Wireless Industrial Node
Datalogging and condition monitoring

Typical application
and ST positioning

Sensor Tile Wireless Industrial Node
STEVAL-STWINKT1B

Predictive Maintenance function pack &
dashboard
FP-IND-PREDMNT1 & DSH-PREDMNT

Datalogging function pack
FP-SNS-DATALOG1

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Condition based monitoring typical applications

Factory Automation		Industrial motor vibration monitoring		Bearings ultrasound monitoring		Motor current monitoring
Power, Energy & Utilities		Pipe flow monitoring		Temperature, humidity, gas monitoring		Acoustic monitoring
Home Appliances and Building Automation		Compressor vibration monitoring		Washing machine, vacuum cleaner monitoring		Lighting monitoring
Structural Health Monitoring		Infrastructure inclination monitoring		Railways monitoring		Bridge vibration monitoring

ST's portfolio for condition monitoring applications
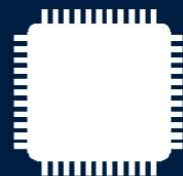
Factory Automation

Power, Energy & Utilities

Home Appliances and Building Automation

Structural Health Monitoring

Processing	Sensing & Actuating	Security
Connectivity	**Power & Energy Management**	**Signal Conditioning & Protection**

Multiple applications, one platform, one vendor

Steps to a predictive maintenance system

Data Acquisition	Condition Monitoring	Anomaly detection & classification	Predictive maintenance

Data Acquisition
- Acquisition sensor setup
- Retrieve data over wired/ wireless connectivity
- Label data
- Store data

Condition Monitoring
- Data cleaning / denoising
- Data visualization
- Preprocessing and Feature Extraction
- Feature Engineering

Anomaly detection & classification
- Machine learning of the system behavior
- Semi-supervised learning at the edge for anomaly detection
- Supervised learning to classify anomalies

Predictive maintenance
- Model deployment
- Remaining Life prediction models
- Overall efficiency optimization
- Operational systems integration

Edge - Factory Level (processed sensors data)   **Company Level (ERP, etc.)**

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Sensor Tile Wireless Industrial Node STEVAL-STWINKT1B

Motors   Equipment   Environment

Processing
Local Processing & Security
- Ultra-low-power ARM® Cortex®-M4 STM32L4R9
- Secure Element STSAFE-A110

Connectivity
Embedded Wireless and Extension
- BLE 5.0 (BlueNRG-M2) , WiFi (Inventek)
- Modular expansion: LTE, LoRa, Industrial Ethernet
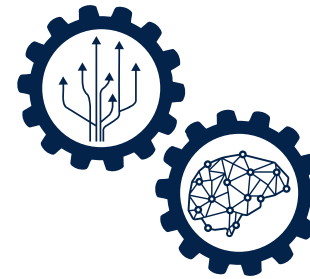
Sensing
Industrial-grade sensors for
- Vibration analysis (IIS3DWB, ISM330DHCX)
- Sound Emission up to 80 kHz (IMP23ABSU)
- Environment monitoring (HTS221, STTS751, LPS22HH)

Power
Power Management
- Li-Ion linear battery charger with load switches
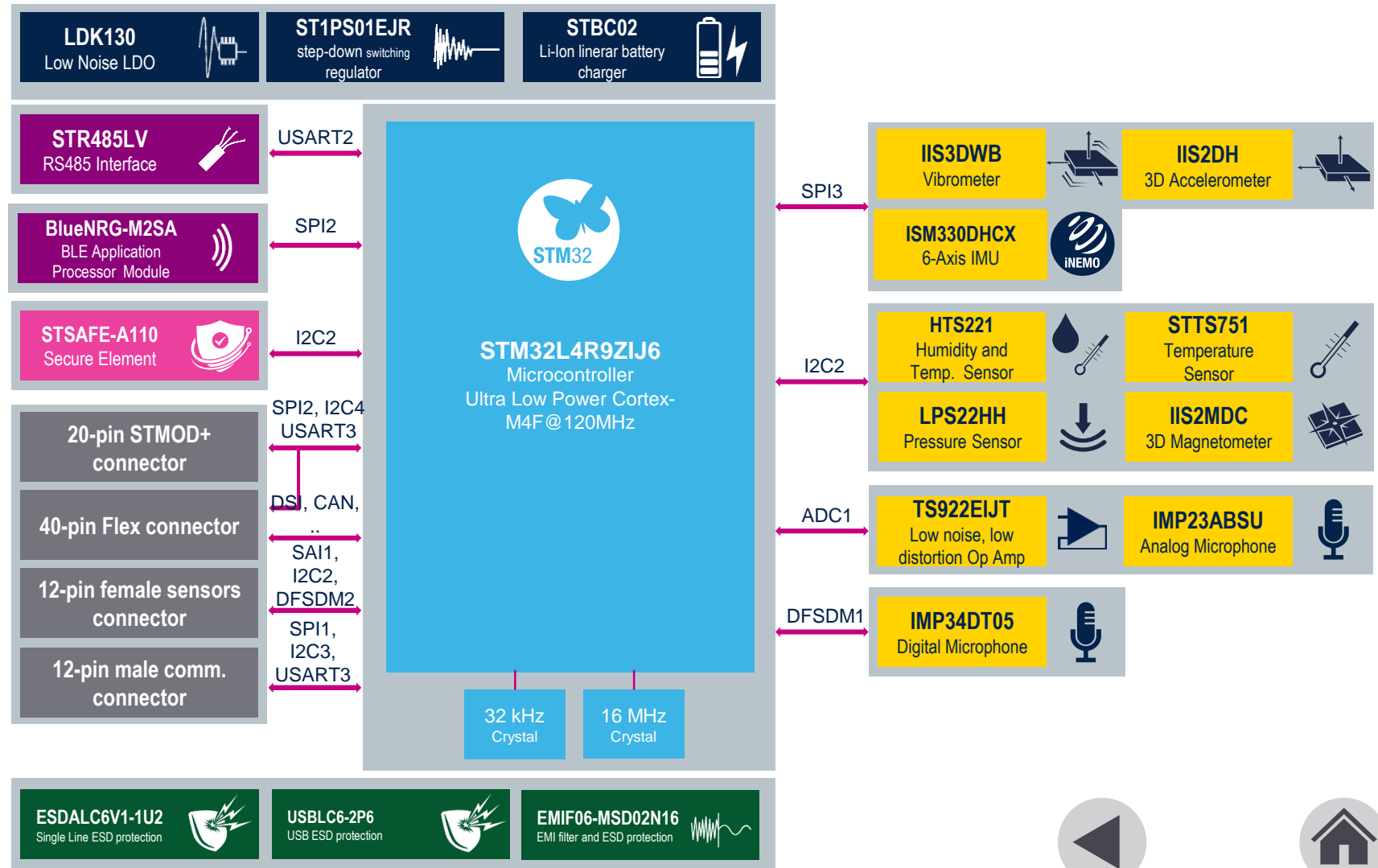- Miniaturized synchronous step-down converter with high-efficiency conversion

WiFi™

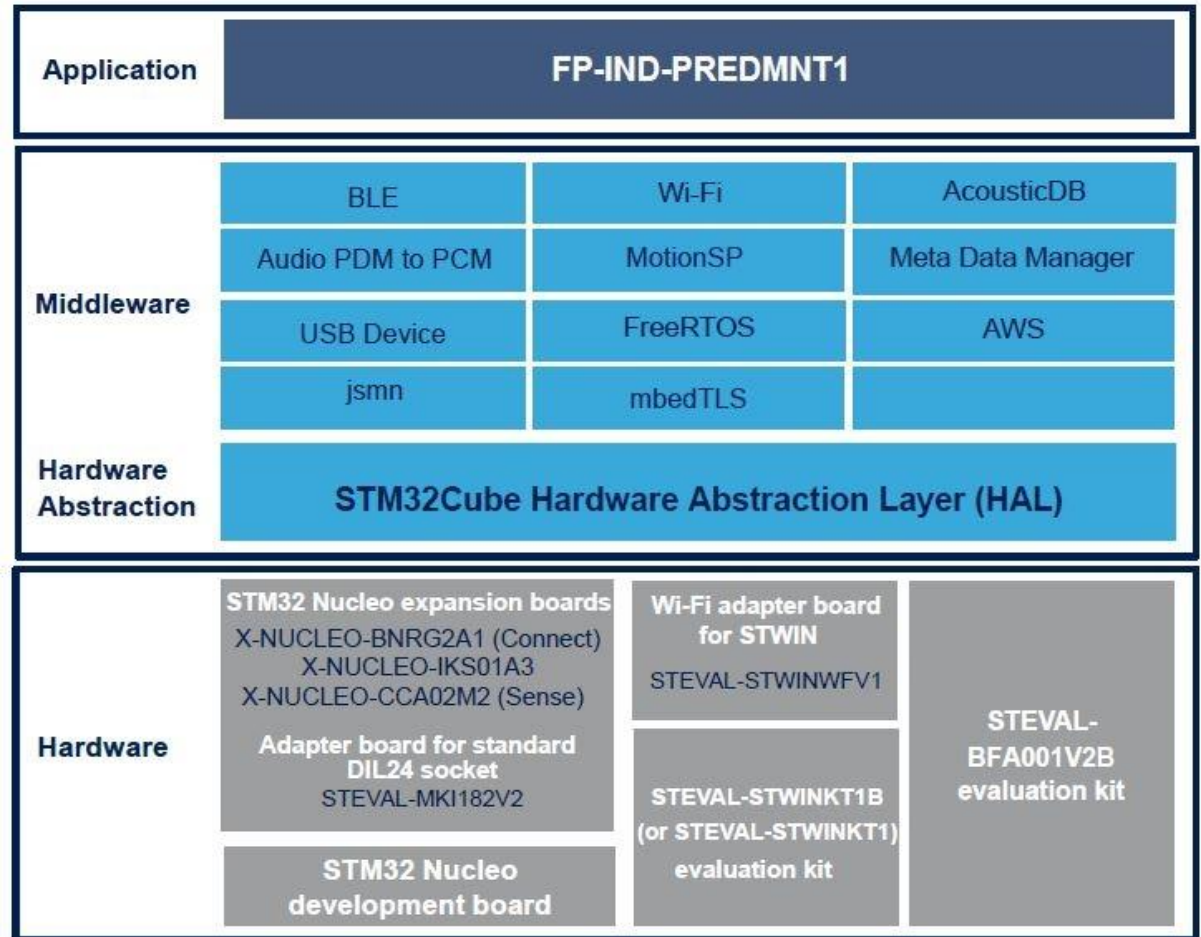STEVAL-STWINWFV1

http://www.st.com/stwin

- 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

LDK130
Low Noise LDO

ST1PS01EJR
step-down switching regulator

STBC02
Li-Ion linerar battery charger

STR485LV
RS485 Interface
— USART2 →

BlueNRG-M2SA
BLE Application Processor Module
— SPI2 →

STSAFE-A110
Secure Element
— I2C2 →

20-pin STMOD+ connector
— SPI2, I2C4 USART3 →

40-pin Flex connector
— DSI, CAN, .. →

12-pin female sensors connector
— SAI1, I2C2, DFSDM2 →

12-pin male comm. connector
— SPI1, I2C3, USART3 →

STM32L4R9ZIJ6
Microcontroller
Ultra Low Power Cortex-M4F@120MHz

32 kHz
Crystal

16 MHz
Crystal

← SPI3 →
IIS3DWB
Vibrometer

IIS2DH
3D Accelerometer

ISM330DHCX
6-Axis IMU

← I2C2 →
HTS221
Humidity and Temp. Sensor

STTS751
Temperature Sensor

LPS22HH
Pressure Sensor

IIS2MDC
3D Magnetometer

← ADC1 →
TS922EIJT
Low noise, low distortion Op Amp

IMP23ABSU
Analog Microphone

← DFSDM1 →
IMP34DT05
Digital Microphone

ESDALC6V1-1U2
Single Line ESD protection

USBLC6-2P6
USB ESD protection

EMIF06-MSD02N16
EMI filter and ESD protection

- Dedicated algorithms for advanced time and frequency domain signal processing and analysis of the **3D digital Vibrometer with flat bandwidth** up to 6.3kHz.

- Audio algorithms for acoustic emission (AE) up to 20 kHz, and **ultrasound emission** analysis up to 80 kHz.

- Pressure, relative humidity and temperature sensor monitoring

- Monitor and log the algorithm output and sensor data using the **ST BLE Sensor app** (STWIN original FW out of the box)

- With Wi-Fi expansion **STEVAL-STWINWFV1** is possible to connect the device directly to the dedicated web-based dashboard **DSH-PREDMNT** to monitor and log the algorithm output, sensor data and equipment status.

Application	FP-IND-PREDMNT1		
Middleware	BLE	Wi-Fi	AcousticDB
	Audio PDM to PCM	MotionSP	Meta Data Manager
	USB Device	FreeRTOS	AWS
	jsmn	mbedTLS	
Hardware Abstraction	STM32Cube Hardware Abstraction Layer (HAL)		
Hardware	STM32 Nucleo expansion boards X-NUCLEO-BNRG2A1 (Connect) X-NUCLEO-IKS01A3 X-NUCLEO-CCA02M2 (Sense) Adapter board for standard DIL24 socket STEVAL-MKI182V2	Wi-Fi adapter board for STWIN STEVAL-STWINWFV1	STEVAL-BFA001V2B evaluation kit
	STM32 Nucleo development board	STEVAL-STWINKT1B (or STEVAL-STWINKT1) evaluation kit	

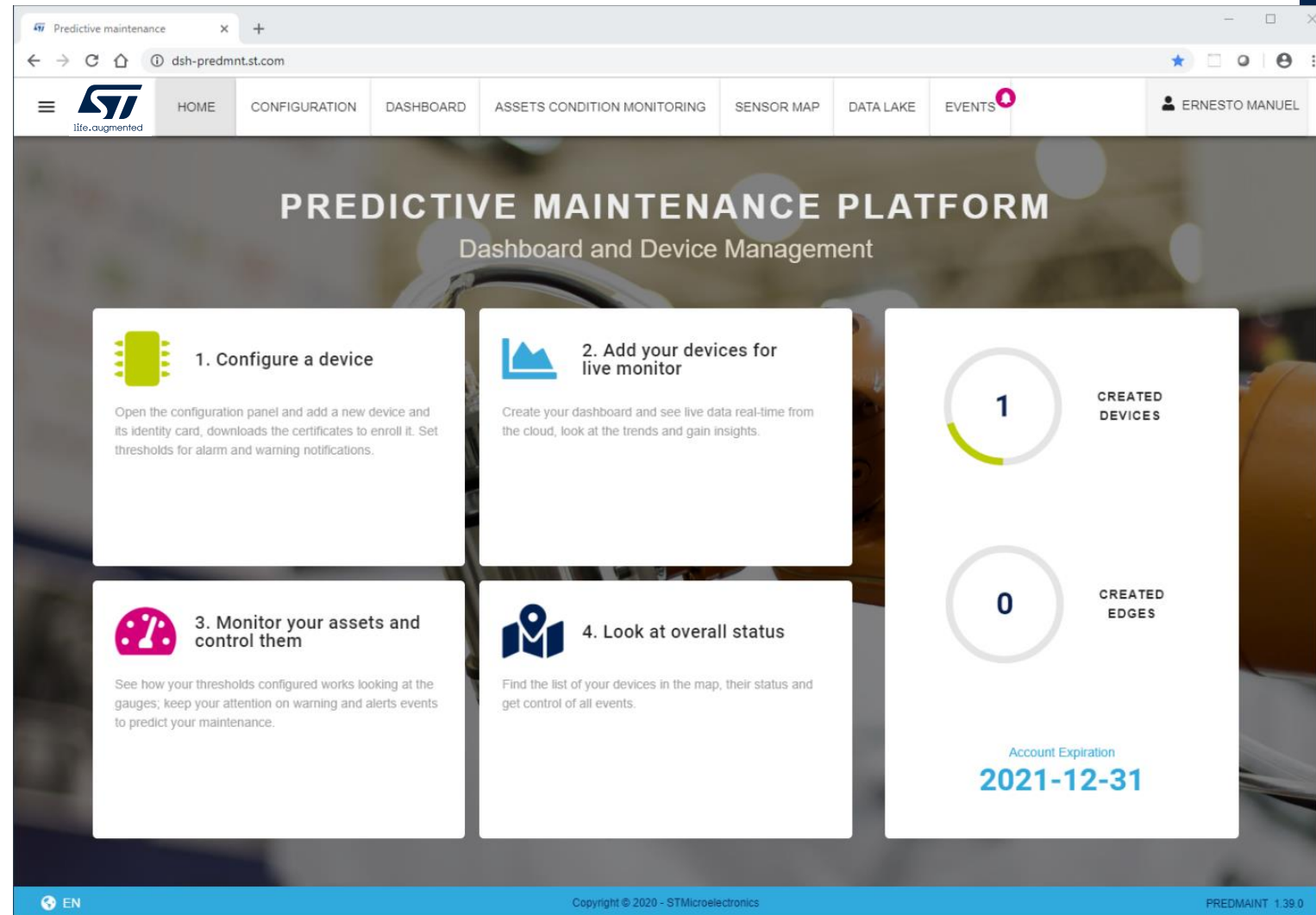# STWIN to DSH-PREDMNT

HARDWARE

- STEVAL-STWINKT1B
- STEVAL-STWINWFV1

FIRMWARE

- FP-IND-PREDMNT1

DASHBOARD

- dsh-predmnt.st.com
- Free with my.st.com login
- Up to 5 Sensor Nodes
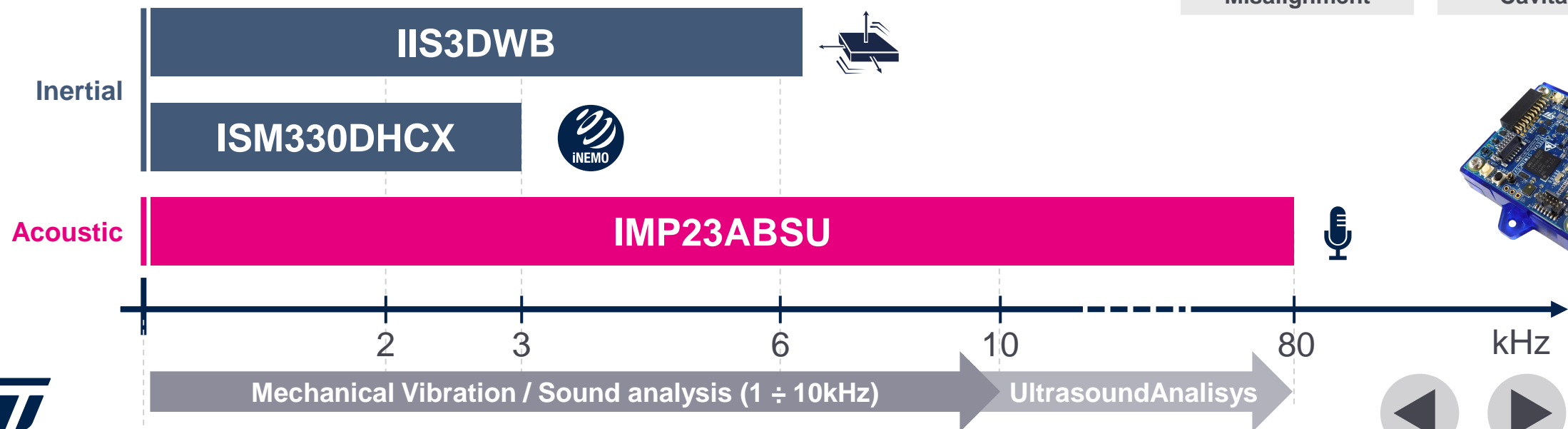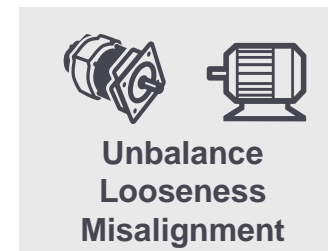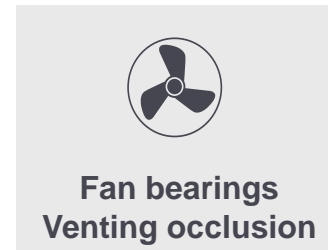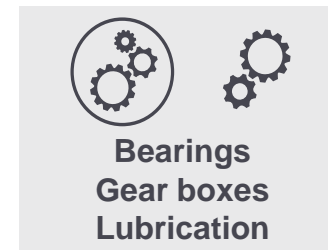- Up to 6 Months usage

- High Speed Datalog application for **STEVAL-STWINKT1B**.

- Comprehensive solution to save data from any combination of sensors and microphones configured up to the **maximum sampling rate**

- Compatible with Unico-GUI which enables configuration of ISM330DHCX Machine Learning Core unit
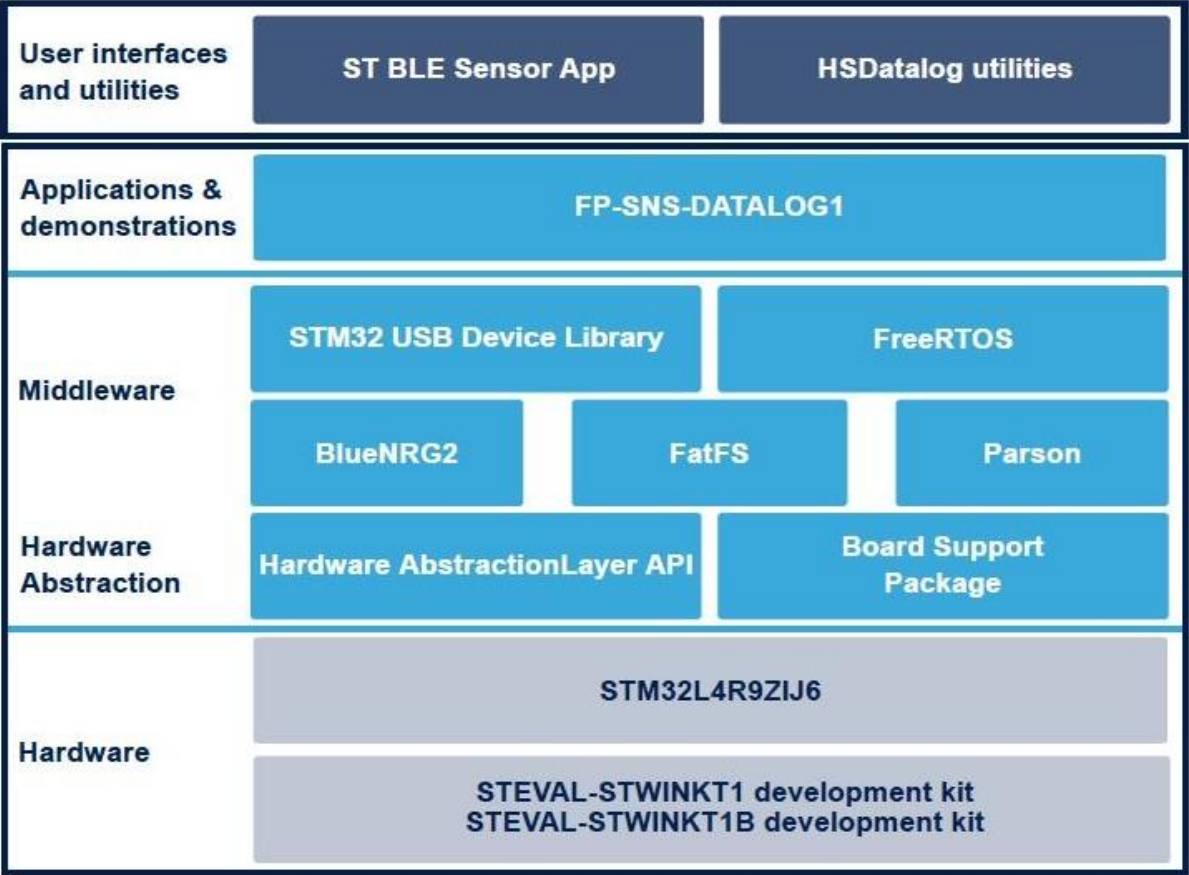
Vibration sensing: why high speed?

- Inertial 3 axis MEMS: 6 Bytes per sample (2 Bytes x 3 axis)
  - **IIS3DWB** ODR@26.7 kHz: **1.3 Mbps**
  - ISM330DHCX ODR@6.667 kHz (axl + gyro): 640 kbps
- Audio data rates
  - Audio PCM @ 48 kHz sampling rate: 768 kbps
  - **Ultrasound PCM** @ 192 kHz sampling rate: **3.1 Mbps**

Bearings
Gear boxes
Lubrication

Fan bearings
Venting occlusion

Unbalance
Looseness
Misalignment

Roller Bearings
Gearing
Cavitation

Inertial

IIS3DWB

ISM330DHCX

iNEMO

Acoustic

IMP23ABSU

2   3   6   10   80   kHz

Mechanical Vibration / Sound analysis (1 ÷ 10kHz)   UltrasoundAnalisys

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Introducing High Speed Data logging

- STWIN connects to a smartphone app allowing to:
  - configure sensors
  - implement datalogging and labeling
  - interfacing MLC configuration

Control
Data High throughput
Data Low throughput

BLE

SD Card

USB

Host / Gateway

```
class STWIN(Device):
    def __init__(self
        sense = Senso
        power(ultraLo
        brains.AI(STM
```

GUI

SDK

ST-Unico

STM32 Cube.AI

python