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Optimizing smart manufacturing - reducing cost and time-to-market with new sensing and communication technologies

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Optimizing smart manufacturing

Reducing cost and time-to-market with new sensing and communication technologies

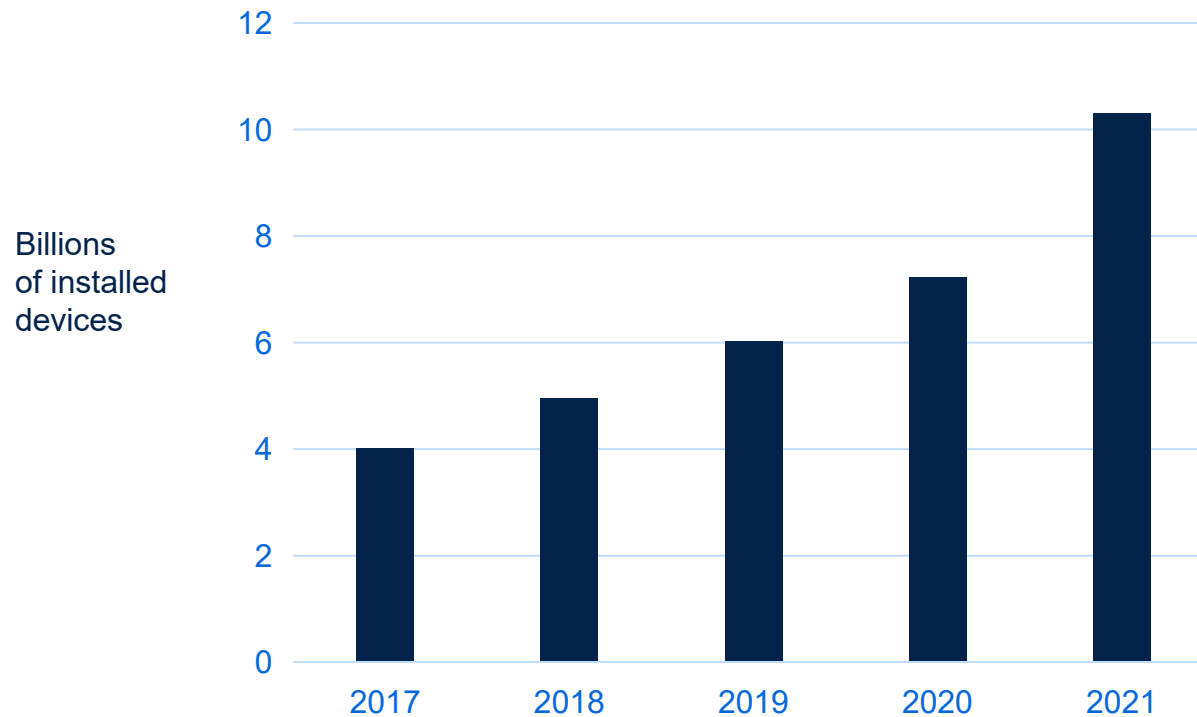
Designing for Industrial environments requires addressing the unique challenges of noise robustness, interoperability and real-time operation.

This session will cover:

1. Latest developments in accelerometers, gyroscopes, microphones, temperature, humidity and Time-of-Flight sensors
2. Real-time Ethernet and IO-Link communication for industrial applications
3. Solution examples that address challenges in cost and time-to-market

Smart industry focus

Internet connected Industrial devices



Utilities, Industrial IoT, Retail, Advertising, and Supply Chain

Growth areas

| Total industrial semiconductor market revenue by application field (\$Bn) | 2019 | 2024 | CAGR |
|---|------|------|-------|
| Manufacturing & Process Automation | 12.5 | 16.3 | 5.45% |
| Medical | 4.8 | 6.2 | 5.59% |
| Military & Civil Aerospace | 4.3 | 5.0 | 3% |
| Power & Energy | 6.5 | 8.7 | 6% |

From industry to smart industry

18th century

20th century

1970's

Today

1st Industrial Revolution

Mechanical production equipment driven by water and steam power

2nd Industrial Revolution

Mass production achieved by division of labour concept and the use of electrical energy

3rd Industrial Revolution

Based on the use of electronics and IT to further automate production

4th Industrial Revolution

Use of cyber-physical systems, communications, IoT and decentralized decisions

All new machines

Change of driving mechanism

Machines largely replaced

Machines partially replaced - connected

How will industry evolve?



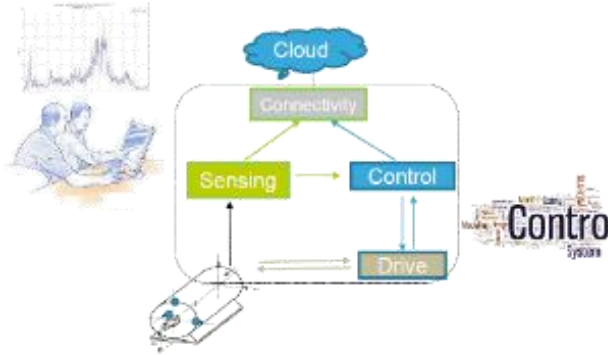
From preventive to predictive maintenance

Predictive maintenance is a key asset in the Industry 4.0

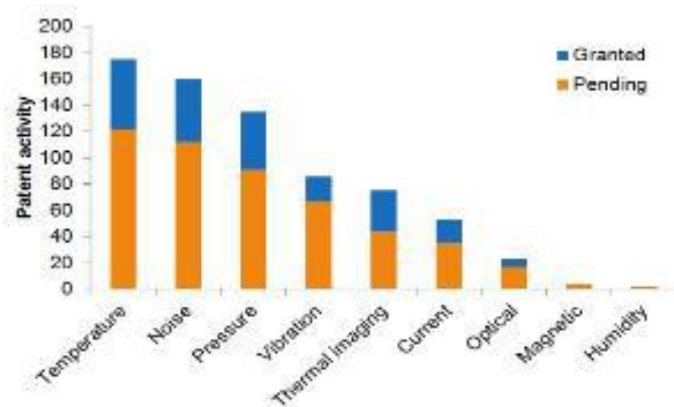


Predictive maintenance at system level

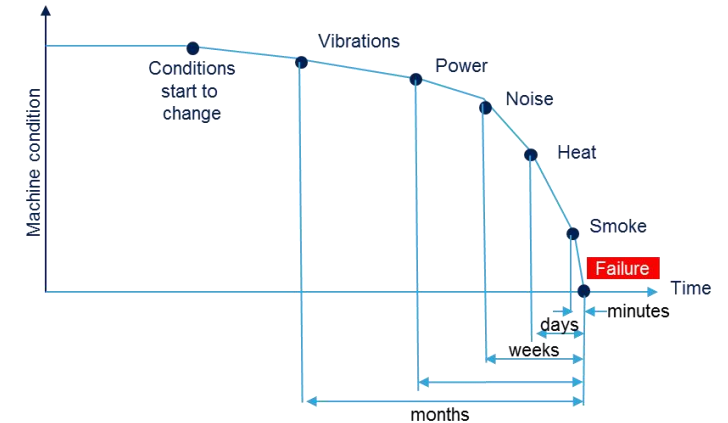
A different business model



Based on early sign detection

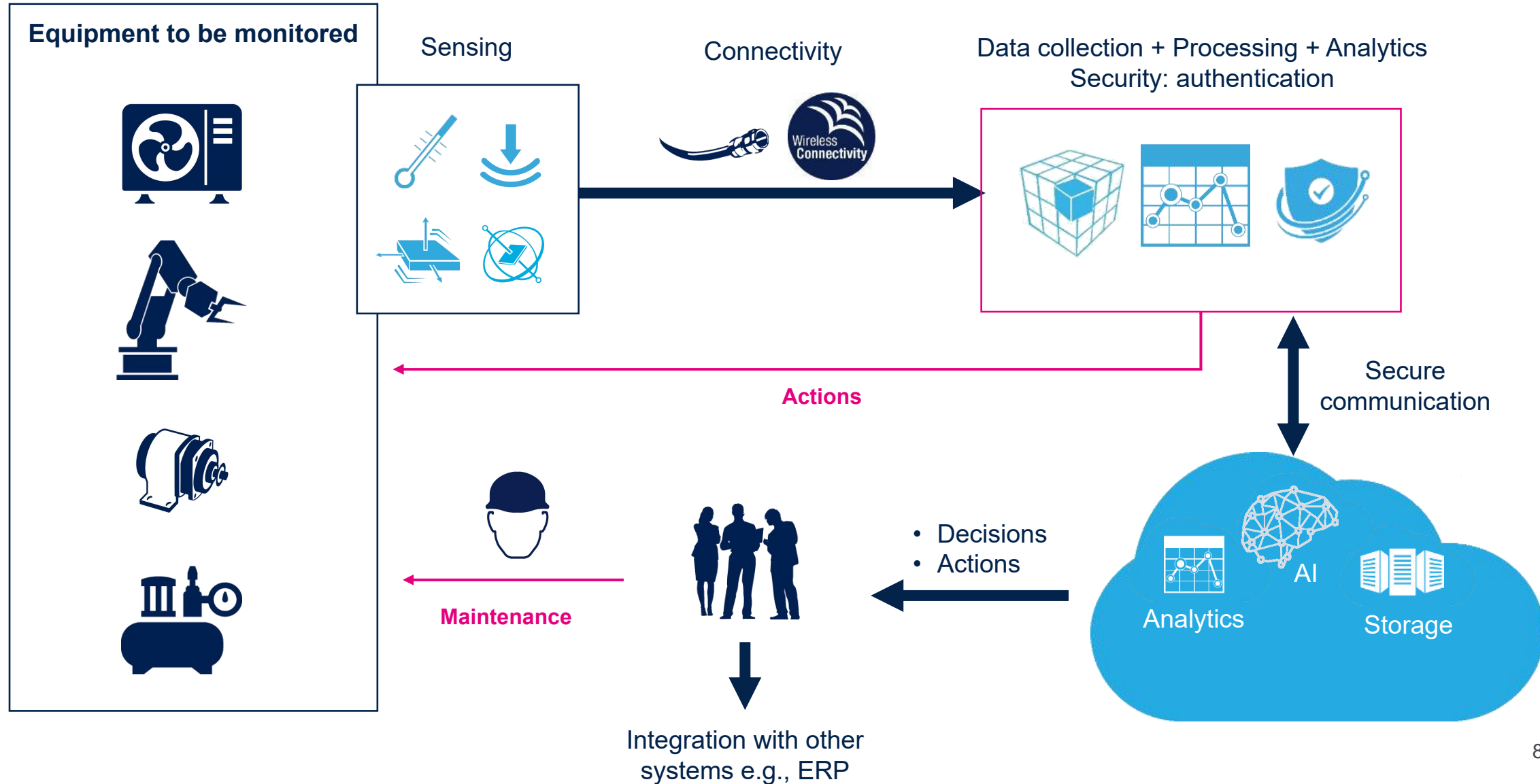


Sources: Lux Research, Inc.
www.luxresearchinc.com



Where sensors play a key role

From preventive to predictive maintenance



ST solutions for factory automation condition monitoring & predictive maintenance

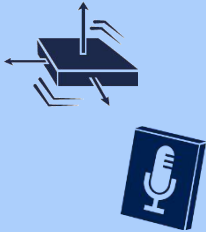
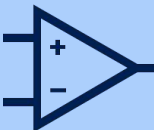
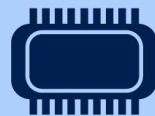






Mechanical vibration

Displacement
Speed
Acceleration
Acoustic noise
Angular speed
Torque

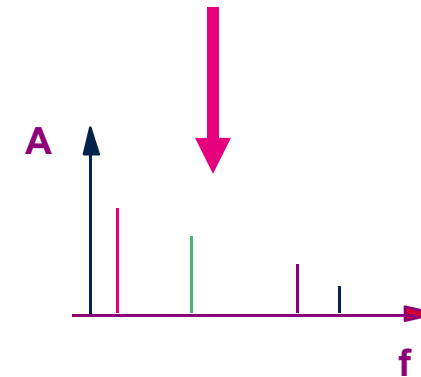
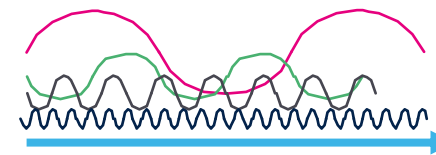
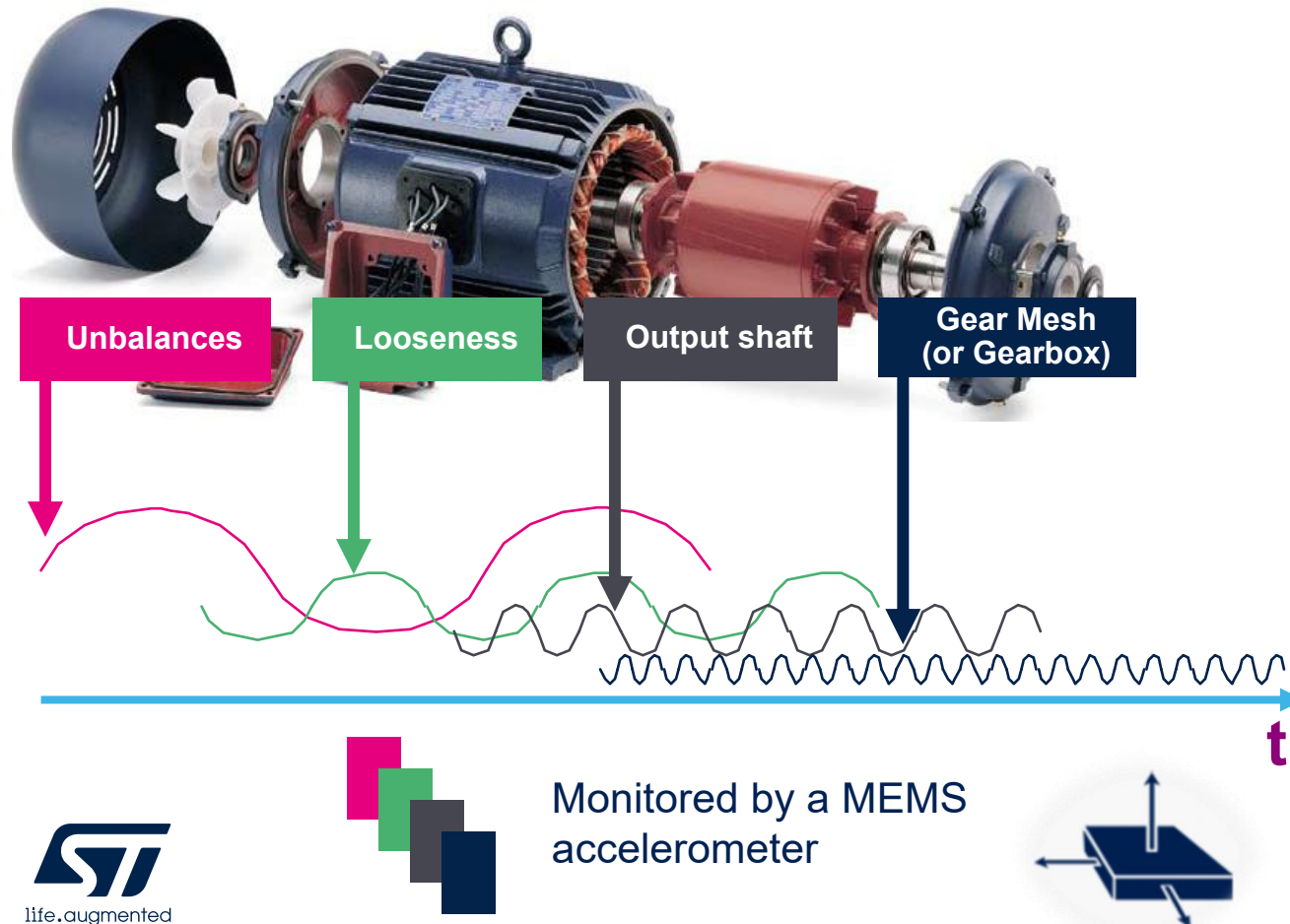
Acoustic signals

Noise
Ultrasound

| Functional needs | Capture vibrations | Signal conditioning | Processing | Power Management | Connectivity | Secure Connections |
|------------------|---|---|--|---|--|---|
| ST solutions | <p>MEMS Sensors</p>  | <p>Op Amps Comparators</p>  | <p>MCU</p>  | <p>Power ICs & Power Discrete</p>  | <p>Bluetooth Wi-Fi Sub-1 GHz IO-Link</p>   | <p>Secure MCU</p>  |

Motor control use case vibration monitor through accelerometer

Typical architecture for mechanical vibrations



Processing

- From Ultra low-power to High Performance MCUs



Connectivity

- Wireless connectivity
 - Wi-Fi, Sub-1 GHz, Bluetooth
- Wired connectivity
 - IO-Link, Fieldbus i.e. Industrial Ethernet
- Connection to Cloud

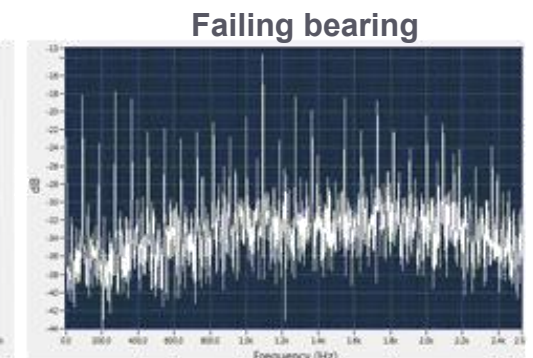
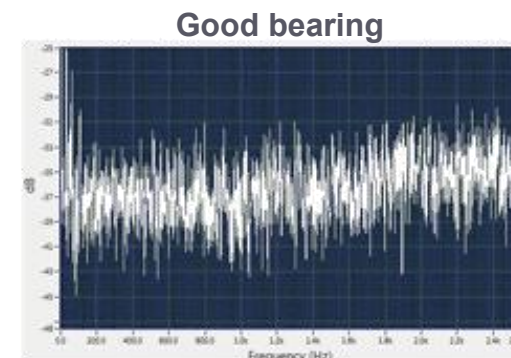
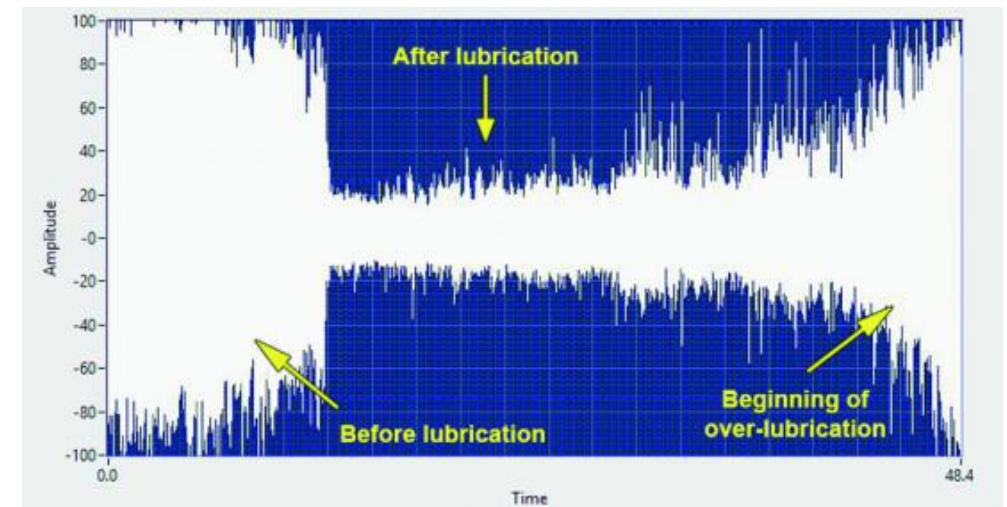
Motor control use case condition monitoring through audio

By 'hearing' problems at an earlier stage, damage is minimized...

- Most common maintenance applications that could be applied in any plant today
 - Air Leak Detection of compressed air equipment
 - Vibration monitor: All rotating equipment produces frictional forces with high frequency ultrasonic signatures which are often masked by ambient plant noise and low frequency vibrations
 - Compressor Valve Inspections
 - Acoustic Lubrication
 - Heat Exchanger and Condenser Leaks
 - Hydraulic Systems
 - Pump Cavitation



Amplitude and
Frequencies matter



Connectivity options to match the needs of industrial environments



Wired Connectivity

P2p, Industrial Fieldbus, Industrial Ethernet



And more ..

Any Industrial protocol for any STM32



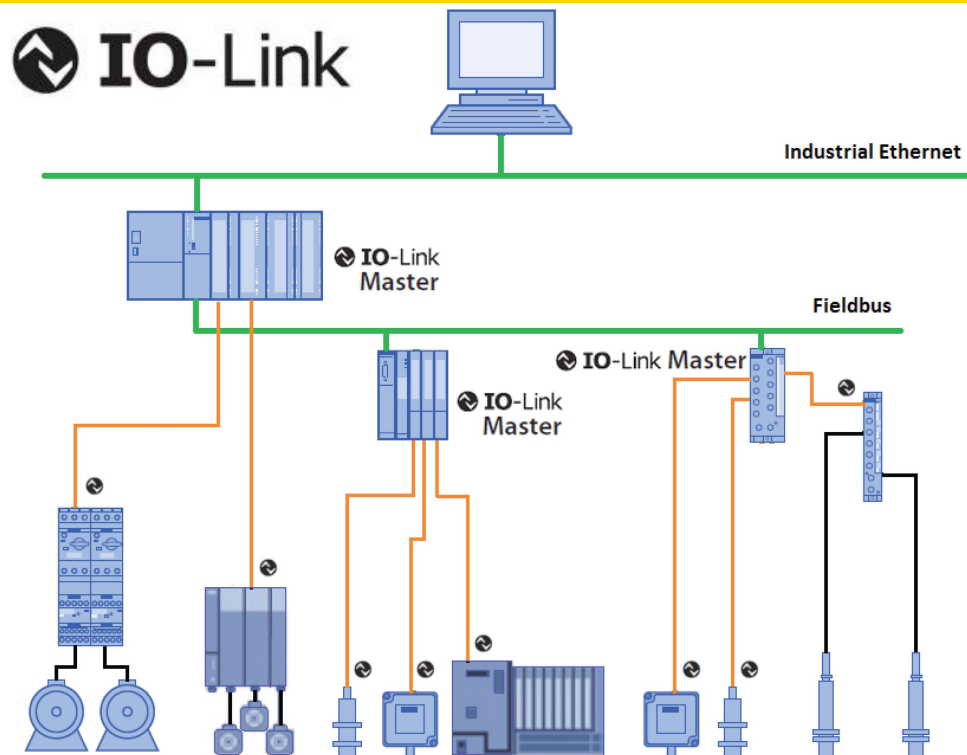
Wireless Connectivity

Retrofit, flexibility of technologies and protocols,
interoperability with Ethernet and Cloud



IO-link point-to-point communication

Get your system ready for Smart Industry communication



Example of system architecture with IO-Link

Three reasons why IO-Link is simple

- **Universal**
 - IO-Link corresponds to the international standard IEC 61131-9
- **Smart**
 - IO-Link offers digital data communication to the last meter between field devices and the machine control
- **Easy**
 - IO-Link is Plug & Play – compatible with existing machinery and systems

Industry 4.0 utilizes

- Ad-hoc-communication
- Predictive maintenance
- Data analytics

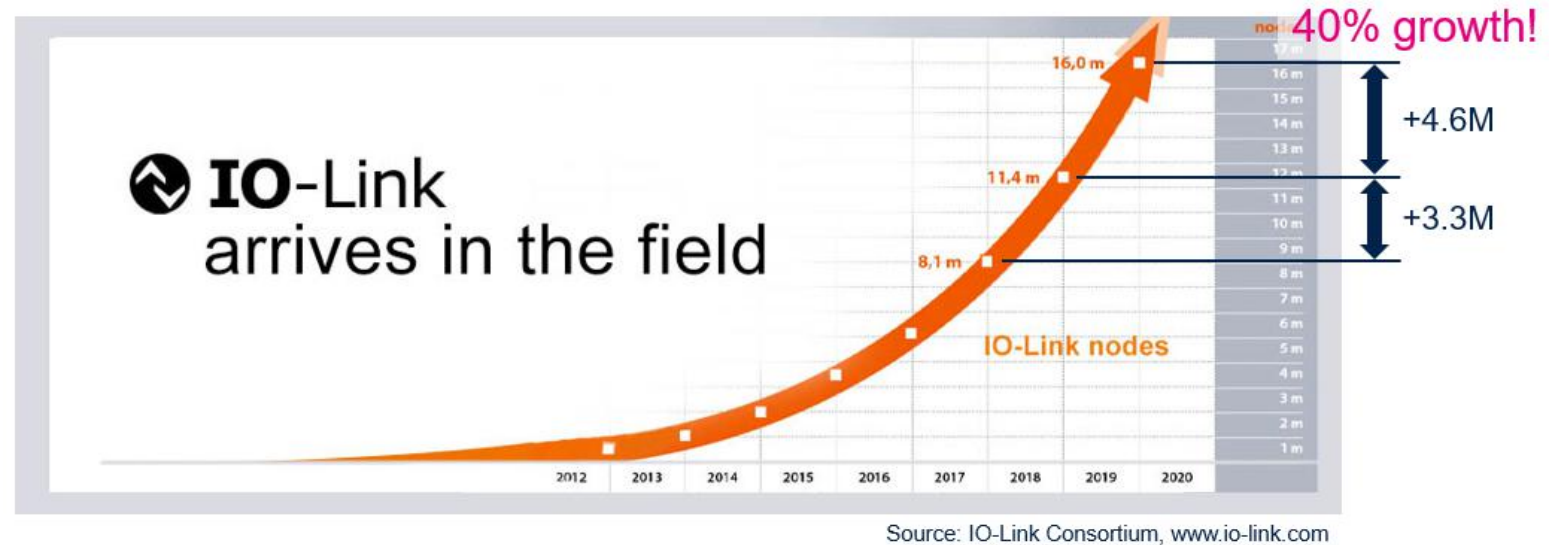
IO-Link Technology

Long-term TAM for IO-Link: to target 100M units / year for Devices + another 100M units for Masters (world-wide)

IO-Link is mostly spread in sensors

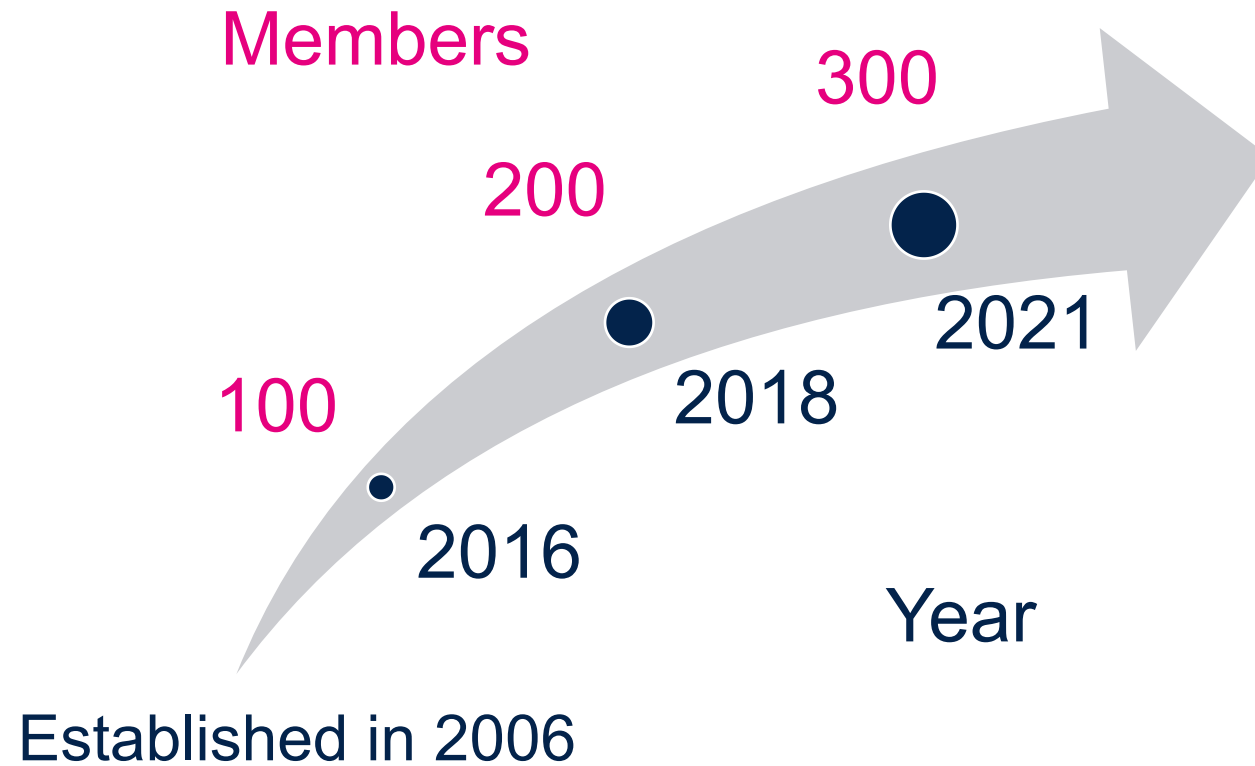
Key Sensor Types implementing  IO-Link

- Position (especially optical)
- Pressure
- Flow
- Level
- Temperature
- Proximity



IO-Link consortium

Group of factory automation market-leading companies



More information at: www.io-link.com



... and many more

Factory automation yesterday

Typical Application Environment

Sensing

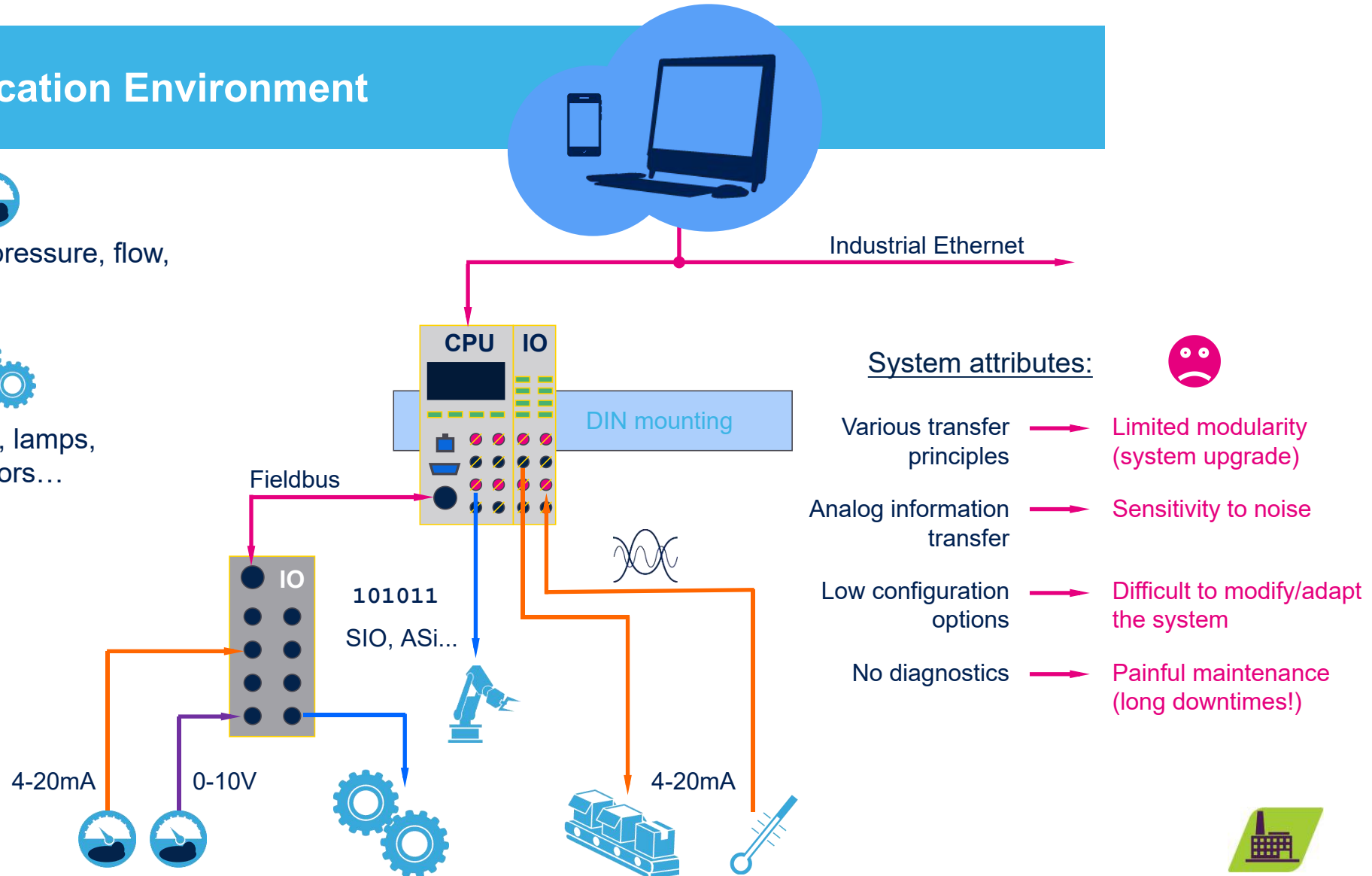


- Temperature, pressure, flow, proximity...

Actuation



- Valves, pumps, lamps, relays, contactors...



Factory Automation Tomorrow with



Typical Application Environment

IoT



Sensing

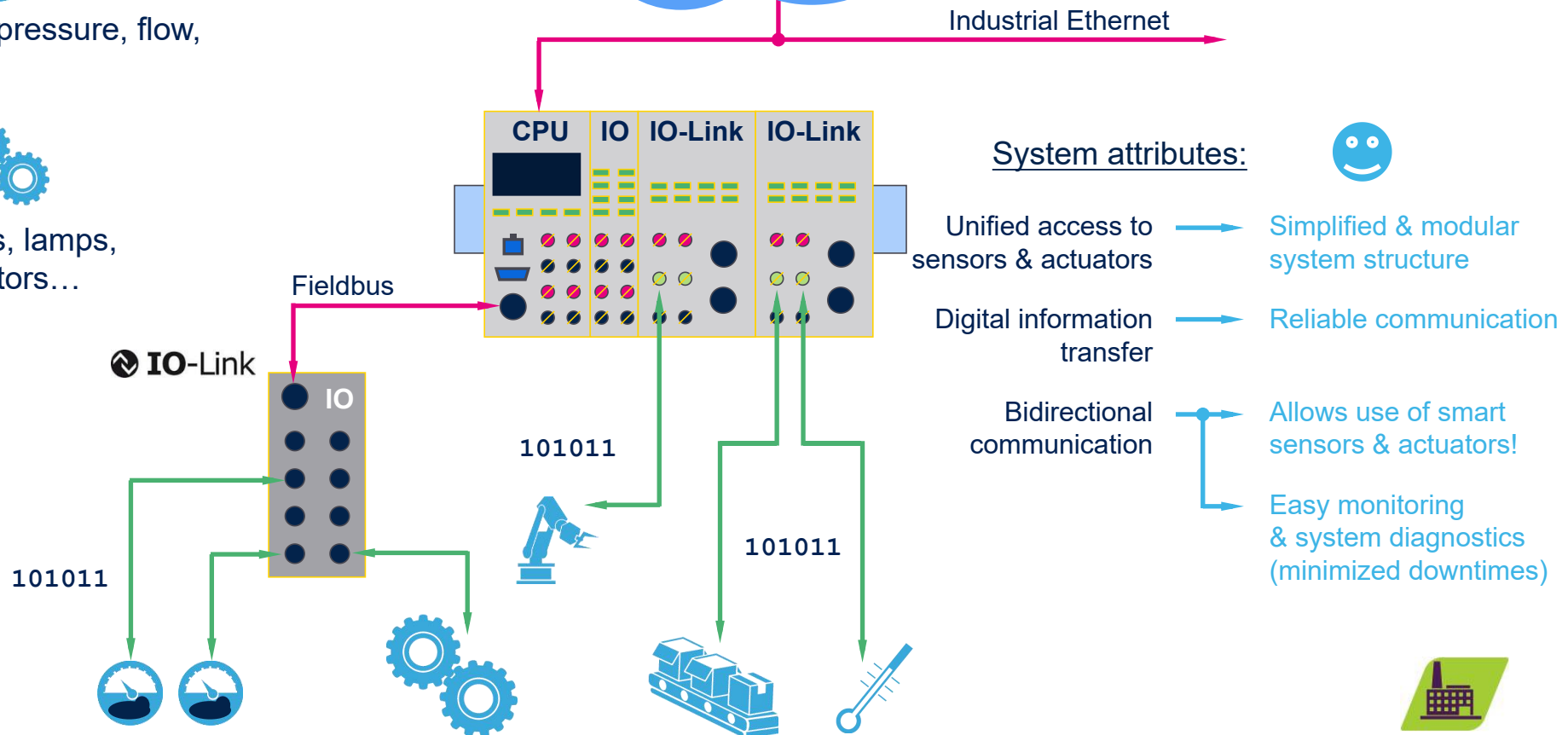


- Temperature, pressure, flow, proximity...

Actuation



- Valves, pumps, lamps, relays, contactors...



Wired connectivity

IO-link: from ICs to development support

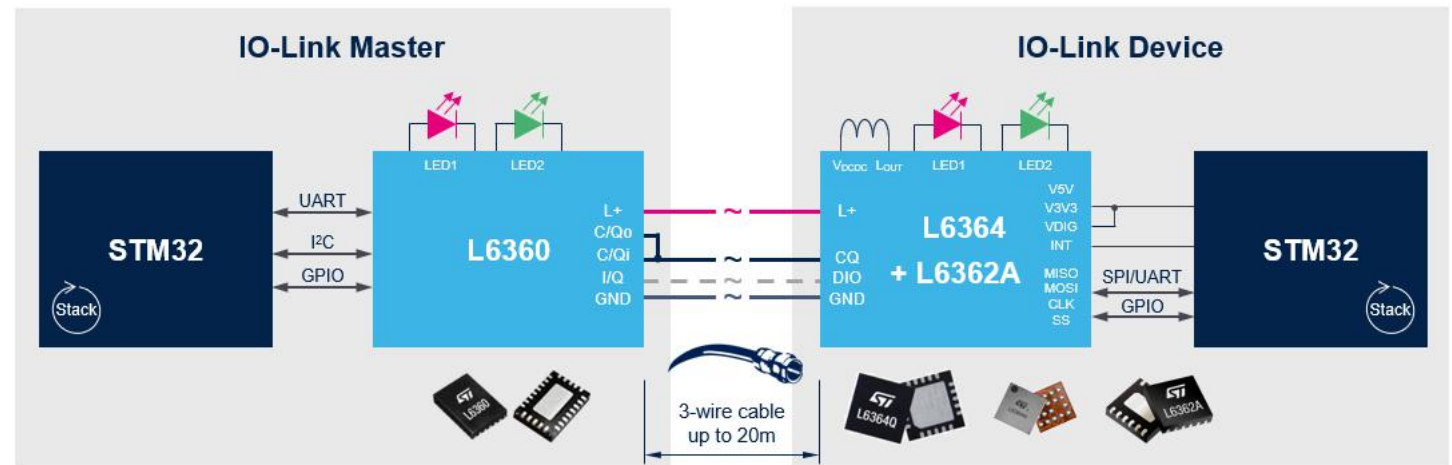
ST covers the complete value chain with the L6360 (Master), L6362A (Device) and MCUs hosting the stack

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/L6364Q

Transceiver Device for IO-Link and SIO mode

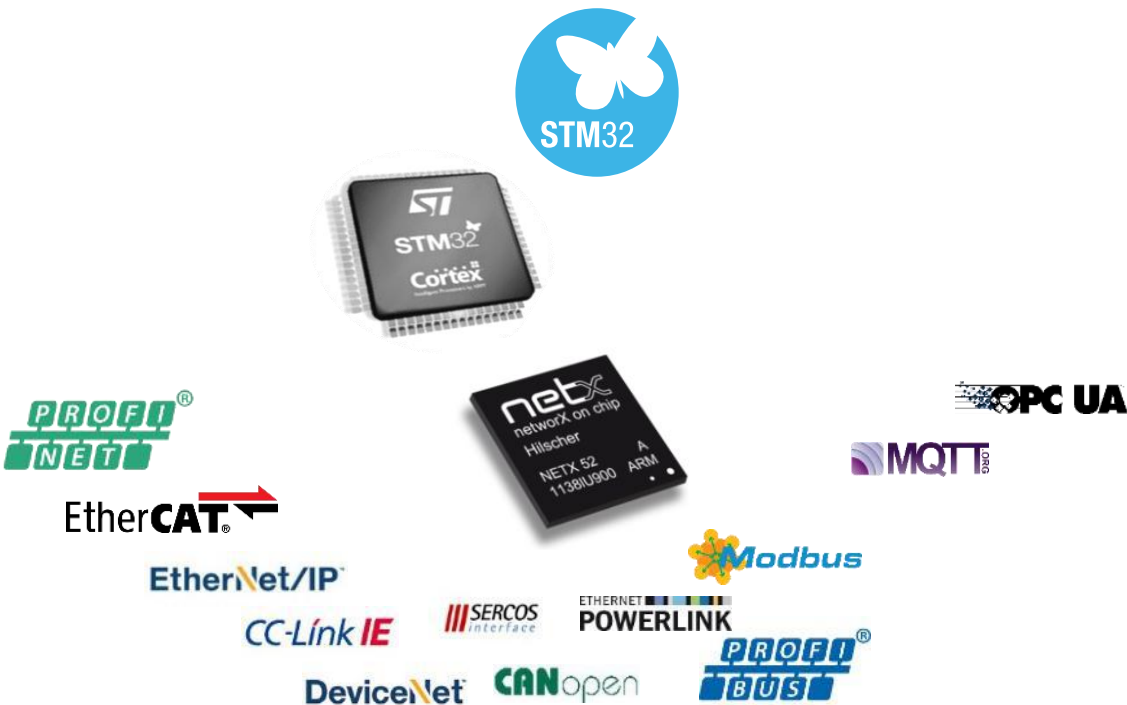


Configurable Output stage: High Side, Low Side, Push-Pull
Reverse Polarity and Surge protections on chip
Up to 400 mA output Current with Overload and Cut-OFF protections
5 V or 3.3 V / 8 mA selectable linear regulator



Wired connectivity RT ethernet development partner

Hilscher netX connects the STM32 to Real-Time Ethernet

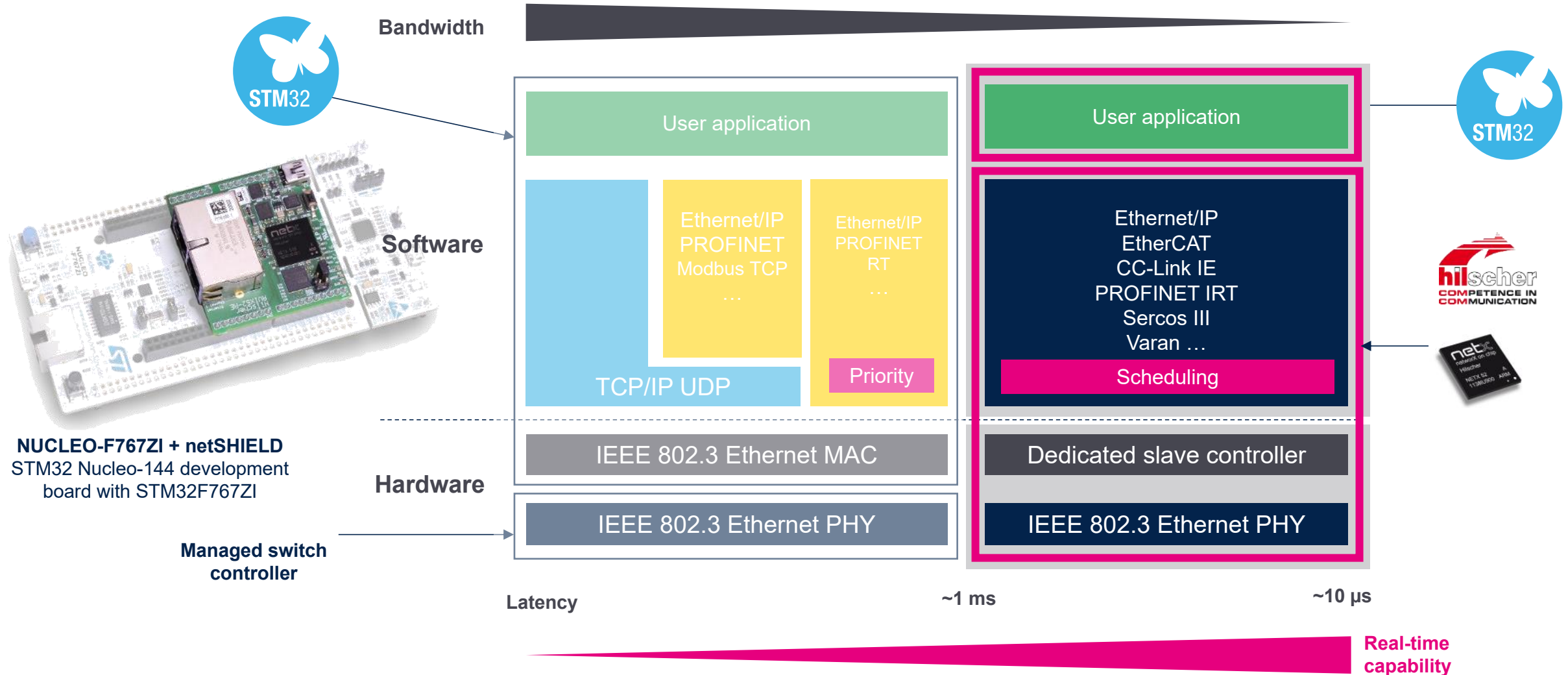


Wide STM32 host controller options

All real-time Ethernet slave stacks available

Industrial IoT and Industry 4.0
MQTT and OPC-UA

Wired Connectivity demanding real-time application solutions



Connectivity options to match the needs of industrial environments



Wired Connectivity

P2p, Industrial Fieldbus, Industrial Ethernet



And more ..

Any Industrial protocol for any STM32

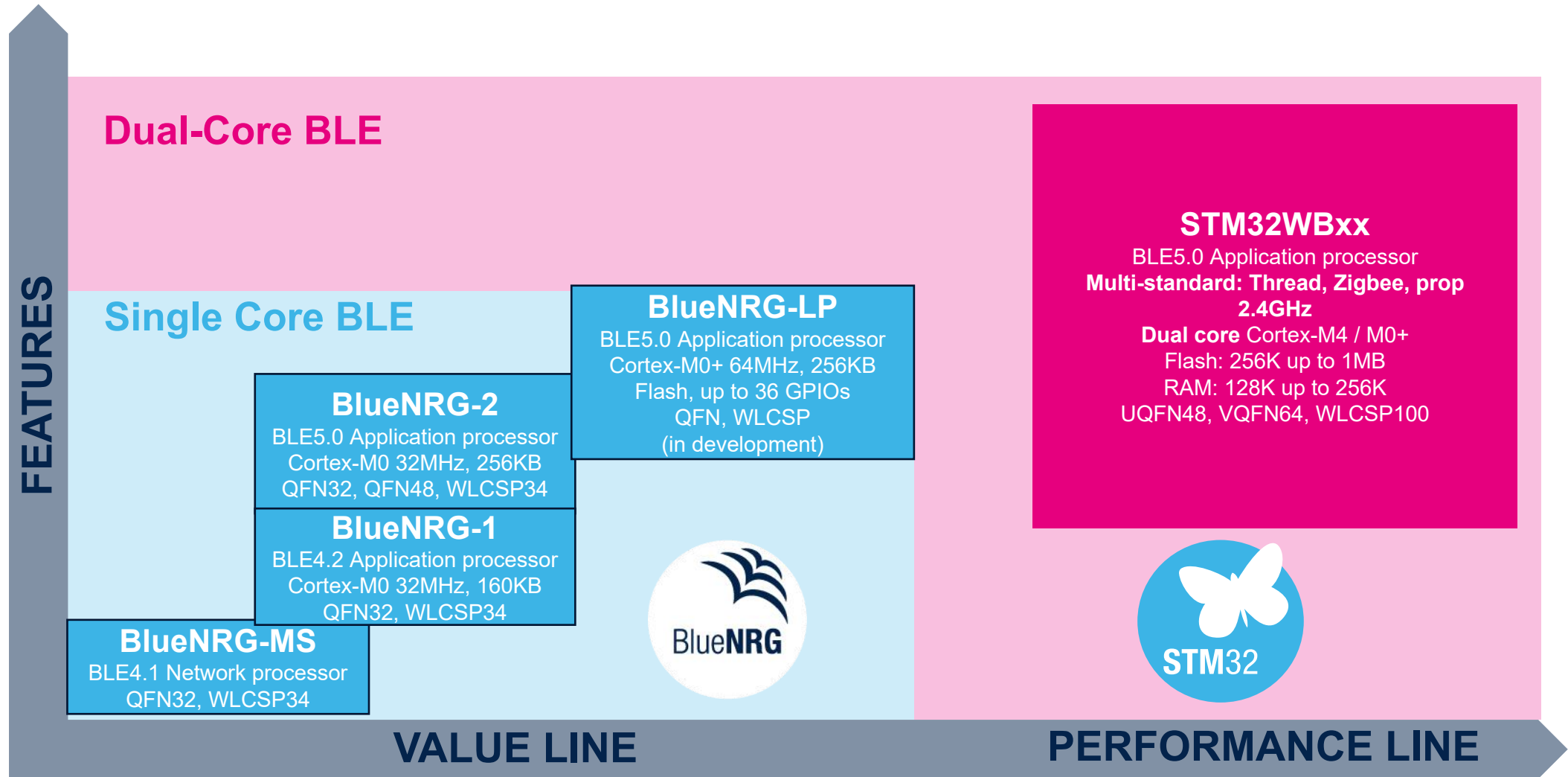


Wireless Connectivity

Retrofit, flexibility of technologies and protocols,
interoperability with Ethernet and Cloud



ST BLE portfolio roadmap





BlueNRG for 2.4 GHz proprietary radio wireless link through a proven 2.4 GHz radio

Open RF SoC solution

Ultra-low latency RF link ($\sim 100\mu\text{s}$) for HID and gaming solutions



- Built-in acknowledge mechanism
- Proprietary implementation possible
- Improved data rate (~ 600 Kbps)
- Small memory footprint (~ 5 Kbyte)
- Encryption feature supported

| | | | | | |
|----------|-----------|--------|--------|---------------|--------|
| 1 Byte | 4 Bytes | 1 Byte | 1 Byte | 0 to 31 Bytes | 3 Byte |
| Preamble | NetworkID | Header | Length | Data | CRC |

Extending Bluetooth's capabilities

PAIRING one-to-one



DATA TRANSFER

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

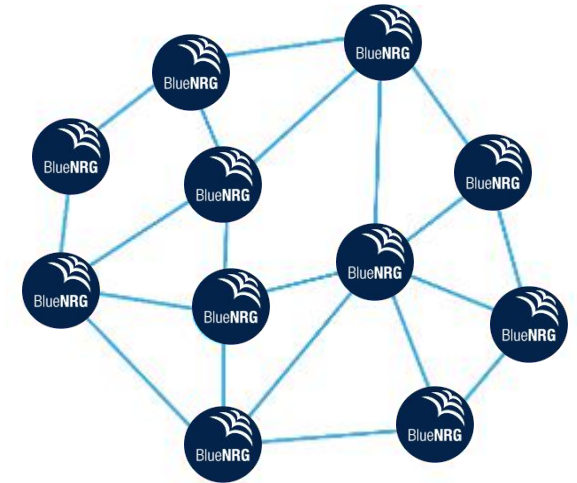
BROADCASTING one-to-many



LOCALIZED INFORMATION

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

NEW MESH many-to-many

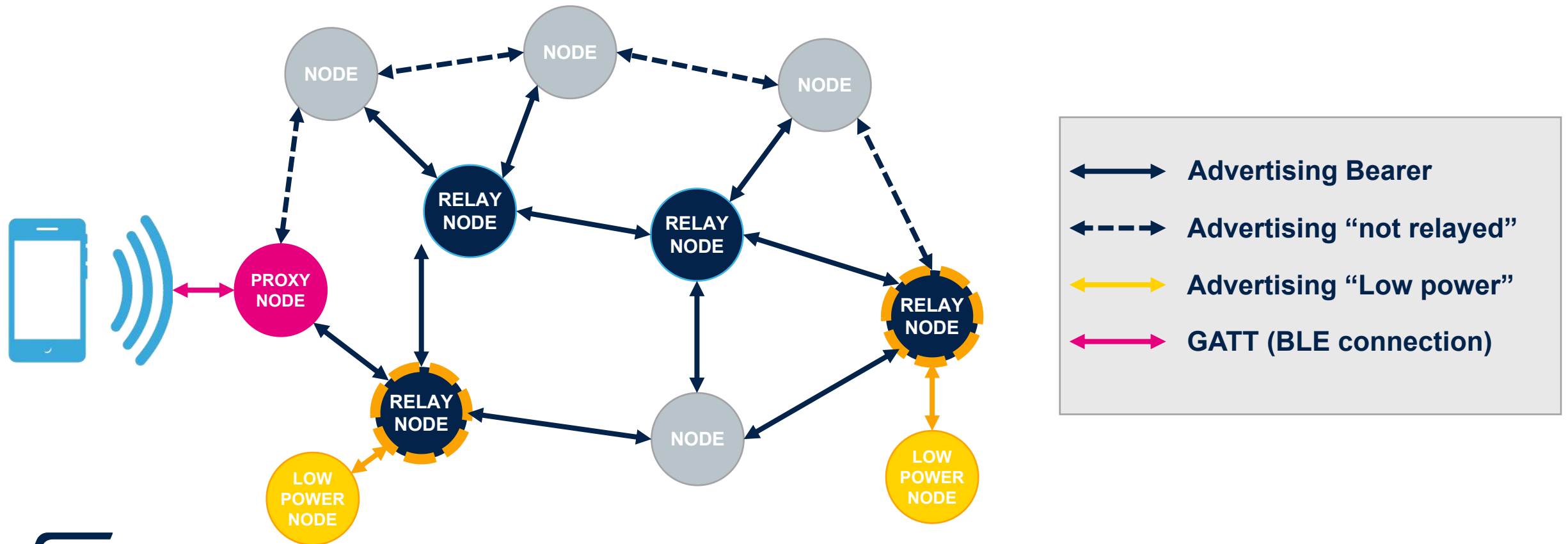


LARGE DEVICE NETWORKS

- Building automation
- Wireless sensor networks
- Asset tracking

Bluetooth Mesh topology managed flooding

Bluetooth Mesh flooding network protocol is easier to deploy than routed protocols. Managed flooding network ensures efficiency



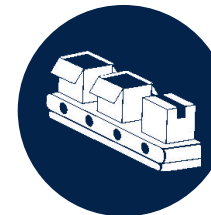
ST enabler products & solutions



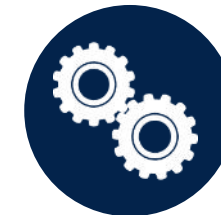
ST enabling Smart Manufacturing



**Smart
manufacturing**



**Factory
automation**



**Smart Motion
control**



**Industrial
robots**



**Industrial
lighting**



**Power
Management**



End-to-end sensors to cloud

Products

Solutions and fast prototyping

Long lifetime support

Sensing



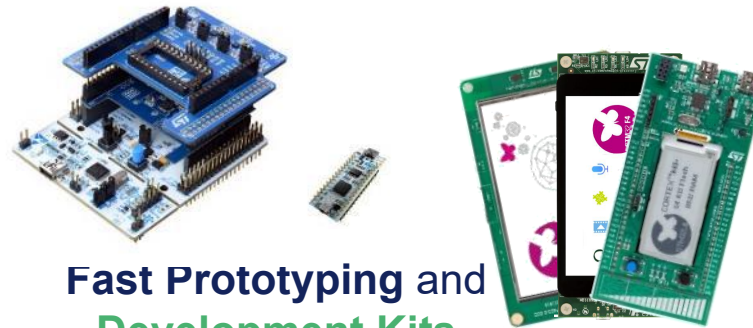
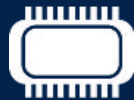
Connectivity



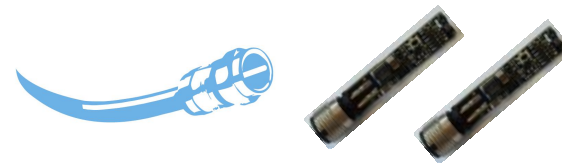
Security



Processing



Fast Prototyping and
Development Kits

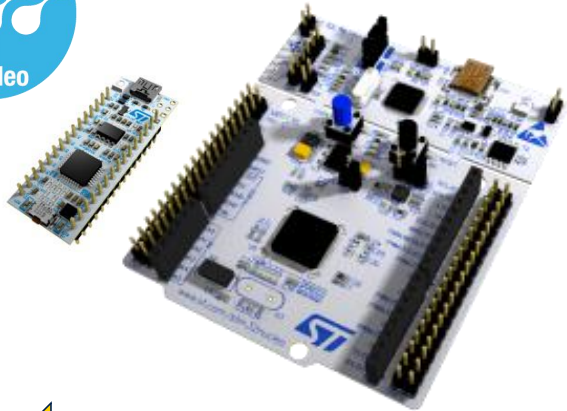


Reference Design



STM32 and hardware tools

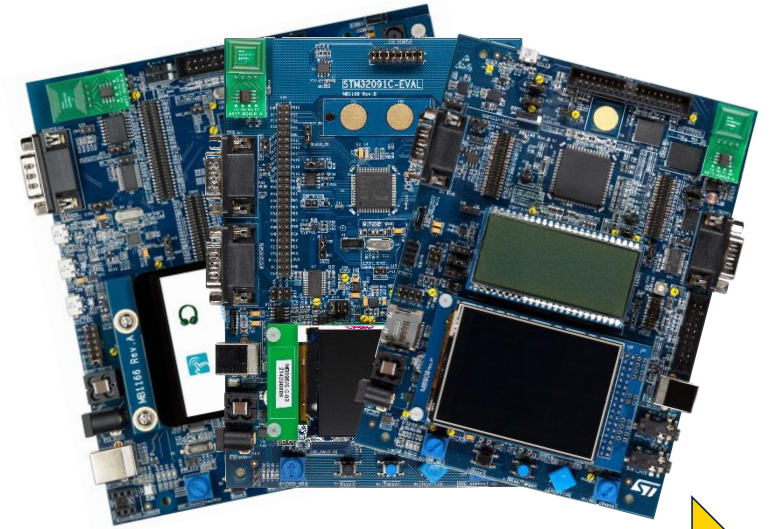
STM32 Nucleo Boards



Discovery Kits



Evaluation Boards



Fast agile prototyping

Feature highlight, prototyping

Full features evaluation

Sensing



Connectivity



Security



Processing



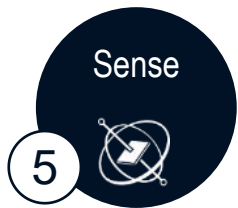
27 processing and security development boards, and growing...



Covering all STM32 microcontroller families
and different development needs



32 expansion boards and growing... covering all the key functions



Motion & environmental
sensors

Proximity sensor

Microphone

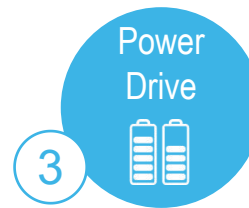


BLE

Wi-Fi

Sub-GHz

NFC



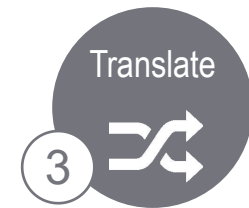
Power management

LED boost



Motor drive

Actuator



Audio amplifier

Op-Amp

Industrial sensors



Environmental



Temperature sensors

Analog and digital contact temperature sensors



Humidity sensors

Combo humidity and temperature sensor



Pressure sensors

With water-proof solutions



Accelerometer

Ultra Wide Bandwidth, Ultra low power



Gyroscope

Wide Bandwidth and Smart Features



Magnetometer

Low-Noise, Low Power

Acoustic



Microphones

Analog, digital, top and bottom port solutions

Optical



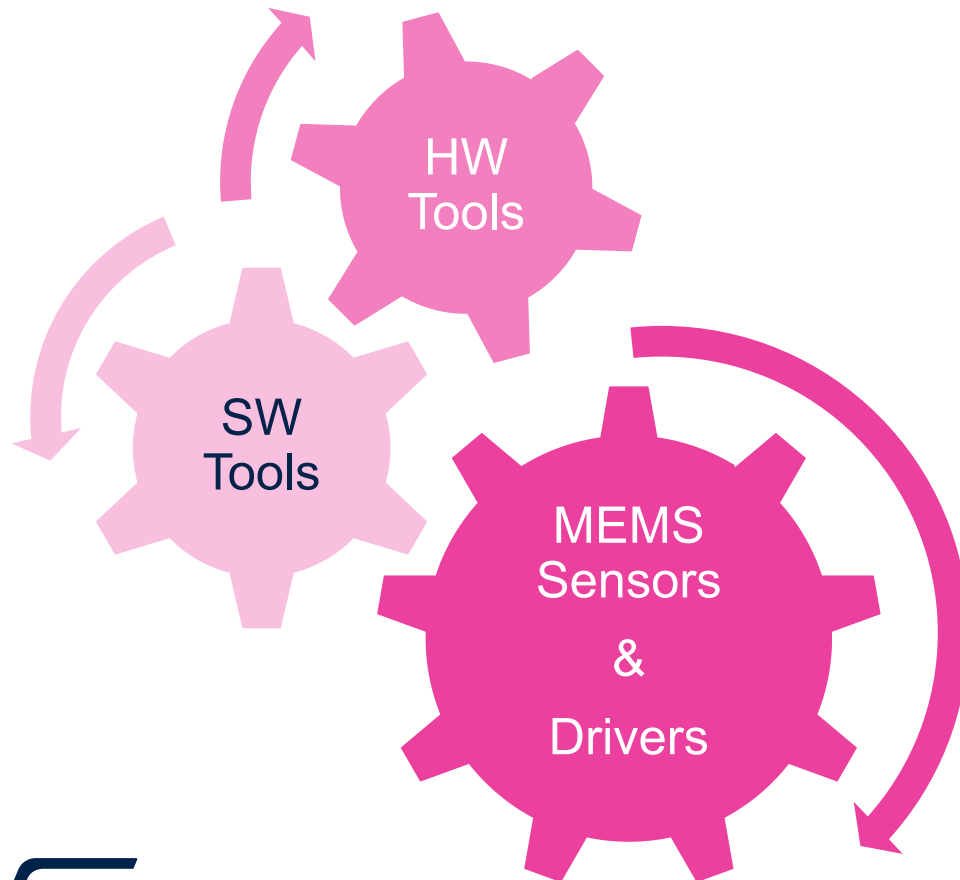
Time of Flight

High precision, surface agnostic distance measure



ST sensors & motion algorithms

Complete package to support development of custom application



MEMS Sensors & Drivers



Accelerometer



Gyroscope / IMU



**Magnetometer
eCompass**



Pressure Sensor

HW Tools

STM32 Nucleo board

- Evaluation board based on different MCU core: M0+, M3, M4

X- Nucleo expansion board

- MEMS sensor Plug-in board for Nucleo

Unicleo-GUI

- GUI to configure MEMS devices and display sensor & apps output

SW Tools

X-CUBE_MEMS1

- Package with example code, libraries and sample apps for STM32 dev ecosystem

X-CUBE_MEMS_XT1

- Sensor and DSP algorithm expansion software pack for STM32

Algobuilder

- SW tool for library development

http://www.st.com/content/st_com/en/support/resources/product-longevity.html

ST MEMs complete software solution

From drivers to software development tools

Low-level Drivers

Standard C Platform Independent drivers

Windows drivers

Linux drivers



[MEMS and Sensors Software - STMicroelectronics](#)

X-CUBE-MEMS-XT1 X-CUBE_MEMS1

Development Tool based on Low level drivers

Runs on STM32

Sample implementation of de
featu



[Go to st.com](#)

Libraries

Generic sw libraries

Accuracy, Calibration, Positioning, Activity tracking, Health monitoring

Dedicated sw libraries

FSM, Prog, Sens, Libs



[Open.MEMS - STMicroelectronics](#)

AlgoBuilder Tool

Dedicated software Tool for libraries development

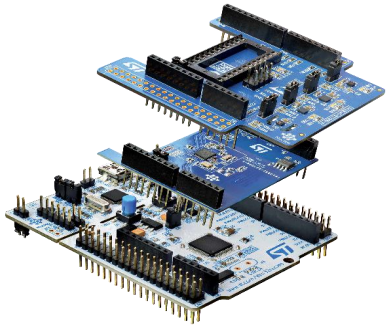
Graphical design apps to build and use algorithms



[Go to ST.com](#)

System solutions development platforms

General Purpose



X-Nucleo

Set of modular developer boards designed around the STM32 MCU family, motherboards and expansion boards for Motion MEMS, environmental and microphones

Sensor Tile

Bluetooth low energy, with a wide spectrum of motion and environmental MEMS sensors, and microphone

STEVAL-STLKT01V1

Wearable & IoT



MEMS Evaluation



Mainboard supports most MEMS devices via 24-pin socket

STEVAL-MKI109V3

Multiple microphones, Proximity, Environmental and Motion sensing + BLE

STEVAL-BCNKT01V1

Audio



NFC Tag Sensor Node



SmarTAG

Dynamic NFC Tracker with sensors

STEVAL-SMARTAG1

IoT Discovery

Sensorized IoT node, allows direct cloud connections

STM32F0DISCOVERY

IoT & Cloud



World's smallest Time-of-flight ranging sensor



VL53L1X

OLGA: 4.9x2.5x1.56 mm
FoV: 15-27° (programmable)

- **Fully integrated** (IR 940nm Vcsel emission, filters, SPAD receiving array, advanced μ C)
- **Various operating modes available:**
 - **Long range:** Up to 4 meters (white target, dark, 33ms)
 - **High-Accuracy:** Up to +/- 3%
 - **Low power:** 10uA-standby, ~200uA in nominal operation
 - **High-Speed:** Configurable timing budget (up to 30Hz)
- **Better ambient light robustness and no visible red glow** (940nm)
- **Laser Class1 device** (eye safe)
- **Complete Android SW driver** provided by ST

Applications

Object / user detection

- Autonomous mode with interrupts
- Vacuum cleaners: Obstacle avoidance
- Smart home
- IoT



Simple & robust gesture recognition

- Control of devices
- Loudspeaker
- Coffee machines
- White goods



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