arm Education

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Supported by

cadence

Industry 4.0
Enabling smart systems

Vinay Thapliyal - MPU Marketing

GPM Sub-group, MDG

Agenda

1. Smart industries focus
2. Semiconductor enablers
3. Smart industry use-cases
4. Take aways

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From industry to smart industry

18th century	20th century	1970's	Today
1st Industrial Revolution	**2nd Industrial Revolution**	**3rd Industrial Revolution**	**4th Industrial Revolution**
Mechanical production equipment driven by water and steam power	Mass production achieved by division of labour concept and the use of electrical energy	Based on the use of electronics and IT to further automate production	Use of cyber-physical systems, communications, IoT and decentralized decisions
All new machines	Change of driving mechanism	Machines largely replaced	Machines partially replaced - connected

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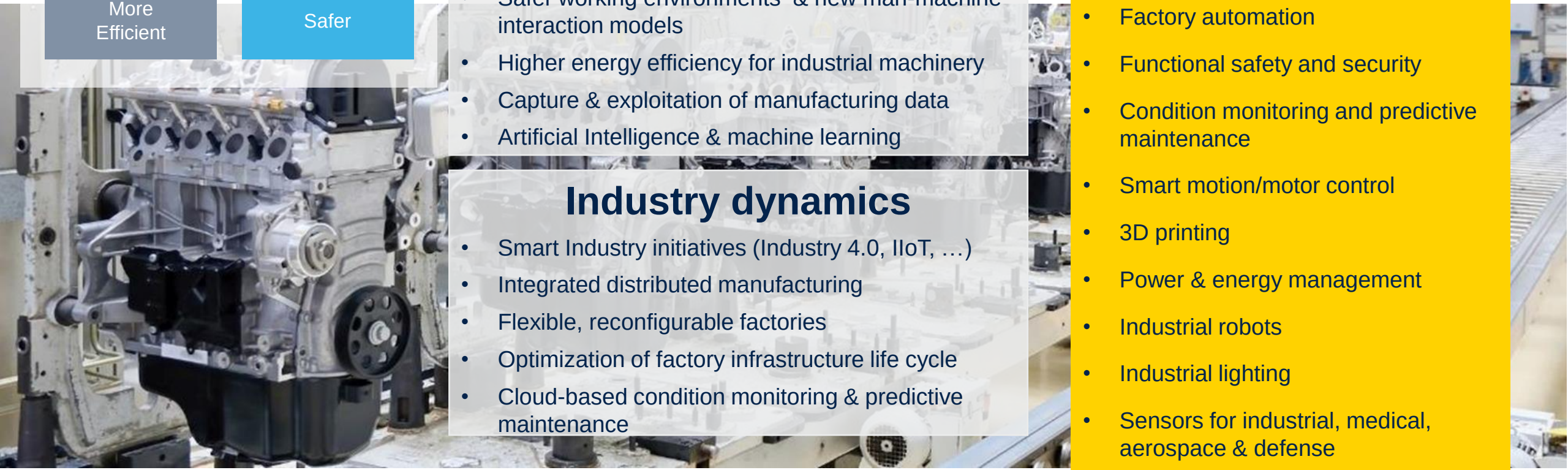
Smart industry focus

More Intelligent & Aware

More Connected

More Efficient

Safer



Key trends

- Next levels of automation with distributed control
- Safer working environments & new man-machine interaction models
- Higher energy efficiency for industrial machinery
- Capture & exploitation of manufacturing data
- Artificial Intelligence & machine learning

Industry dynamics

- Smart Industry initiatives (Industry 4.0, IIoT, …)
- Integrated distributed manufacturing
- Flexible, reconfigurable factories
- Optimization of factory infrastructure life cycle
- Cloud-based condition monitoring & predictive maintenance

Key applications

- Smart manufacturing
- Factory automation
- Functional safety and security
- Condition monitoring and predictive maintenance
- Smart motion/motor control
- 3D printing
- Power & energy management
- Industrial robots
- Industrial lighting
- Sensors for industrial, medical, aerospace & defense

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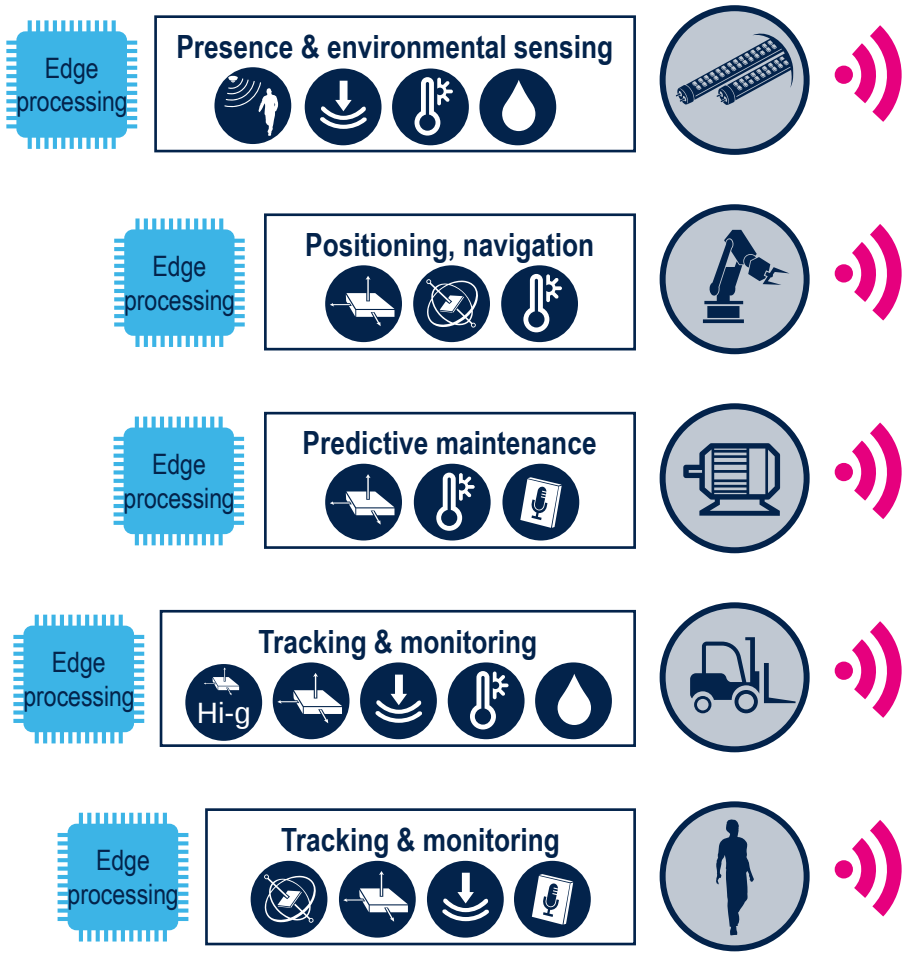
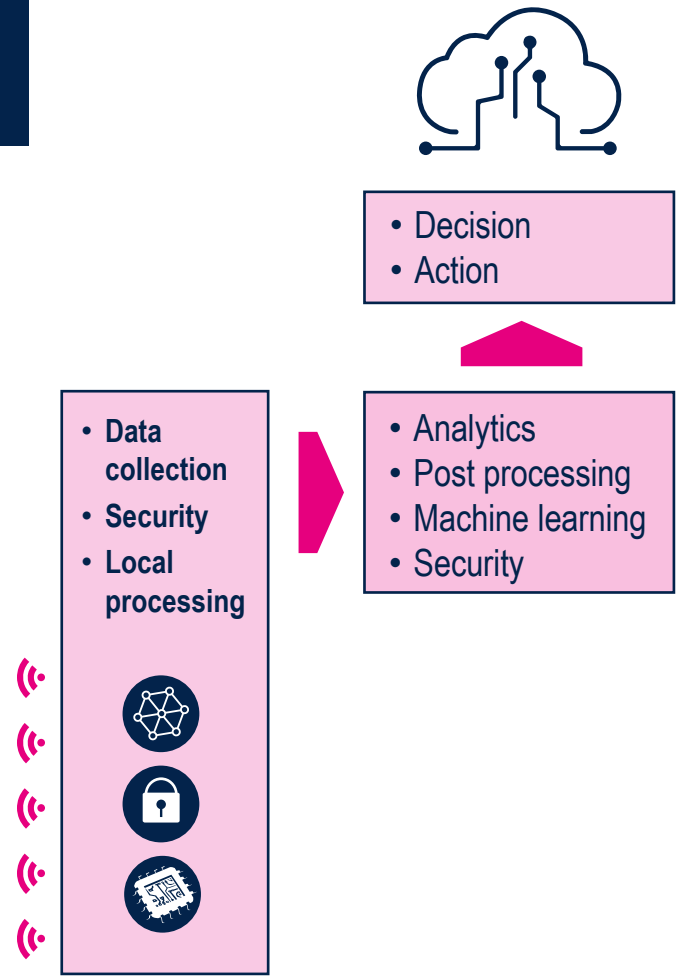
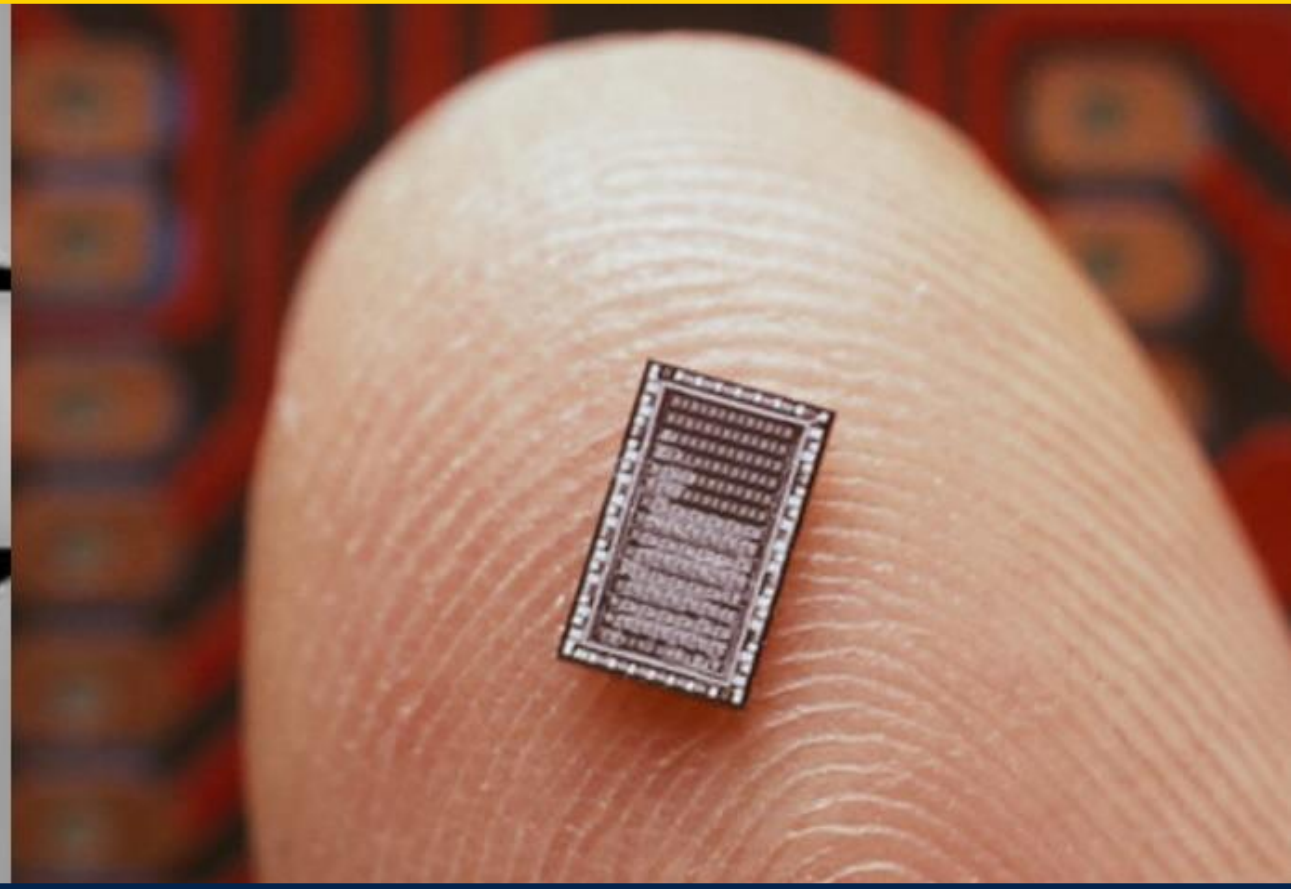
The industry 4.0 revolution

Revolution boosted by sensors, edge processing & connectivity





Innovations through MEMS



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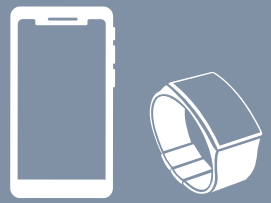
MEMS sensors and actuators

Core business



Smartphones and wearables

- User Interface
- Gaming
- Optical stabilization
- Smart watches & Fitness bands

CECP

- Printheads
- Memory array temperature sensing

Automotive safety and infotainment

- Electronic stability control
- Navigation
- Telematic box

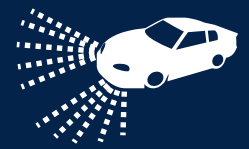
High-growth areas

Emerging applications

- TWS
- AR / VR / MR
- Health data sensing

Industrial

- Industry 4.0+
- Predictive maintenance
- Building structure monitoring
- Presence detection



Automotive

- ADAS
- Electrification
- Powertrain management
- LiDAR

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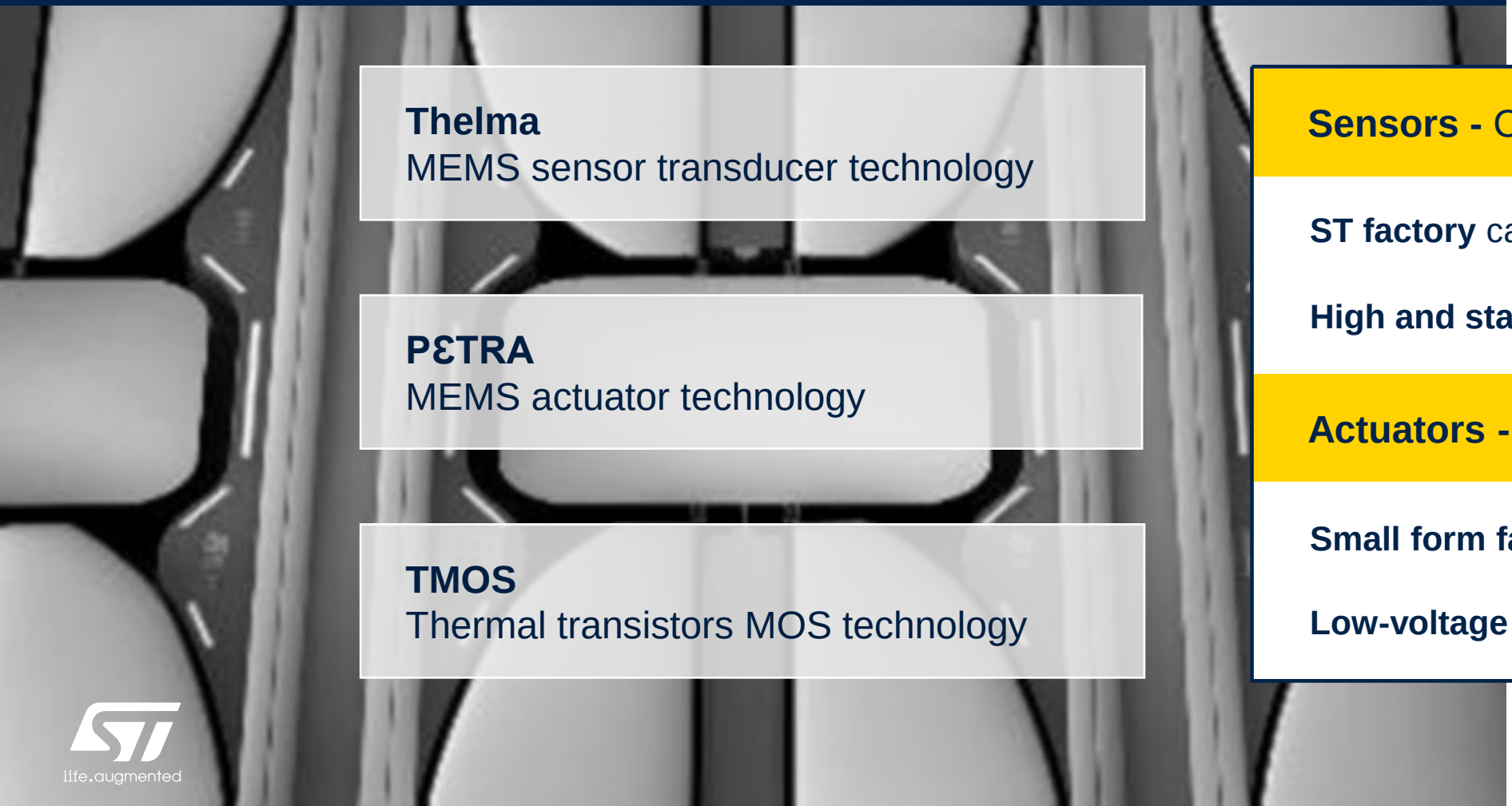
Continuing to build competitive advantage in MEMS through our technologies and IPs

Leveraging ST MEMS proprietary technologies and accuracy + ecosystem + AI in the edge



Thelma
MEMS sensor transducer technology

PƐTRA
MEMS actuator technology

TMOS
Thermal transistors MOS technology

Sensors - Calibration friendly

ST factory calibrated

High and stable performance

Actuators - System-integration friendly

Small form factor and **light weight**

Low-voltage driven

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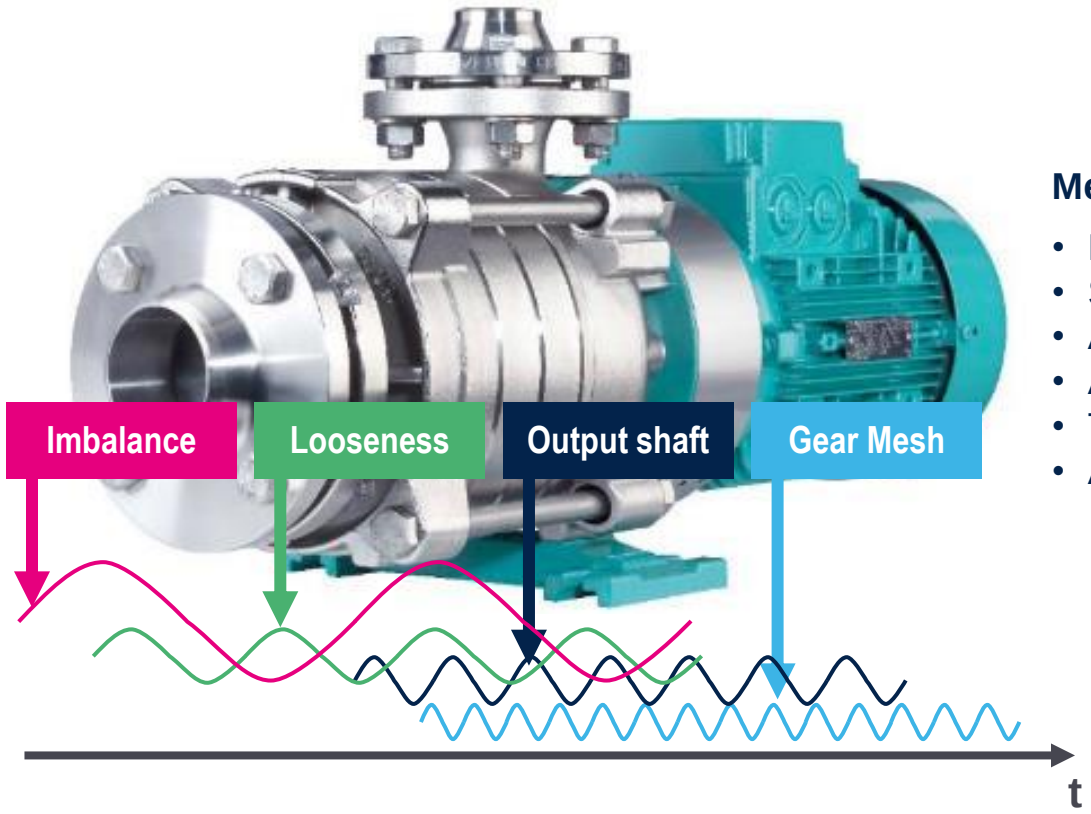
Example of condition monitoring

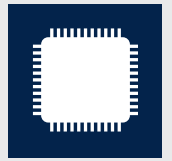
Any parameter deviation is an indicator of potential failure



Mechanical vibration

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

Functions to enable monitoring

Vibration capture	
Connectivity	
Processing	
Secure connections	

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AI at the Edge

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Making AI at the edge a reality

Introducing ST's game-changing Neural MCU

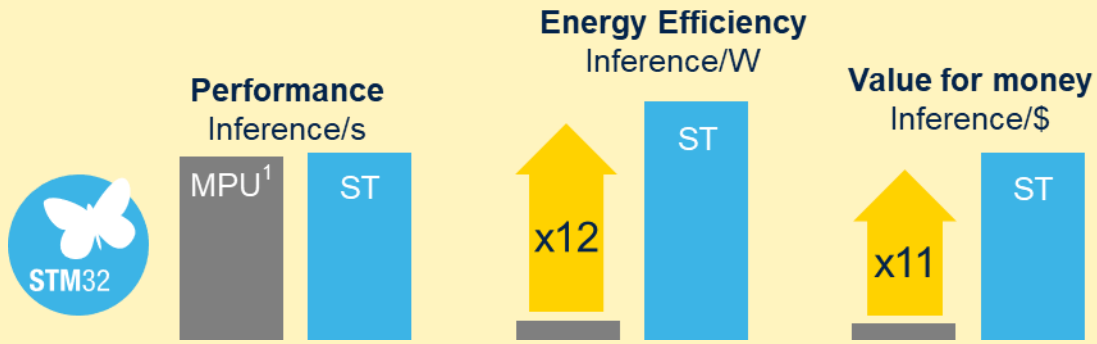
NEW

STM32**N6**

First MCU with **ST Neural-ART NPU** Accelerator

State of the art Inference/W and Inference/$

Powered by STM32 Cube.AI



"The new STM32N6 Neural MCU is dramatically lowering the AI technology implementation price point. This breakthrough supports our roadmap of new generation intelligent sensors allowing rapidly growing adoption in Smart Cities"

LACROIX

Vincent SABOT,
Executive Managing Director, LACROIX - City activity

Accelerating Development of Edge AI Solutions

NanoEdge Studio Edge AI Productivity Lab

No AI experts required
Up to 95% shorter development cycle
Fit small footprints, MCU & ISPU
Accretive royalty model

NANOEDGE AI STUDIO

Anomaly detection sensor

OXYtronic

STM32F4

12 months from concept to market

Multi sensor capability

Extreme flexibility

Broad deployment planned

Predictive maintenance

AIRBUS

ALTEN

STM32F4

30% increase in cutting tool life

Preventing operational failure

Extending to all drilling & cutting tools

[1] Comparison with competitor quad-core microprocessor with AI hardware acceleration

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Anomaly detection lowering the barrier to develop in-sensor edge AI

ISPU is supported by NanoEdge™ AI Studio

NANOEDGE AI STUDIO

NEAI is a Software Development Environment to radically simplify and shorten Edge AI Solution design

by NANOEDGE AI

Create a self learning engine based on AI commercial models

Embed the library into the ISPU

For anomaly detection, the model is self-trained at the Edge

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Our customers have increasingly ambitious use-cases for ever smarter products

AD
Anomaly Detection

1C
1-Class Classification

nC
n-Class Classification

E
Extrapolation

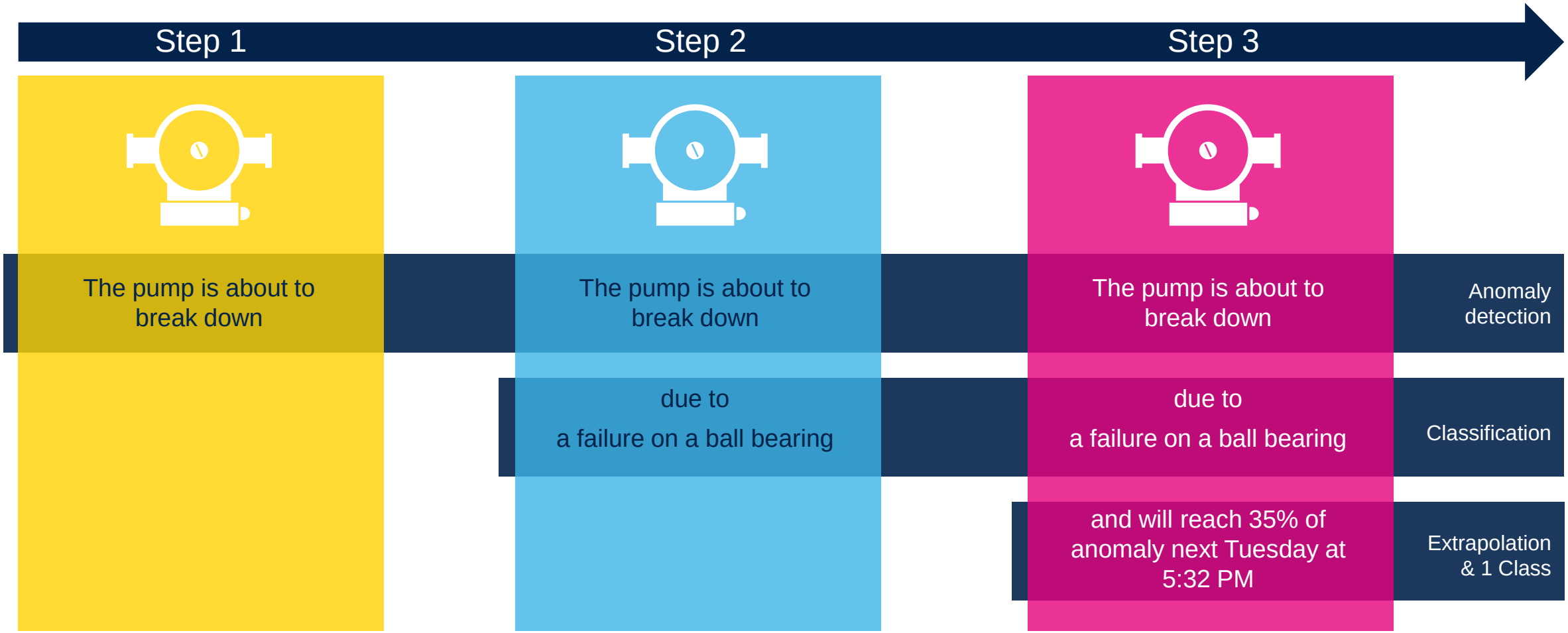
I want them to autonomously adapt to their target environment and detect anomalies by themselves

I want to detect any outliers / I don't have example of anomaly

I want to know by name what problems are occurring"

I want to anticipate the vibration level so that I have time for corrective actions

Always more added value, always as simple to use



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NANOEDGE AI STUDIO

NKE WATTECO

CHALLENGE

Easily and quickly deploy predictive maintenance 4.0 solutions without the usual constraints of deploying an AI-based solution:

- Need to collect huge amounts of data to train static models
- Need for data scientists to develop complex algorithms

SOLUTION

The “Shazam of vibrations” right out of the box.
With embedded AI based on NanoEdge AI Studio, snap Bob assistant to the machines in your factory and Bob will carefully learn and analyze the vibrations and warn you before a problem impacts the production line.

BENEFITS

With just a few contextual inputs, anyone can generate optimized and effective machine learning algorithms with NanoEdge AI Studio. The ability to learn algorithms on the device allows the user to tailor anomaly detection to a specific equipment or environment to reduce false positives and false negatives.

Application of NanoEdge AI Studio

NANOEDGE AI STUDIO

Microcontroller	M3 @ 80Mhz
Library Type	Anomaly detection
Signals used	Vibrations
RAM / FLASH	6K / 28K

IRMA

Intelligent Resource for Maintenance Application

CHALLENGE

Being able to predict issues in machinery is a considerable advantage in many respects but it is often complicated to understand precisely the nominal operating state of an equipment to deduce a malfunction.

SOLUTION

IRMA can predict failures thanks to its multiple sensors and its embedded AI at the edge. First, IRMA collects data (vibration, temperature, pressure, humidity, acoustics and gas) then compares them via the embedded AI algorithms with a database that is constantly enriched. IRMA warns you at the slightest anomaly.

BENEFITS

"Without data science experts on the team and with a very short development time, we managed to create a unique solution on the market combining embedded intelligence and 6 sensors. IRMA has already been recognized as a major innovation by several industrial awards and is already installed in production by prestigious customers"

LoRaWAN® + BLE + Zigbee, IP67, ATEX Zone 0

Application of NanoEdge AI Studio

NANOEDGE AI STUDIO

Microcontroller	STM32L4
Library Type	Anomaly detection and classification
Signals used	Humidity, acoustic, vibration (1 and 3 axes),temperature, gas, pressure
RAM / FLASH	9Kb / 17Kb

Making Edge AI accessible to all STM32 portfolio

NanoEdge AI Studio & STM32Cube.AI are both compatible with all STM32 series

LONGEVITY 10 YEARS COMMITMENT

MPU

- STM32**MP1**: Up to 1 GHz Cortex-A7, 209 MHz Cortex-M4
- STM32**MP2**: Dual 1.5 GHz Cortex-A35, 400 MHz Cortex-M33

High Perf MCUs

- STM32**F7**: 1082 CoreMark, 216 MHz Cortex-M7
- STM32**H7**: Up to 3224 CoreMark, Up to 550 MHz Cortex -M7, 240 MHz Cortex -M4
- STM32**N6**: MCU with neural processing unit
- STM32**F2**: Up to 398 CoreMark, 120 MHz Cortex-M3
- STM32**F4**: Up to 608 CoreMark, 180 MHz Cortex-M4
- STM32**H5**: Up to 1023 CoreMark, 250 MHz Cortex-M33

Mainstream MCUs

- STM32**F3**: 245 CoreMark, 72 MHz Cortex-M4
- STM32**G4**: 569 CoreMark, 170 MHz Cortex-M4

Mixed-signal MCUs

- STM32**C0**: 114 CoreMark, 48 MHz Cortex M0+
- STM32**F0**: 106 CoreMark, 48 MHz Cortex-M0
- STM32**G0**: 142 CoreMark, 64 MHz Cortex-M0+
- STM32**F1**: 177 CoreMark, 72 MHz Cortex-M3

Ultra-low Power MCUs

- STM32**L0**: 75 CoreMark, 32 MHz Cortex-M0+
- STM32**L4**: 273 CoreMark, 80 MHz Cortex-M4
- STM32**L4+**: 409 CoreMark, 120 MHz Cortex-M4
- STM32**L5**: 443 CoreMark, 110 MHz Cortex-M33
- STM32**U5**: 651 CoreMark, 160 MHz Cortex-M33

Wireless MCUs

- STM32**WL**: 162 CoreMark, 48 MHz Cortex-M4, 48 MHz Cortex-M0+
- STM32**WB**: 216 CoreMark, 64 MHz Cortex-M4, 32 MHz Cortex-M0+ ●
- STM32**WBA**: 407 CoreMark, 100 MHz Cortex-M33

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Latest product generation ● Radio co-processor only ▭ New series introduced in 2023 ▭ Pre-announcement

The best of three worlds in a cost-effective MPU

Arm® Cortex®-A7 core running up to 1 GHz

LONGEVITY 10 YEARS COMMITMENT

BuildRoot Making Embedded Linux Easy
yocto PROJECT SILVER COMPATIBLE
OpenSTLinux

Accessible

- Strong, user-friendly ecosystem for STM32 MPUs (OpenSTLinux, Linux-RT, RTOS)
- PCB layout reference designs

Secure

- Strong robustness
- Certified for faster time to market

Power efficient

- Best-in-class consumption in low power modes
- Over 90% energy savings in Standby and V_{BAT} modes

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Accelerate your time to market

Get STM32 MPU embedded software

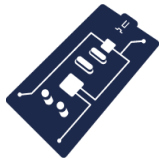
Software development

Security management & board provisioning

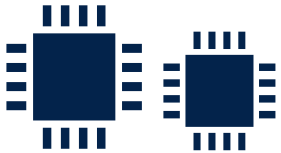
- Keys generator
- Signing tool
- OTP programming
- Flash programming

Your application

Development boards



PCB layout examples



Hardware configuration

- Pinout
- Clock tree
- DRAM Tuning tool

Where to find help online

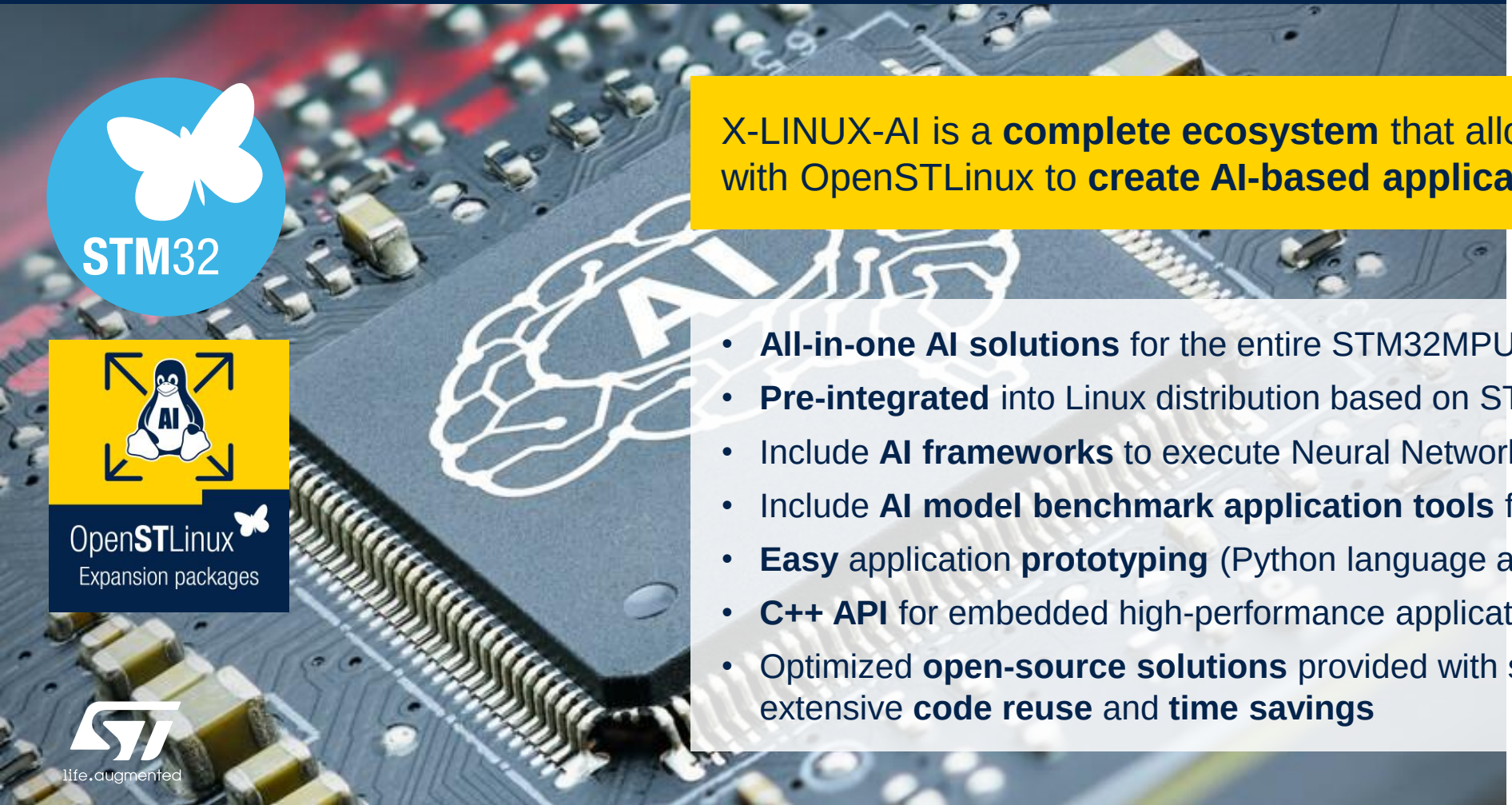
- wiki.st.com/stm32mpu
- Community

Partner tools & ecosystem

- System-on-modules
- Software services

X-Linux-AI
Enabling AI on STM32MP1 series

A free of charge open-source software package dedicated to AI



X-LINUX-AI is a **complete ecosystem** that allow developers working with OpenSTLinux to **create AI-based applications very easily**

- **All-in-one AI solutions** for the entire STM32MPUs series
- **Pre-integrated** into Linux distribution based on ST environment
- Include **AI frameworks** to execute Neural Network models
- Include **AI model benchmark application tools** for MPU
- **Easy** application **prototyping** (Python language and AI frameworks Python API)
- **C++ API** for embedded high-performance applications
- Optimized **open-source solutions** provided with source codes that allow for extensive **code reuse** and **time savings**

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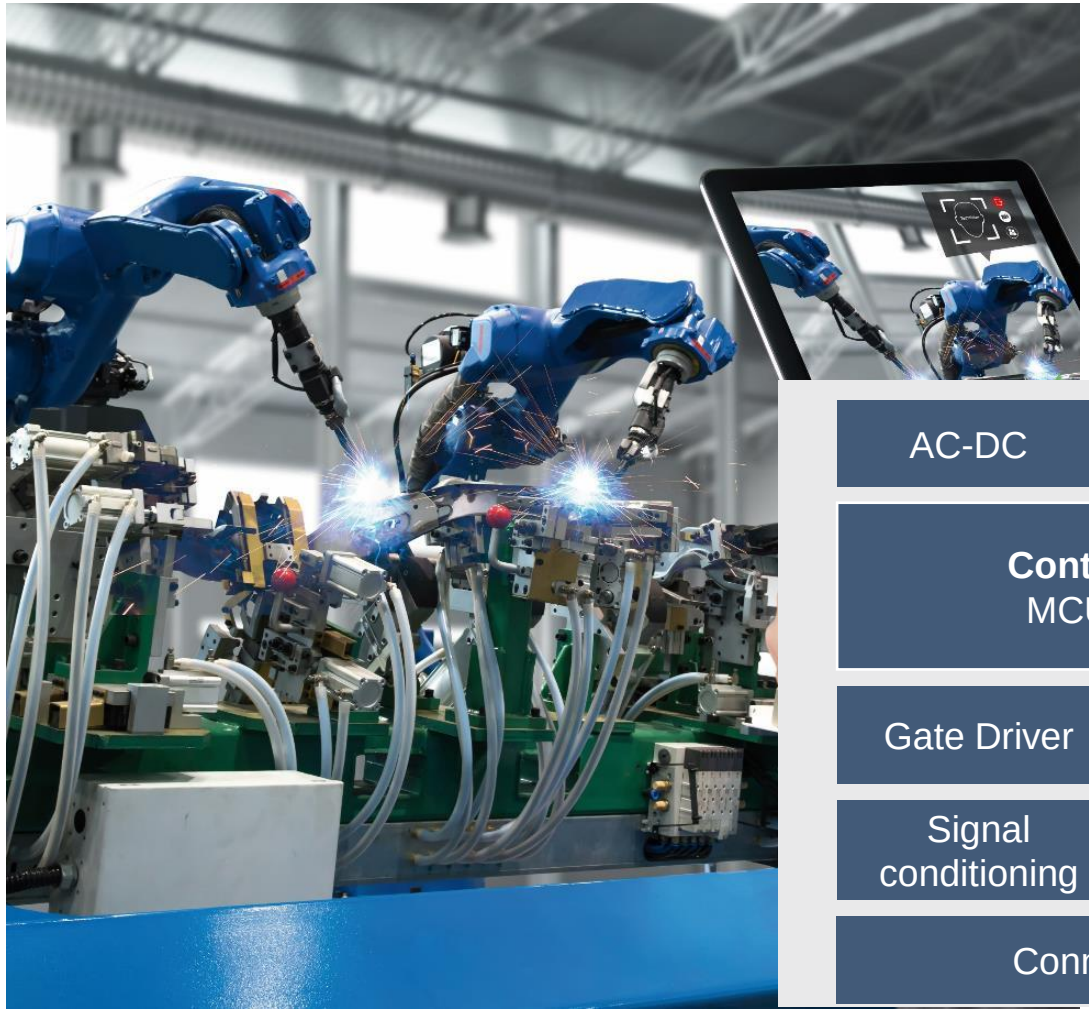
ST solutions for industrial applications



AC-DC

DC-DC

Control Unit
MCU MPU

Gate Driver

MOSFET/
IGBT

Signal
conditioning

Sensors

Connectivity

Factory automation

ST solutions

- STM32 Microcontrollers & Microprocessors
- Motion, environmental and optical sensors
- Wide bandgap & silicon power discretes
- Analog signal processing ICs
- Galvanic isolated drivers
- IO-Link & industrial Ethernet

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Factory automation

Information layer

Control layer

Distribution layer

Drive layer

Execution/ Sensor layer

PLC Controller

HMI

PROFI NET

PROFI BUS

IO-Link Master

Ethercat Master

Distribute IO module

CANopen

Function Expansion Modules

EtherCAT

EtherCAT

IO Hub

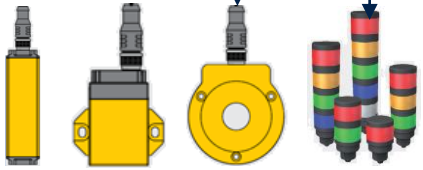
EtherCAT

Servo/ Motion

Stepper

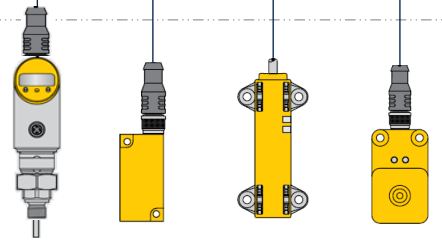
PROFIBUS DP

DA/PA Link coupler



Actuator

Industrial Robots



Industry Sensor

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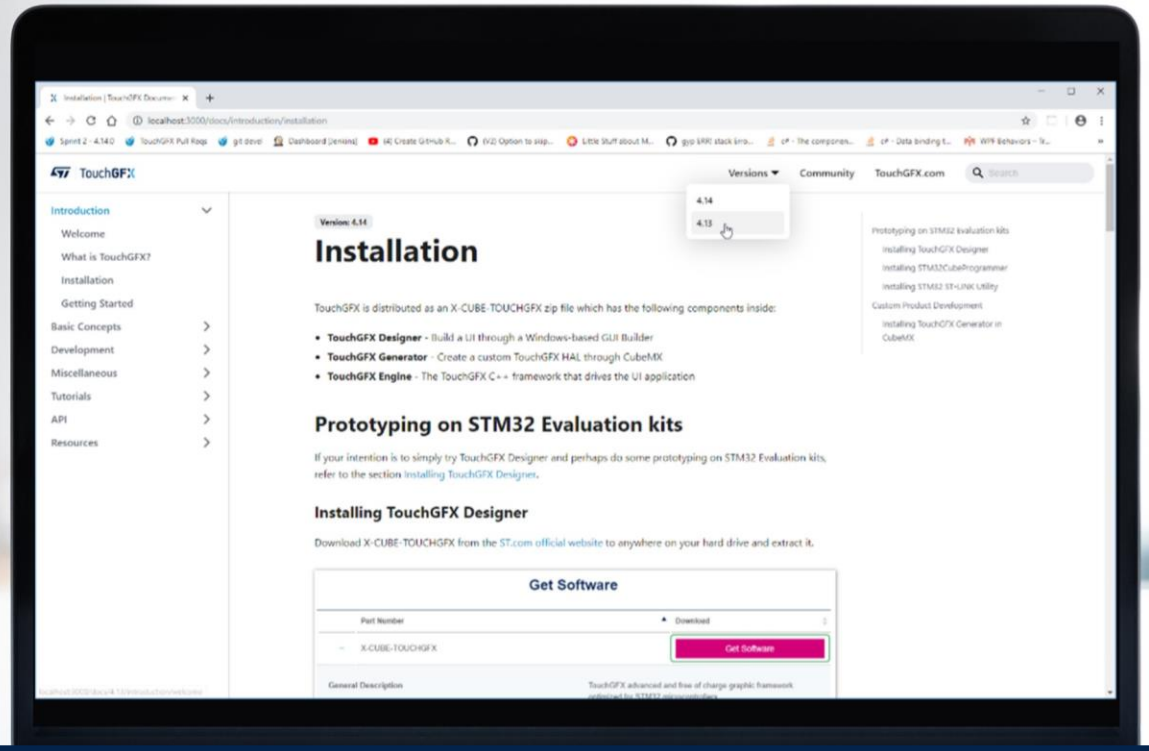
Resources



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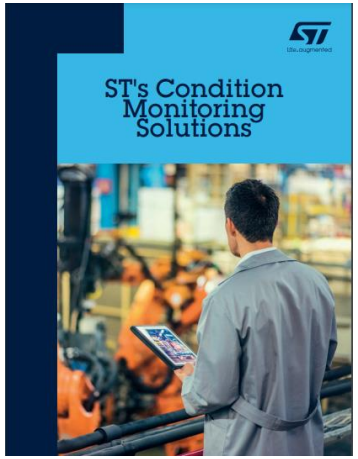
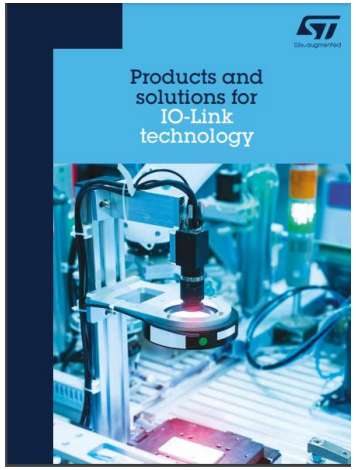
Our dedicated resources

BRSI0421
Products and solutions for Smart Industry



BRPREDMAINT0121
ST's Condition Monitoring solutions



BRIOLINK0720
Products and solutions for IO-Link

IoT for smart industry
https://www.st.com/en/applications/iot-for-smart-industry.html

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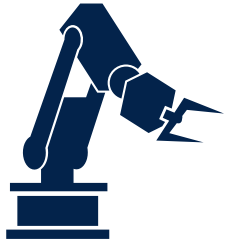
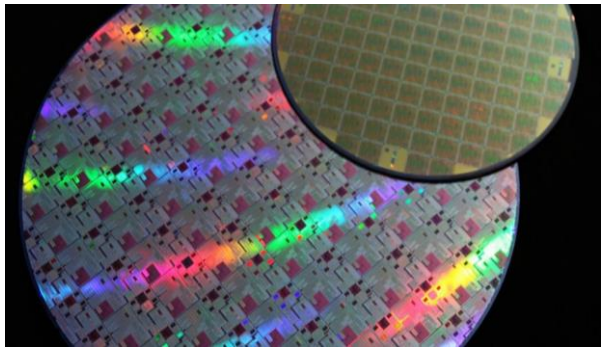
Key takeaways





Smart Industry	Smart Industry trend is bringing about a fundamental change in the way factories and workplaces function
Enablers	Revolution boosted by sensors, edge processing & connectivity
ST Solutions	ST is playing a leadership role with its catalog of products that help make Smart Industry a reality, today

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Our technology starts with You

Find out more at www.st.com

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