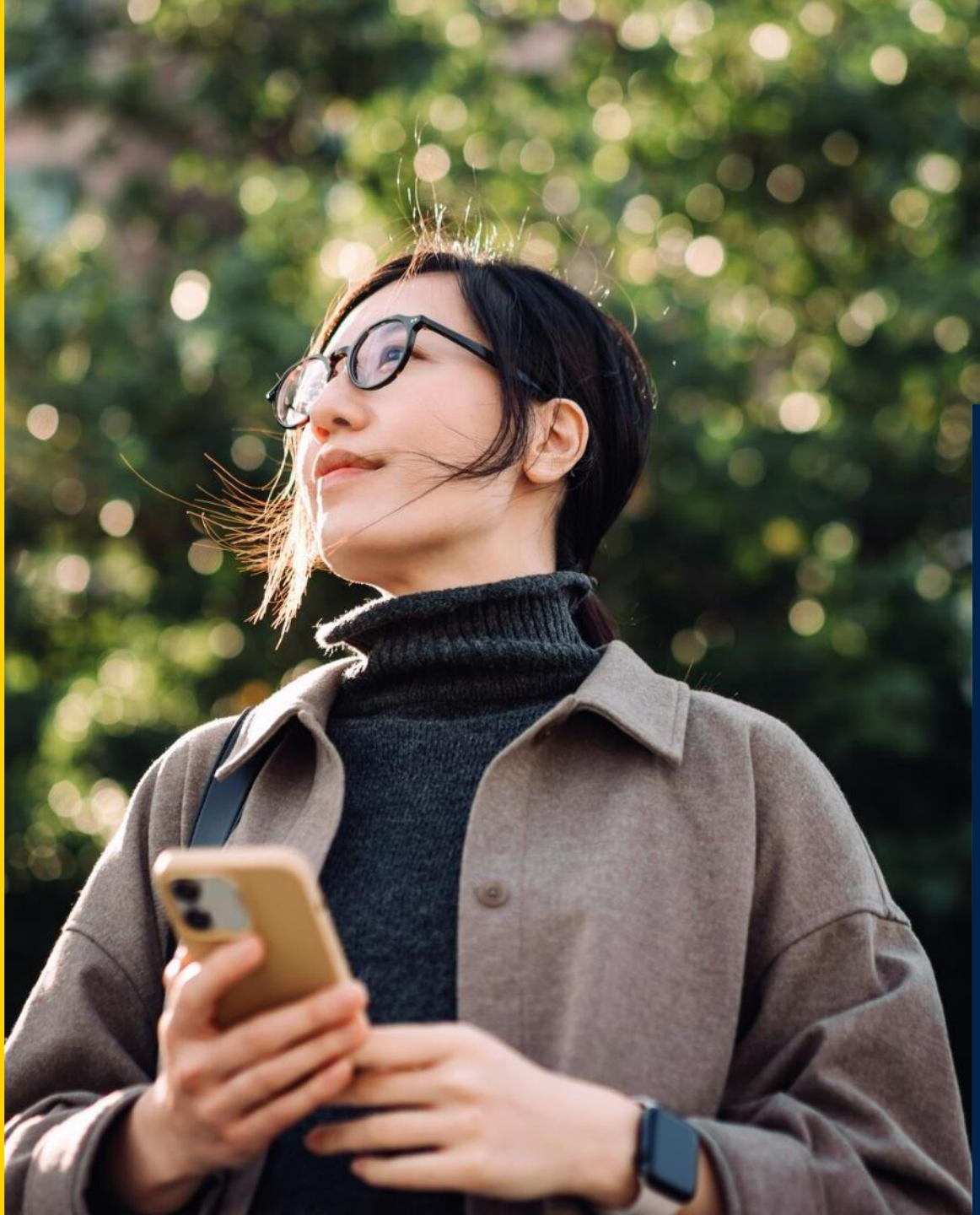

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Discover the evolution of smart sensors

Evan HSIEH

AMS APeC, MEMS Product Marketing

Sensors at the heart of our interactions with the digital world

Human centered

Sensors are the key components to **bridge** the **physical** and the **digital worlds**

Sustainable

Sensors becoming **smart** answer **human expectations** while ensuring a **sustainable future**

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Why ST sensors?

Smart

Sensors able to **process data**

Open

Sensors configured to **your needs**

Accurate

Sensors providing a **correct set of data**

Meaningful data provided in an optimal way

Human centered

Sustainable

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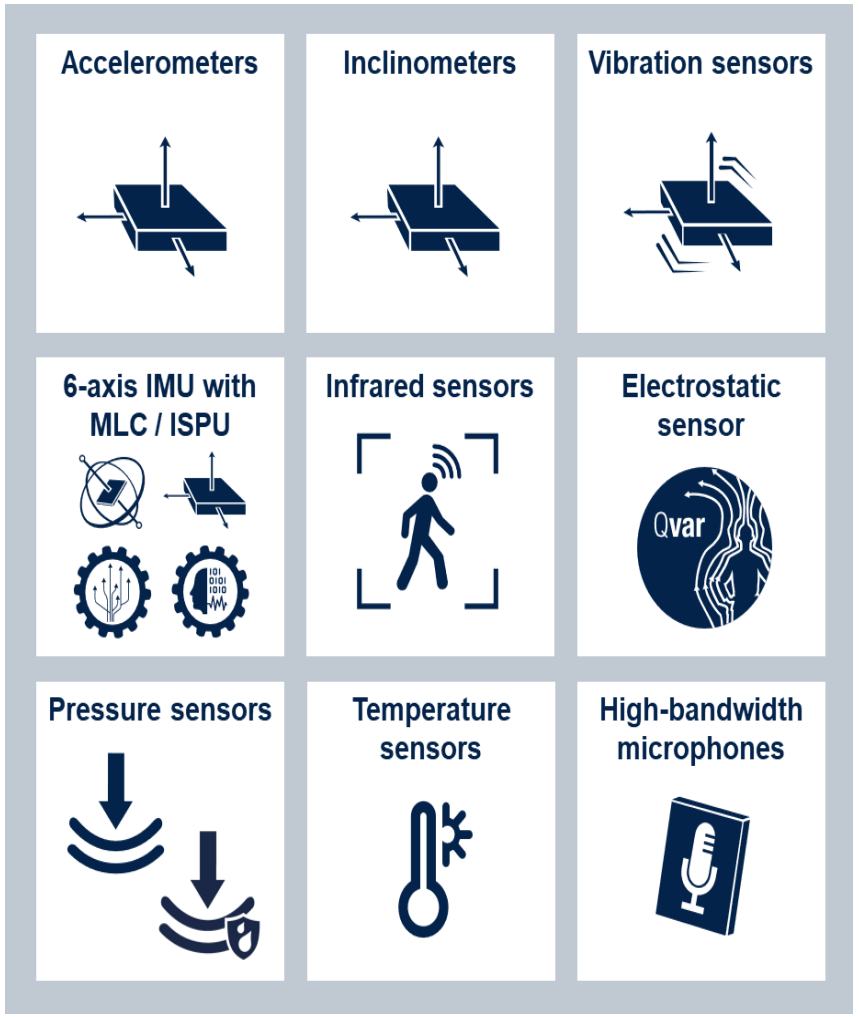
Where you find us

Making **driving** safer, greener, and more connected

Making **homes & cities** smarter, for better living, higher security, and to get more from available resources



Enabling the evolution of **industry** towards smarter, safer, and more efficient factories & workplaces

Making everyday **things** smarter, connected, and more aware of their surroundings

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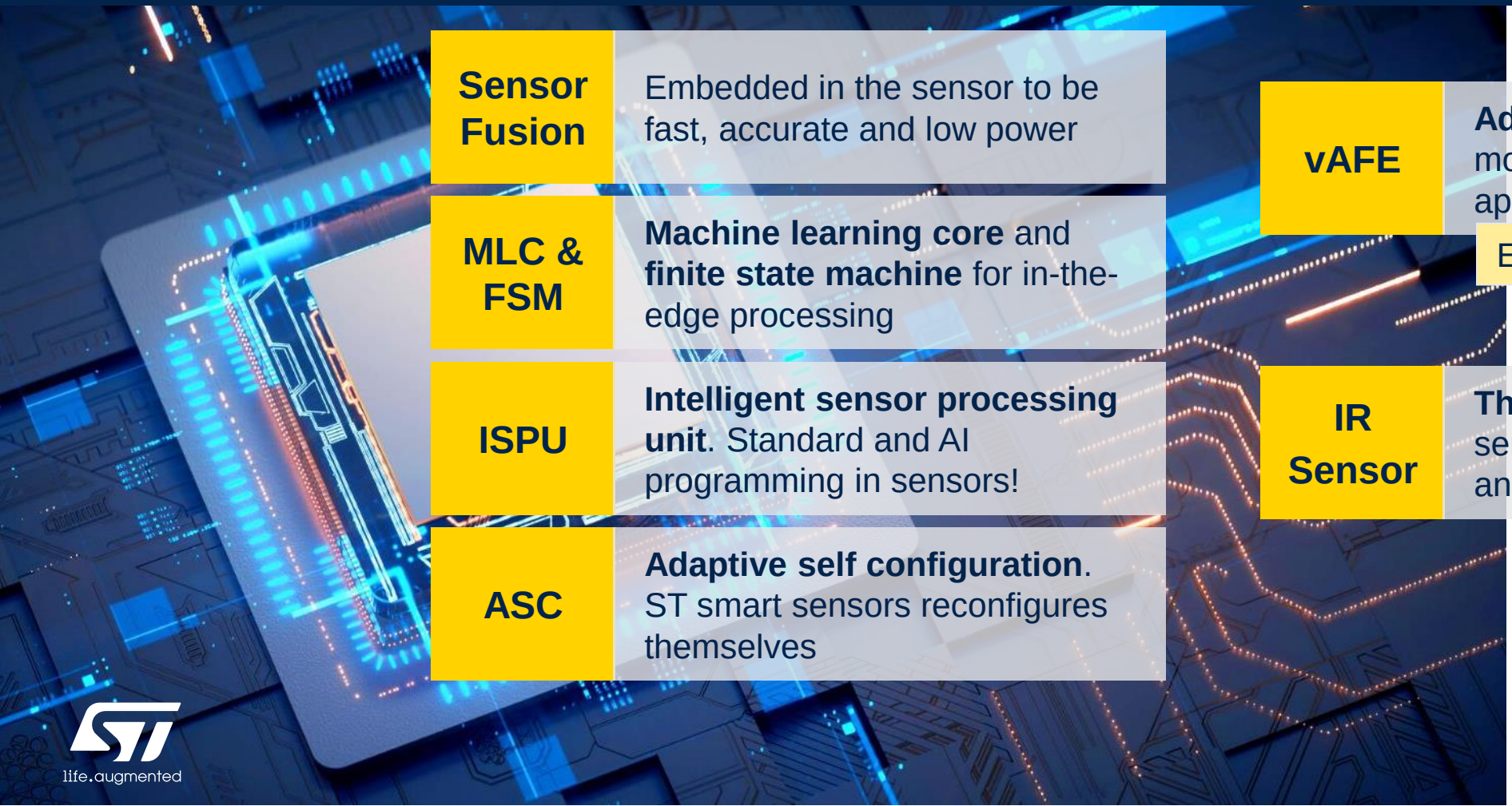
Our enabling technologies

To be the innovation leader, we need the right technologies!

ST PATENT



Sensor Fusion	Embedded in the sensor to be fast, accurate and low power
MLC & FSM	**Machine learning core** and **finite state machine** for in-the-edge processing
ISPU	**Intelligent sensor processing unit**. Standard and AI programming in sensors!
ASC	**Adaptive self configuration**. ST smart sensors reconfigures themselves

vAFE	**Ad-hoc analog front** end with motion detection for specific applications (verticals) ENG ECG Qvar …
IR Sensor	**Thermal MOS**. Innovative sensing of presence detection and biometrics

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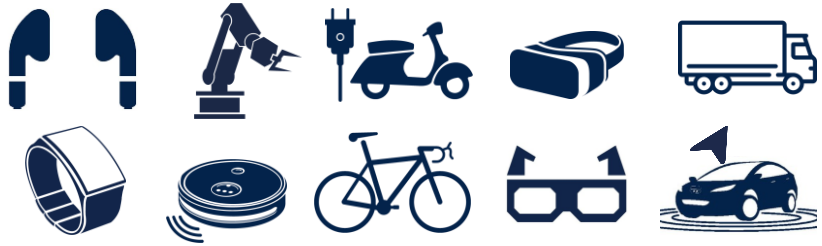
Sensor Fusion



Low power sensor fusion for always-on applications

Plug & play solution for in-the-edge processing

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6x game rotation vector (accelerometer + gyroscope)

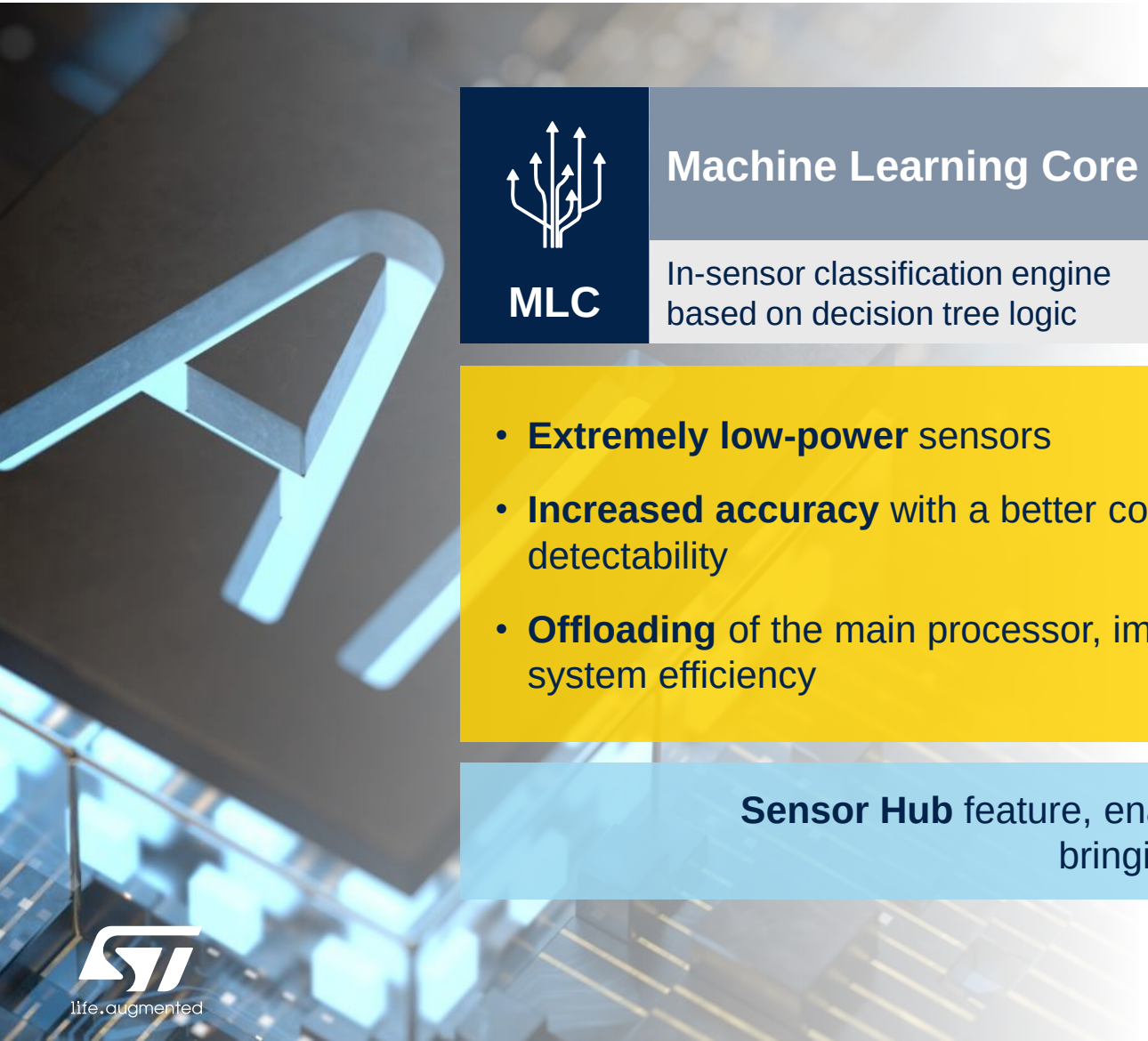
High performance and **high-accuracy**

Ultra-low power operation
50% power reduction vs. external MCU(1) processing

(1) Same Sensor Fusion software library running on STM32L476RG cortex M4 @ 65 uA (120Hz ODR)

MLC ISPU

A unique offering of smart sensors



MLC — Machine Learning Core

In-sensor classification engine
based on decision tree logic

- **Extremely low-power** sensors
- **Increased accuracy** with a better context detectability
- **Offloading** of the main processor, improving system efficiency

ISPU — Intelligent Sensor Processing Unit

Highly specialized DSP
for machine learning and processing

- **Ultra-low power** consumption at **system level**, thanks to **optimized data transfer**
- High-processing capability with **AI-enabled programmable core**
- Comprehensive **ecosystem**

Sensor Hub feature, enabling connection of external standard sensors,
bringing **intelligence at the egde**

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MLC ISPU

Moving the Intelligence in the Edge

“**ON** the Edge”

Sensor + MCU

Microcontroller

MCU standalone or hosted in the sensor package

Standard
MCU runs the algorithms

Runs any kind of SW
provided it matches the MCU specs

“**IN** the Edge”

MLC

reconfigurable Processing Unit (rPU)

rPU integrated in the sensor ASIC

Optimized
reconfigured through register setting

Constrained
runs same model/mapping (MLC, FSM)

ISPU

Intelligent Sensor Processing Unit

ISPU integrated in the sensor ASIC

Programmable
ANSI-C plus AI dedicated instruction set

Runs several AI algorithms
full precision to 1-bit NN

8

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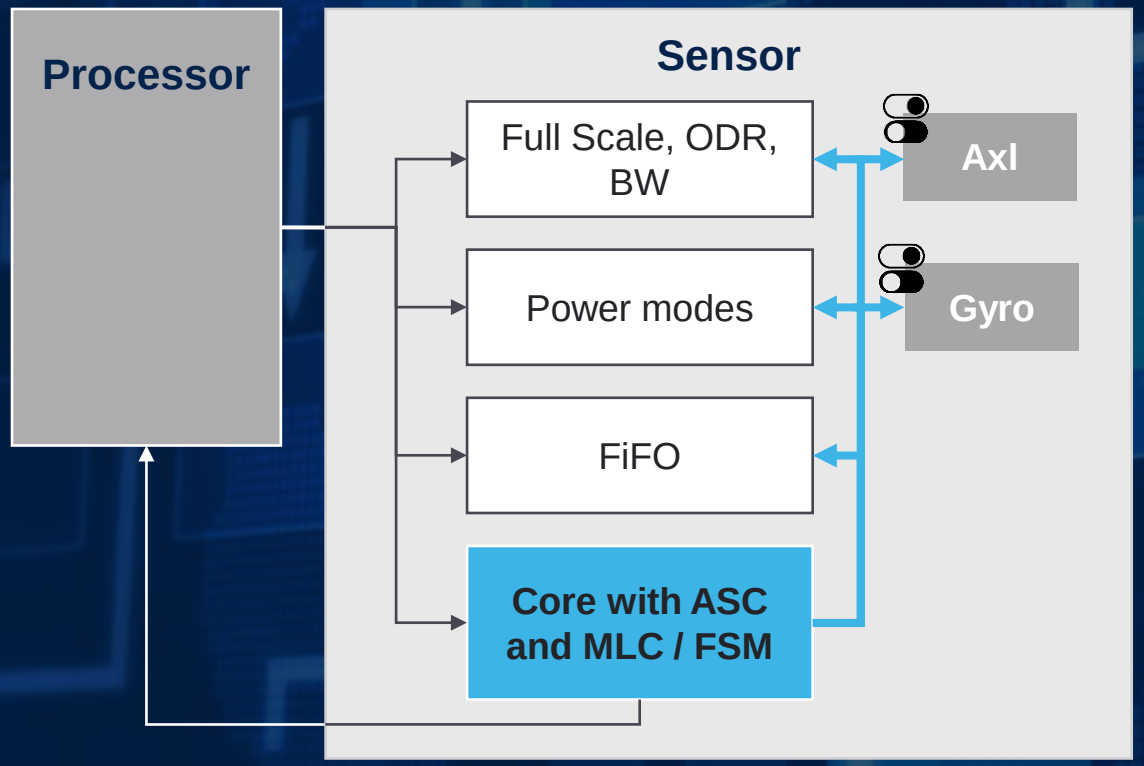
ASC

Adaptive self configuration (ASC)

Flexible and power-efficient sensor settings configuration



The ASC modifies the **sensor settings automatically** based on the **events detected** by the Machine Learning Core or the Finite State machine

No interaction with external processor
→ **No additional current consumption**

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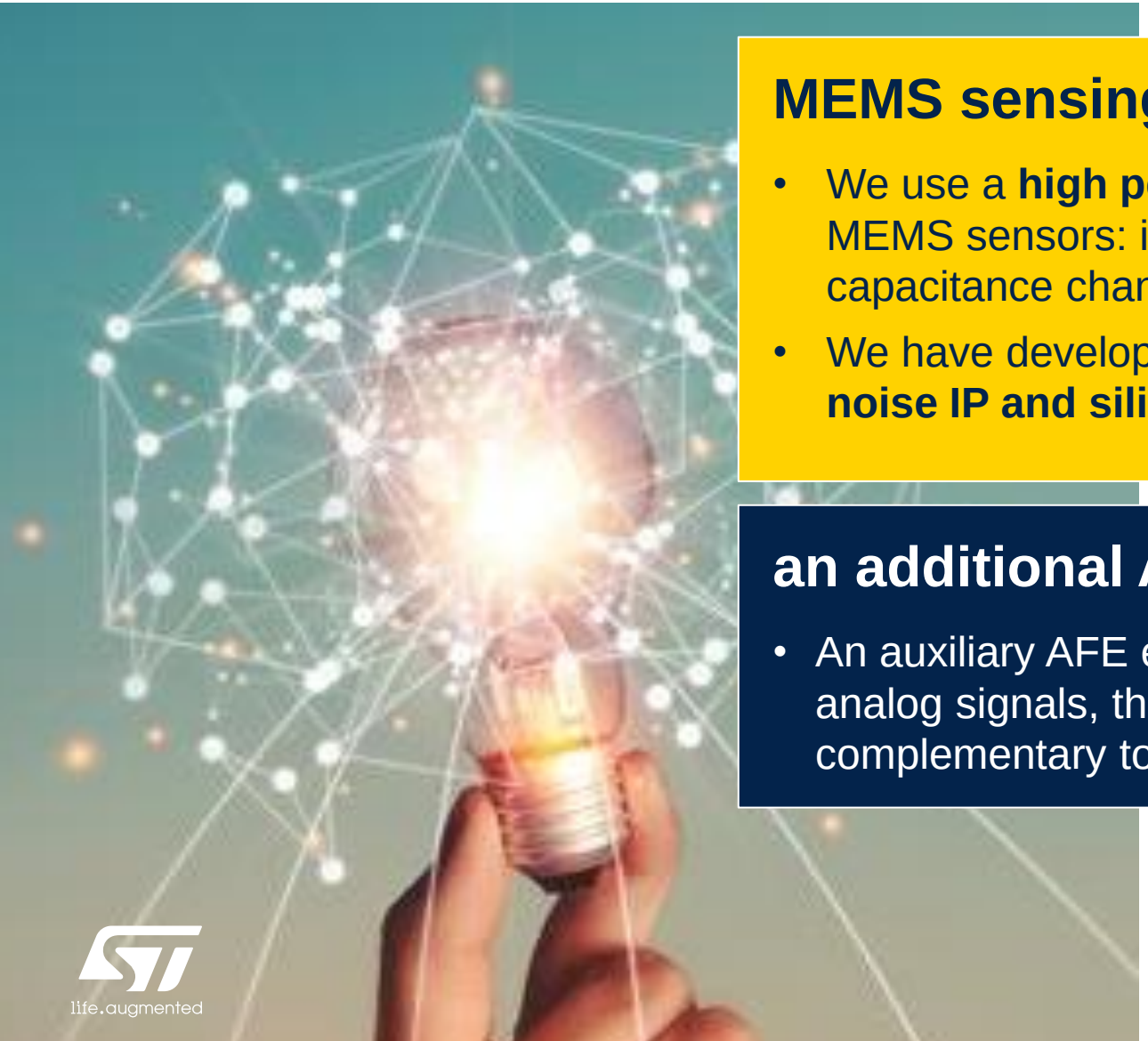
vAFE

vAFE, because the world is analog



MEMS sensing

- We use a **high performance AFE** in MEMS sensors: it reads and converts capacitance change ~ 0.1aF*
- We have developed **specific low noise IP and silicon technologies**

an additional AFE: vAFE

- An auxiliary AFE enables reading of analog signals, that are complementary to motion signal

vertical **AFE**

vAFE and Motion signals are intrinsically **synchronous**.

The result is a unique **context aware analysis** done in-the-edge, thus low power and with the minimum possible latency.

And we do it in standard package dimensions.

* 1aF = 10^{-18}F

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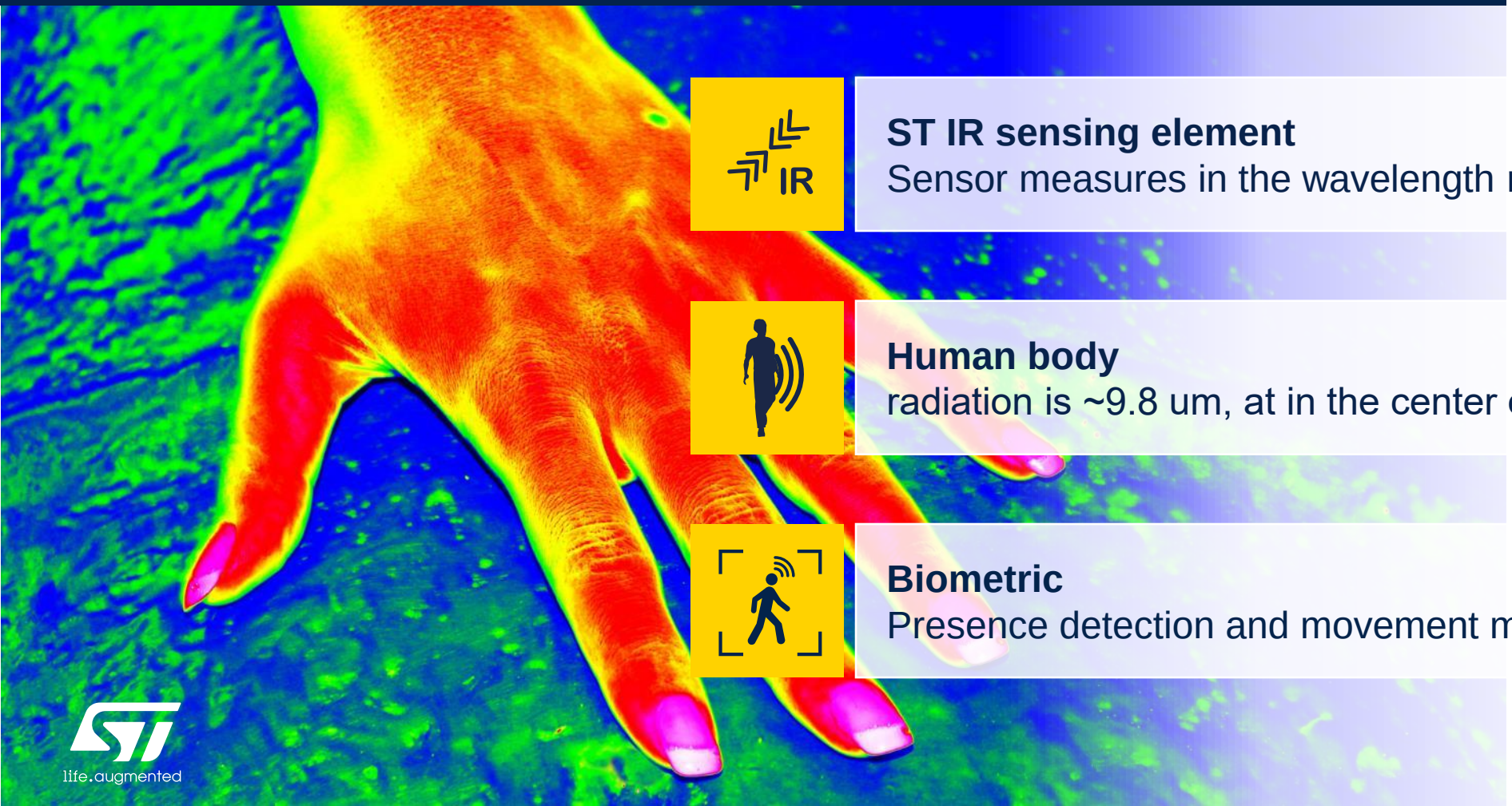
IR Sensor

IR Sensor STHS34PF80 , ready to go

STHS34PF80 IR Sensor based TMOS technology starts in Mass Production



ST IR sensing element
Sensor measures in the wavelength range from 5 to 20 um

Human body
radiation is ~9.8 um, at in the center of the sensor’s range

Biometric
Presence detection and movement measurement

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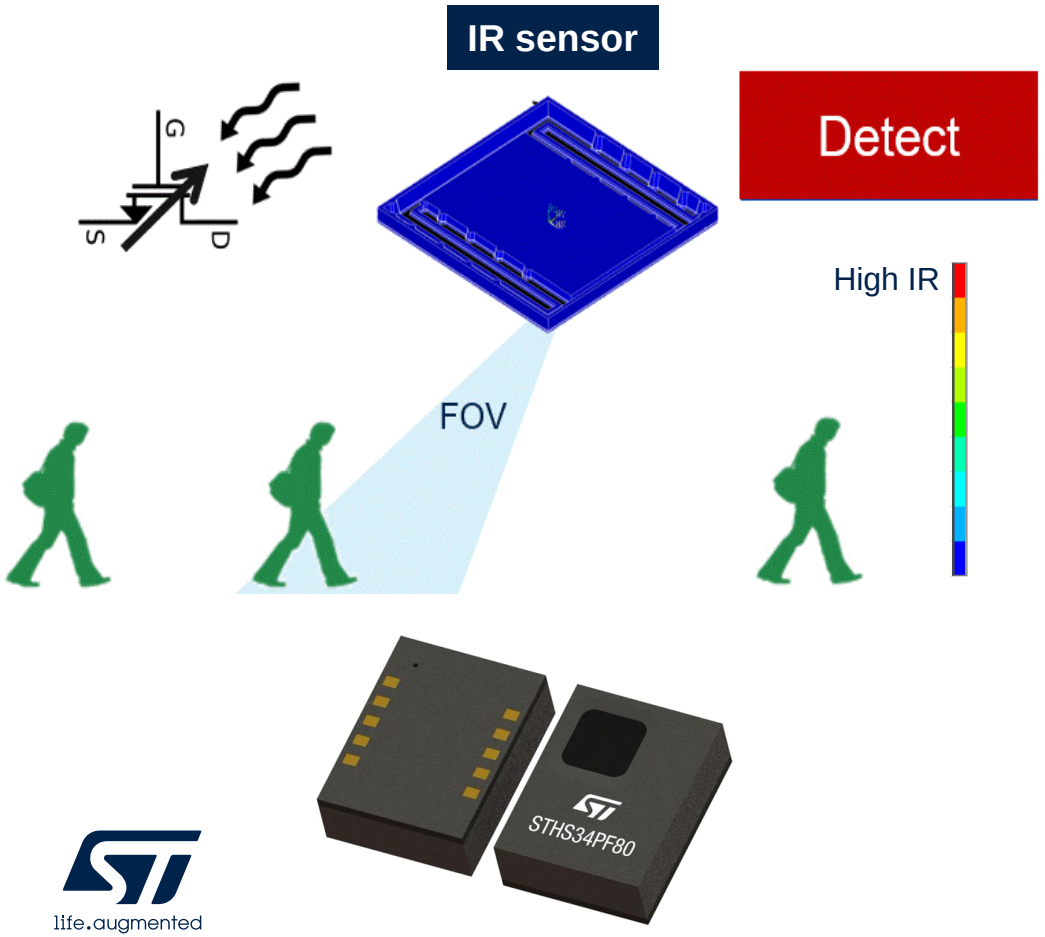
IR Sensor

IR sensor: technology highlights

Superior performance – **presence** and **motion** detection with TMOS technology



Small size & Factory calibrated

80° Field of View (FOV)
4 meters presence / movement detection

On-going designs
Under validation of TMOS from various customers & applications.

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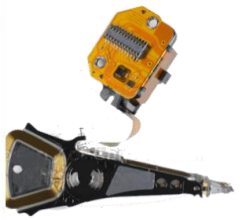
ST Pressure Sensor in Market segment (PE / CE-CP / Industrial)

Personal Electronics — **CE & CP** — **Industrial**

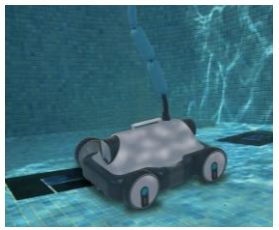











- ✓ Altitude / Vertical Monitoring
- ✓ Activity Monitoring
- ✓ Flow Detection (with 2 x Pressure sensor)
- ✓ Water Depth Monitoring
- ✓ Sealing / Leakage Monitoring

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Pressure Sensor
End Customer Use Cases

High accuracy of pressure is key for vertical position / flow control and water depth monitoring enabled by ST Solution

Barometer

Water Proof Pressure Sensor

Activity Recognition

Vertical context detection
Stair count / Man Fall down
Pose & Fitness monitoring

Mobile Phone
Wearable Watch

Vertical Detection

Altitude monitoring
Indoor vertical position for E911
Ambient pressure monitor

Mobile Phone
Wearable Watch
Wifi 6/7
HDD
Drone
Weather Station

Flow Detection

Puff detection
Air Flow metering

E-Cigarette
Gas metering
Vacuum Cleaner
SMART Filter

Airplane mode detection

Recognize take-off
and landing to set
the radio/GPS signal

Asset Tracking

Water Depth Monitoring

Water Depth monitoring

Wearable Watch
Water Depth meter

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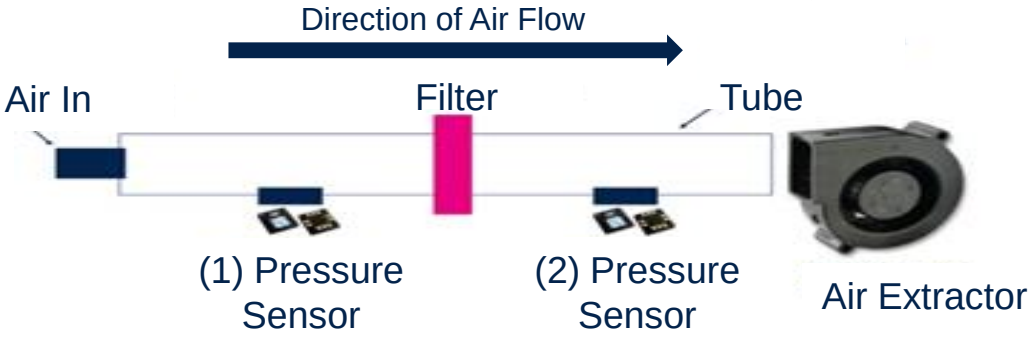
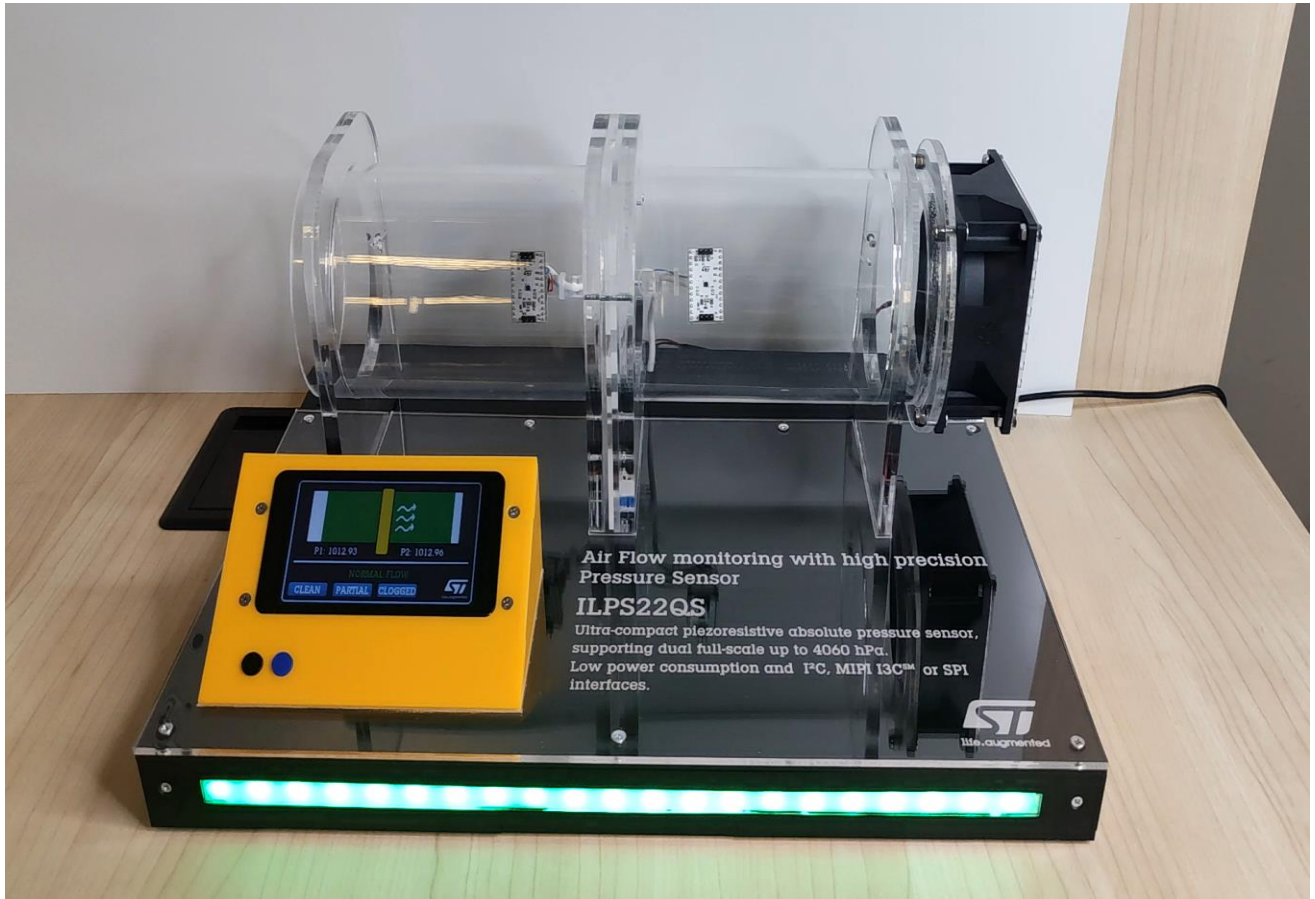
Air flow monitoring demo



Description:

- This demo show a typical application where is needed to monitor the air flow inside a pipe. In the middle of the transparent pipe is located a controlled mechanical shutter to emulate a real filter usage
- The demo is composed of **2x ILPS22QS** high precision absolute pressure sensor located before and after the filter and a commercial fan is used to create the air flow.
- Thanks to the 2 precision absolute sensors it is possible to detect and give feedback in real time about the **filter clogging** or **air input obstruction**.
- A display shows the current status of the tube and its level of clog



Take away

ST MEMS Sensors shipped 22 BILLION

New Generations MEMS Sensors

	Features	Products	Applications
iNEMO® Inertial Module	Embedded **ISPU**	**LSM6DSO16IS** **ISM330IS**	
	MLC, **FSM**, **ASC**, **SFLP**, **Qvar**, **Audio AXL, BC**	**LSM6DSV16X** **ASM330LHH** **LSM6DSV16BX** **ISM330DHCX**	
Accelerometers	ULP, 12b resolution, AAF, 128 samples FIFO ;(i.e. 0.47µA @6Hz ODR) **FSM, MLC**, Pedometer, **Qvar**	**LIS2DU12** **AIS2IH** **LIS2DUX12** **IIS2DLPC** **LIS2DUXS12**	
Pressure Sensors	Water resistant & WP, better accuracy, lower power consumption, Dual FS **Qvar**	**LPS22DF** **LPS28DFW** **ILPS22QS** **ILPS28QSW**	
Presence & Motion detection	**Presence** Detection up to 4 meter 80° Field Of View TMOS sensor	**STHS34PF80**	

FS: Full Scale
FSM: Finite State Machine
ASC: Adaptive Self Configuration
AAF: Anti Aliasing Filter
ISPU: Intelligent Sensor Proc Unit
WP: WaterProof

ULP: Ultra Low Power Mode
MLC: Machine Learning Core
SFLP: Sensor Fusion Low Power
Qvar: Electrostatic Charge Variation
NEAI: Nano Edge AI
TDM: Time Density Modulation

* Available soon

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Thank you

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