

# STM32 Solution for Smart Industry

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APAC



# What are the Enablers for Smart Industry?

## More efficient

Higher efficiency at all points in power usage

- Power conversion & energy harvesting
- Power Management
- Power storage
- Motor Control

## More Intelligent & Aware

Sensors collect information about every machine and distributed local processing allows data to be turned into information

Safe & Secure real-time processing

Products contain the instructions for their manufacturing

Machines are aware of the humans around them and provide easier and safer interactions

## More Connected

Machines are connected inside the factory, to the larger supply chain and to the cloud

Real-time communication down to the lowest level (sensor & actuator)

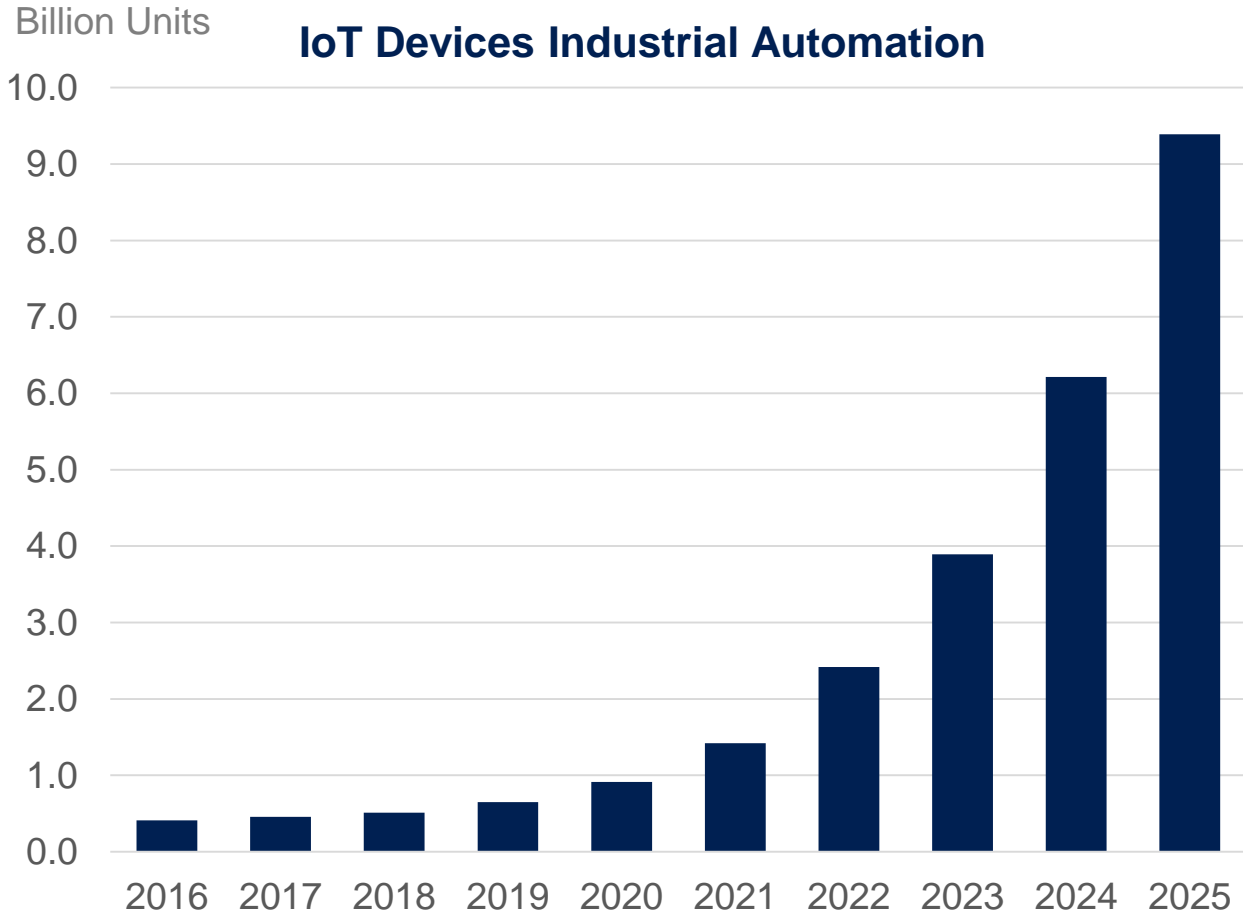
All communications must be secure



Smart Industry

# Smart Industry Application Focus

## Factory Automation



**Smart Sensing**

- Environmental sensors
- Motion sensors
- Acoustic MEMS
- Ranging sensors

**Processing**

- STM32 32-Bit MCU
- Secure MCU

**Connectivity**

- Power line modem
- Bluetooth modules
- Wi-Fi modules
- Sub-1 GHz connectivity (LPWA)
- I/O link
- NFC

**Actuation & motor control**

- Motor drivers
- Gate drivers
- Power switches

**Power management**

- AD/DC converters
- DC/DC regulators
- Analog & digital I/Os
- Protections



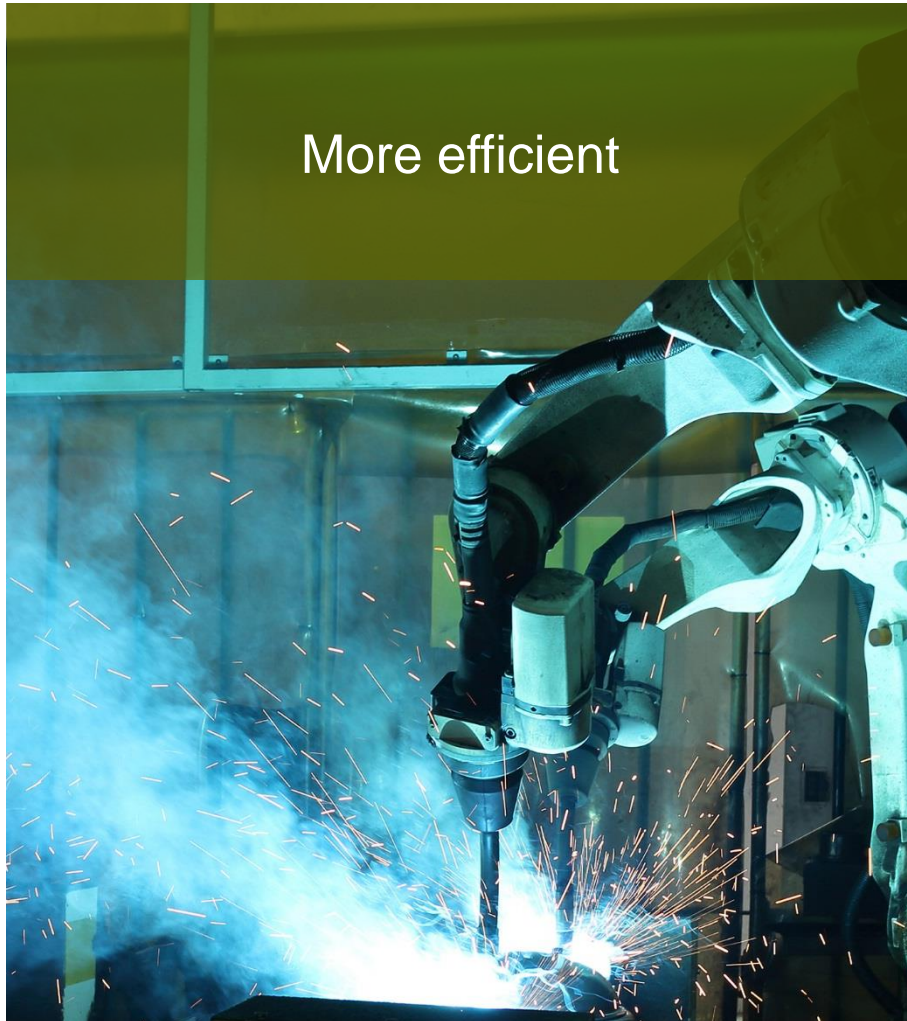
# Smart Industry Enablers

More Intelligent and Aware, More Connected, Safer





Smart Industry



More efficient



# Enablers

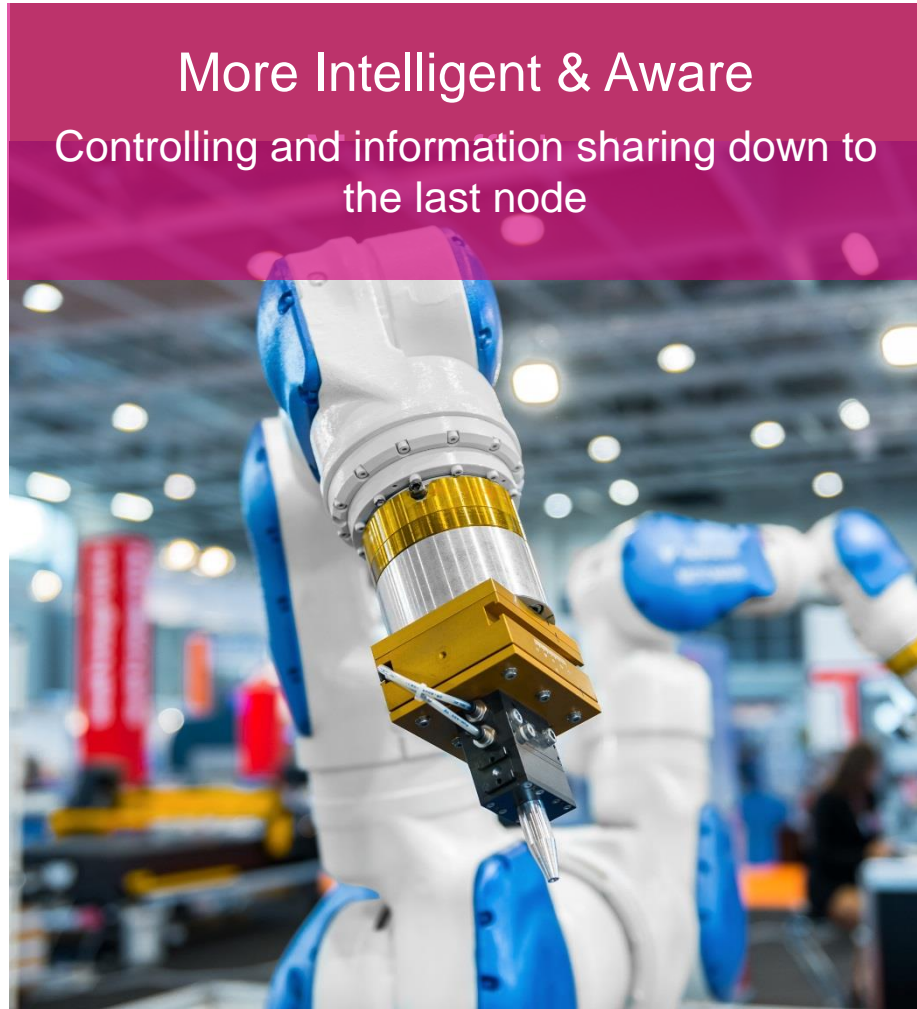
## Safer & More Efficient

5

Analog & Digital inputs	MCU	Secure MCU
Motor Drivers	Gate Drivers	Intelligent Power Switches
Galvanically Isolated ICs	Safety Integrity Level (SIL) ICs	ASICs with Embedded Diagnostics
Power Management	AC-DC Conversion	Digital Power
Power Modules & Discrete	MOSFET IGBT SiC	



Smart Industry



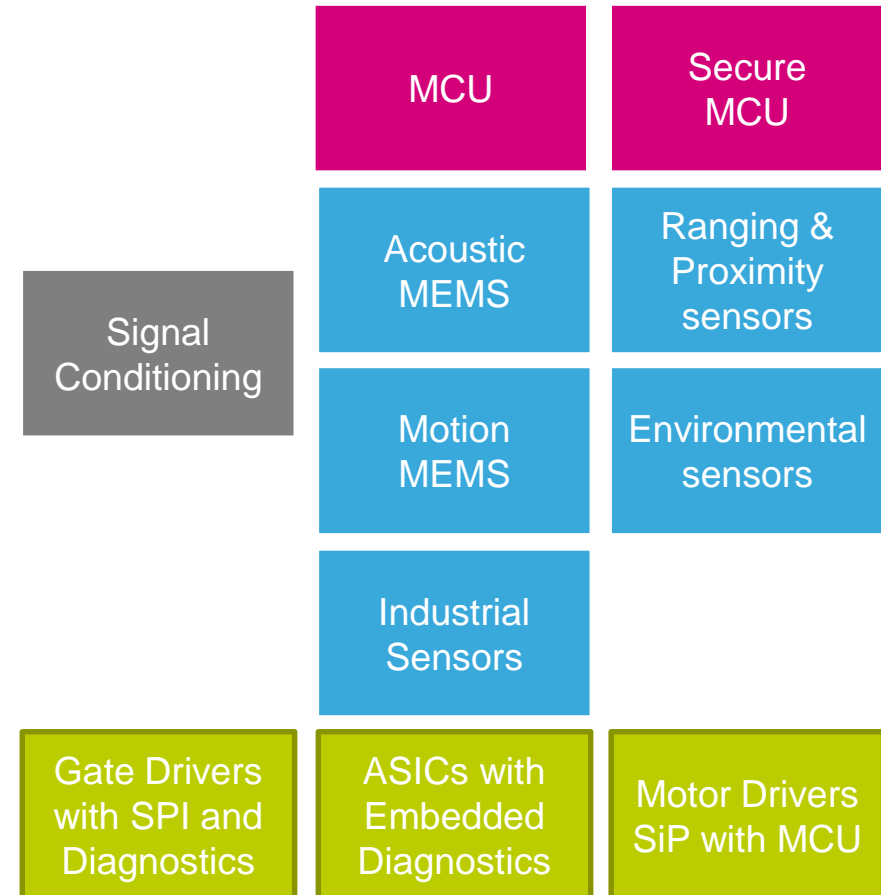
## More Intelligent & Aware

Controlling and information sharing down to the last node



# Enablers

## More Intelligent and Aware

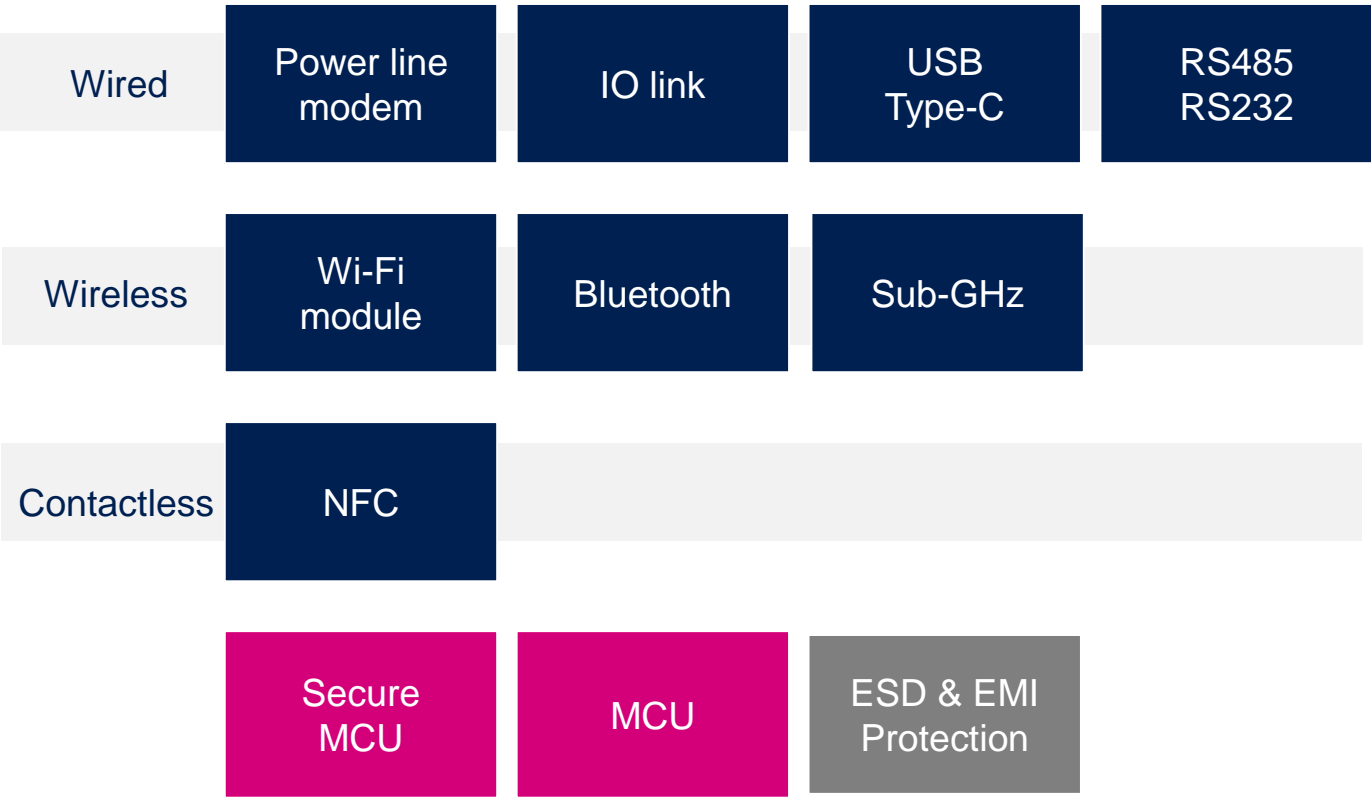




Smart Industry

# Enablers

## More Connected

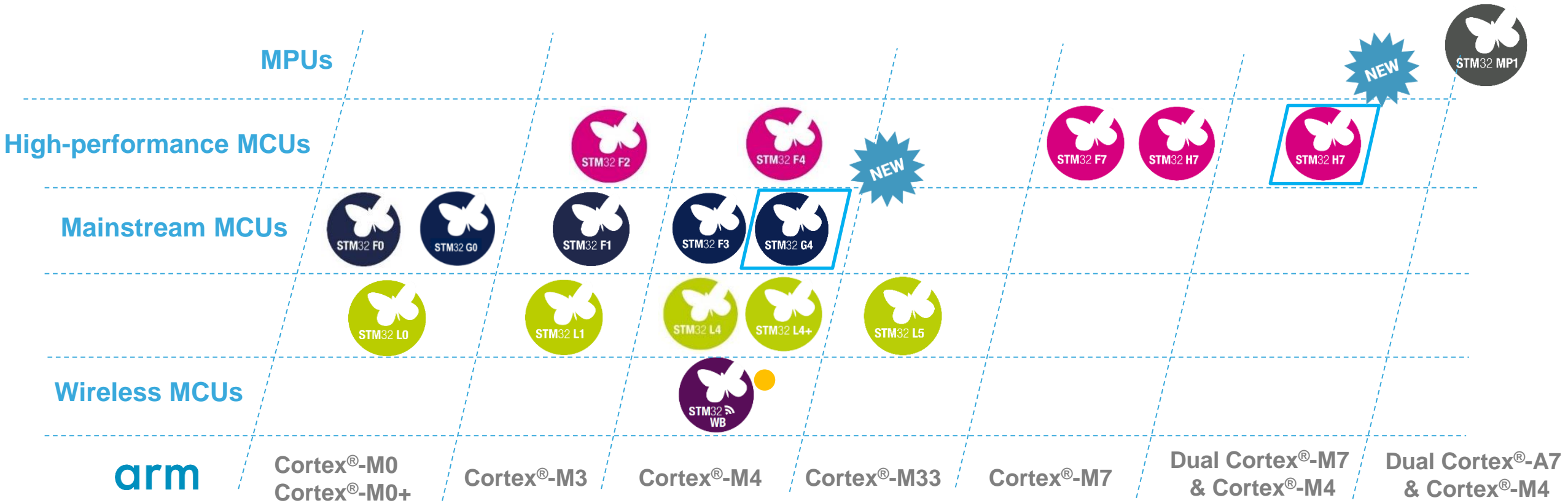


Supporting more than 20 different industrial protocols including IO-Link, Profinet, EtherCat, EtherNet, Sercos, KNX, M-bus, ....  
**Support the ecosystem to Connect information and data to the Cloud**



# Today - STM32 Portfolio Positioning

16 product series / More than 50 product lines



arm

Cortex<sup>®</sup>-M0  
Cortex<sup>®</sup>-M0+

Cortex<sup>®</sup>-M3

Cortex<sup>®</sup>-M4

Cortex<sup>®</sup>-M33

Cortex<sup>®</sup>-M7

Dual Cortex<sup>®</sup>-M7  
& Cortex<sup>®</sup>-M4

Dual Cortex<sup>®</sup>-A7  
& Cortex<sup>®</sup>-M4



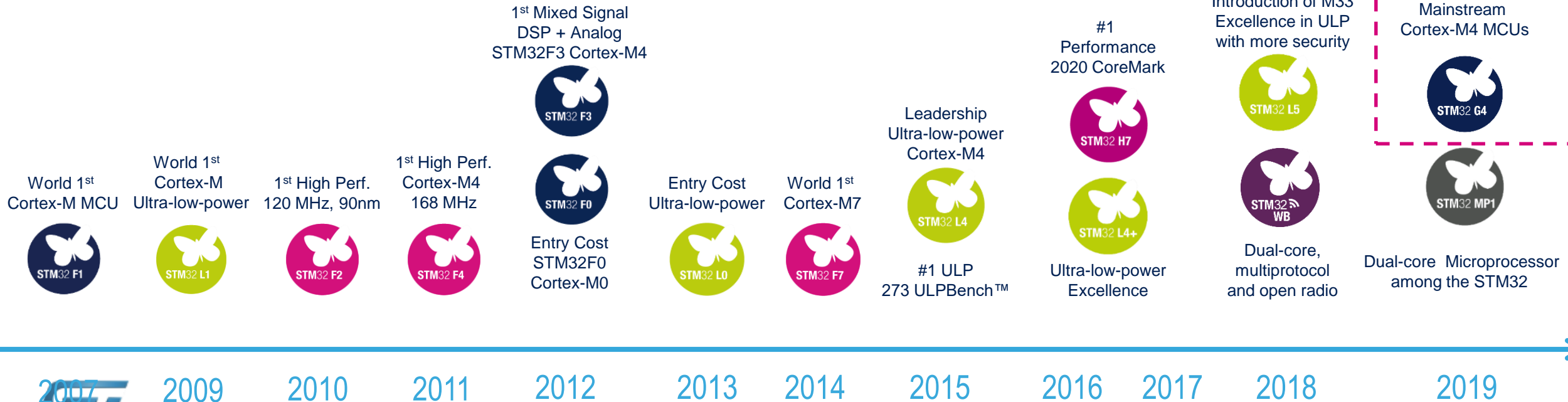
Note ● : Cortex-M0+ Radio Co-processor



More than  
40,000 customers



# Key Milestones To Remember



## ULP excellence with more security

First STM32 MCU based on Arm® Cortex®-M33 and TrustZone®

- A full set of security
- Extended battery lifetime
- High integration & innovation



# STM32G4 Series

11

Ideal for applications requiring MCU with advanced and rich analog peripherals



# STM32H7 & F7

## Value lines

12

Flash Trimmed, Possibilities Flourish

- New price point
- Flash kept to the essential
- Full features



New High Performance  
lines  
**Mass market**

# STM32H7 Dual Core

## STM32H7x5 & STM32H7x7

13

New STMicroelectronics' STM32H7 Microcontrollers Combine  
Dual-Core Performance with Rich Feature Integration



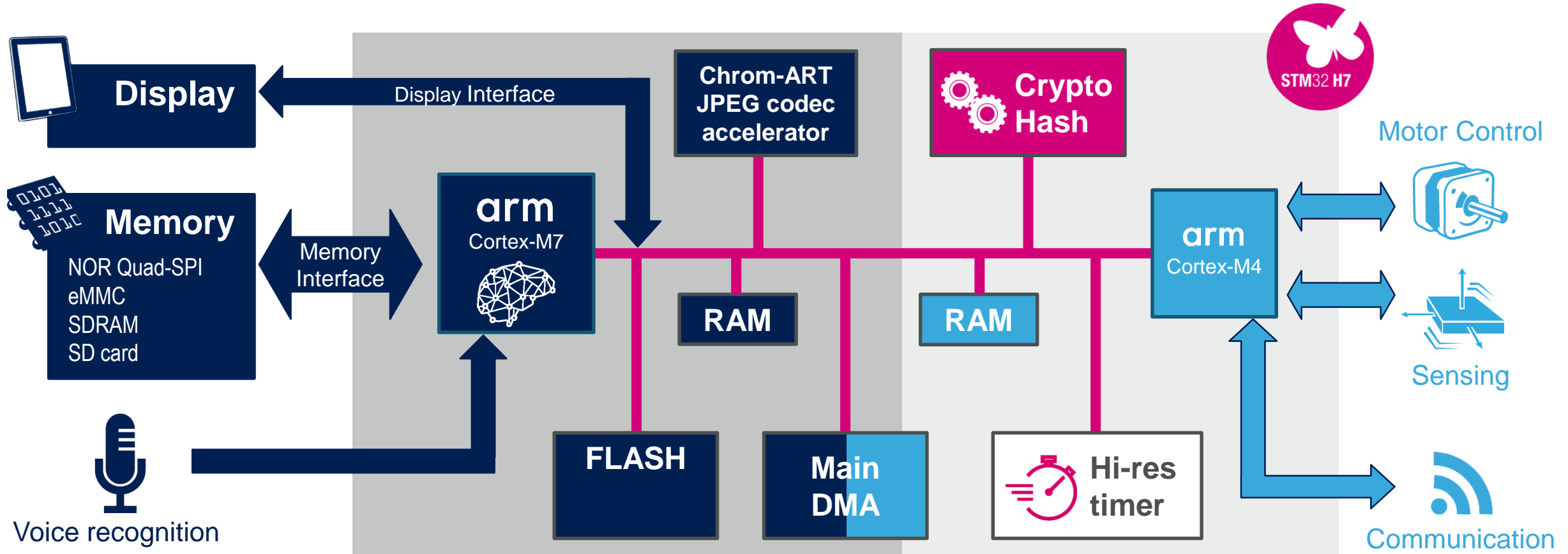
- System integration
- Advanced connectivity and control
- Security services

[www.st.com/stm32h7](http://www.st.com/stm32h7)

# STM32H7 Dual-Core (CM7+CM4)

## Mixing AI and Real-time Control

Connected Kitchen Aid with advanced HMI (Large display and Voice recognition)



New High Performance  
lines

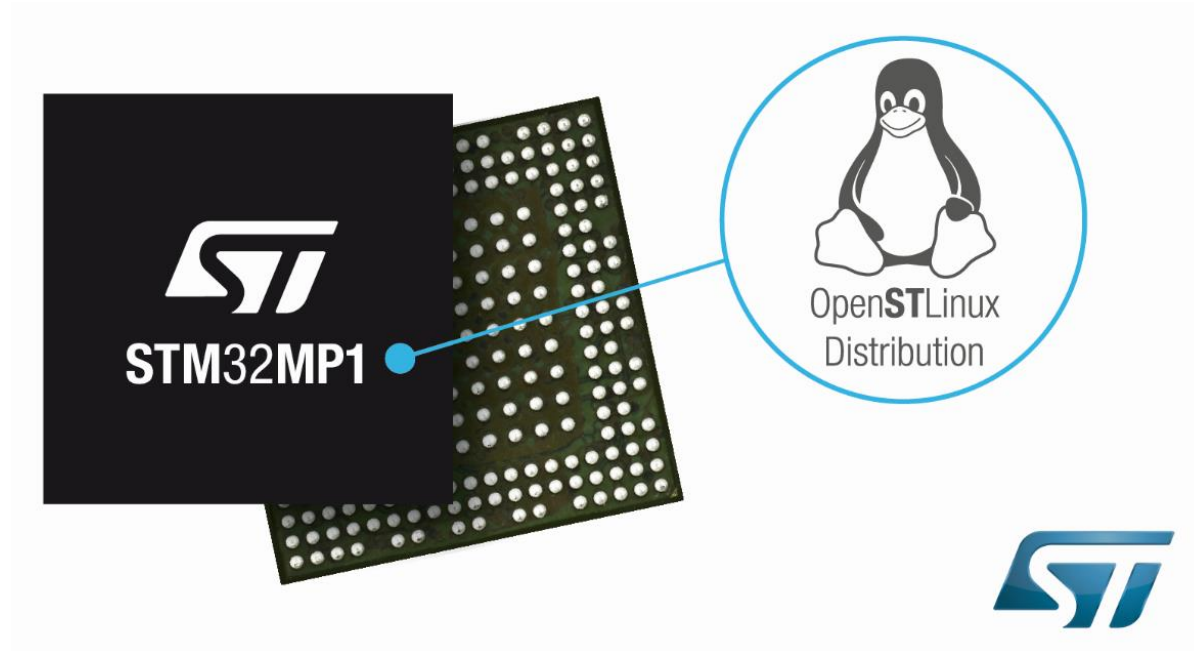
Mass market

# STM32MP1 series

15

with a flexible architecture ideal  
for Linux and real-time applications

Its mainlined OpenSTLinux Distribution and STM32Cube ecosystem  
drastically reduce development time.



# ST Strategy and Offer for Smart Industry

IoT is an end-to-end system from device to cloud involving many actors

ST has a coherent strategy to cover the market needs

The right building blocks for IoT devices

Lower barriers for developers getting started

Lower barriers from prototyping to first product

Lower barriers to connect devices to the Cloud


Enable product & service commercialization

### Building Blocks


Processing	Security
Sensing & Actuating	Connectivity
Motor Control	Power & Energy Management
Conditioning & Protection	

### Stackable Boards & modular SW

STM32 Nucleo development boards



STM32 Nucleo expansion boards






### Application specific SW

Audio Algorithms      Sensor Fusion



### Pre-integrated Software for vertical Applications

Smart Home      Building automation      Wearable



### Integration of Cloud Provider SDKs

amazon web services™      Microsoft Azure



Watson IoT      Alibaba.com



### Ready to use Smartphone Apps



### Partner Program

ST life.augmented

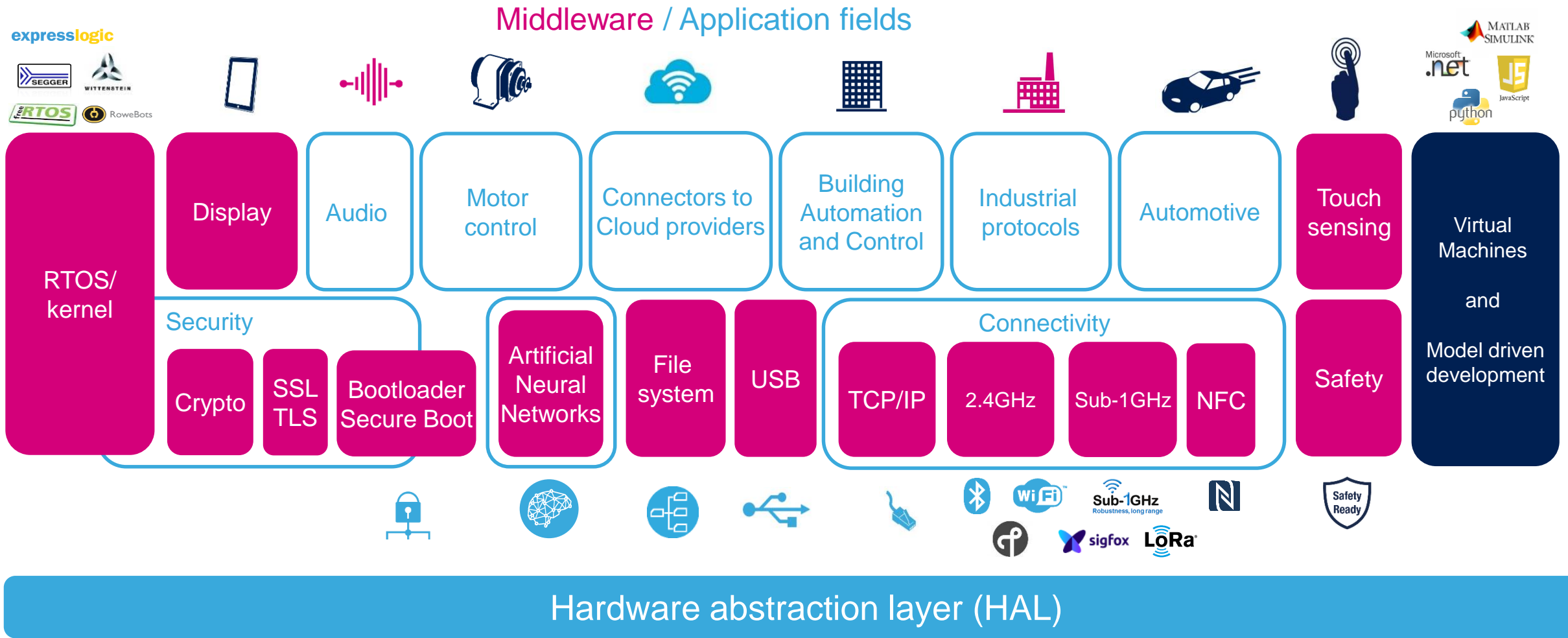


Partner Program





# Solutions at All Levels

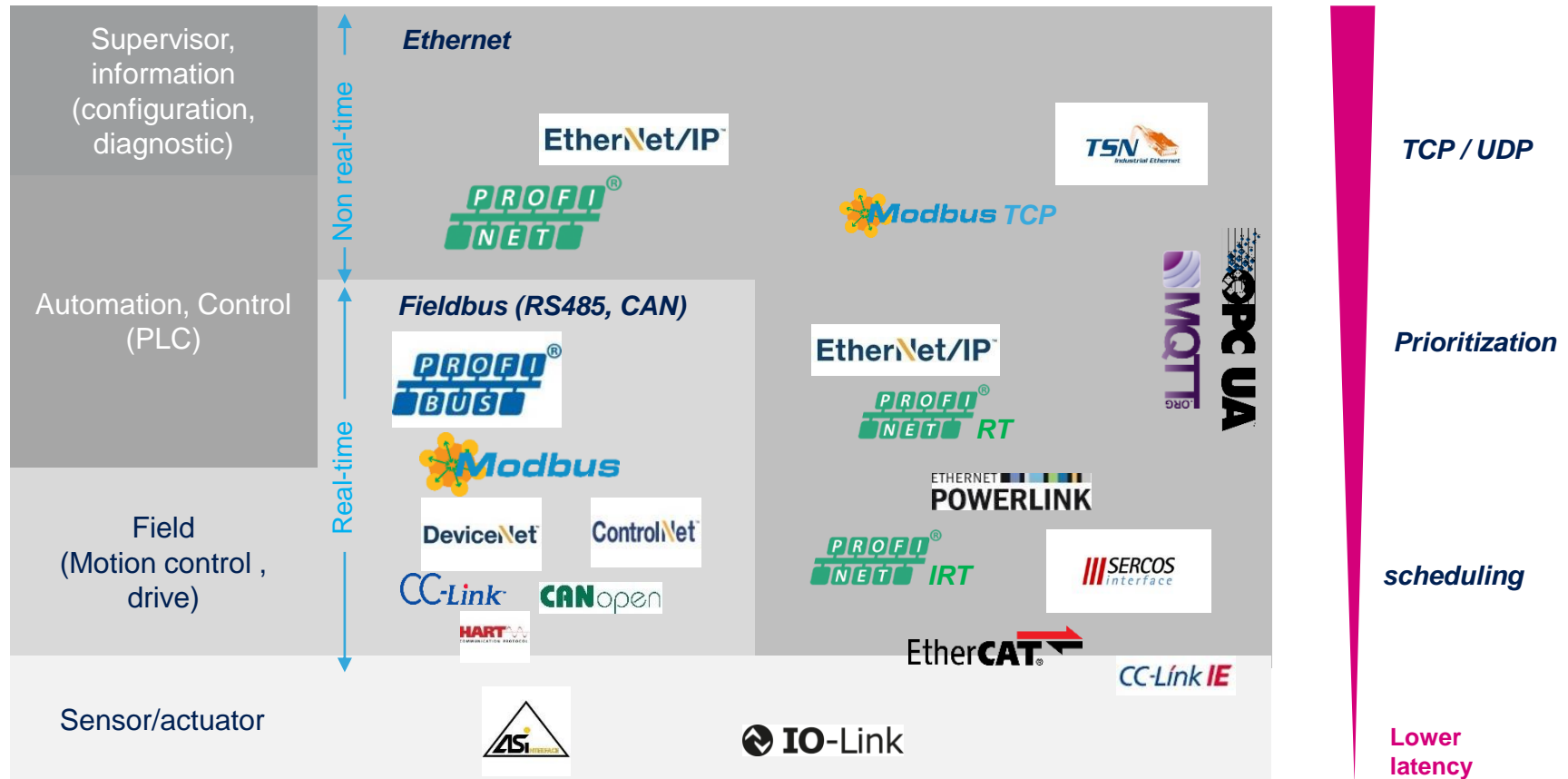


Select the area of interest for more details



# Application Field – Industrial Protocols

Industrial market needs are very fragmented in terms of communication protocols. Many different protocols are available for different target applications in factory automation

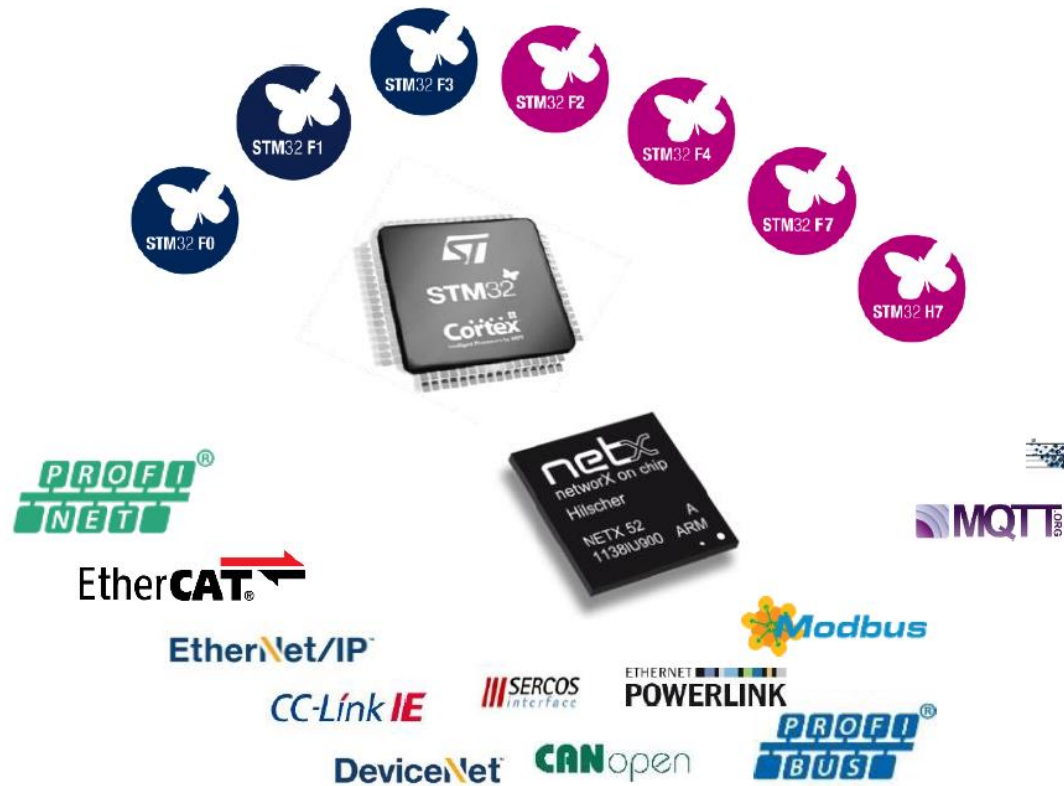





# STM32 Industry Protocol Solution

A unique and flexible platform for Industry 4.0

## STM32: Hilscher-netX Real-time Ethernet



 Wide STM32 offering

 All Real-time Ethernet slave stacks available

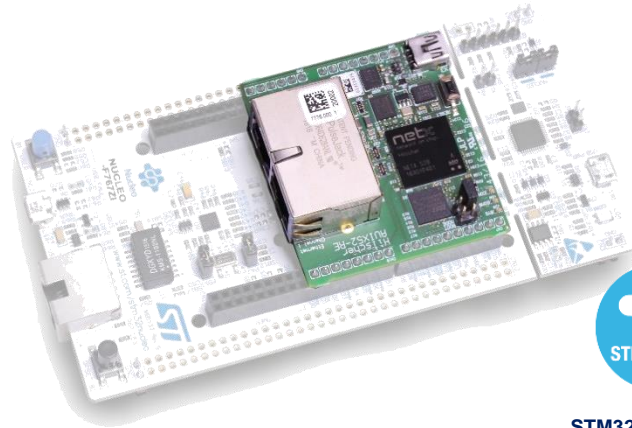
 Industrial IoT and Industry 4.0 MQTT and OPC-UA



# STM32 and netX Evaluation

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## NUCLEO-F767ZI + netSHIELD



STM32 Nucleo-144  
development board  
with STM32F767ZI  
MCU



Free netX loadable firmware for evaluation  
PROFINET, EtherCAT and EtherNet/IP

STM32Cube software expansion I-CUBE  
Including Hilscher cifX toolkit and API

A batch of netSHIELD is available in ST  
available from amazon Germany

[www.st.com/i-nucleo-netx](http://www.st.com/i-nucleo-netx)

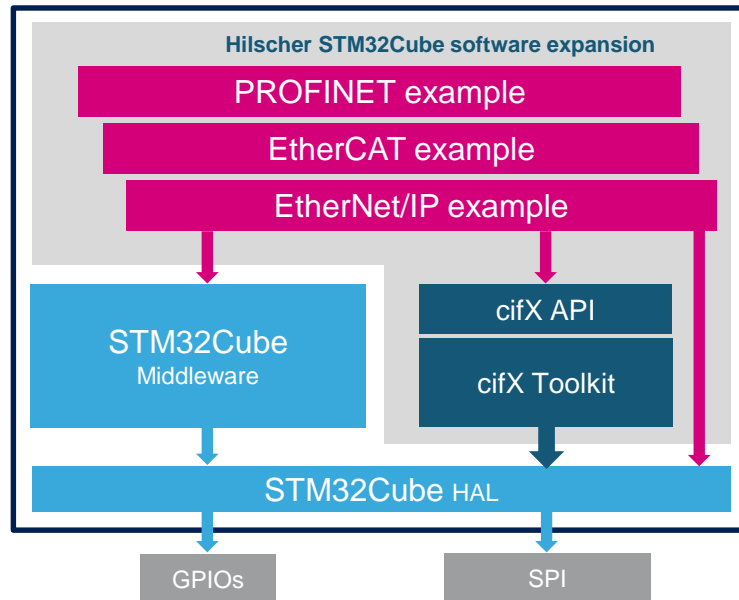


Smart industry



# STM32Cube Software Expansion

Common API for all STM32™ MCUs and all real-time Ethernet protocols



Portability across STM32 series  
F0, F1, F2, F3, F4, F7

Common cifX API  
Straight-forward migration across communication protocols

3 application examples  
PROFINET, EtherCAT and EtherNet/IP

[www.st.com/i-cube-netx](http://www.st.com/i-cube-netx)

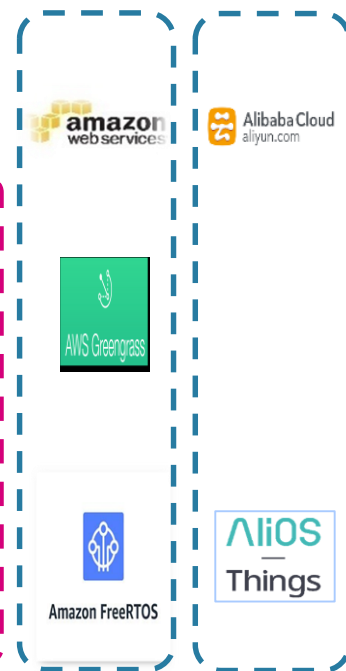
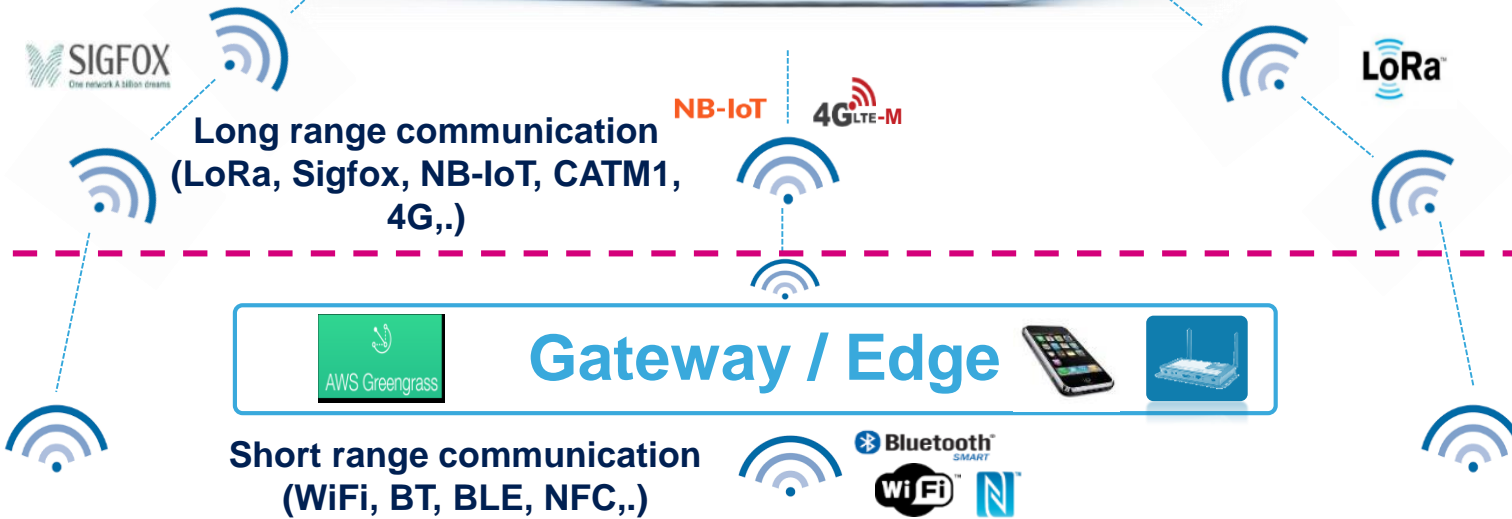
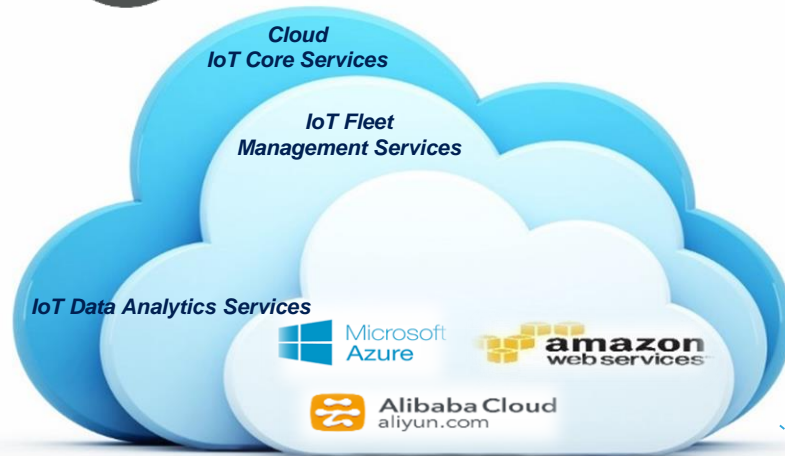


Smart industry



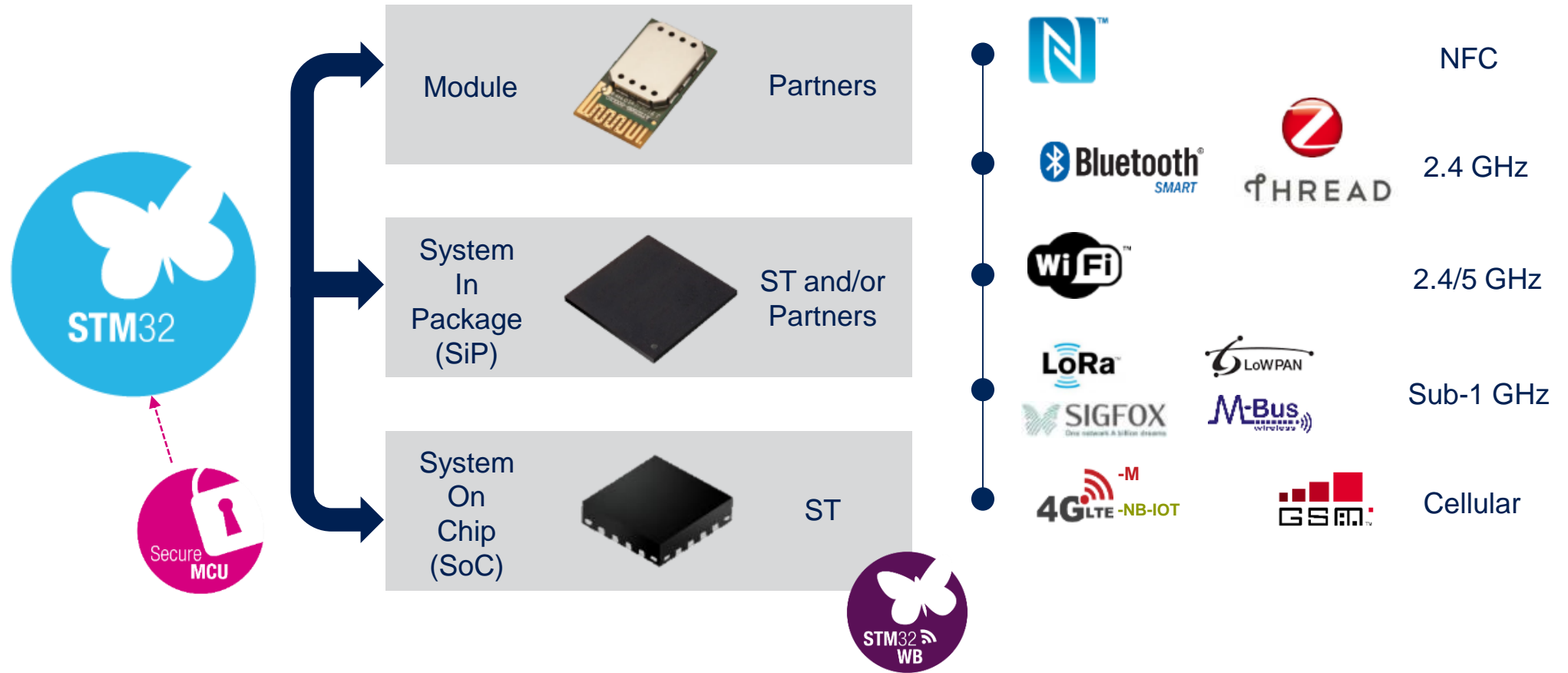
# From Node to Cloud

IoT Seamless Integration



# Connectivity Powered by the STM32

## from Module to Integrated Solutions



# Wireless & ULP MCU

State-of-the-art RF perf

STM32 with BLE 5.0 & IEEE 802.15.4  
Dual-core, built-in key storage

- Dual-core
- Dual-protocol
- Key storage
- BOM saving

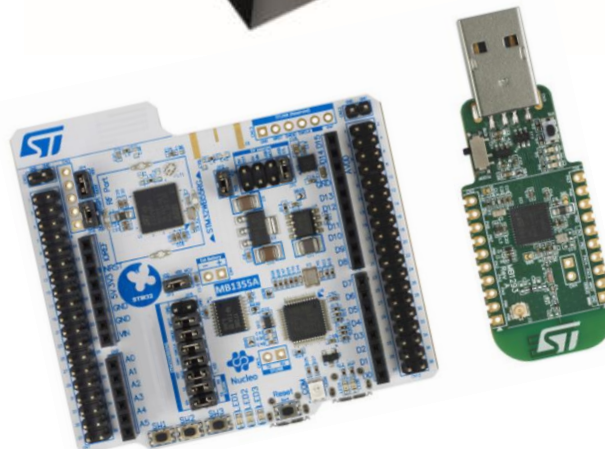
[www.st.com/stm32wb](http://www.st.com/stm32wb)



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# Protecting Your Application From A to Z

## Authenticated Firmware Through The Whole Product Life Cycle

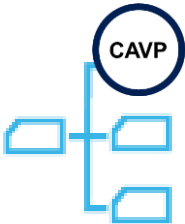


Definition Design Develop

Design & Development



**Secure your application with ready to use FW libraries**



CAVP certified crypto Libraries supporting all STM32 (w/ and w/o Hardware acceleration) (X-Cube-CryptoLib)



Manufacture

In Production



**Secure Firmware Install solution & toolset**



SFI solution by ST and with partners



Upgrade End of Life

In The Field



**Secure Boot and Secure Firmware update reference implementation**

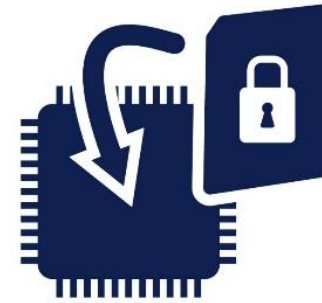


STM32 F4 STM32 F7 STM32 L0 STM32 L4 And More ...

# STM32Trust: A Complete Toolset

an ecosystem for embedded family

STM32Trust Ecosystem from ST Consolidates Cyber-Protection Resources for IoT Designers



## Code Protection

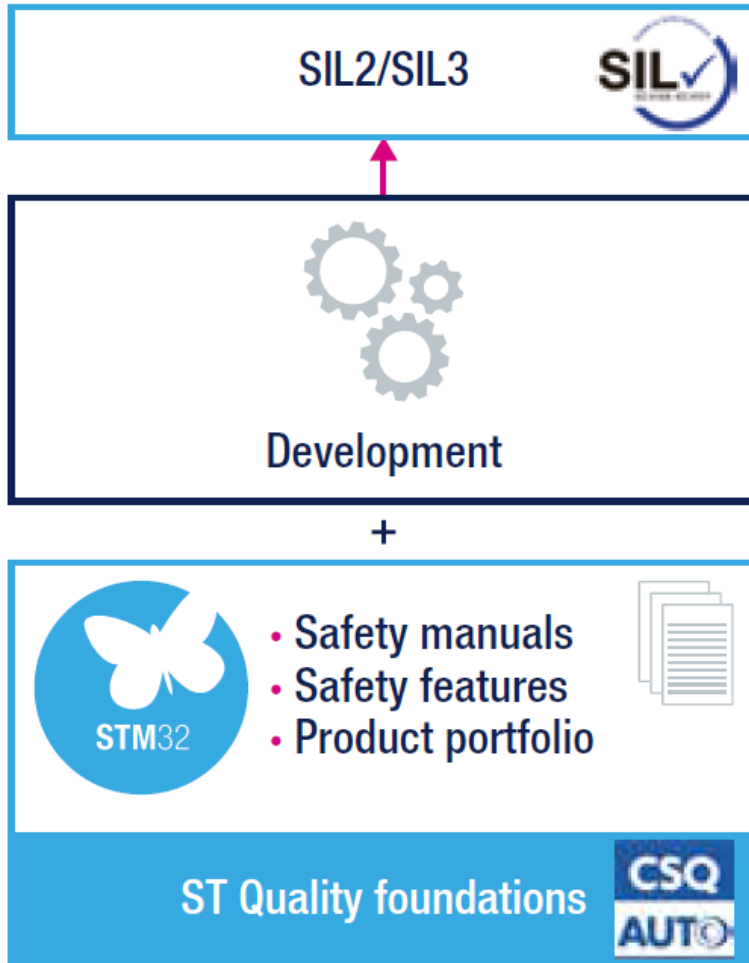
- X-CUBE-SBSFU software library
- X-CUBE-CRYPTOLIB
- Secure Firmware Install solution
- STM32CubeProgrammer
- STM32HSM-V1
- FASTROM programming services

## Execution protection

- Debug
- Secure boot
- Memory Protection Unit
- Dual core
- TrustZone
- Firewall



## The chain of Safety management - Functional Safety



[www.st.com/stm32safety](http://www.st.com/stm32safety)



### KEY FEATURES

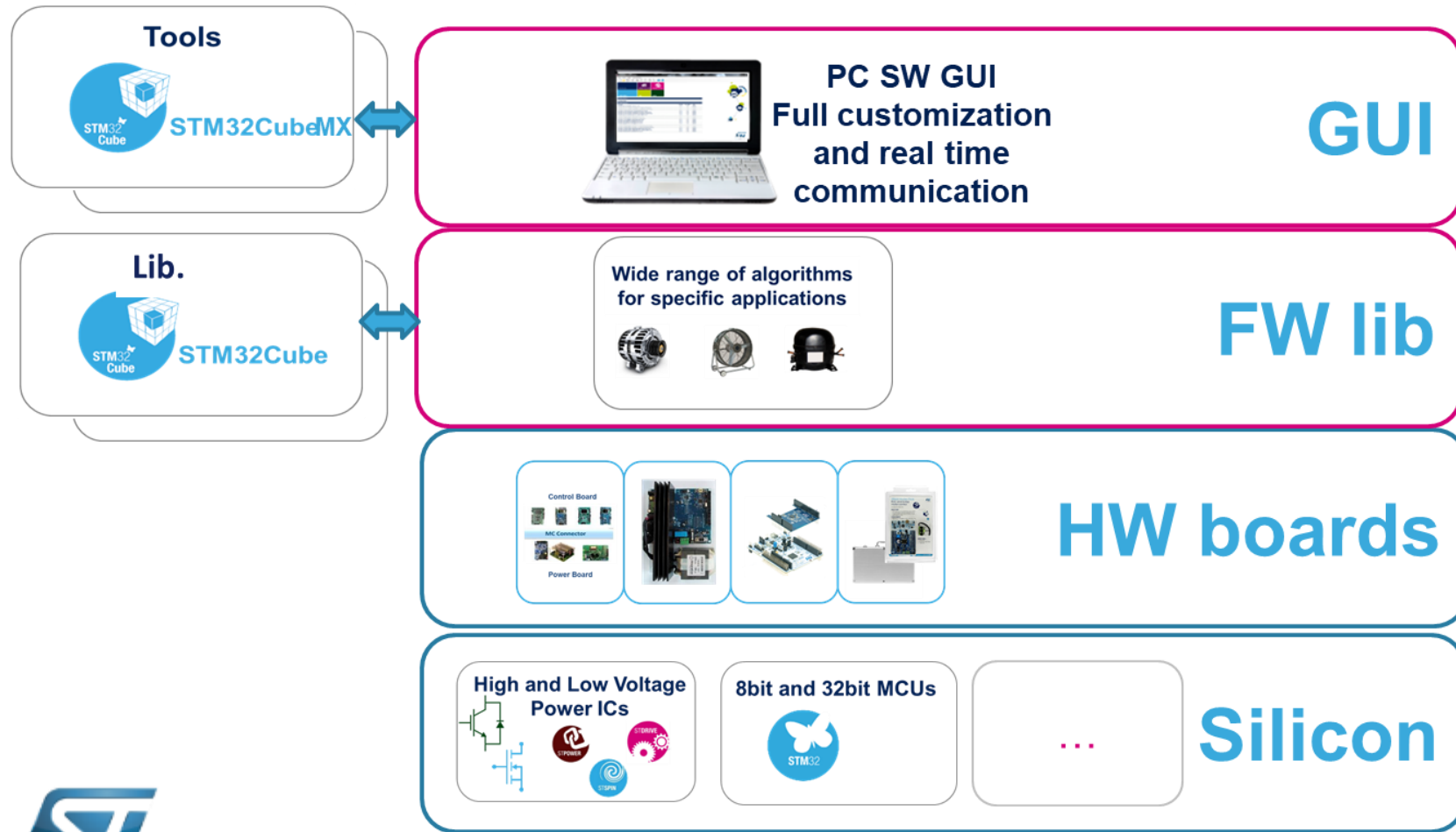
- Detailed list of safety requirements (conditions of use) and examples to guide STM32 users to achieve Safety Integrity Level 2/3 according to IEC 61508 for the application-dependent layer (e.g. peripherals, watchdog)
- Available for STM32F0, STM32F1, STM32F2, STM32F3, STM32F4, STM32L0 and STM32L1 microcontroller series



# STM32 Motor Control Solution

## Plug-and-spin with STM32Cube

### New STM32 Software Development Kit (X-CUBE-MCSDK) from STMicroelectronics Makes Motor-Control Design Faster and Easier








Motor Control X-CUBE-MOTORP





# STM32 Motor control Hardware Platform

## STM32 PMSM FOC SDK (Firmware library)

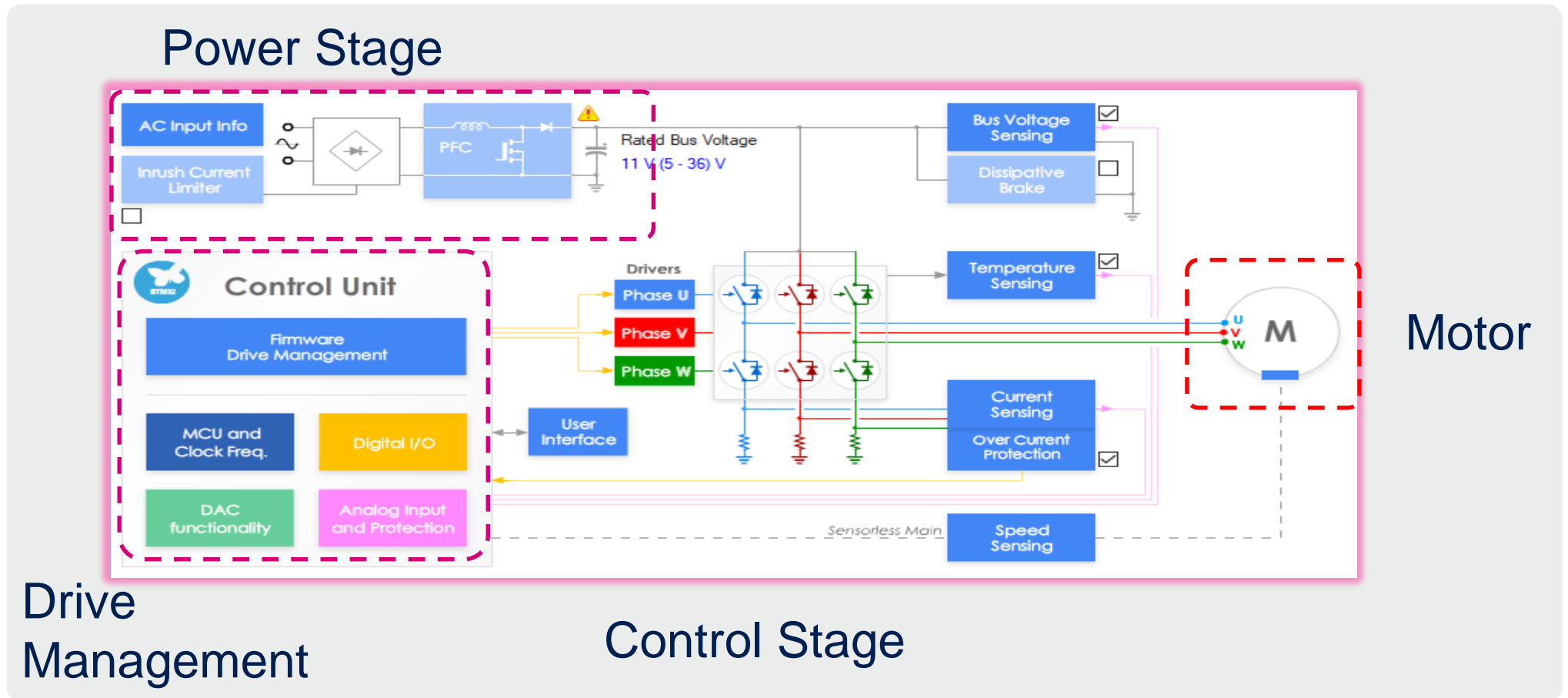
Flexible Motor Control platform	Complete Motor Control drives	STM32 ODE: Nucleo + X-NUCLEO	Motor Control Kit
<p>based on ST MC connector Control stages</p>  <p>MC Connector</p>  <p>Power stages</p>			



# STM32 MC Workbench

30

- Dedicated PC software that reduces the design effort and time in the STM32 MC FW library configuration.
- Through a graphical user interface (GUI), the user generates all parameter header files, which configures the library according to his MC application needs



# STM32 & TouchGFX

## Revolutionizing the HMI of Things

ST Adds High-Quality User-Interface Design Software to Free Development Ecosystem for STM32 Microcontrollers





# STM32 Graphical Solution

## ST acquires Draupner Graphical - TouchGFX

- TouchGFX is a C++ framework, designed for microcontrollers. It is capable of delivering smartphone graphics, utilizing Chrom-ART, has a very small footprint and keeps MCU load at a minimum

- Features

- Transparency, alpha-blending
- Anti-aliased fonts and kerning
- Touch gestures
- Animations
- 2D/3D rotations
- Screen transitions

STM32CubeMX v5.0  
A new experience



+ TouchGFX



- Achieves high frame rates on high-resolution, true color displays

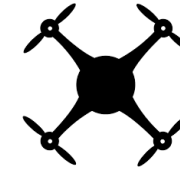


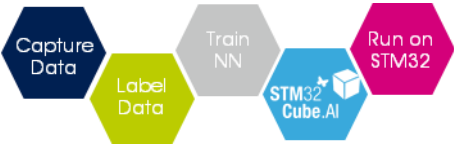


# A.I. is Blooming Everywhere

- AI is a superset of all the studies to reproduce human reasoning or mental activities with computers and is used everyday in our life

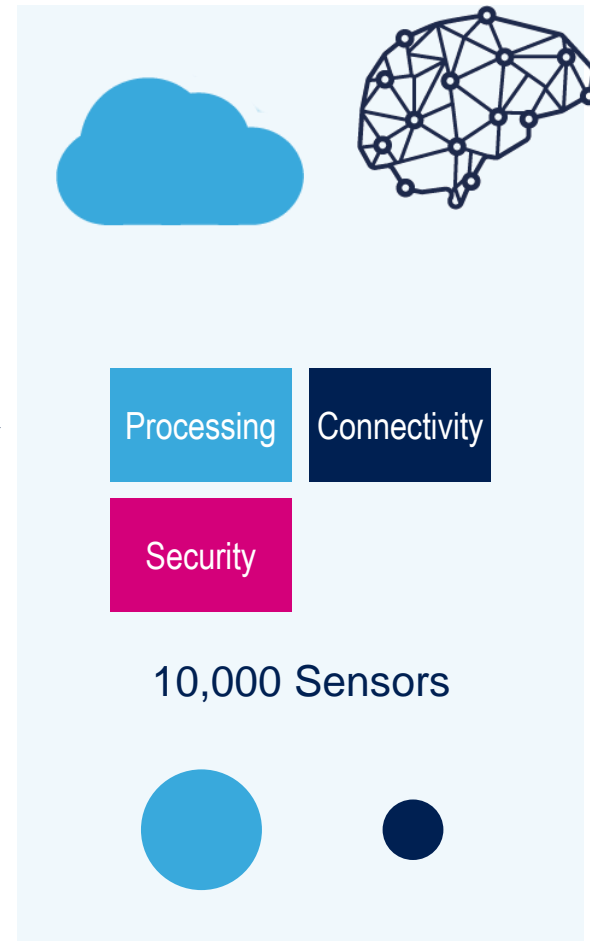
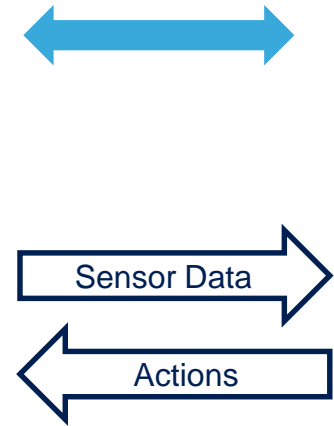
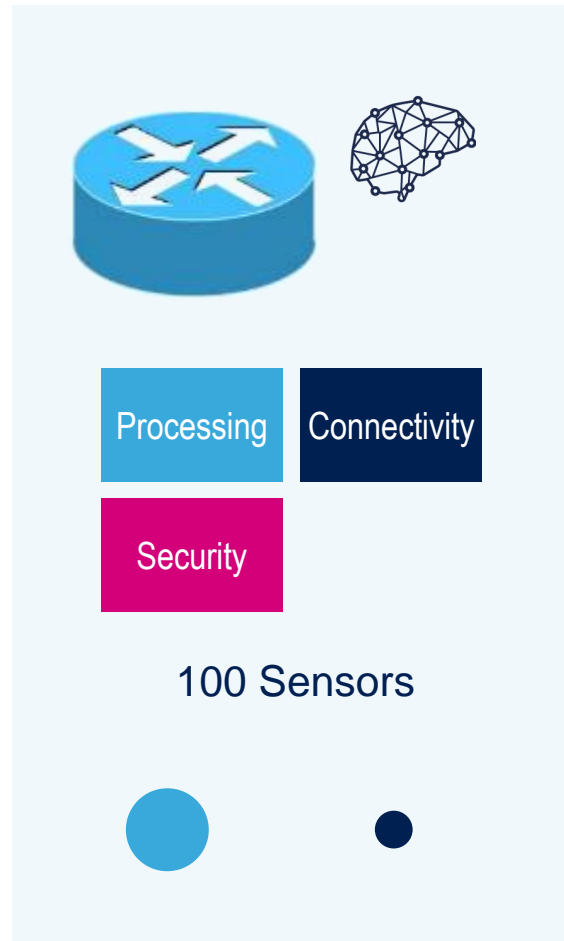
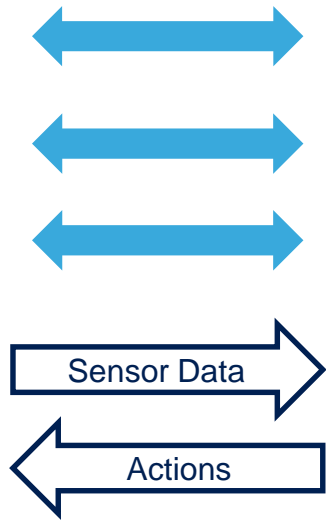
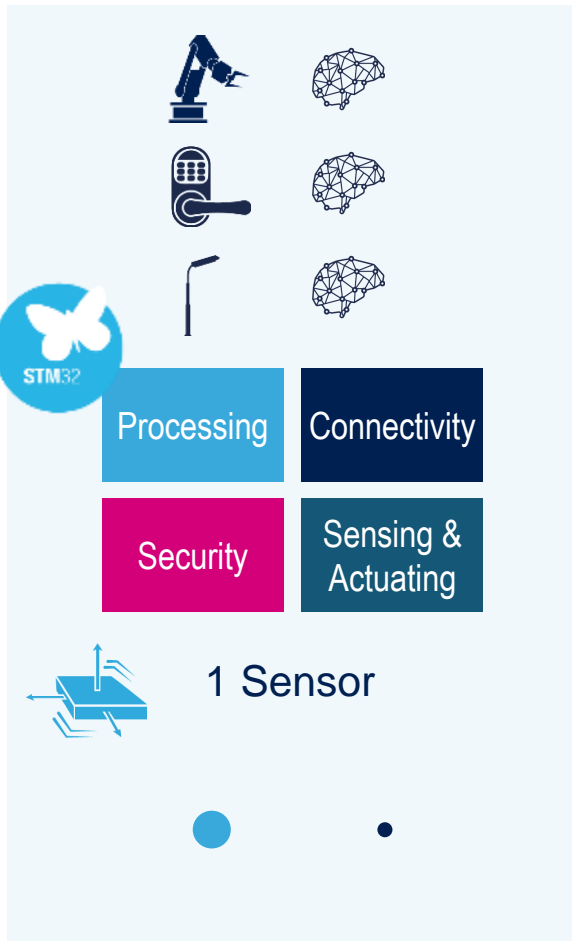
- Face / voice recognition
- Stock market trading strategy
- Disease symptom detection
- Predictive maintenance
- Hand writing recognition
- Content distribution on social media
- Fraudulent credit card transaction
- Chatbot for customer service
- Suggested shopping
- ...

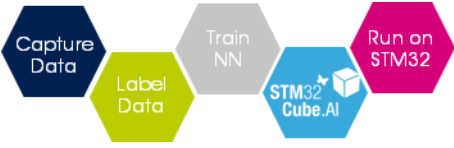




# Artificial Intelligence

## NODES



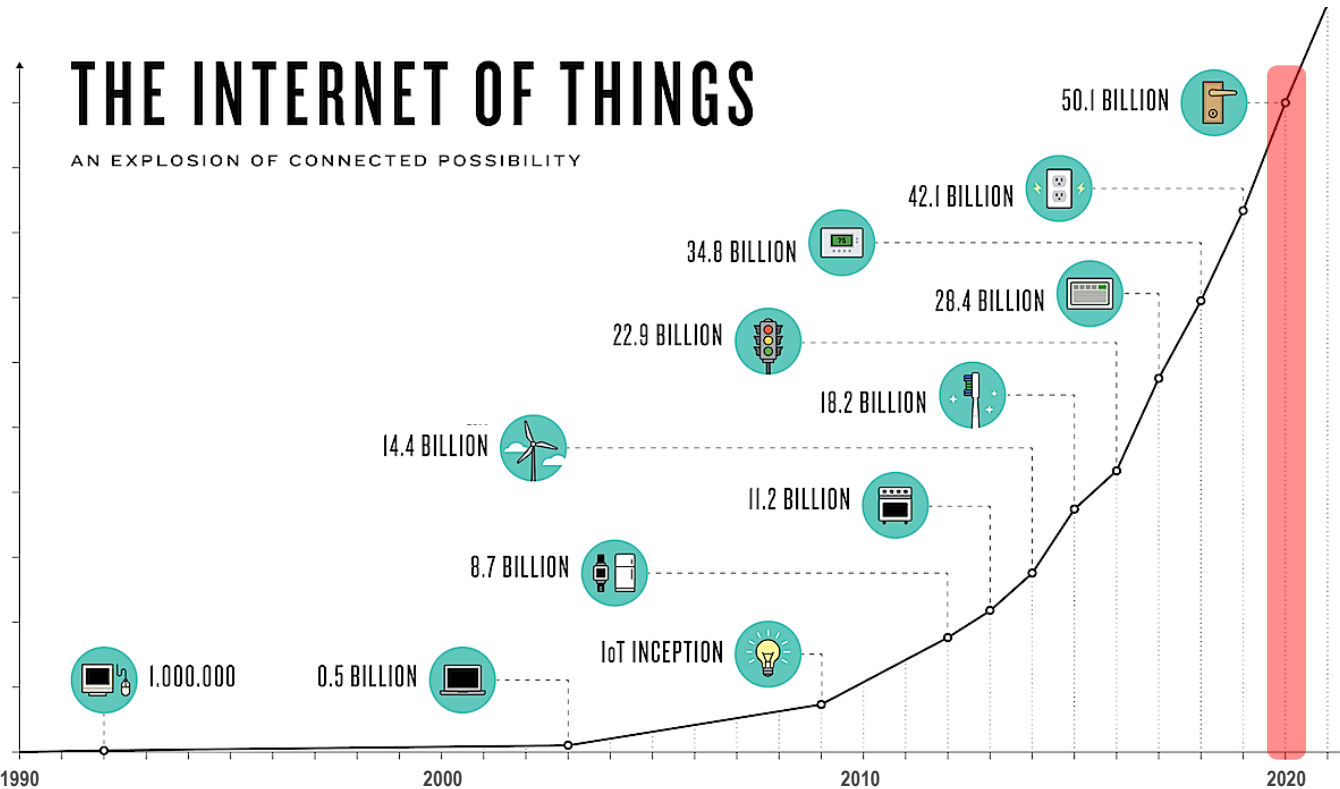


# IoT Push AI on the Edge

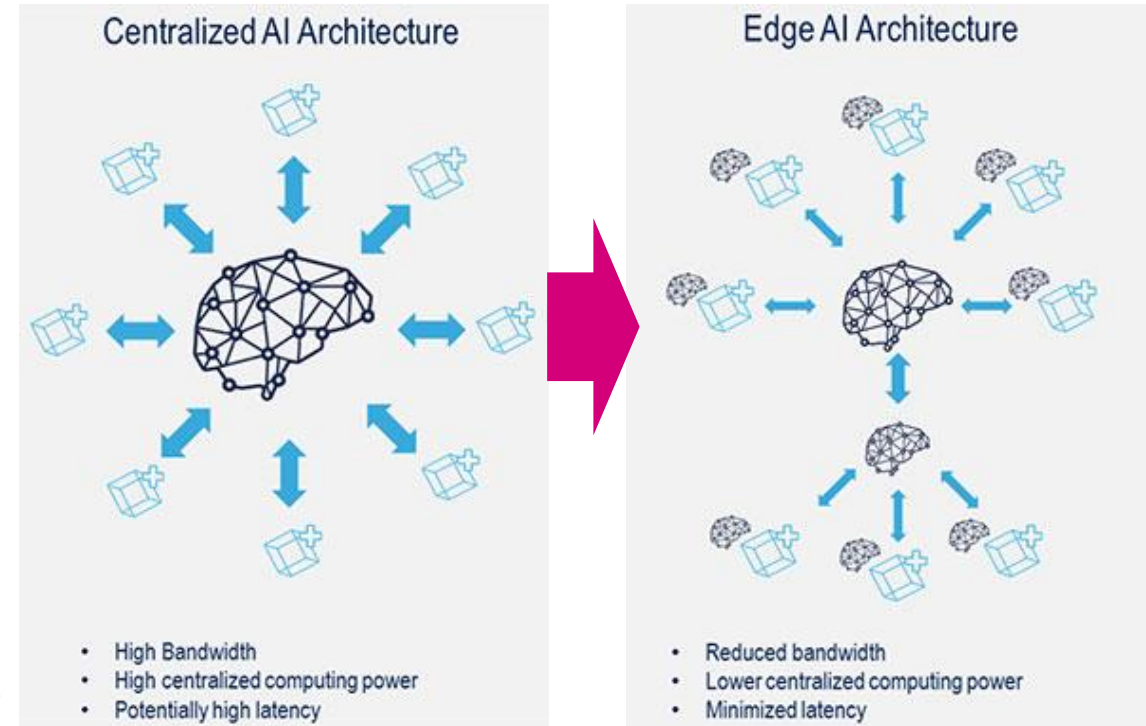
- The large IoT growth requires the transfer of some AI from the cloud to the edge
  - Infrastructures cannot handle data transfers from billions of devices to the cloud
    - IoT embedded devices needs to be able to run distributed AI and offload processing on the cloud
    - AI on the edge allows object to become autonomous, low latency and data privacy

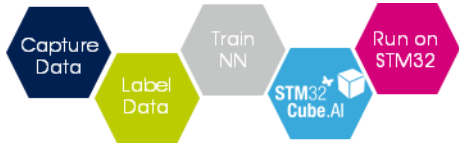
## THE INTERNET OF THINGS

AN EXPLOSION OF CONNECTED POSSIBILITY



Source: Cisco





# Artificial Intelligence in ST

- ST’s motto is “Making Everything Smarter” with our products as a way to realize our life.augmented vision
  - Devices able to sense and understand their environment, to process and act based on sensed data and to communicate securely with the rest of the world
- AI is a natural evolution of ST’s vision of embedded intelligence in “Smart Things”
  - Tens of billions of intelligent connected devices that will make our lives easier and make the environments in which we live and work safer and more efficient
- ST portfolio ready to address AI on the edge



### 32-bit MCU

Widest range of 32-bits microcontrollers  
High performance, ultra-low power, Bluetooth



### Sensors

Motion, environmental, audio, ...



### Connectivity

Bluetooth, LPWAN

# Current Scope of Applications

## Classic sensor



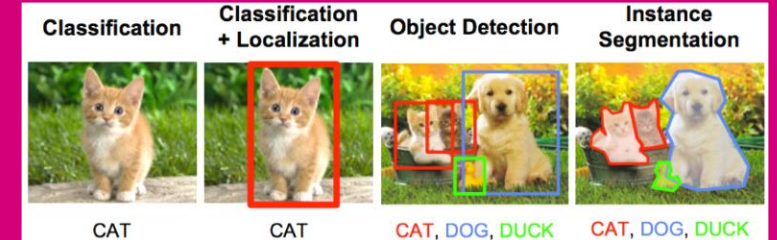
- Activity recognition with inertials
- DCNN, ESN, LSTM
- Stress analysis or attention analysis
- DCNN, SON

## Audio analysis



- Speech Recognition
- DeepSpeech, Wave2Letter
- Speech Synthesis
- WaveNet, Tacotron

## Computer vision

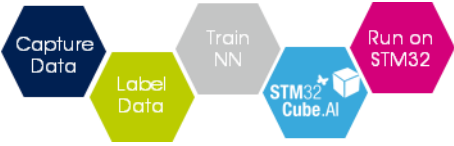


- Classification
- Alexnet, Inception, VGG
- Detection
- Yolo, SSD

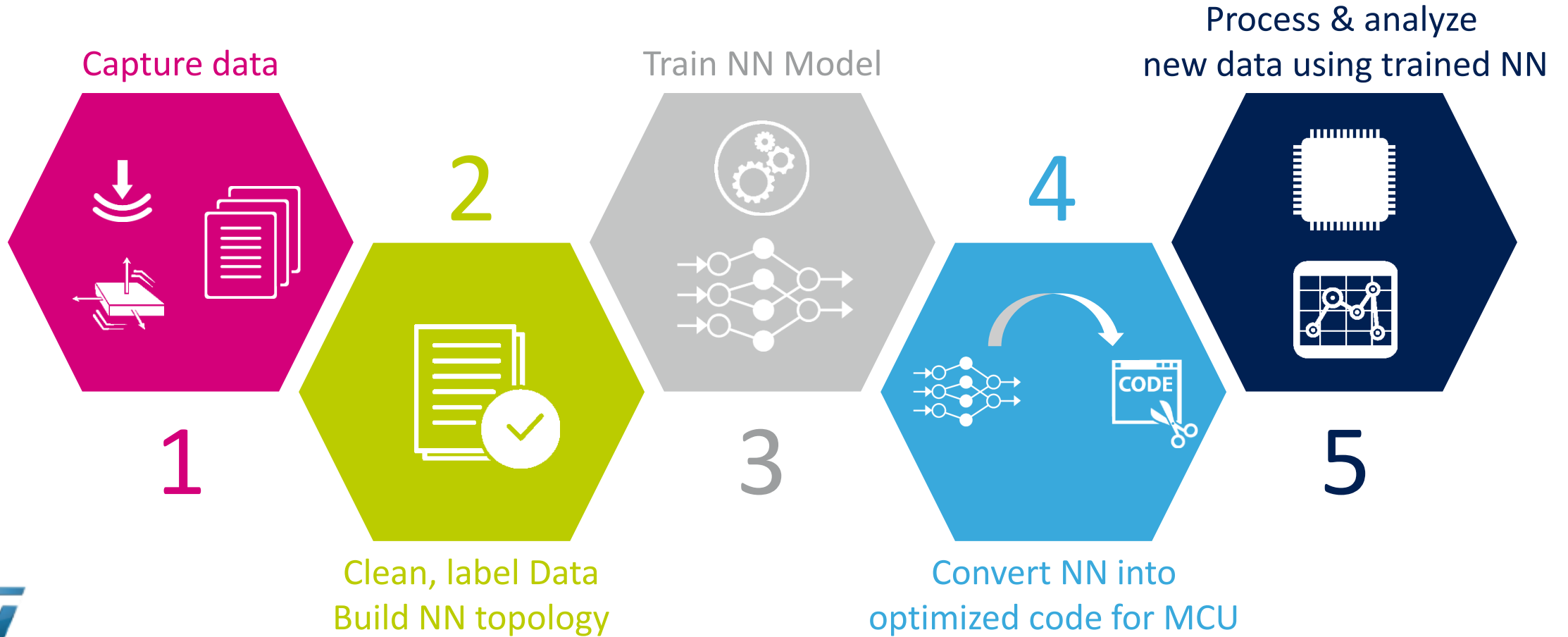
ST embedded processing : STM32 (hundreds MOPs)

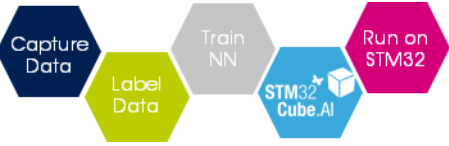
Dedicated AI hardware needed (GOPs to TOPs)

- Classic sensor use cases are 100% on the scope
- Keyword spotting audio with commands use cases are accessible
- Advanced audio with natural language understanding use cases are not yet accessible for MCUs with software deep learning
- Computer vision use cases to be addressed in the future with a dedicated hardware deep learning

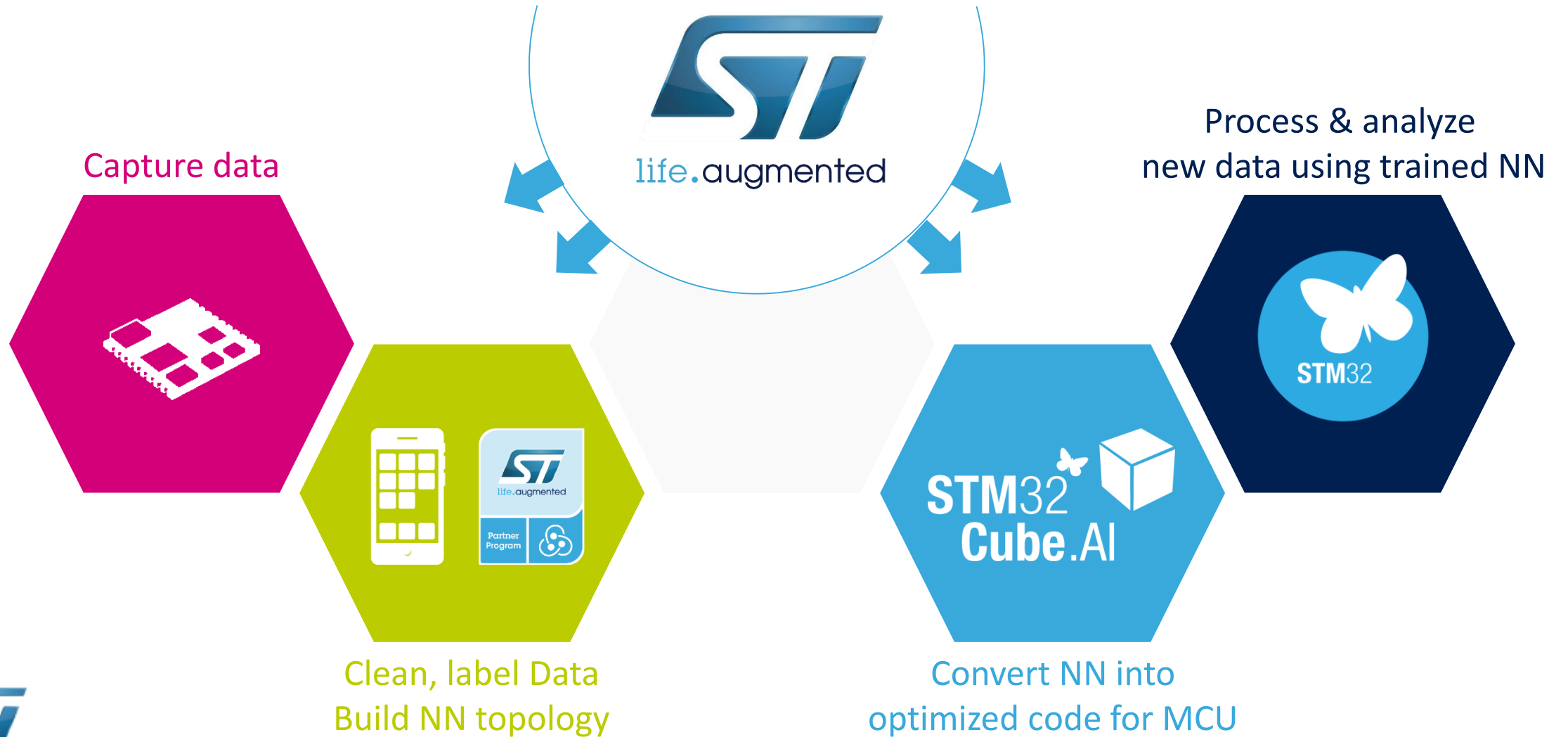


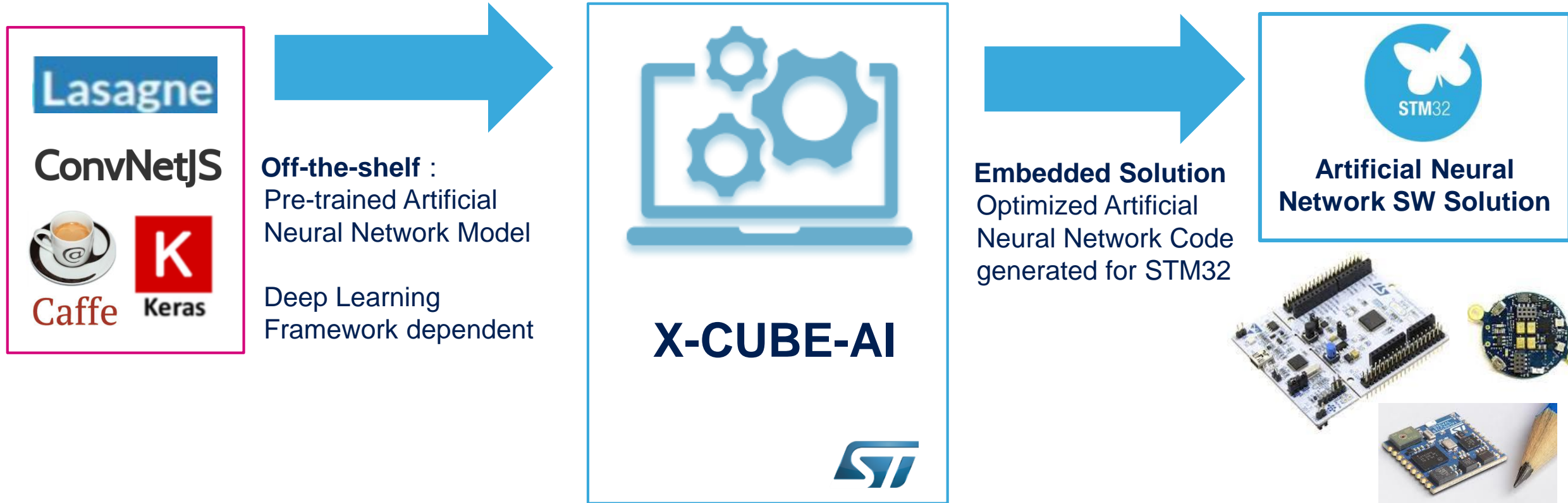
# The Key Steps Behind Neural Networks





# ST Toolbox for Neural Networks



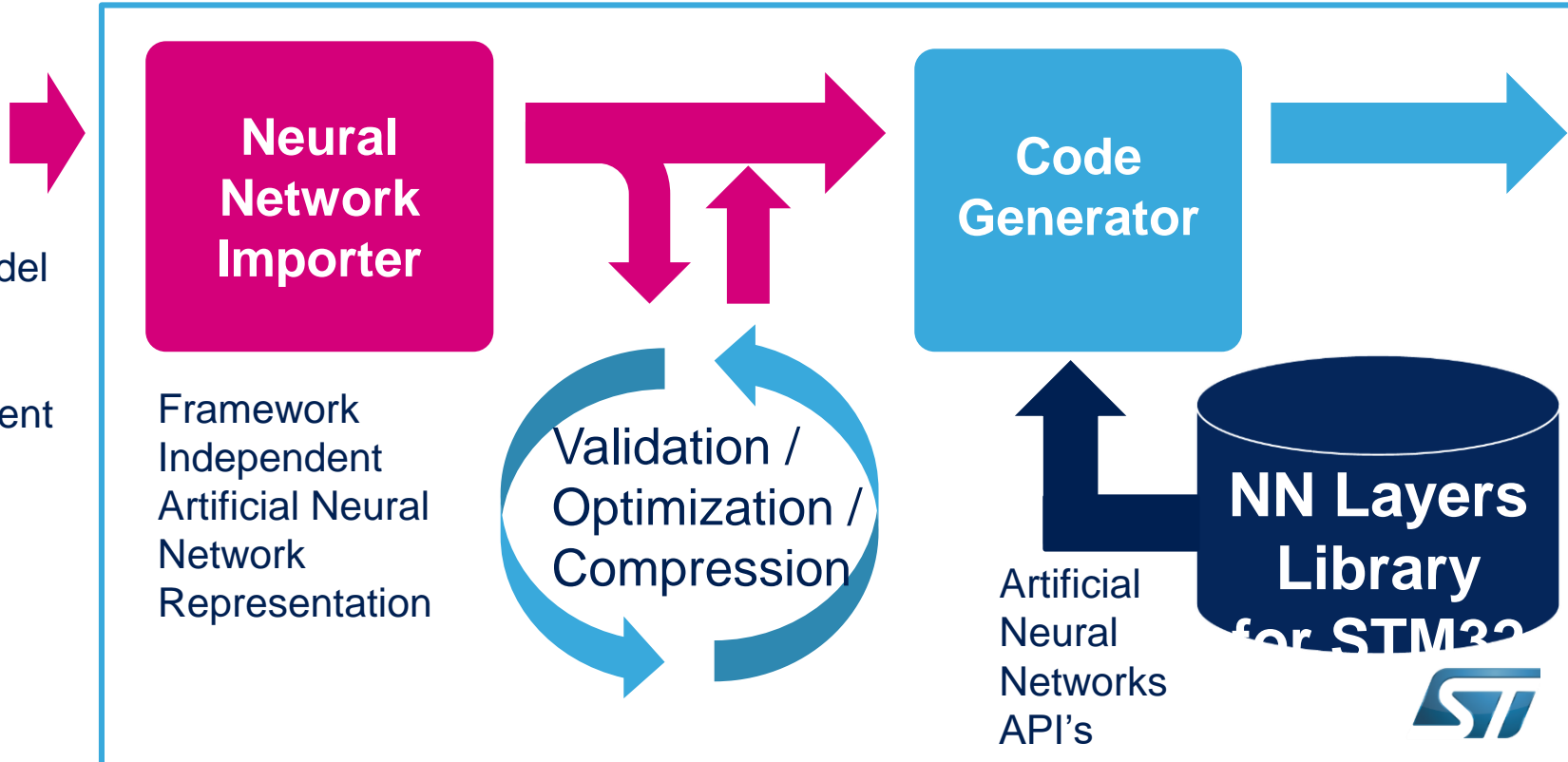


... brings your AI-based innovation to the existing Cortex-M4/M7 STM32



**Off-the-shelf :**  
Pre-trained Artificial  
Neural Network Model

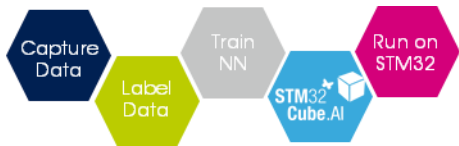
Deep Learning  
Framework dependent



**Embedded Solution**  
Optimized Artificial  
Neural Network Code  
generated for STM32



This optimized STM32 Artificial neural network model can be included into the user project (using KEIL, IAR, OpenSTM32) and can be compiled and ported onto the final device for field trials



# STM32CubeMX Extension

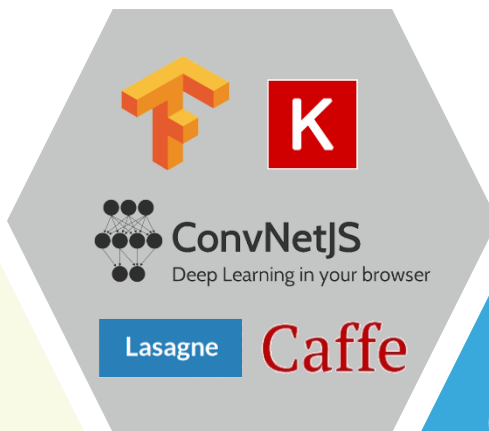
## AI Conversion Tool

Input your framework-dependent, pre-trained Neural Network into the **STM32Cube.AI** conversion tool

Automatic and fast generation of an STM32-optimized library

**STM32Cube.AI** offers interoperability with state-of-the-art Deep Learning design frameworks

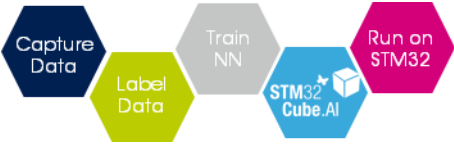
Train NN Model



Process & analyze new data using trained NN

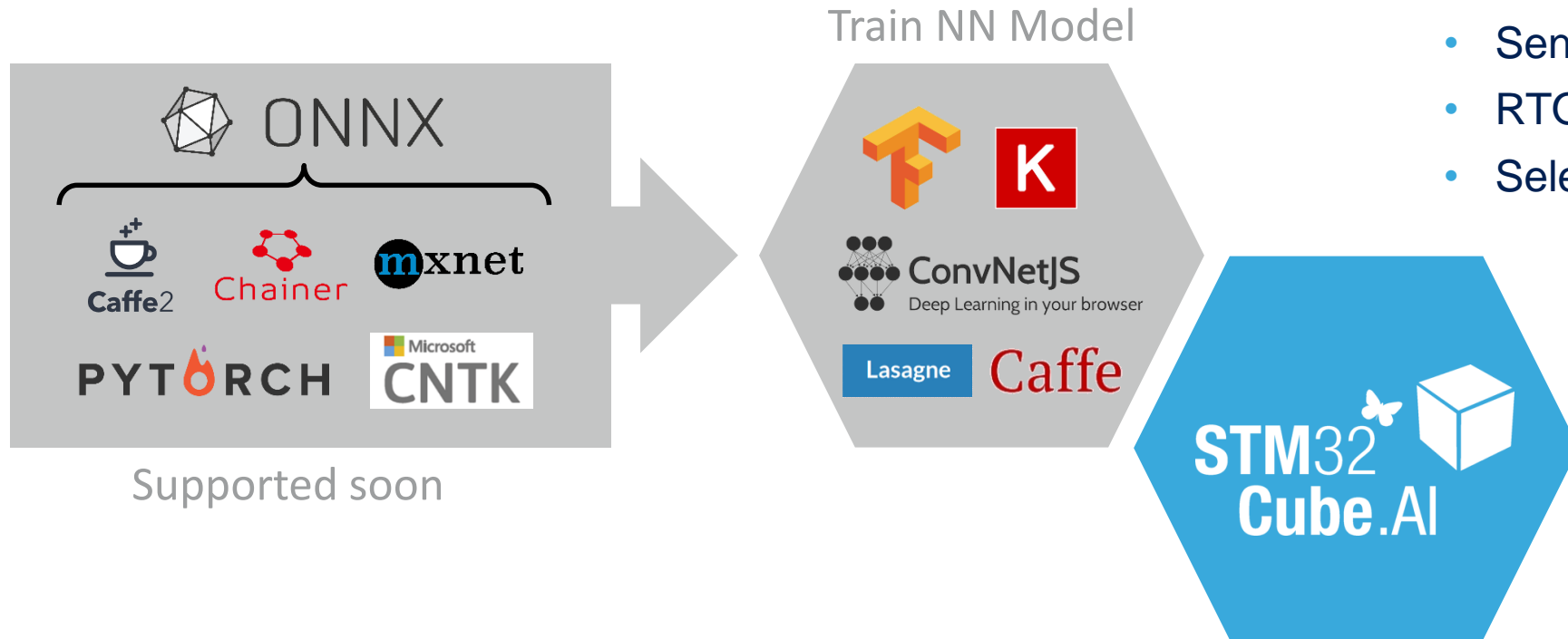


Convert NN into optimized code for MCU



# STM32CubeMX Extension

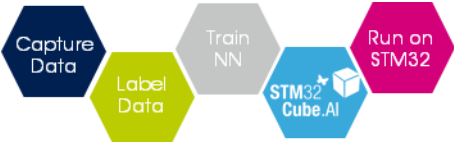
## STM32Cube.AI Interoperability



- Easy add of user code via public API interfaces
- Sensor agnostic
- RTOS agnostic or bare metal
- Select your IDE:

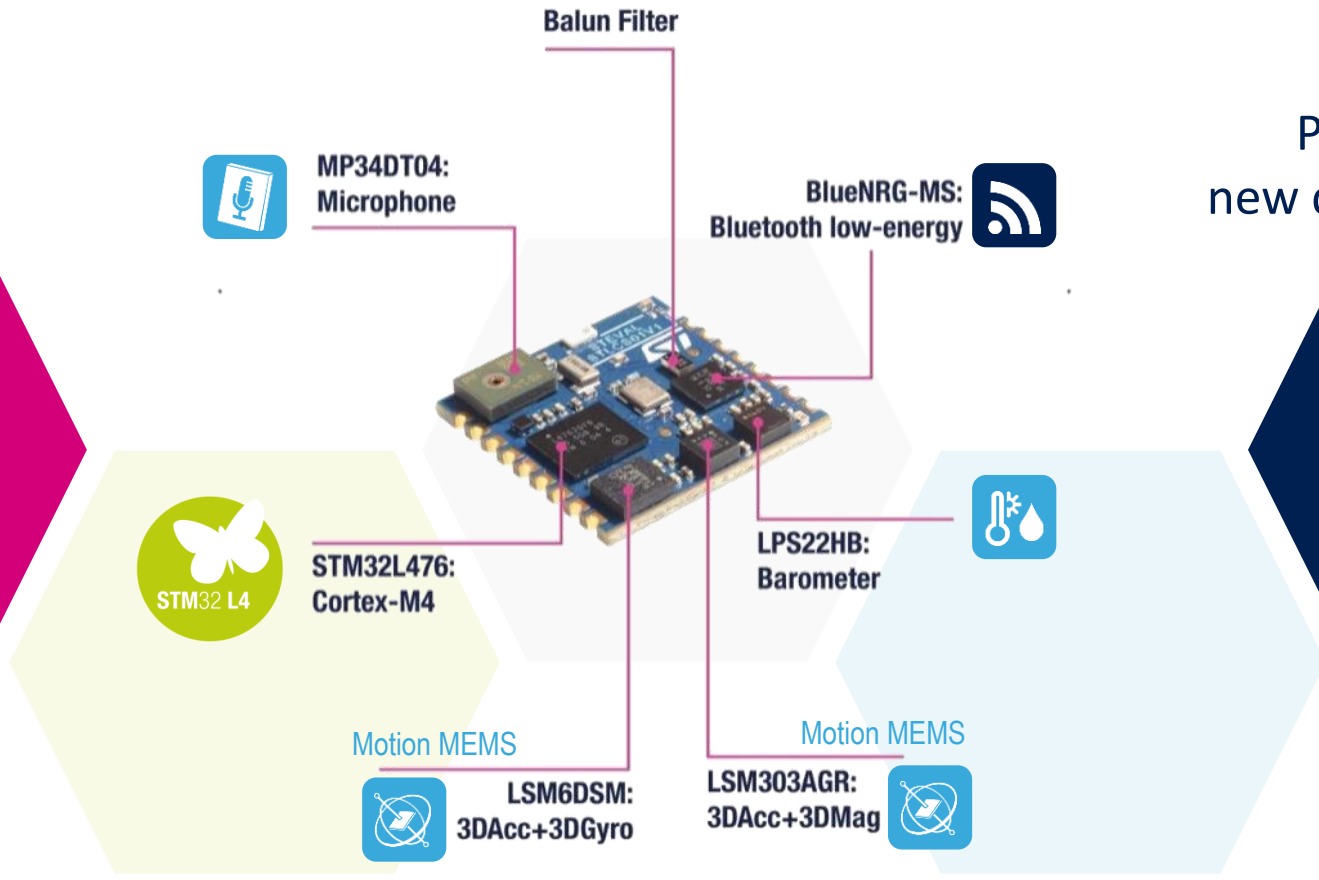
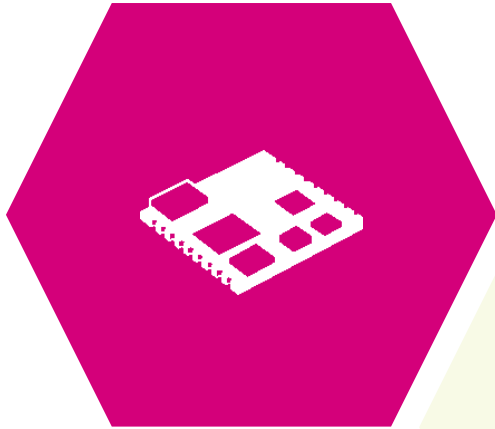


Convert NN into optimized code for MCU

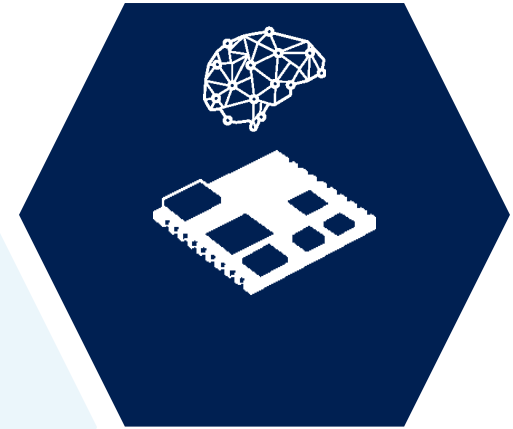


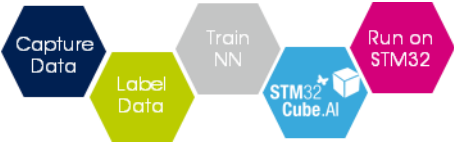
# Form Factor Hardware to Capture and Process Data

Capture data



Process & analyze new data using trained NN



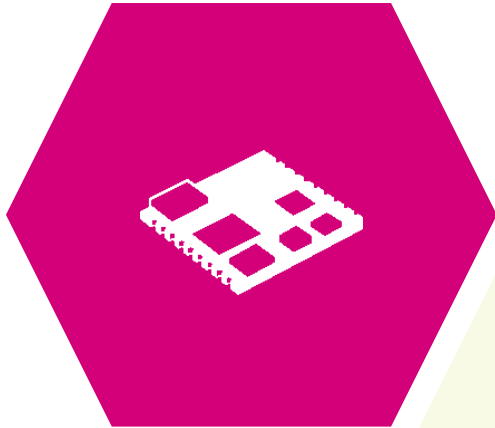


# Form Factor Hardware

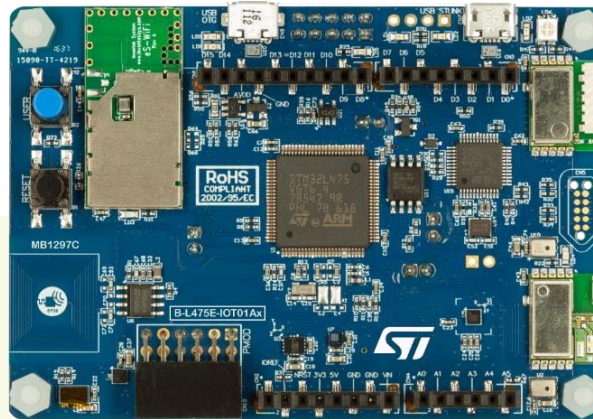
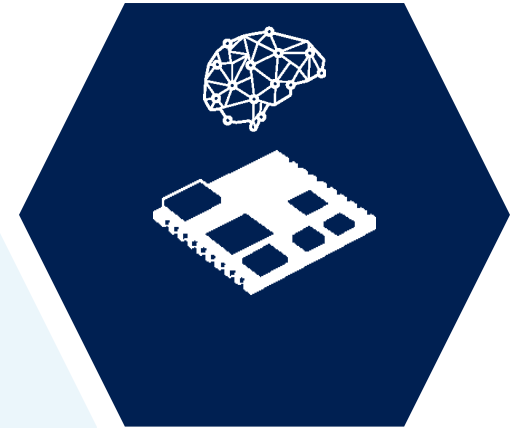
## AI IoT Node for More Connectivity



Capture data



Process & analyze new data using trained NN

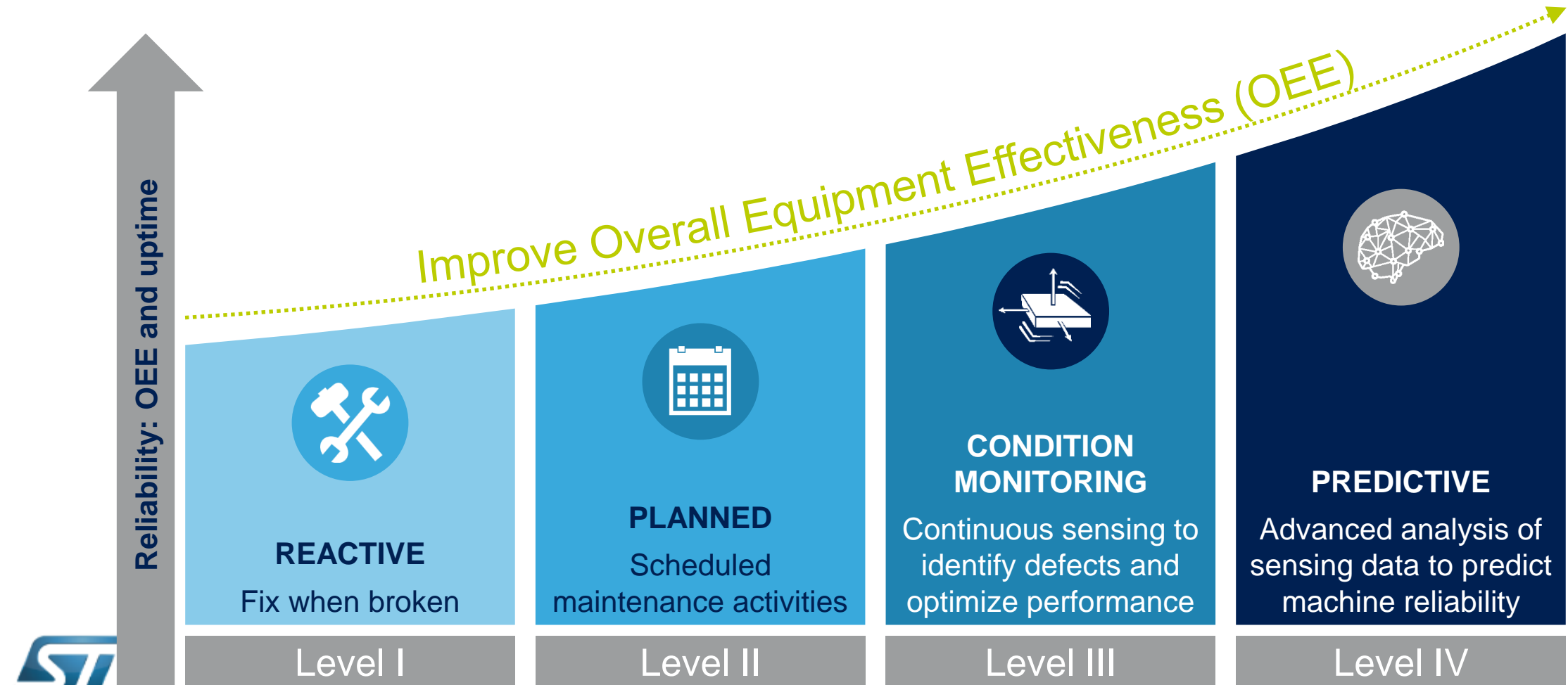


More debug capabilities

- Integrated ST-Link/V2.1
- PMOD extension connector
- Arduino Uno extension connectors

# Maintenance Strategy Continuum

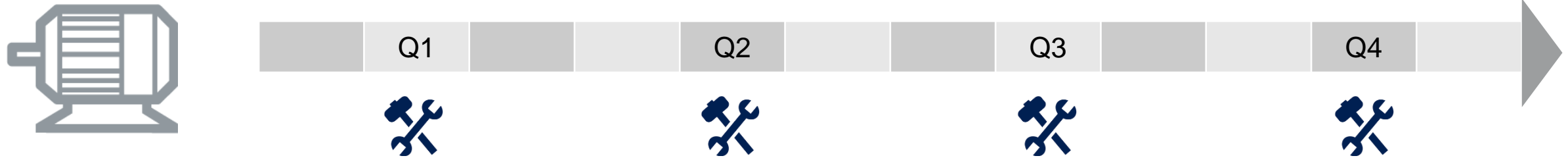
Improve Overall Equipment Effectiveness



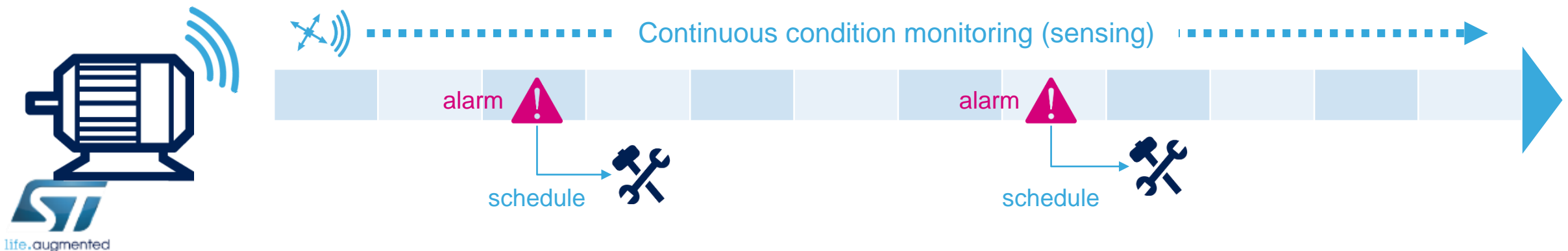
# Predictive Maintenance

Minimizes the Impact on Production and Optimizes Cost

## Preventive Maintenance (planned)

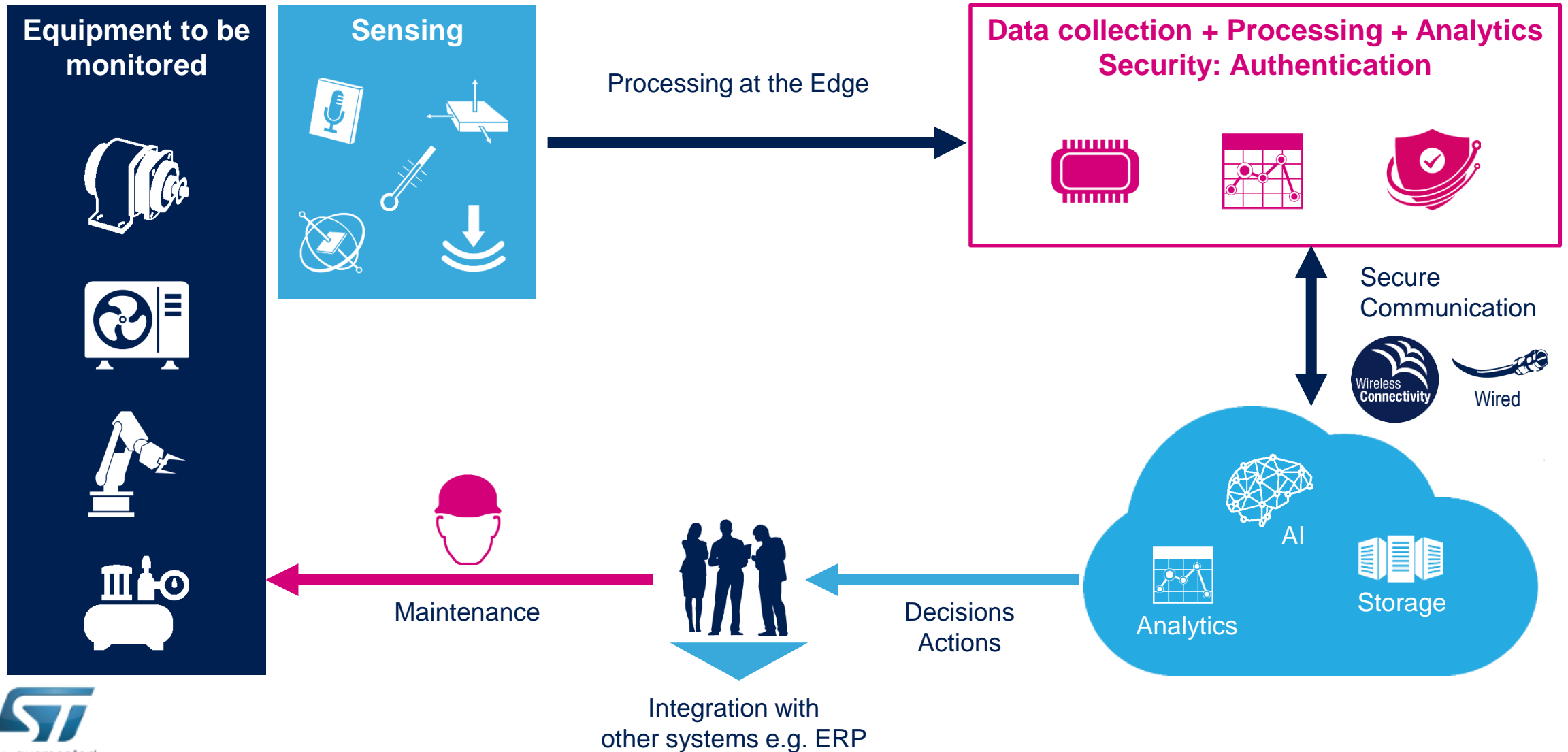


## Predictive Maintenance (at the optimal moment)

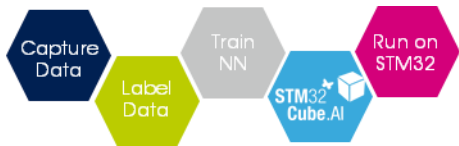


# Predictive Maintenance

Minimizes the Impact on Production and Optimizes Cost







# STM32 Solutions for AI

## More Than Just the STM32Cube.AI

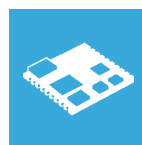
An extensive toolbox to support easy creation of your AI application

**AI extension for STM32CubeMX**  
To map pre-trained Neural Networks onto the STM32



**Function packs for Quick prototyping**  
Audio and motion examples

**SensorTile reference hardware**  
To run inferences or data collection



... And more coming!



**STM32 Community** with dedicated Neural Networks topic

**Mobile phone application**  
To collect and label data  
To display the result of inference processing on the STM32



**ST Partner Program** with a dedicated group of Partners providing Neural Networks engineering services  
Data scientists and Neural network architects

# Thank you

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