Predictive Maintenance: Use of Advanced Sensors in Smart Industry Applications

Ernesto Manuel CANTONE
AME IoT Marketing
What is “Smart Industry”?

- Industry 1.0: Mechanization, Steam Power
- Industry 2.0: Mass Production, Assembly Line, Electrical Energy
- Industry 3.0: Automation, Computers and Electronics
- Industry 4.0: Cyber Physical Systems, IoT, Networks
Smart Industry
Scope and Goals

More efficient operation

Producing more **efficiently** and in more **environmentally friendly** manner

Less waste

Responding to demand more **flexibly** and with more **customization**

Safer working environments

With a better and safer **human experience**

Evolved man-machine cooperation

Collecting and using manufacturing and supply chain **data** better

Local, mass customized production

Big data & Cloud computing
Predictive Maintenance
A Smart Industry hot topic

Maintenance is a set of actions to keep a machine working properly

<table>
<thead>
<tr>
<th>Preventive Maintenance</th>
<th>Condition Based Maintenance</th>
<th>Predictive Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduled maintenance tasks based on a time schedule – don’t care of the actual status of the equipment</td>
<td>Maintenance is based on the estimated conditions of the machine, typically monitored through inspection or sensors</td>
<td>Maintenance actions predicted in advance based on monitoring combined with a dynamic predictive model for failure analysis</td>
</tr>
<tr>
<td>Advantages</td>
<td>Advantages</td>
<td>Advantages</td>
</tr>
<tr>
<td>• Simple to plan</td>
<td>• Maintenance only takes place when necessary</td>
<td>• Maintenance optimized for machine life and production efficiency</td>
</tr>
<tr>
<td>Drawbacks</td>
<td>Drawbacks</td>
<td>Drawbacks</td>
</tr>
<tr>
<td>• Maintenance may happen too late (or too early)</td>
<td>• Maintenance only after machine begins to show signs of failure</td>
<td>• Requires complex overall system</td>
</tr>
</tbody>
</table>
Predictive Maintenance Architecture
Architecture for Predictive Maintenance

Low power / Scalable / Secure / Real-time

Sensing – Processing – Connectivity

Monitoring
- Sensors to detect anomalies
- Communication at factory level
- Processing (e.g. FFT analysis in vibration monitoring)
- Secure communication outside the factory
- Remote monitoring from the Cloud

Analytics

Predictive algorithms
- Analytical models limited to representing linear characteristics
- Machine learning techniques based on classification methods
Smart Industry: Trends and Enablers

SMART NODE

ARTIFICIAL INTELLIGENCE & EDGE COMP.
Smart Industry: Trends and Enablers

SMART NODE

SMART SENSORS

ARTIFICIAL INTELLIGENCE & EDGE COMP.

Wireless Connectivity

Cloud Computing

Life, augmented

ST
Sensors Technologies and Predictive Maintenance
Monitoring of an Industrial Motor

Typical Use Case

Any parameter deviation is an indicator of potential failure

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

Thermal
- Winding temperature
- Bearing temperature

Electromagnetic
- Current
- Voltage
- Electrostatic discharge
- Magnetic flux – internal
- Magnetic flux – external
Pressure measurements for "air management" systems, which monitor the performance indicators and the different stages of the air compressors connected to the compressed-air supply grid.

Humidity sensors are adopted in HVAC systems to control water vapor level or to help in regulating parameters such as air temperature and blowing speed.

Measuring operating temperatures is crucial for detecting losses or improperly terminated electrical connections, overloading, defective contacts, phase imbalances and other electrical issues.
Accelerometer and Microphone
Distinctive sensors for Predictive Maintenance

The curve slope depends on the life-cycle of the equipment.

Machine conditions

Time

Conditions start to change

- Ultrasound
- Vibration
- Power
- Noise
- Heat
- Smoke

Failure
Post processing analysis
Ultrasound frequencies to detect and classify leaks

Most common maintenance applications
- Air Leak Detection of compressed air equipment
- Vibration monitor
- Compressor Valve Inspections
- Acoustic Lubrication
- Heat Exchanger and Condenser Leaks
- Hydraulic Systems
- Pump Cavitation
While FFT are widely used, Deep Learning and AI can enable new scenarios:

- **Embedded FFT** analysis on the sensor can isolate vibration.
- **Alarm** can be set according to specific threshold to detect potential defects.
- **AI** improves the data analysis (vs FFT) hence the capabilities of failure prediction.
- **AI models**, resulting on a “learning process” can be distilled down into a **Neural Network hosted into MCUs** or even down to new generation of smart sensors.
Predictive Maintenance

ST enables new approaches with a distributed architecture

- Connectivity/Bandwidth Requirements
- Connectivity
- Security

- Sensor Data
- Actions

- Edge

1 Sensor

100 Sensors

10,000 Sensors

Processing Requirements
Connectivity/Bandwidth Requirements
ST Enablers: Products and Solutions
## Complete Ecosystem Offering by ST

<table>
<thead>
<tr>
<th>All building blocks for IoT devices</th>
<th>Lower barriers for developers getting started</th>
<th>Lower barriers from prototyping to first product</th>
<th>Enable product &amp; service commercialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcontrollers</td>
<td>Stackable boards &amp; modular SW</td>
<td>Pre-integrated software for vertical applications</td>
<td>Integration of Cloud Provider SDKs</td>
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<tr>
<td>Secure solutions</td>
<td></td>
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<tr>
<td>Sensors &amp; actuators</td>
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<tr>
<td>Connectivity solutions</td>
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<tr>
<td>Power management</td>
<td></td>
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<tr>
<td>Motor control</td>
<td>Form-factor boards</td>
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<tr>
<td>Analog components</td>
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</tbody>
</table>

### Stackable boards & modular SW
- STM32 Nucleo Development & Expansion boards

### Pre-integrated software for vertical applications
- Smart Things
- Smart Home & City
- Smart Industry

### Development ecosystem
- Code generators
- Prototyping software
- Development environments
- Artificial Intelligence toolbox
- Debug solutions
- Simulation and analysis tools
- On-line design tools

### Partner Program and ST community
- Code generators
- Prototyping software
- Development environments
- Artificial Intelligence toolbox
- Debug solutions
- Simulation and analysis tools
- On-line design tools
Microcontrollers and Microprocessors
Today - STM32 Portfolio Positioning

15 product series / More than 50 product lines / ~1000 products

- **MPUs**
- **High-performance MCUs**
- **Mainstream MCUs**
- **Ultra-low-power MCUs**
- **Wireless MCUs**

**arm**
- Cortex®-M0
- Cortex®-M0+
- Cortex®-M3
- Cortex®-M4
- Cortex®-M33
- Cortex®-M7
- Dual Cortex®-M7 & Cortex®-M4
- Dual Cortex®-A7 & Cortex®-M4

Note: Cortex-M0+ Radio Co-processor

More than 40,000 customers
STM32 Rolling Longevity Commitment

Longevity commitment is renewed every year starting January 1st 2019 until 2029.

- STM32F1 (launched in 2007) - 22 years of commitment
- STM32L1 (launched in 2009) - 20 years of commitment
- STM32F2 (launched in 2010) - 19 years of commitment
- STM32F4 (launched in 2011) - 18 years of commitment
- STM32F0 (launched in 2012) - 17 years of commitment
- STM32F3 (launched in 2012) - 17 years of commitment
- STM32L0 (launched in 2013) - 16 years of commitment
- STM32F7 (launched in 2014) - 15 years of commitment
- STM32L4 (launched in 2015) - 14 years of commitment
- STM32L4+ (launched in 2016) - 13 years of commitment
- STM32H7 (launched in 2016) - 13 years of commitment
- STM32WB (launched in 2018) - 11 years of commitment
- STM32G0 (launched in 2018) - 11 years of commitment
STM32Cubé.AI SW tool allows our customers to innovate…

Off-the-shelf tools

Pre-trained Neural Network Model from major framework

STM32Cube.AI SW tool

Optimized Neural Network code automatically generated for STM32

ST AI solution

Trained model inference

… bringing AI into the STM32 Portfolio
Sensors
A Broad Sensor Portfolio

Market leading #1 in the Consumer MEMS segment

Motion sensors 40% share (#1)
Pressure sensors 31% share (#2)

New sensors portfolio for Industrial applications

Brodest sensors portfolio addressing Personal Electronics, Industrial & Automotive

High stability IMU for Always ON applications, finite state machine, w/ I3C Interface

Unique Pressure Sensors portfolio: Dust and Water resistant packages

Complete system solutions and official Partners for fast go-to-market

IHS Motion Sensors Market Share Report 2017
10-Year Product Longevity

Benefits

- 10-YEAR LONGEVITY FROM PRODUCT INTRODUCTION DATE
- DESIGN AND MANUFACTURING FOR HIGHER ROBUSTNESS & PERFORMANCES
- CALIBRATION & TESTING FOR HIGHER ACCURACY & QUALITY
- EXTENDED TEMPERATURE RANGE AND ENDURANCE TO SHOCK AND VIBRATION

Growing Product Family

Motion Sensors and more

Humidity and temperature sensors as enablers for in-situ calibration

- **Motion sensors**: Accelerometers, gyroscopes, 6-axis IMUs, magnetometers
- **Temperature sensors**: Analog and digital contact temperature sensors
- **Humidity sensors**: Combo humidity and temperature sensors
- **Pressure sensors**: Water proof solutions
- **MEMS microphones**: Analog, digital, top and bottom port solutions
<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Features</th>
<th>Chip Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IIS3DWB</strong></td>
<td>Accelerometer - Ultra Wide Bandwidth</td>
<td>LGA-14 2.5x3 mm</td>
</tr>
<tr>
<td><strong>IIS3DHHC/IIS2ICLH</strong></td>
<td>Inclinometer - High Resolution, Ultra Low Power</td>
<td>LGA-16 5x5 mm</td>
</tr>
<tr>
<td><strong>IIS2DH/IIS2DLPC</strong></td>
<td>Accelerometer - Wide Bandwidth, Ultra-low-power</td>
<td>LGA-12 2x2 mm</td>
</tr>
<tr>
<td><strong>IIS2MDC</strong></td>
<td>Magnetometer Low-Noise, Low Power</td>
<td>LGA-12 2x2 mm</td>
</tr>
<tr>
<td><strong>3D Accelerometer</strong></td>
<td>- 16g Full Scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Digital Output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ultra Wide Bandwidth (to 5 kHz)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ultra Low Noise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Up to 105°C Operating Temp</td>
<td></td>
</tr>
<tr>
<td><strong>Inclinometer</strong></td>
<td>- Digital Output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- High Accuracy (&lt;0.5° over Temp. and Time)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ultra Low Current consumption: 400 uA</td>
<td></td>
</tr>
<tr>
<td><strong>AMR Technology</strong></td>
<td>- up to 50 Gauss Full Scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ultra Low Noise, Low Power</td>
<td></td>
</tr>
<tr>
<td>(<strong>Contact Sales</strong></td>
<td>for availability</td>
<td></td>
</tr>
</tbody>
</table>
### ISM330DLC
**Combo accelerometer & Gyroscope**
Wide Bandwidth

- **LGA-14 2.5x3 mm**
- 3D accelerometer with full scale up to ±16g
- 3D gyroscope with full scale up to ±2000 dps
- Accelerometer with Wide Bandwidth (up to 3 kHz)
- Ultra Low Power and Smart Features

### ISM330DHCX
**Combo accelerometer & Gyroscope**
Wide Bandwidth

- **LGA-14 2.5x3 mm**
- 3D accelerometer with full scale up to ±16g
- 3D gyroscope with full scale up to ±4000 dps
- Accelerometer with Wide Bandwidth (up to 3 kHz)
- Ultra Low Power and Machine Learning Core

### ISM303DAC
**E-Compass**
Combo Accelerometer and Magnetometer

- **LGA-12 2x2 mm**
- 3D Accelerometer – Digital Output
- 3D Magnetometer – Digital Output
- ±2/±4/±8/±16 g selectable acceleration full scales
- Up to ±50 gauss magnetic dynamic range
Environmental Sensors for Smart Industry

**LPS22HH**
Pressure Sensor – High Accuracy – Compact Size

- **Absolute Pressure Sensor**
  - 260 to 1260 hPa Range - Digital Output
  - High Accuracy (±0.75 hPa)
  - Low noise (0.75 Pa RMS)
  - Ultra Compact full molded package

**LPS33W/LPS27HHW**
Pressure Sensor – Water Resistant

- 3.3 x 3.3 x 2.9 mm
- 2.7 x 2.7 x 1.7 mm

**HTS221**
Humidity and Temperature Sensor – High Accuracy

- **Humidity and Temperature Sensor**
  - Digital Output
  - High Accuracy:
    - Humidity: ±3.5 %RH
    - Temperature: ±0.5 deg
  - Low Power

**STTS751**
Digital Temperature Sensor

- **Accuracy ±1.0 °C ; Programmable resolution**
- **TO92/SO8**

**LM235 – STLM20**
Analog Temperature Sensor

- **Accuracy ±1.0 °C ; Op. Temp up to 150 °C**
- **TO92/SO8**

**STTS22H**
Digital Temperature Sensor – High Accuracy

- **High Accuracy**
  - Temperature: ±0.2 deg
- **Low Power**

(*) Contact Sales for availability
MEMS Microphones for Smart Industry

**MP23ABS1**
Analog Differential Microphone

3.35x2.5x0.98 mm

Bottom Port Microphone
Analog Differential Output
Wide Acoustic Bandwidth (up to 80 kHz)
Wide Dynamic Range (AOP up to 135 dBSPL)

**MP23DB01HP**
Digital Bottom Port Microphone

3.35x2.5x0.98 mm

Bottom Port Microphone
Multi mode PDM Output
Wide Dynamic Range (AOP up to 137 dBSPL)
Hi SNR 65.5dB

**IMP34DT05**
Digital Top Port Microphone

3x4x1 mm

Top Port Microphone
Digital Output
Wide dynamic range (AOP up to 122 dBSPL)
-26dBFS ± 3 dB sensitivity

(*) Contact Sales for availability
Accelerometer and Microphone

When frequency matters

Type of Defect / Wear

Unbalance Losses Misalignment
Roller Bearings Gearing Cavitation
Bearings Gear Box Lubrication
Fan Bearings Venting Occlusion Cooling failure

Bandwidth

2Khz 5Khz 10Khz >50Khz

Sound analysis (10-10KHz) Ultrasound analysis

IIS3DWB
ISM330DLC
IMP34DT05
IIS2DH
MP23ABS1

30
### IIS3DWB

**Ultra-wide Bandwidth, Low-Noise, 3-axes digital accelerometer**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. of axis</td>
<td>3-axis</td>
</tr>
<tr>
<td>Full Scale [g]</td>
<td>±2/±4/±8/±16</td>
</tr>
<tr>
<td>Output i/f</td>
<td>Digital: SPI</td>
</tr>
<tr>
<td>Bandwidth (-3dB) [kHz]</td>
<td>5</td>
</tr>
<tr>
<td>ODR [kHz]</td>
<td>26.7</td>
</tr>
<tr>
<td>Noise Density [µg/√Hz]</td>
<td>90 (65 in single axis)</td>
</tr>
<tr>
<td>Current Consumption [mA]</td>
<td>1.1</td>
</tr>
</tbody>
</table>

**Features**
- FIFO (3kbyte)
- Programmable HP Filter
- Interrupts
- Temp. Sensor
- Embedded Self Test

**Operating Temp [°C]**
- -40 ; +105

**Operating Voltage [V]**
- 2.1 ÷ 3.6

**Package [mm3]**
- LGA 2.5x3x0.83 14Lead

**3-axis Digital**
- **Ultra Wide Bandwidth (5Khz)**
- **Low Noise**
- **105°C Operating Temp**

**Pin2pin compatible with ISM330x/LSM6DSx devices**
MP23ABS1 and IMP34DT05
Low-noise high-performance Microphones

**Main parameters**
- **MP23ABS1**
  - Sensitivity: 38dB ±1dB
  - SNR: 64dB(A) (min)
  - AOP: 130dBSPL
  - Wide Acoustic Bandwidth (up to 80 kHz)

- **IMP34DT05**
  - Sensitivity: 26dB ±3dB
  - SNR: 64dB(A) (typ)
  - AOP: 122.5dBSPL
  - High ESD protection ±15KV

**Features / Benefits**
- Wide Dynamic range Analog single ended microphone
- Analog device enabling ultra wide bandwidth for ultrasonic detection (predictive maintenance)
- Ultra low power device for battery operated applications
- High acoustic overload point to avoid sensor saturation due to loud sound detection
- Top port high robustness organic package (CbM)
- Digital output (PDM) is the optimal solution for complexity, cost and reliability
Connectivity
Connectivity Options

Match the needs of Industrial Environments

**Wired Connectivity**
- P2p, Industrial Fieldbus, Industrial Ethernet
- IO-Link
- CANopen
- PROFINET
- EtherCAT
- sercos III
- EtherCAT
- Any Industrial protocol for any STM32

**Wireless Connectivity**
- Retrofit, flexibility of technologies and protocols, interoperability with Ethernet and Cloud
- Bluetooth SMART
- WiFi
- Sub 1GHz
- LoRa
- sigfox
- LTE
- LoWPAN

And more ..
Development Kits
IO-Link: from ICs to a wide offering of solutions

**L6360**
Single port Master PHY for IO-Link and SIO mode
- Supply voltage up to 32.5 V
- Up to 200 mW max. power dissipation
- Over-voltage (>36 V) and over-temperature protection
- ESD protection according IEC 61000-4-2
- Conform to IEC 61000-4-4, IEC 61000-4-5

**L6362A**
Transceiver Device for IO-Link and SIO mode
- Configurable Output stage: High Side, Low Side, Push-Pull
- Reverse Polarity and Surge protections
- Up to 400 mA output Current with Overload and Cut-OFF protections
- 5 V or 3.3 V / 8 mA selectable linear regulator

Visit st.com for the full list of IO-Link solutions

Based on **Master L6360**

Based on **Device L6362A**

The **P-NUCLEO-IOM01M1** is a STM32 Nucleo pack for IO-Link Master with IO-Link v1.1 PHY and stack

The **P-NUCLEO-IOD01A1** is a STM32 Nucleo pack for IO-Link Device fully compatible with IO-Link v1.1 PHY and stack
From Sensor to Fieldbus

Predictive maintenance kit with sensors and IO-Link capability

**Use cases**
- Motors
- Equipment
- Environment

**Sensing**
- Vibration and Environmental
  - ISM330DLC 6-Axis digital MEMS axel + gyro (*)
  - MP34DT05-A Microphone
  - LPS22HB MEMS Pressure sensor
  - HTS221 Humidity & Temperature Sensors

**Connectivity**
- Optimized form factor for industrial M12 connector
- Embedded algorithm for sensors data analysis, detecting anomalies like unbalance, misalignment, or bad equipment condition
- Logging of worst working condition events

**Processing**
- STM32F469AI 32-bit ARM Cortex-M4 microcontroller

**Wired**
- L6362A IO-Link communication transceiver device IC

*ISM330DLC bandwidth is 3 kHz, coming soon replacement with IIS3DWB (5 kHz)

**Main Features**
- Optimized form factor for industrial M12 connector
- Embedded algorithm for sensors data analysis, detecting anomalies like unbalance, misalignment, or bad equipment condition
- Logging of worst working condition events
STEVAL-IDP004V1

Applications with 2+ nodes to be monitored

Adapter RS485 / USB
Optional USB

STEVAL-IDP004V1
Also available the firmware package STSW-IO-LINK

Axel spectrum

STEVAL-BFA001V1B

Download the condition monitoring_iol fw from the STSW-BFA001V1 Demonstration folder
ST’s Solutions for Cloud

**Common SW platform**

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

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

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

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

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

SensiBLE

Discovery Kit IoT Node

Bluecoin

SensorTile

SmarTAG

**Modular hardware**
STM32L475 Discovery Kit IoT Node
B-L475E-IOT01A

Cloud Connectivity Out-of-the-Box

- Ultra-low-power STM32L475 Arm® Cortex®-M4, 1 Mbyte Flash memory, 128 Kbytes of SRAM
- Firmware example for IoT end node connected with Wi-Fi®
  - 802.11 b/g/n compliant Wi-Fi® module
- Low Power Communications
  - Bluetooth 4.1, Sub-GHz, Dynamic NFC Tag
- Multiway Sensing
  - 3D Accelerometer, 3D Gyroscope, 3D Magnetometer, Temperature/Humidity, Pressure, Time of Flight, Microphones
STM32 Cloud Connected IoT Nodes

- **X-CUBE-AWS**
  - Cloud Connector: libraries and application examples
- **FP-CLD-AWS1**
  - Companion AWS-based web dashboard
- **Amazon FreeRTOS**
  - STM32’s port of the Amazon operating system for microcontrollers that makes small, low-power edge devices easy to program, deploy, secure, connect, and manage.

- **X-CUBE-AZURE**
  - Cloud Connector: set of libraries and application examples
- **FP-CLD-AZURE1**
  - Companion Dashboard with full support for Azure device management primitives and sample implementation for firmware update over the air (FOTA).

- **X-CUBE-WATSON**
  - Cloud Connector: libraries and application examples
  - IBM Quickstart and Registered Mode support.
- **FP-CLD-WATSON1**
  - Includes pre-integrated FFT algorithms for the processing of accelerometer

- **X-CUBE-GCP**
  - Cloud Connector: set of libraries and application examples, MCU acting as end devices.

- **X-CUBE-CLD-GEN**
  - Cloud Connector: libraries and application examples
STWIN SensorTile Wireless Industrial Node
STEVAL-STWINKT1

Use cases
- Motors
- Equipment
- Environment

Industrial grade sensors for
- Vibration analysis
- Sound Emission up to 80 kHz
- Environmental

Embedded Wireless and Extension
- BLE, WiFi (Inventek)
- Modular expansion: LTE, LoRa, Industrial Ethernet

Local Processing & Security
- ARM® Cortex®-M4 STM32L4R9
- Secure Element STSAFE on request

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

Alpha engagements
STM32MP157C MPU Discovery Kit
STM32MP157C-DK2

AWS IoT Greengrass v1.8.0 Certified

- STM32MP157 Arm®-based dual Cortex®-A7 32 bits + Cortex®-M4 32 bits MPU in TFBGA361 package
  - ST PMIC STPMIC1
  - 4-Gbit DDR3L, 16 bits, 533 MHz
  - 1-Gbps Ethernet (RGMII) compliant with IEEE-802.3ab
  - USB OTG HS
  - Audio codec
  - 4 user LEDs
  - Ethernet RJ454, USB Type-A, USB Type-C™, DRPMIPI DSISM, HDMI®, headset jack including analog microphone input, micro SD™ card
- GPIO expansion connector
  - Raspberry Pi® shields capability
  - ARDUINO® Uno V3 expansion connectors
Sensor to Cloud
From Dev Kits to End-to-End Solutions

- **STEVAL-BFA001V1B**
  Stand Alone Sensor Node

- **STEVAL-IDP004V1**
  Expand your capabilities up to 4 Nodes

- **STM32MP157C-DK2**
  Discovery Kit

- **B-L475E-IOT01A**
  Discovery Kit IoT Node

- **STEVAL-STWINKT1**
  SensorTile Wireless Industrial Node
Serial Predictive Maintenance Kit

Wi-Fi IoT Discovery Kit Node

STM32MP1

AWS IoT Greengrass

Ultrasound, Vibration, Environmental sensing

IoT hardware boards

Predictive Maintenance Kit

Serial

Wi-Fi/Ethernet

AWS IoT Shadow
Platform Evolution

Ultrasound, Vibration, Environmental sensing

- IoT hardware boards
- Predictive Maintenance Kit
- STM32MP1
- AWS IoT Greengrass
- Wi-Fi/Ethernet
- Serial
- Amazon FreeRTOS
- STWIN
- Amazon S3
- AWS IoT Core
- AWS Lambda
- Amazon DynamoDB
- Amazon API Gateway
- Amazon Cognito
- AWS WAF
- AWS Shield
Predictive Maintenance Solutions

Value Proposition

**Smart Sensor Nodes: different connectivity and UI to evaluate specific products**

**Evaluation**
FP-IND-PREDMNT1

**PoC**
STEVAL-BFA001V1B

**Field Test: Predictive Maintenance Platform**

**Understanding Needs**

- HW Available
- SW available
- BLE Data log with APP

**Full feature evaluation: Equipment/Asset Retrofitting**

- STEVAL-BFA001V1B and STEVAL-IDP004 available
- STWIN available end of July 2019 (Alpha Engagements)
- PC Data log, GUI and DLL for Matlab
- BLE Data log with APP

**Edge and Cloud: e2e**

- Gateway SDK available on GitHub
- Dashboard on st.com available end of September 2019
- Cloud dashboard Data Log

**Same SW Library shared with same features: Vibration and Sound Analysis**