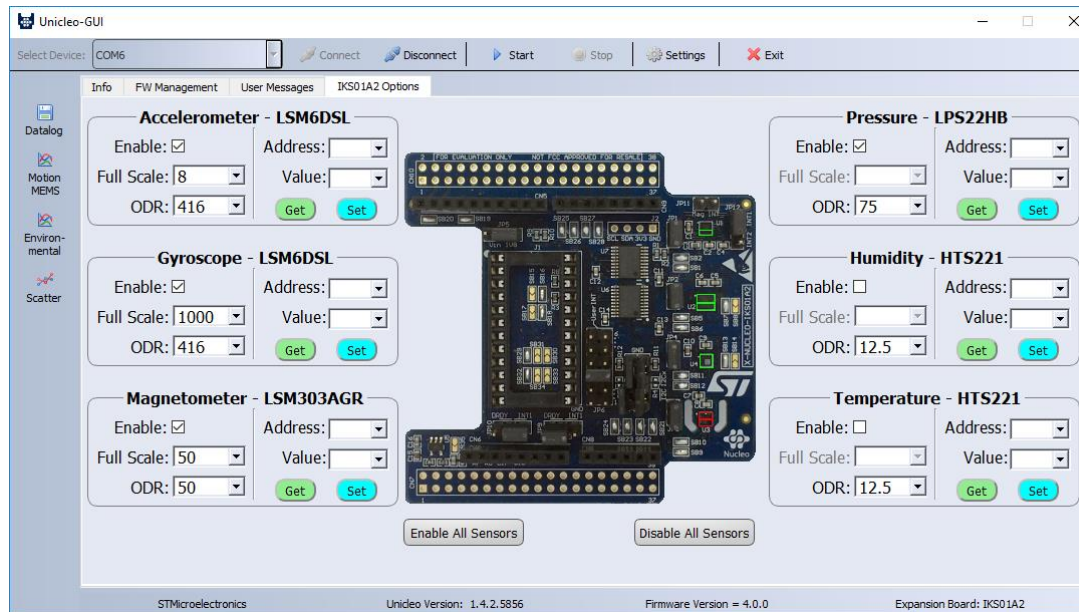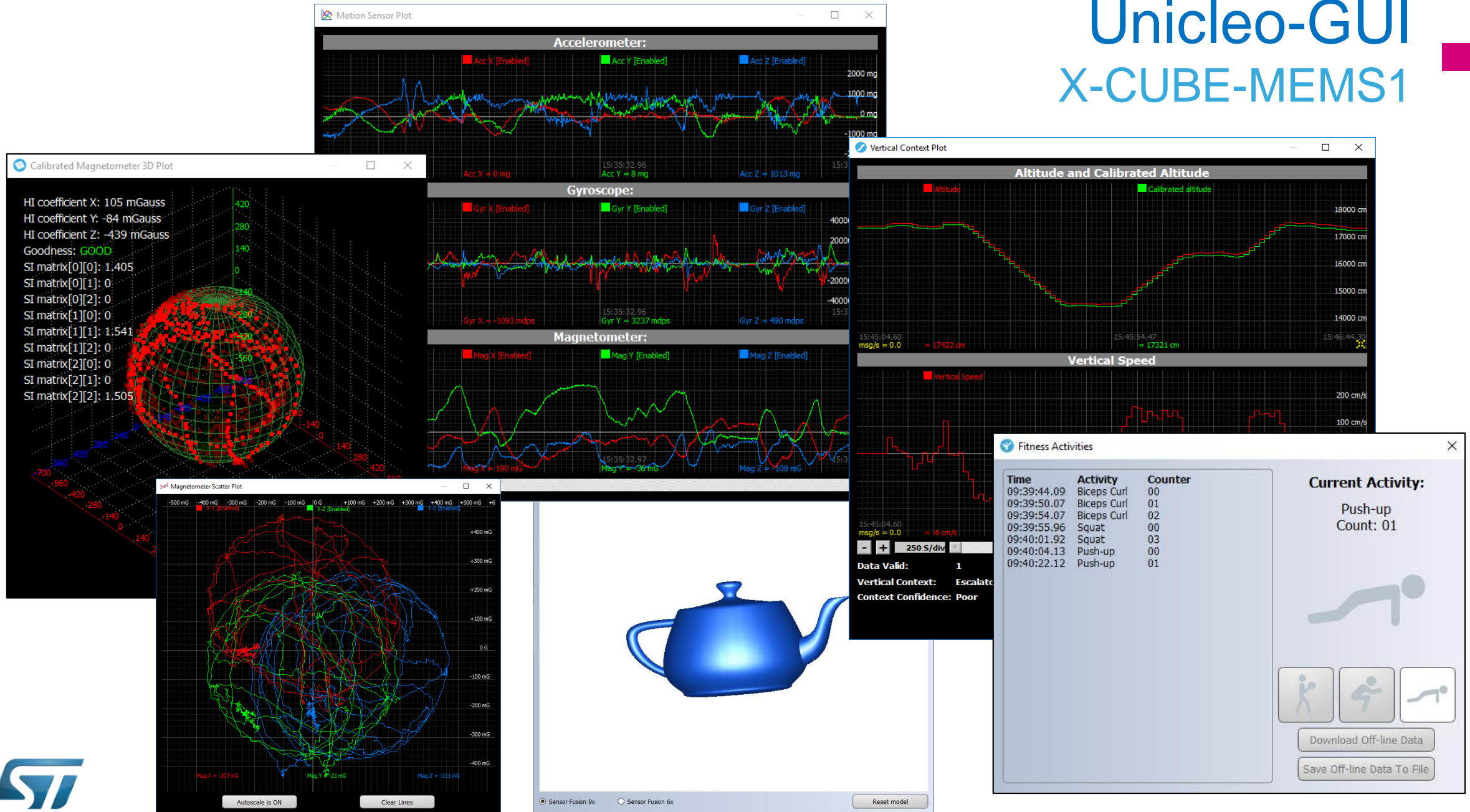
X-CUBE-MEMS1

Hardware

STM32 Nucleo + X-NUCLEO-IKS01A2
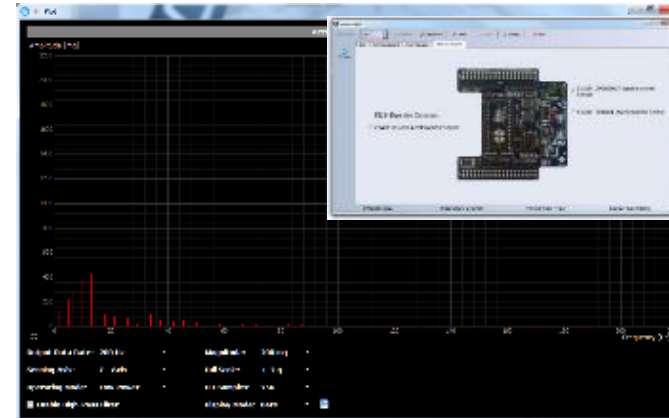

(optional DIL24 adapter)

Software

- X-CUBE-MEMS-XT1 package
  - MotionSP middleware – including both time and frequency analysis
  - FFT Demo example

Windows application: Unicleo-GUI

Serial terminal
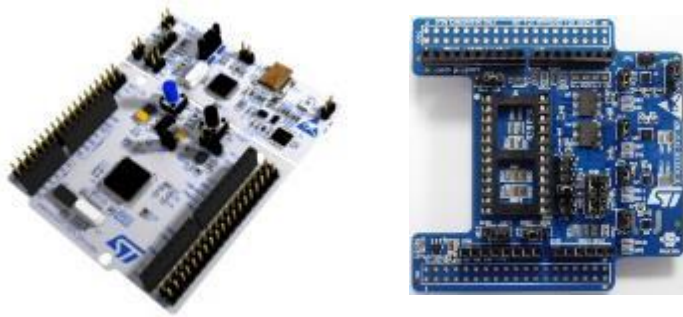
- **Hardware**

  STM32 Nucleo + X-NUCLEO-IKS01A2

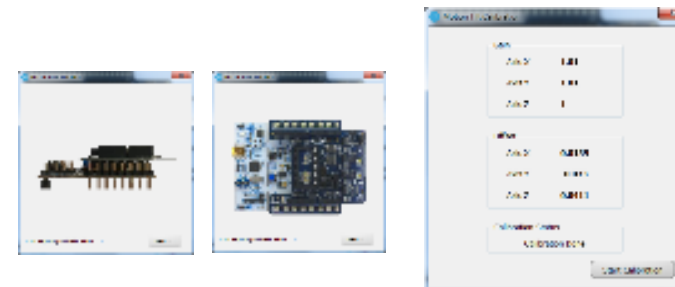 (optional DIL24 adapter)

- **Software**

  - X-CUBE-MEMS-1 package

    - MotionTL middleware – including both tilt calculation and 6-point calibration

- **Unicleo-GUI**

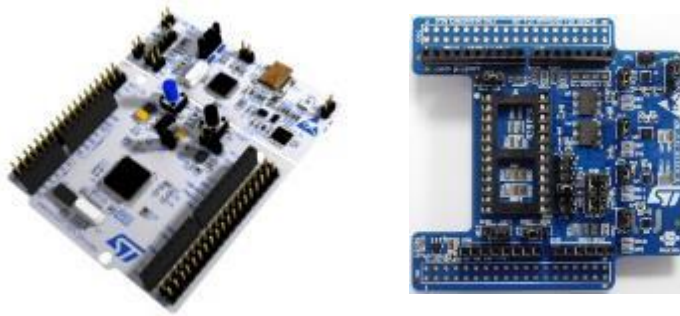 - Tilt calculation

  - 6-point accelerometer calibration

- **Hardware**

  STM32 Nucleo + X-NUCLEO-IKS01A2
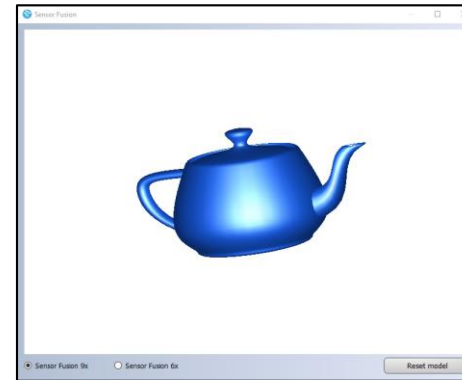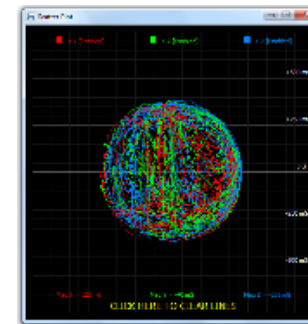
  (optional DIL24 adapter)

- **Software**

  - X-CUBE-MEMS-1 package

    - MotionFX middleware – 6 / 9 axis sensor fusion and gyroscope and magnetometer calibration

- **Unicleo-GUI**

  - Orientation in 3D space

  - Magnetometer calibration

X-CUBE-MEMS1
Ready-to-go Software Libraries for Voice and Motion

Calibration Algorithms

Magnetometer Calibration **Gyroscope Calibration** **Accelerometer Calibration**

Position Tracking

Sensor Fusion **eCompass** **Tilt Sensing**

Activity Tracking for Mobile Devices

Activity Recognition **Carry Position** **Gesture Recognition** **Pedometer** **Fall Detection**

Activity Tracking for Wrist Devices

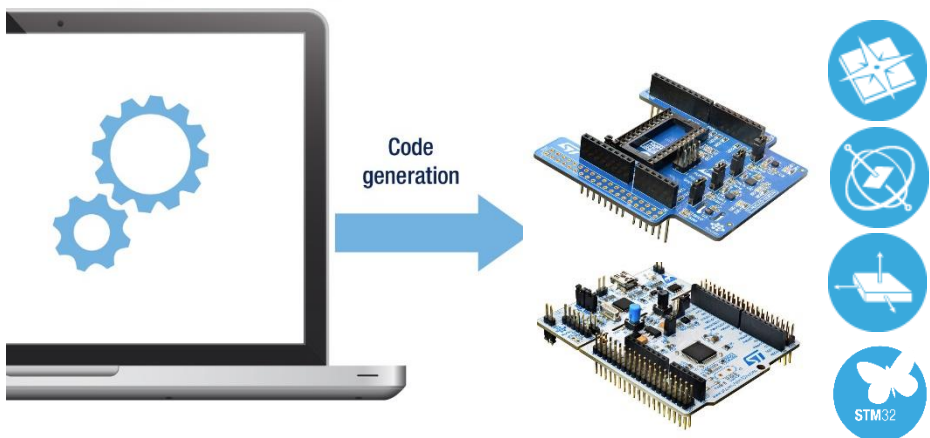**Activity Recognition for Wrist** **Pose Estimation** **Motion Intensity Detection** **Standing vs Sitting Desk Detection** **Fitness Activities** **Active Time** **Pedometer** **Sleep Monitoring**

Web Page

AlgoBuilder
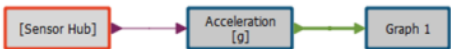
An application for the graphical design and testing of algorithms

Code generation

Existing algorithms
User-defined data processing blocks
Additional functionalities

GUI quickly elaborates proto applications
for
MEMS sensors
and
STM32 microcontrollers

AlgoBuilder
eases the process of
implementing
proof of concept
without writing the code

Web Page

Professional MEMS tool
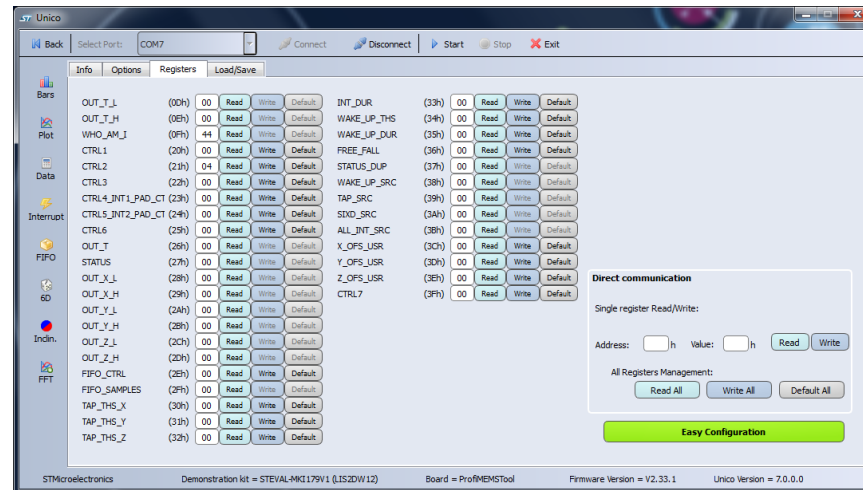
STEVAL-MKI109V3

Professional MEMS tool

- **Professional MEMS tool (STEVAL-MKI109V3)** motherboard is a complete, ready-to-use platform for the evaluation of STMicroelectronics MEMS products.

- It includes a high-performance 32-bit microcontroller which functions as a bridge between the sensors and a PC, on which you can download and run the graphical user interface (GUI) **Unico** or dedicated software routines for customized applications
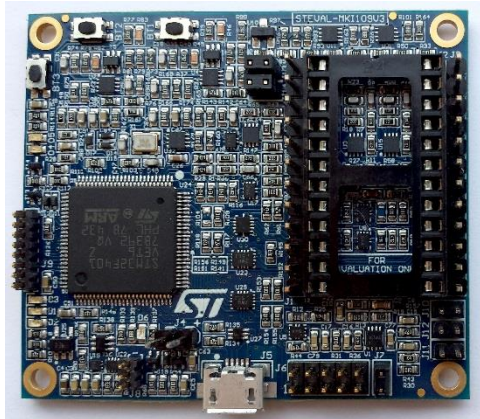
**Professional MEMS tool
(STEVAL-MKI109V3)**

DIL 24 adapter

**Unico – GUI for Windows PC
(STSW-MKI109W)**

| Part Number	Manufacturer	Description
STEVAL-MKI105V1	ST	LIS3DH adapter board for standard DIL 24 socket
STEVAL-MKI106V1		LSM303DLHC adapter board designed to be plugged into a standard DIL24 socket
STEVAL-MKI107V2		L3GD20 adapter board for a standard DIL 24 socket
STEVAL-MKI122V1		LSM330DLC adapter board for standard DIL24 socket
STEVAL-MKI135V1	ST	LIS2DH adapter board for standard DIL24 socket
STEVAL-MKI137V1	ST	LIS3MDL adapter board for standard DIL24 socket
STEVAL-MKI159V1	ST	LSM9DS1 adapter board for standard DIL24 socket
STEVAL-MKI160V1	ST	LSM6DS3 adapter board for standard DIL24 socket
STEVAL-MKI161V1	ST	LSM6DS0 adapter board for standard DIL24 socket
STEVAL-MKI163V1	ST	LSM303C adapter board for standard DIL24 socket
STEVAL-MKI164V1	ST	LIS2HH12 adapter board for a standard DIL24 socket
STEVAL-MKI165V1	ST	LPS25HB adapter board for a standard DIL24 socket
STEVAL-MKI172V1	ST	LSM303AGR adapter board for a standard DIL 24 socket
STEVAL-MKI173V1	ST	LSM303AH adapter board for standard DIL24 socket
STEVAL-MKI174V1	ST	LIS2DS12 adapter board for standard DIL24 socket
STEVAL-MKI186V1	ST	IIS3DHHC adapter board for a standard DIL 24 socket
STEVAL-MKI188V1	ST	L20G20IS adapter board for a standard DIL24 socket
STEVAL-MKI192V1	ST	LPS22HH adapter board for a standard DIL24 socket

Info available at
STEVAL-MKI109V3
STSW-MKI109W
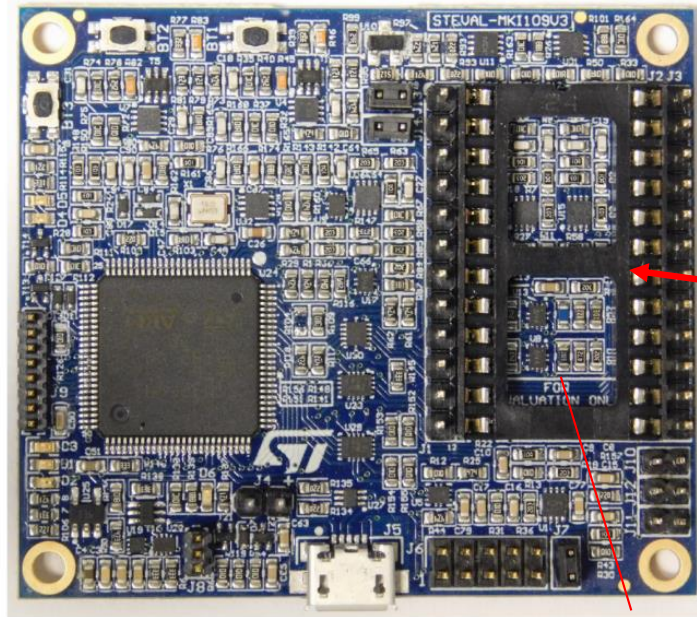
Socket Board

DIL24 Adapter
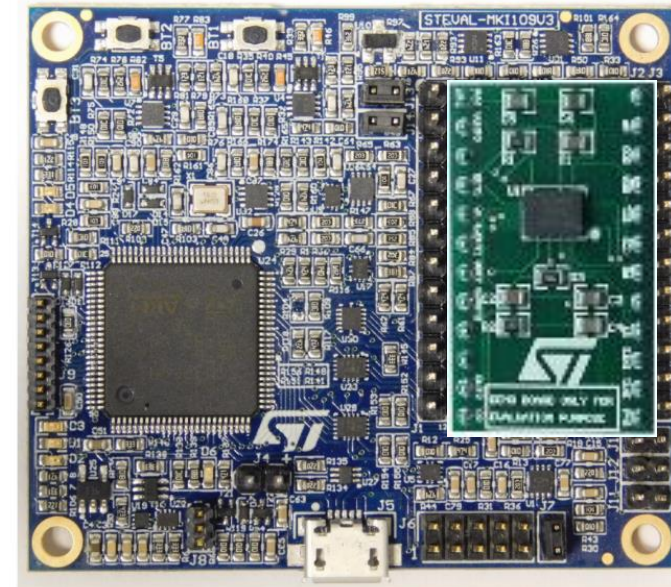
All ST MEMS sensors are available with DIL24 adapter support
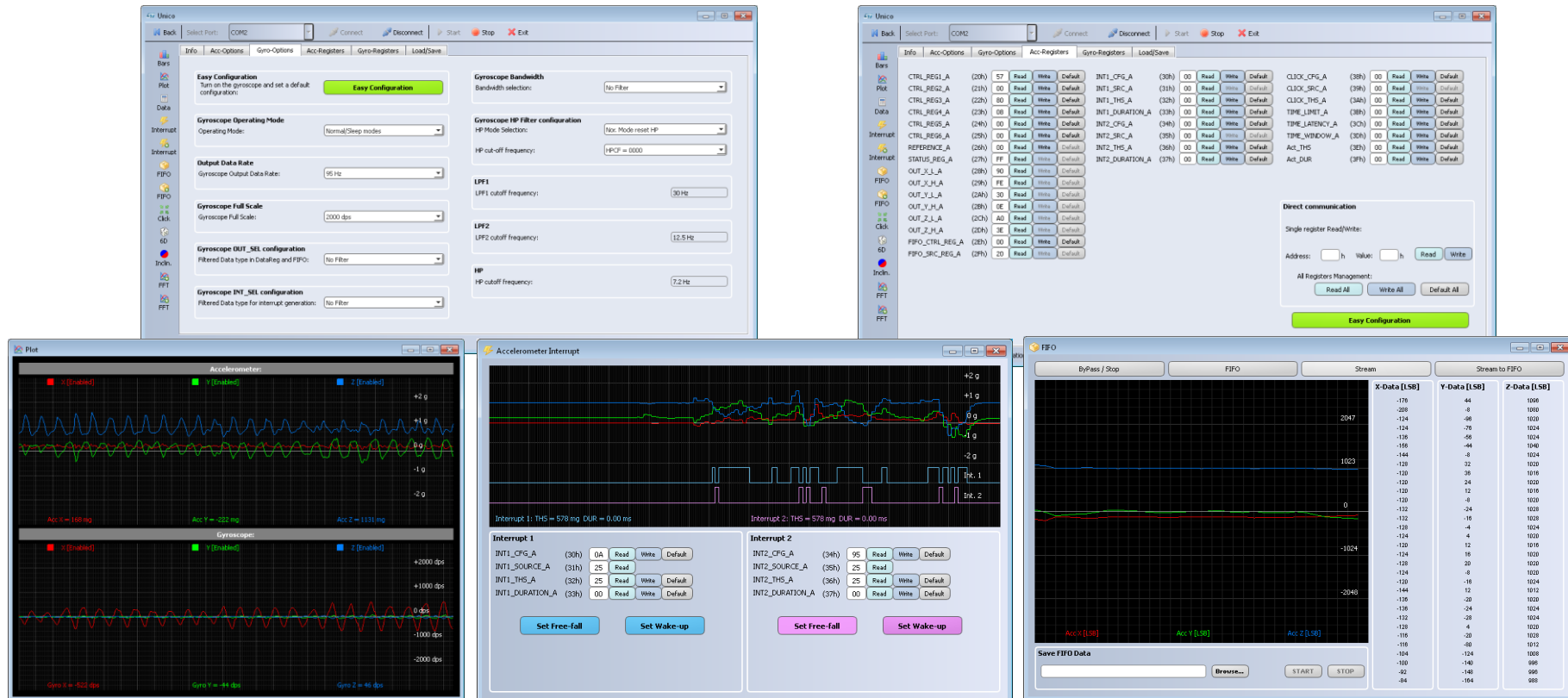The DIL24 Adapter can be placed on socket board

Professional MEMS Tool – UNICO GUI SW

Profi MEMS Tool connected with UNICO SW:

The STM32F401VE uses the STM32 microcontroller as a bridge between the sensor under test mounted on socket and the PC by USB cable.

It Is possible to use the UNICO graphical user interface (GUI) or dedicated software routines for customized applications (Virtual Com Command Line Interface) to read/write all sensor registers, plot the data, manage FIFO, set and show interrupts, set easy configuration, etc.
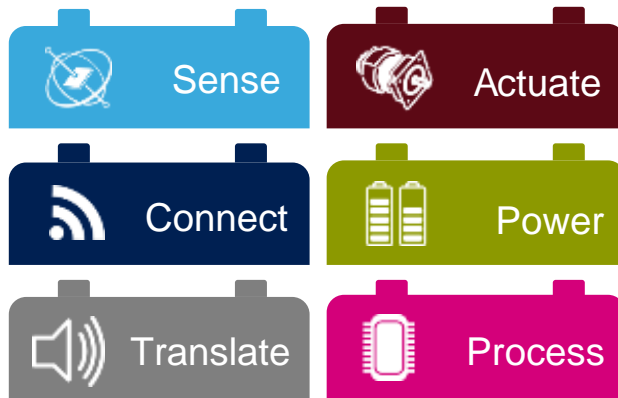
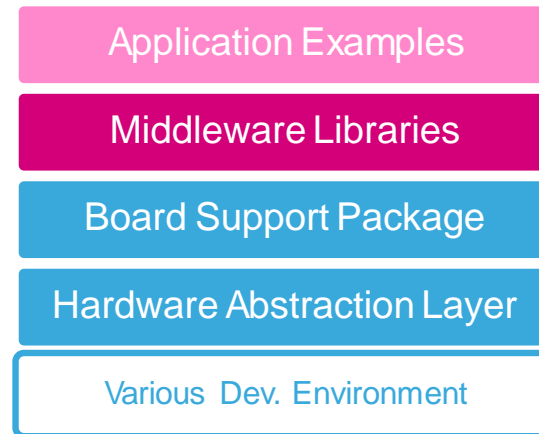# Takeaways

ST Augmenting the Development

STM32 Nucleo + **STM32 Cube** + (cloud)

Hardware bricks

Sense	Actuate
Connect	Power
Translate	Process

Software bricks

- Application Examples
- Middleware Libraries
- Board Support Package
- Hardware Abstraction Layer
- Various Dev. Environment

Cloud services

Microsoft Azure · amazon web services™ · IBM Watson · Google Cloud

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INTEGRATION

Common SW platform

3 Cloud provider SDKs supported, enabling sensor-to-cloud platforms

135 SW packages from drivers to full application examples and mobile applications

STM32 **O**pen **D**evelopment **E**nvironment

Wearable

IoT Smart Things

Smart Home

Building automation

27 STM32 Nucleo development boards
Covering the broad portfolio of STM32 MCU families

40 STM32 Nucleo expansion boards (X-NUCLEO)
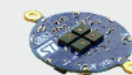Offering peripheral functions

Modular hardware

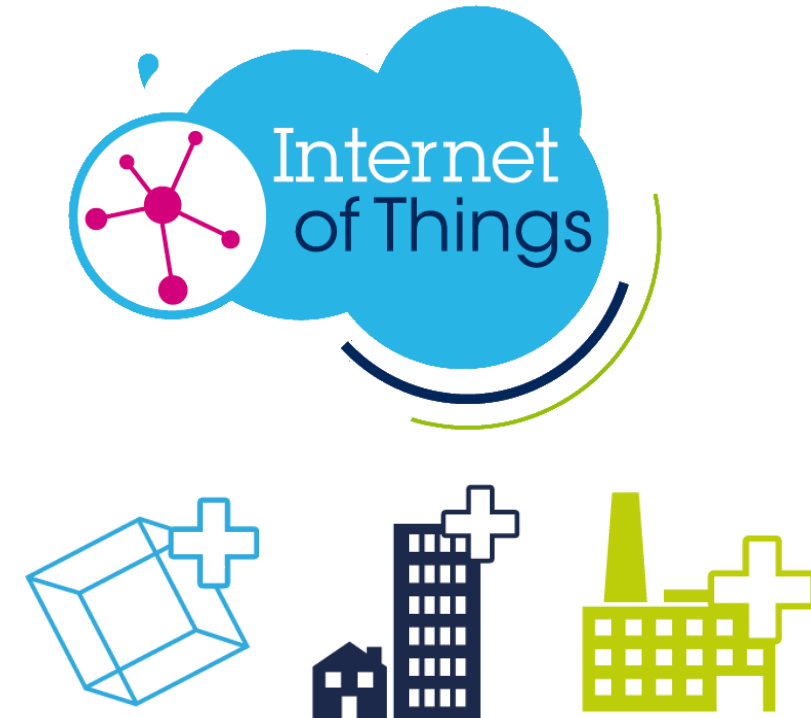## ST & 3rd-party form-factor boards

NFC Sensor TAG

SensiBLE

Bluecoin

Sensor Tile

IoT Discovery

Form factor boards

Summary

- Internet of Things offers many opportunities for ST from Sensor to Cloud

- ST offers a wide range of development platforms such as:
  - IoT Discovery Kit
  - SensorTile Development Kit
  - BlueNRG-Tile: Bluetooth LE-enabled sensor node development kit
  - STM32 Nucleo Expansion boards
  - Professional MEMS tool: ST MEMS adapter motherboard

- Our constantly expanding development ecosystem makes design fast

Thank You!

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