

ISPU: Intelligent sensor processing unit

ISPU: What and Why



ISPU commercial products



ISPU in Industrial: Anomaly Detection
With NanoEdge.AI



ISPU in Personal Electronics:
X-CUBE-ISPU and
Unsupervised on device learning



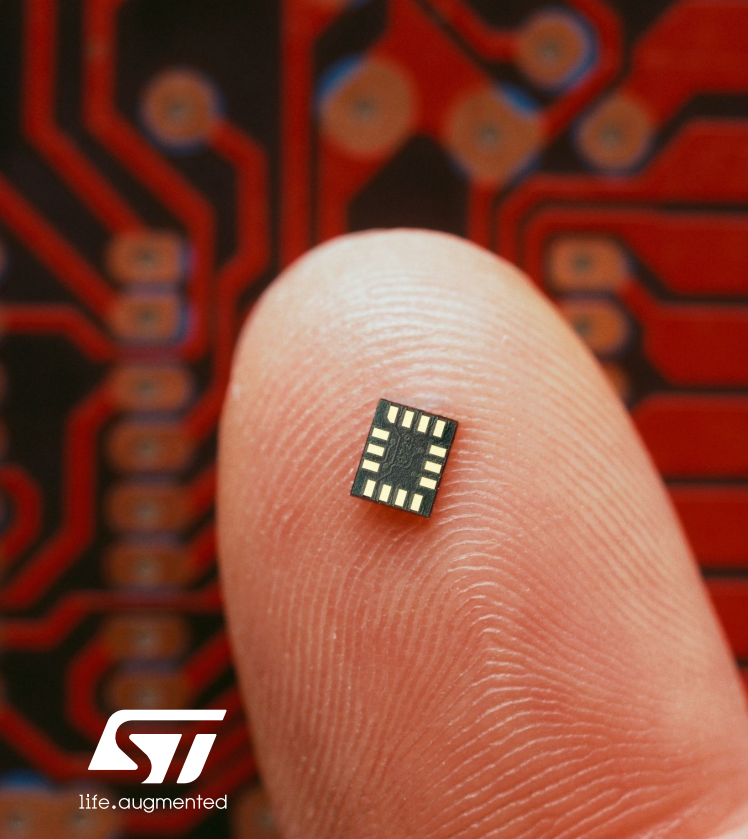


ISPU: What and Why

Intelligent Sensor Processing Unit (ISPU):

DSP core HIGHLY-SPECIALIZED for Machine Learning and Processing

TINY SILICON



Unique solution for **TinyML** with **Machine Learning (ML)**, **Binary Neural Network (BNN)**, and **processing** capabilities



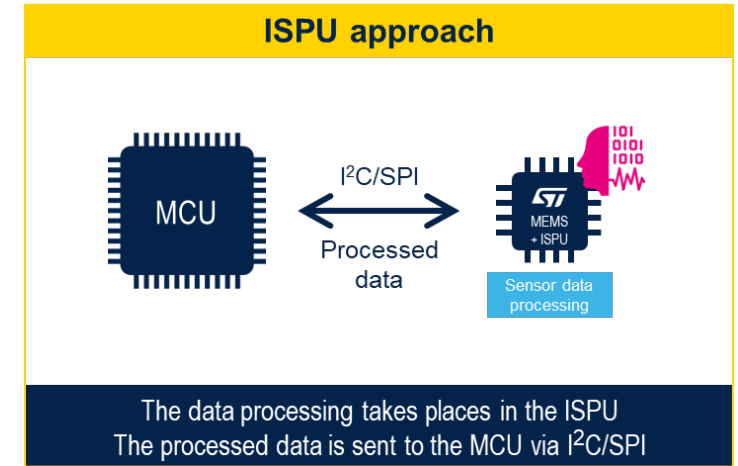
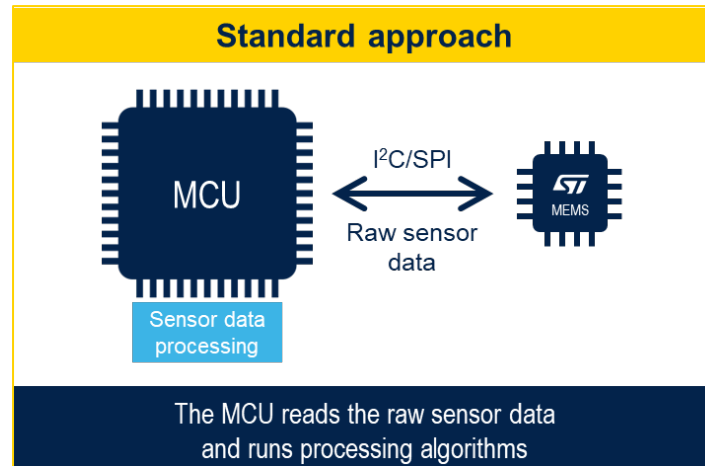
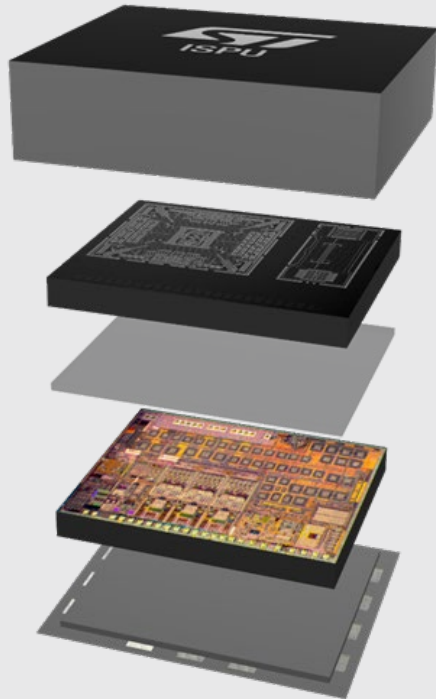
Lowest power consumption IoT node in the market with AI in the Edge



Productivity: empowers 10M+ C language developers
Complement STM32 MCU portfolio for AI

AI in the edge: sensors with an Intelligent Sensor Processing Unit (ISPU)

Moving processing from the MCU to the Intelligent Sensor Processing Unit



The MCU only runs when needed
When an event occurs



Ultra low latency
Processing/decisions are made directly in the sensor



High flexibility
The ISPU is programmable in C language



Keeping the same package size
Package is P2P compatible with other ST IMUs



What's inside?

DSP for real-time processing and Artificial Intelligence

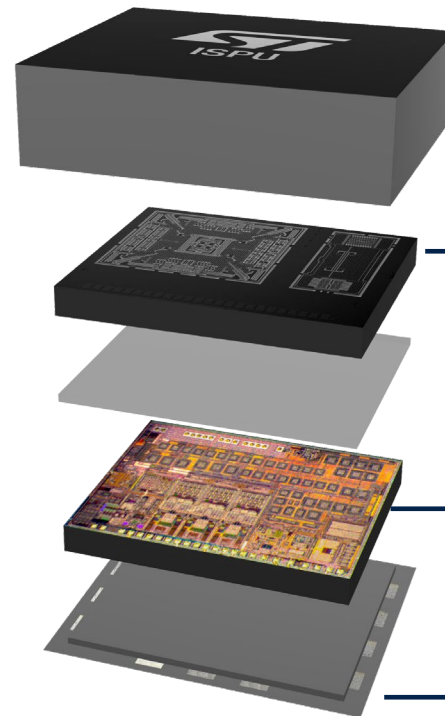
Raw data from MEMS sensor



ISPU locally process
data in a few μW



Only meaningful
processed data



MEMS Sensor: 3 axis accelerometer
3 axis gyroscope

Sensor hub to collect data from
additional external sensors (up to 4)

ISPU core

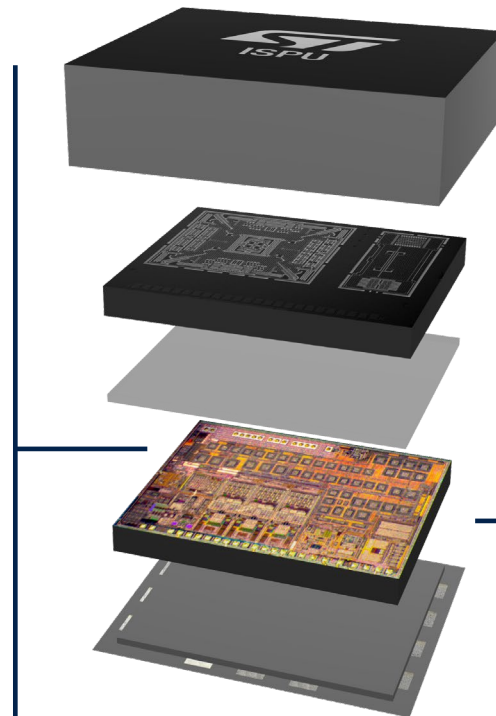
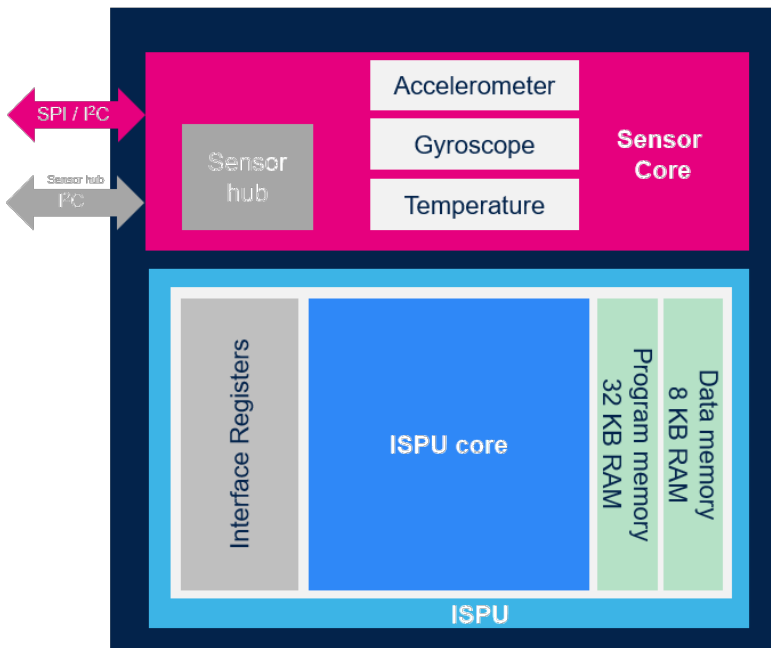
Standard package: 2.5 x 3 mm²



What's inside?

DSP for real-time processing and Artificial Intelligence

Architecture



Small Area: enhanced 32-bit RISC Harvard architecture in 8 kilogates

RAM based: 40 kB (program + execution)

Full Precision: Floating Point Unit

Binary Neural Network convolution accelerator: patented by ST

Fast interrupt response: 4 cycles vs. 15 (Cortex)

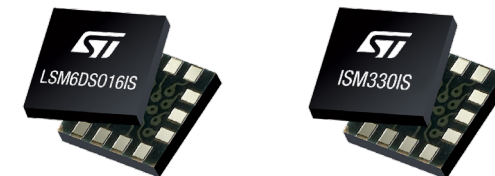
Frequency / ODR max:
5 MHz / 3.33 kHz – 10 MHz / 6.66kHz





6-axis IMU with embedded ISPU ISM330IS, LSM6DSO16IS

Ultralow power 6-axis IMU for AI in the edge



LGA 14L
2.5x3x0.86 mm

(Pin2Pin compatible with
all the ST's 6-axis IMU)



ISPU

MadeForAI@Edge

Key applications

- Complex motion and gesture recognition, event detection, activity, and tracking recognition from wearable accessories
- Anomaly detection, asset tracking, robotic arm positioning, predictive maintenance

Configurability

- Gyro FS: from ± 125 up to ± 2000 dps
- Axel FS: from ± 2 g up to ± 16 g
- ODR up to 6.6 kHz
- SPI / I²C digital interface

Performance & Power consumption

- Axel+Gyro (combo HP mode): 0.590 mA ; Axel only (HP mode): 0.180 mA
- Gyro Noise 3.8 mdps/ $\sqrt{\text{Hz}}$; Axel Noise 70 $\mu\text{g}/\sqrt{\text{Hz}}$

Programmability & digital features

- Embedded **ISPU**: Ultralow power programmable core for AI algos and processing
 - 10 MHz clock
 - 32 KB RAM for program / 8 KB RAM for data
 - Floating Point / Integer 32bit unit
- Sensor hub (up to 4 slaves)

Operating temperature range from -40 to +85 °C

Operating voltage range from 1.71 V to 3.6 V



life.augmented



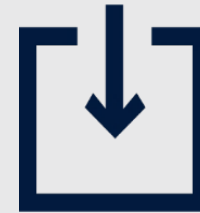


ISPU commercial products

ISPU
& NEAI



NanoEdge AI Studio for on-device learning solutions



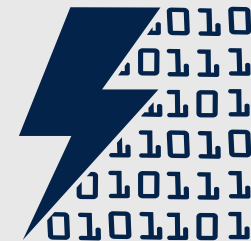
NANOEDGE AI



ISPU &
Open market



ST ISPU toolchain



For programming

- ✓ CLI
- ✓ IDE
- ✓ AlgoBuilder

How-to instructions, example code: [X-CUBE-ISPU](#), [GitHub](#)

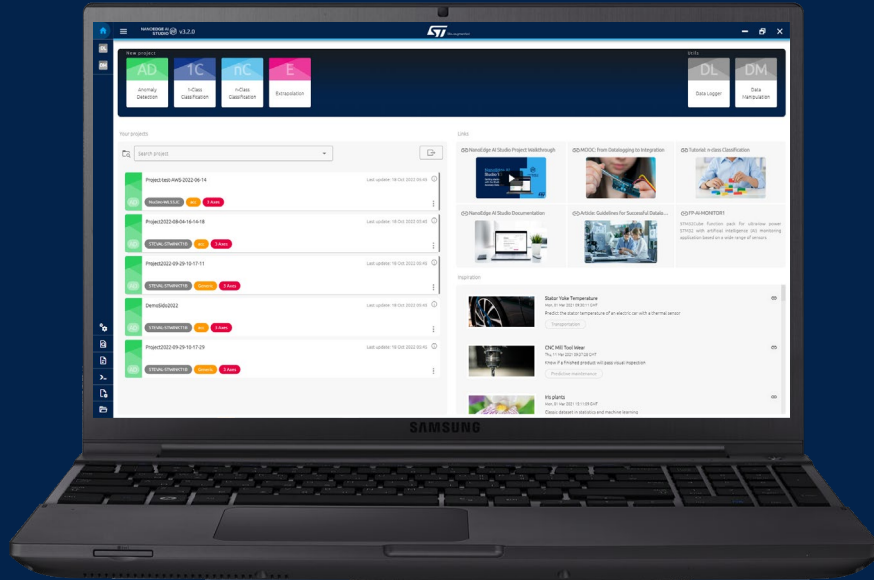




NanoEdge AI Studio V3.2 Optimized for ISPU

ON THE PC

1 Create the library, ONCE.



NANOEDGE AI
STUDIO 

Standalone PC solution
(Win/Linux)

ON THE ISPU

2 Use the library, MANY TIMES.

Create and embed
a self learning engine

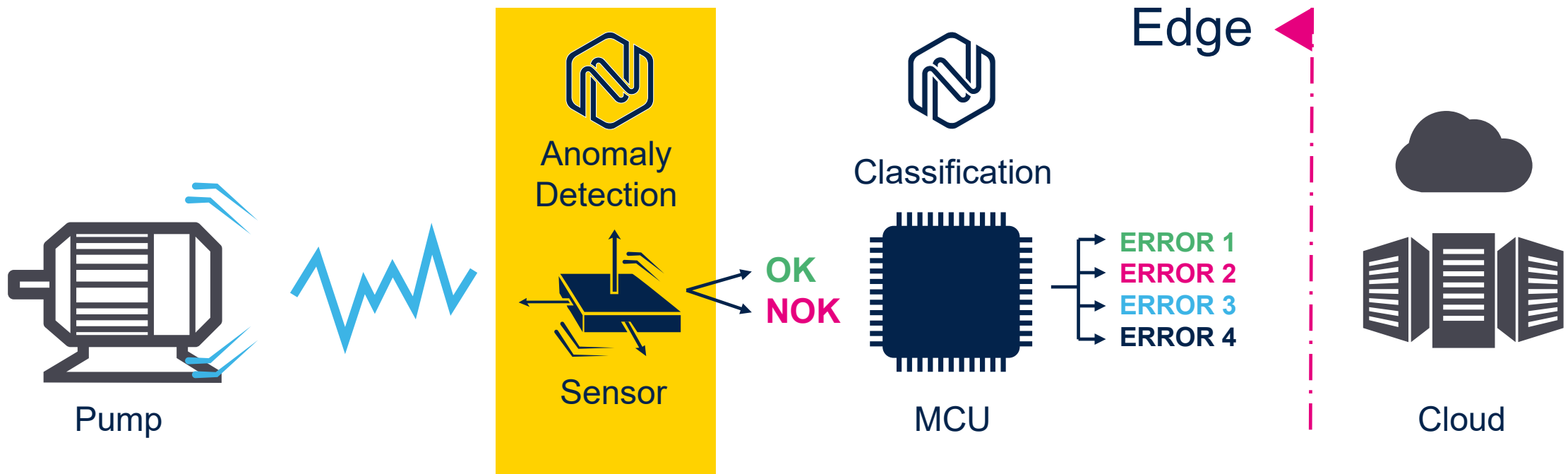


For anomaly detection, the model is
self-trained at the Edge.



Anomaly detection and AI: one step closer to the signal

Possibility to divide the tasks between the sensor and the MCU





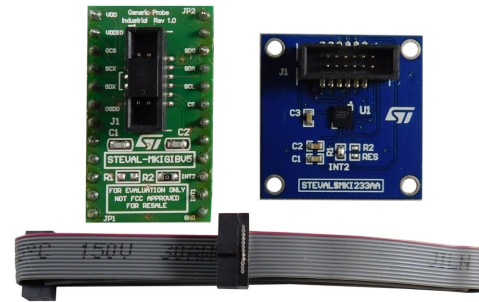
NEAI Studio: how to evaluate the ISPU?

Products



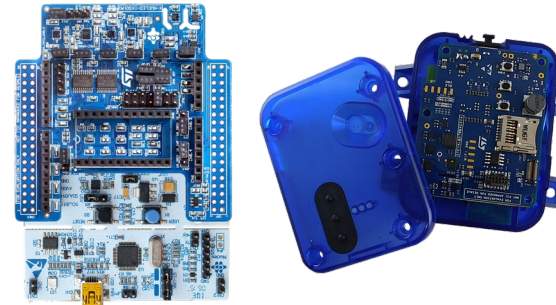
ISM330ISN

Dil24 Adapter



STEVAL-MKI233KA

Eval Boards & Kits

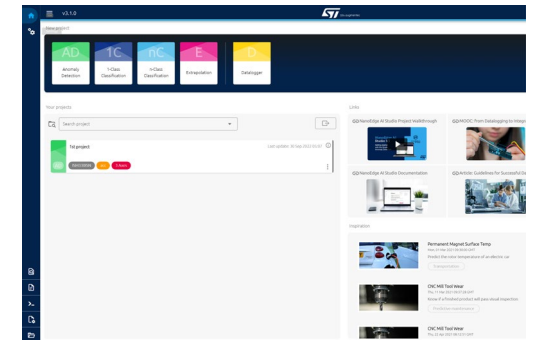


STM32 NUCLEO:

- NUCLEO-F401RE
- Industrial X-NUCLEO-IKS01A2

STEVAL-STWINBX1

Software & Package



Nano Edge AI Studio

X-CUBE-ISPU





Find inspiration to create your personal application

AI in the edge with ultralow power 6-axis IMU for consumer market



A completely new level of capabilities and detection accuracy in smart motion sensors with pattern recognition enabled applications :

- Consumer health
- Gesture recognition
- Activity recognition
- Motion tracking
- Anomaly detection



Gait analysis



Pose estimation



Fall detection



Carry position



Active time



Fitness activities



Activity recognition

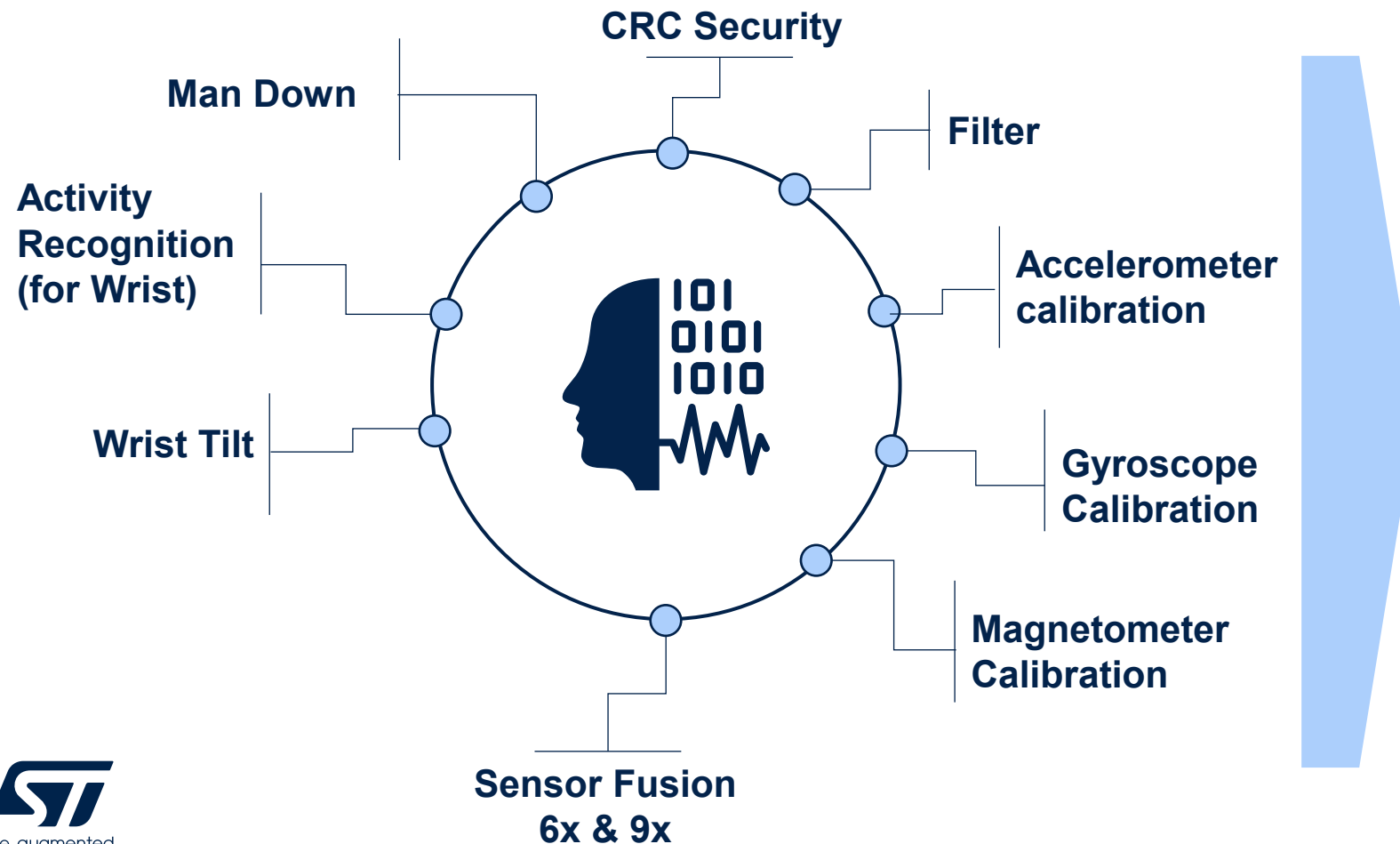


Gesture recognition



X-CUBE-ISPU contents

Leverage ISPU libraries & source code examples for low power processing



- High Efficiency (Computation Resources, Power)
- High Customization level
- Example Libraries available

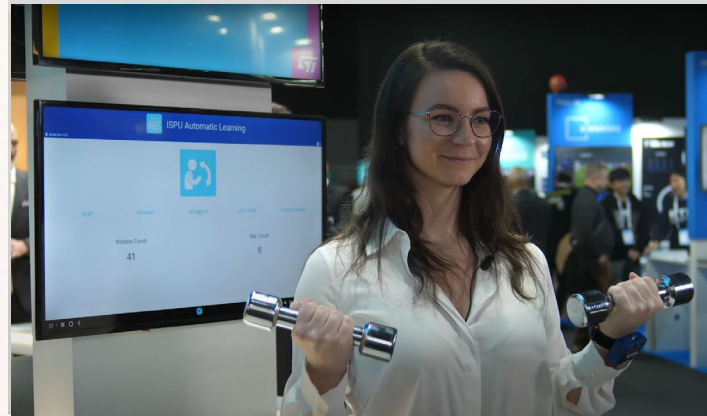


AI in the edge: from model training to activity recognition in few steps

Unsupervised on device learning in ISPU

Smarter and more efficient solutions with ISPU by observing changes in the data and self-adjusting/reconfiguring the sensors' operating model

Train your model



Recognize your activities

