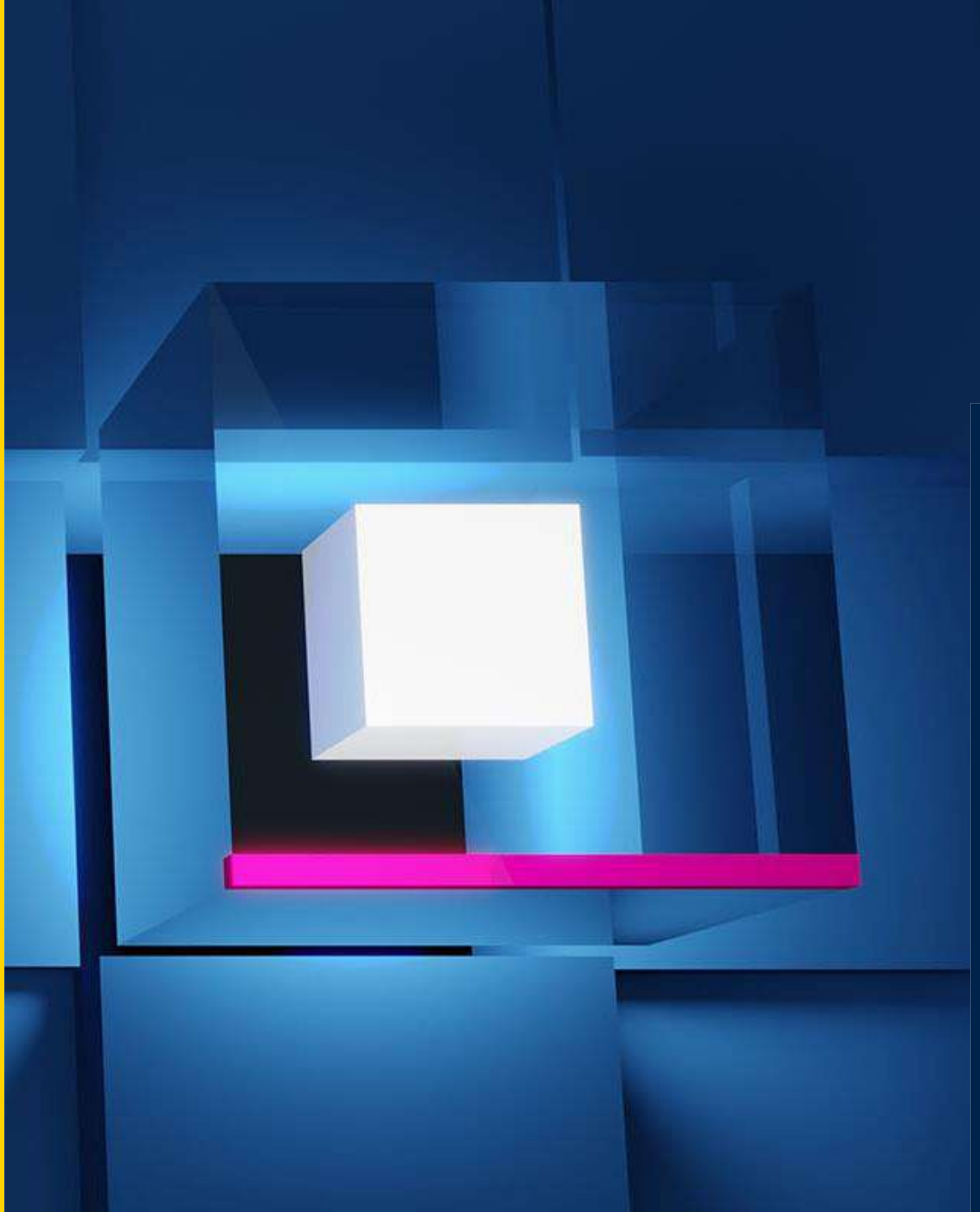

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Artificial intelligence solutions
running on STM32

STM32

Product development new paradigm

From rule-based engineering to data-driven engineering

Standard programming

Handcrafted rules based on experience

- Requires digital signal processing skills
- Manual feature extraction?
- Need to rewrite if environment evolves

Machine learning

Rules learned from real-world data

- Generate code from real-world observations
- Automated feature extraction?
- Relearn from data if environment evolves

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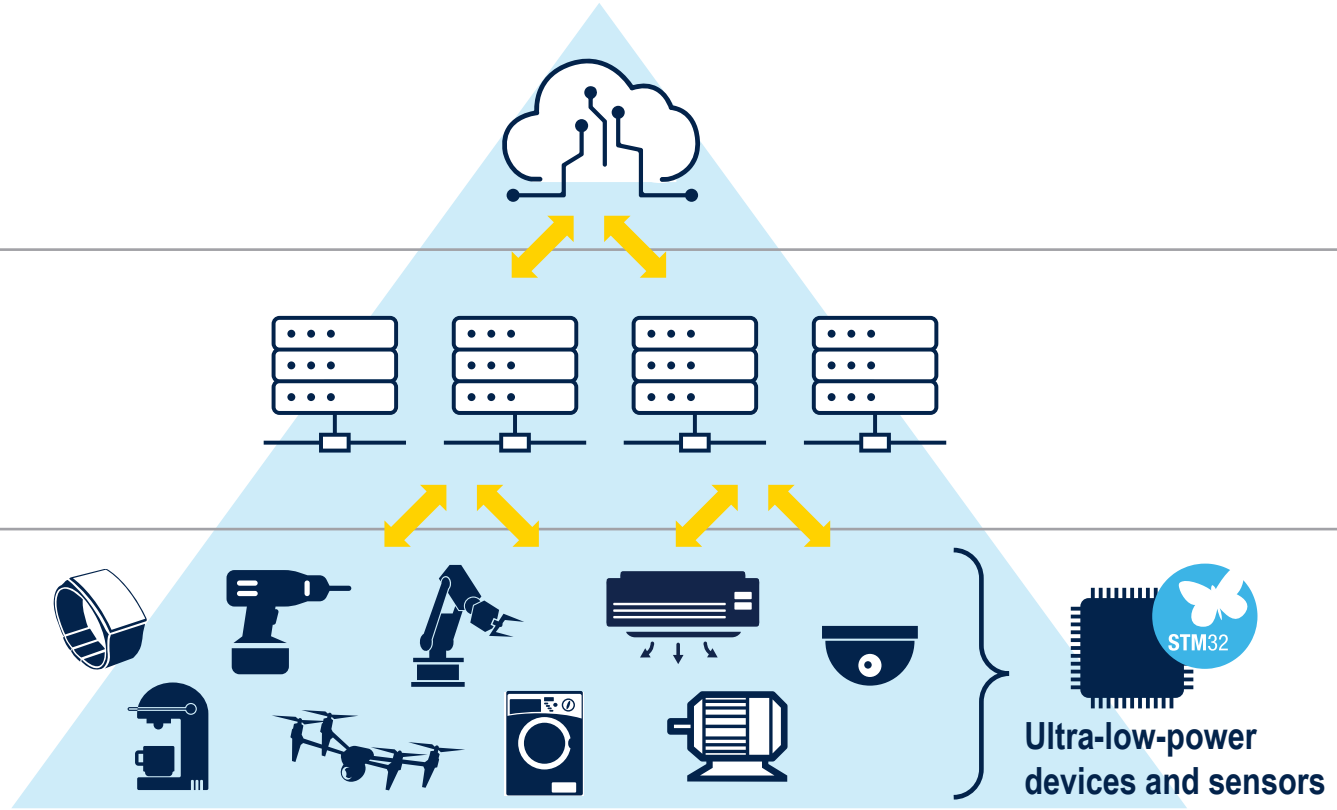
Distributed artificial intelligence approach

Leverage billions of devices at the edge!



Data Center Cloud

Analytics, storage, compute

Edge nodes

IoT gateways, micro datacenters

Edge things

Real time, local processing

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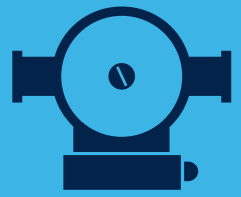
Billions of machines just “want” to do a better job

The washer is not draining properly

because

a belt is showing signs of wear

HOME MAINTENANCE



The pump is about to break down

due to

a failure on a ball bearing

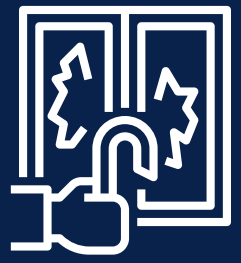
INDUSTRIAL MAINTENANCE

An unusual noise has been detected

and

recognized as a window break

SECURITY



Enterprise restaurant is full

and

your waiting time is currently estimated to 15mn

PEOPLE COUNTING

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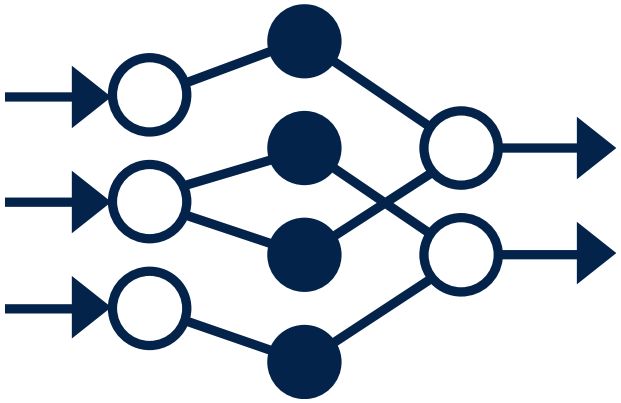
The challenge of deploying embedded AI



AI expertise

Data

Memory footprint

Inference time

Power consumption

eSW development

Deploying embedding AI on MCUs is NOT a walk in the park

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Start today with deep edge AI

"If only

I had solutions to overcome AI design challenges

This is where we come in

A large product offering to cover many use cases

- 3 products to suit needs from embedded developers to data scientists

AD + LOD
SENSING

NANOEDGE AI STUDIO

Easy to use AutoML tool for STM32 MCU

SENSING
AUDIO
VISION

STM32 Cube.AI

AI model optimizer and code generator for STM32 MCU

SENSING
AUDIO
VISION

X-LINUX-AI

A complete AI framework for STM32 MPU

- Covering a broad variety of applications

ANOMALY DETEC. + L.O.D.

- Anomaly detection
- Predictive maintenance
- Learning-on-device

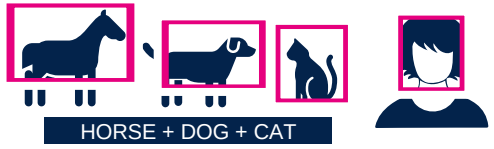
SENSING

- Sensor analysis
- Activity recognition (motion sensors)
- Stress analysis or attention analysis

AUDIO

- Audio (key word, scene detection)
- Speech (sentences) recognition
- Speech synthesis

VISION



- Multiple Objects Detection
- Face/object analysis (eg face detection)

L.O.D : Learning On Device

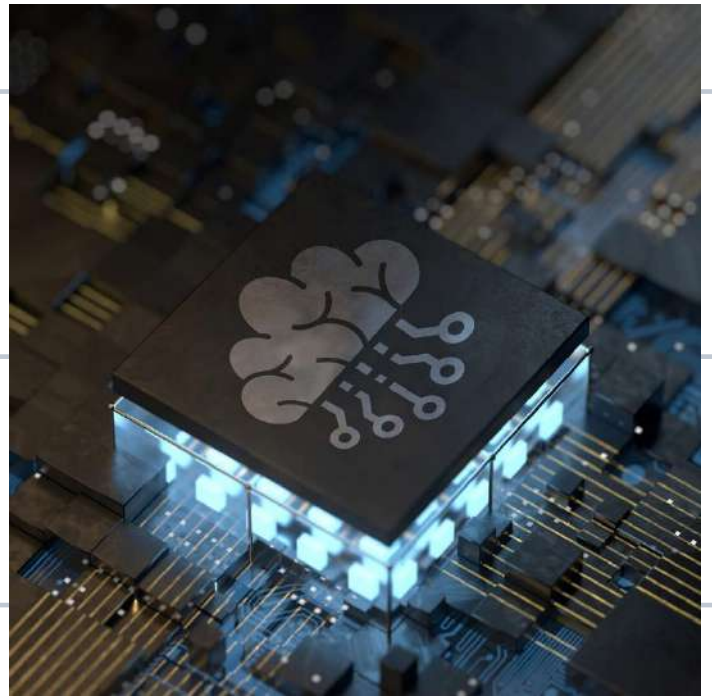
Artificial intelligence at the edge

Moving part of artificial intelligence closer to the data acquisition brings several benefits

Ultra-low latency
Real-time applications

More reliability

Security of data
No sharing in the cloud



Privacy by design
GDPR compliant

Sustainable on energy
Low-power consumption

Better user experience

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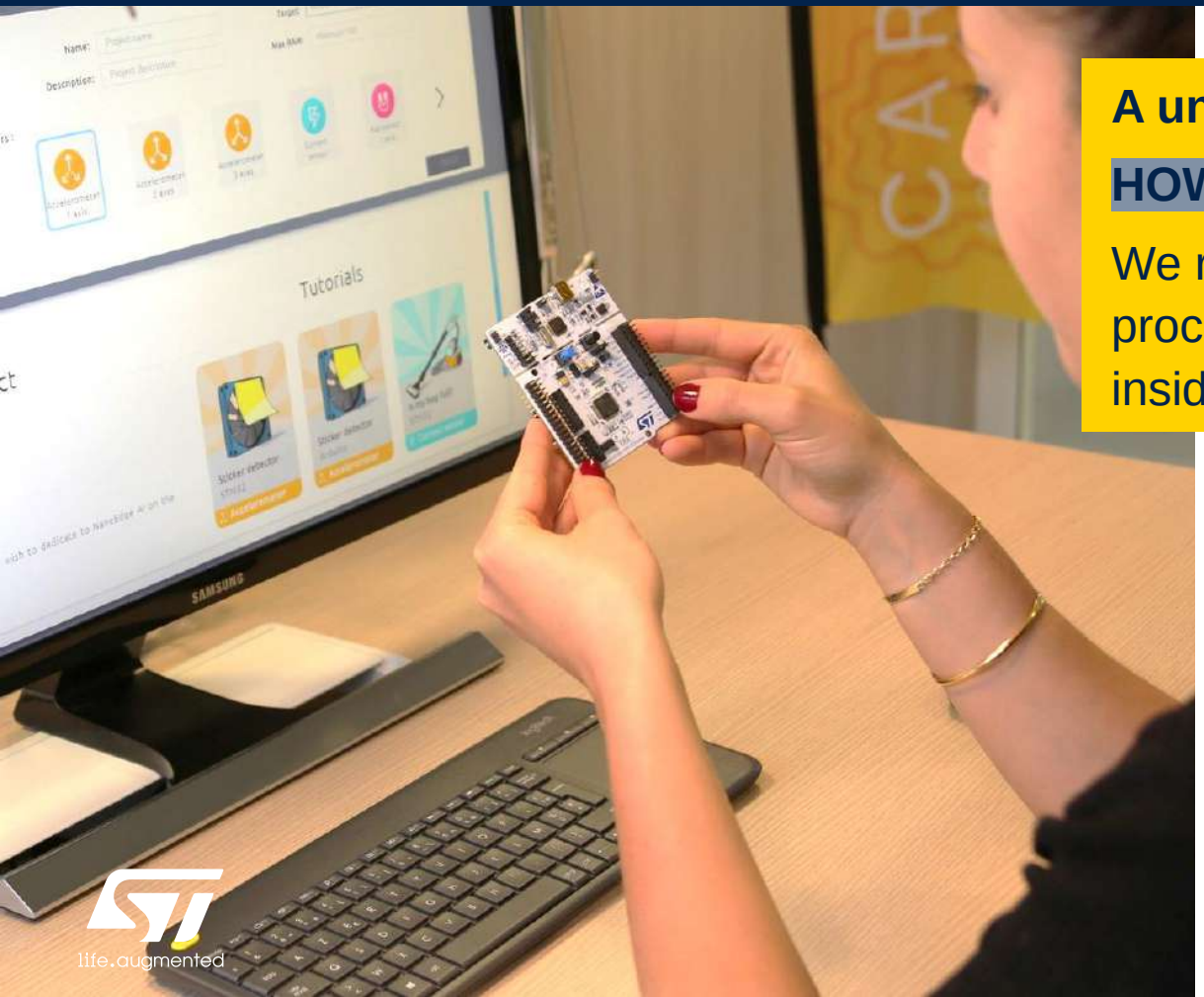
For embedded developers

NanoEdge AI Studio, an automated ML design solution

NANOEDGE AI STUDIO



A unique solution thought from scratch

HOW DID WE DO IT?

We rewrote the algorithms, from the algebra, ML, and signal processing algorithms, so that they can LEARN and INFER inside an MCU.

- Patented technology
- Designed for embedded developers
- Ultra memory efficient (Flash and RAM)
- Unsupervised learning in the device
- Superior security
- Small footprint, runs on any STM32
- Close to 100% accuracy and confidence

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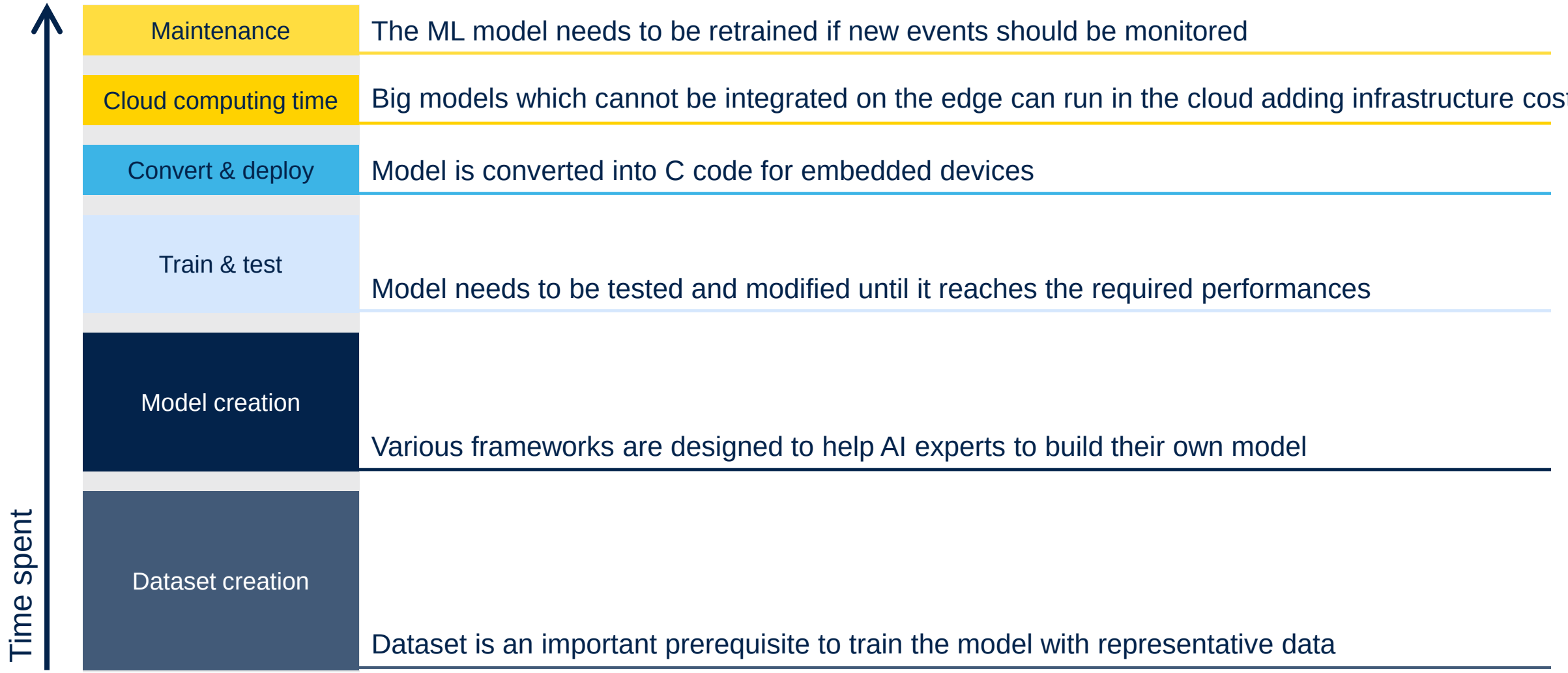
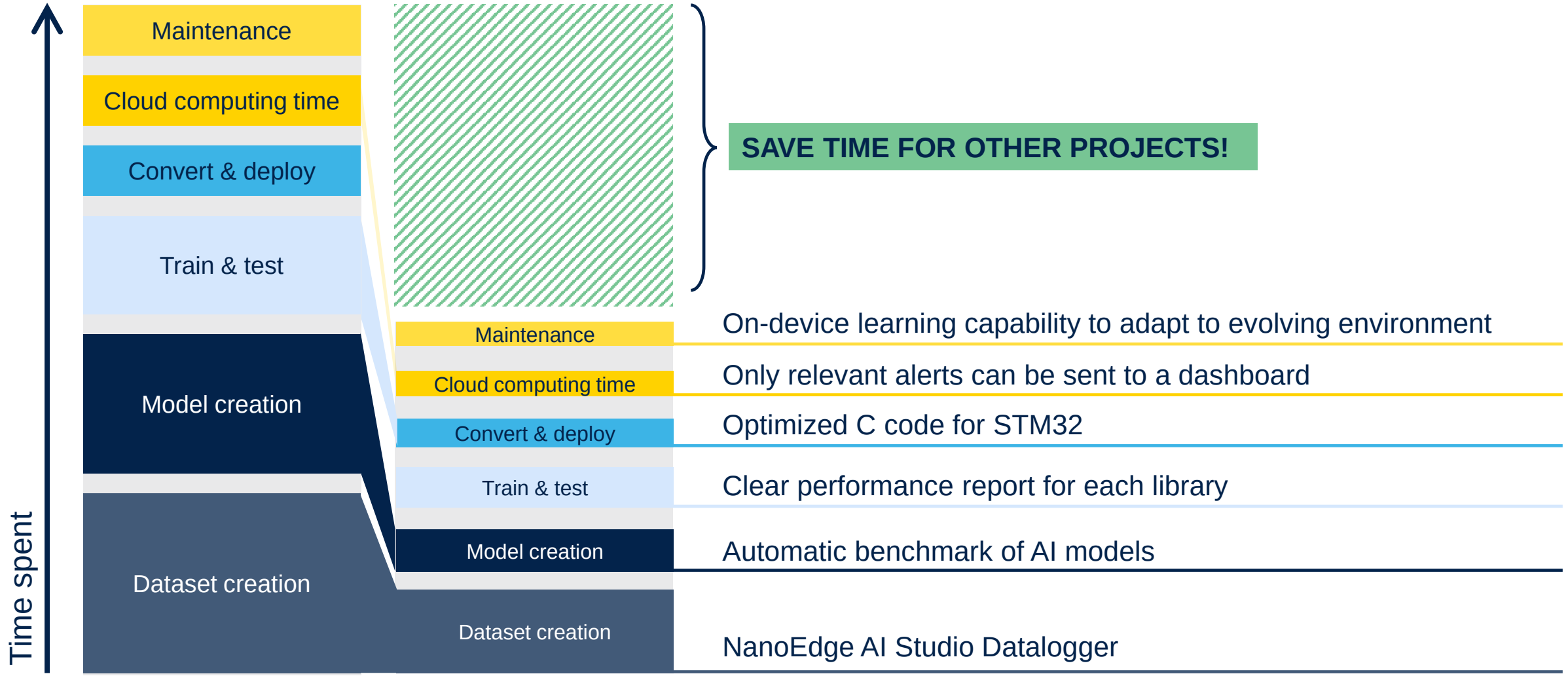
AI solutions development flow



AI solutions development flow

enhanced with NanoEdge AI Studio



NANOEDGE AI STUDIO

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For teams with AI expertise

STM32Cube.AI helps you accelerate your embedded development

STM32 Cube.AI

Easily evaluate, convert, and deploy machine learning and deep neural networks on STM32

An AI extension integrated with the STM32Cube MCU development environment to **optimize** and **tune** models, directly on target.

- Develop and train your model with major AI frameworks

TensorFlow Lite · K · scikit-learn · ONNX · MATLAB · PyTorch

- Best ML performance on STM32 (MLPerf™ Tiny benchmarks)
- Validate performance directly on target
- Small footprint, runs on any STM32

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Making Edge AI accessible to all STM32 portfolio

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

MPU						**STM32MP1** 4158 CoreMark Up to 800 MHz Cortex –A7 209 MHz Cortex –M4
High Perf MCUs	STM32**F3** 245 CoreMark 72 MHz Cortex-M4 Optimized for mixed-signal applications	**STM32G4** 569 CoreMark 170 MHz Cortex-M4	STM32**F2** Up to 398 CoreMark 120 MHz Cortex-M3	STM32**F4** Up to 608 CoreMark 180 MHz Cortex-M4	STM32**F7** 1082 CoreMark 216 MHz Cortex-M7	**STM32H7** Up to 3224 CoreMark Up to 550 MHz Cortex -M7 240 MHz Cortex -M4
Mainstream MCUs	STM32**F0** 106 CoreMark 48 MHz Cortex-M0	**STM32G0** 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**L1** 93 CoreMark 32 MHz Cortex-M3	STM32**L4** 273 CoreMark 80 MHz Cortex-M4	STM32**L4+** 409 CoreMark 120 MHz Cortex-M4	STM32**L5** 443 CoreMark 110 MHz Cortex-M33	**STM32U5** 651 CoreMark 160 MHz Cortex-M33
Wireless MCUs			**STM32WL** 162 CoreMark 48 MHz Cortex-M4 48 MHz Cortex-M0+	**STM32WB** 216 CoreMark 64 MHz Cortex-M4 32 MHz Cortex-M0+		

Latest product generation

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ST now offers the ultimate AI solution framework

Stay focused on your expertise, we bring you everything else

Your industry Expertise

- ✓ Lead with true innovation
- ✓ Improved time to market
- ✓ Optimize cost
- ✓ Minimize risks

AI Design Services

Proven methodology to **accelerate** ML innovation process

Partner Program

Certified partner ecosystem

AI Software and ecosystem

NANOEDGE AI STUDIO

STM32 Cube.AI

Function Packs

Hardware

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Your Industry Expertise

- ✓ Lead with true innovation
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- ✓ Optimize cost
- ✓ Minimize risks

AI Design Services

- ✓ Proven methodology to accelerate ML innovation process
- ✓ Delivered direct or through **certified** partner ecosystem
- ✓ Direct R&D assistance for all sprint projects

AI Software and ecosystem

- ✓ Best AI offering portfolio on the market
- ✓ **Most comprehensive AI stack** ranging from deep learning computer vision to self-learning anomaly detection.

Hardware

- ✓ **Most comprehensive HW portfolio** to address all projects and communication environment

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Want to learn more?

stm32ai.st.com

TRANSPORTATION | CUSTOMER

AI solution for monitoring automatic doors with Crouzet

Predictive maintenance on motors for automatic door motors.

TRANSPORTATION | CUSTOMER

Railway monitoring with Vapérail

On-track predictive maintenance.

INDUSTRIAL | CUSTOMER

AI solution for industrial predictive maintenance with Oxytronic

Predictive maintenance solution for industrial equipment.

INDUSTRIAL | DEMO

Fan anomaly detection based on vibrations

Learn to detect abnormal behavior at the edge on a vibrating machine.

INDUSTRIAL | CUSTOMER

AI solution for reflow oven monitoring with Lacroix Electronics

Predictive maintenance applied to industrial ovens.

INDUSTRIAL | CUSTOMER

AI solution for industrial predictive maintenance with NKE Watteco

Predictive maintenance solution for industrial equipment.

SMART BUILDING | DEMO

People counting with a ranging sensor

Count the number of people passing through a door using a Time-of-Flight sensor.

INDUSTRIAL | CUSTOMER

AI solution for failure prediction on rotating machines with SMRI

Predictive maintenance on high-tech industrial tools.

INDUSTRIAL | DEMO

Pump anomaly detection based on vibrations

Learn to detect abnormal behavior at the edge on a vibrating machine.

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Our technology starts with You

Find out more at stm32ai.st.com/

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