
Techday
Taiwan | 2023
OUR TECHNOLOGY STARTS WITH YOU

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Sensing the World - ST sensors journey

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Where you find us

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

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

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

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

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Smart sensors making our world a better place

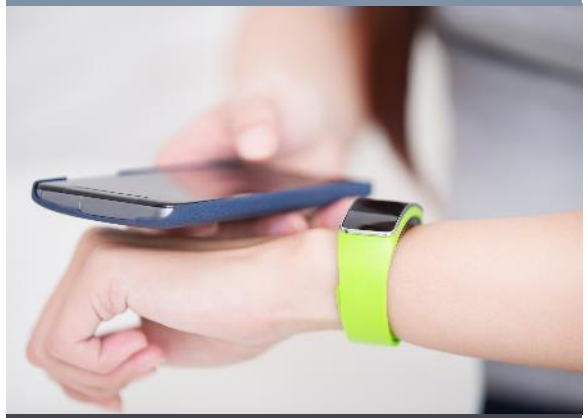
Offline Era

2000

A paradigm change in the man-machine interface

MEMS technology: from a concept to a product.

Online Era



2010

Sensor proliferation and connections to the Cloud

Performance improvement and technology fusion.

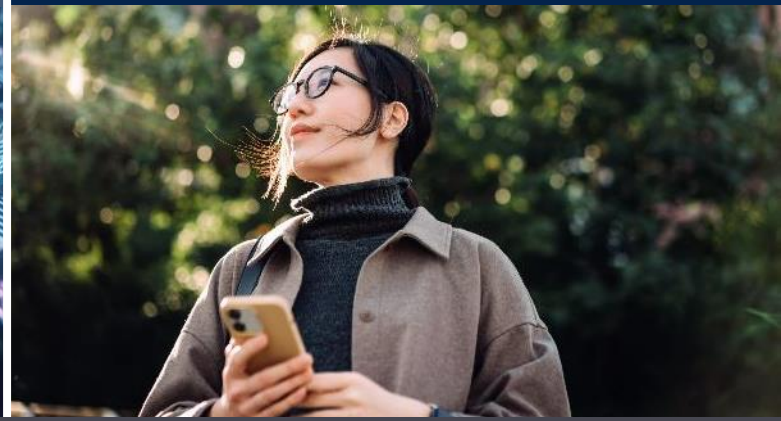
Onlife Era

2020

The fusion of technology and life

MEMS sensors able to sense, process, and act.

Sustainable Onlife



Sustainable sensorization of the world

MEMS sensors sending only the **meaningful data** to the cloud.

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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 to **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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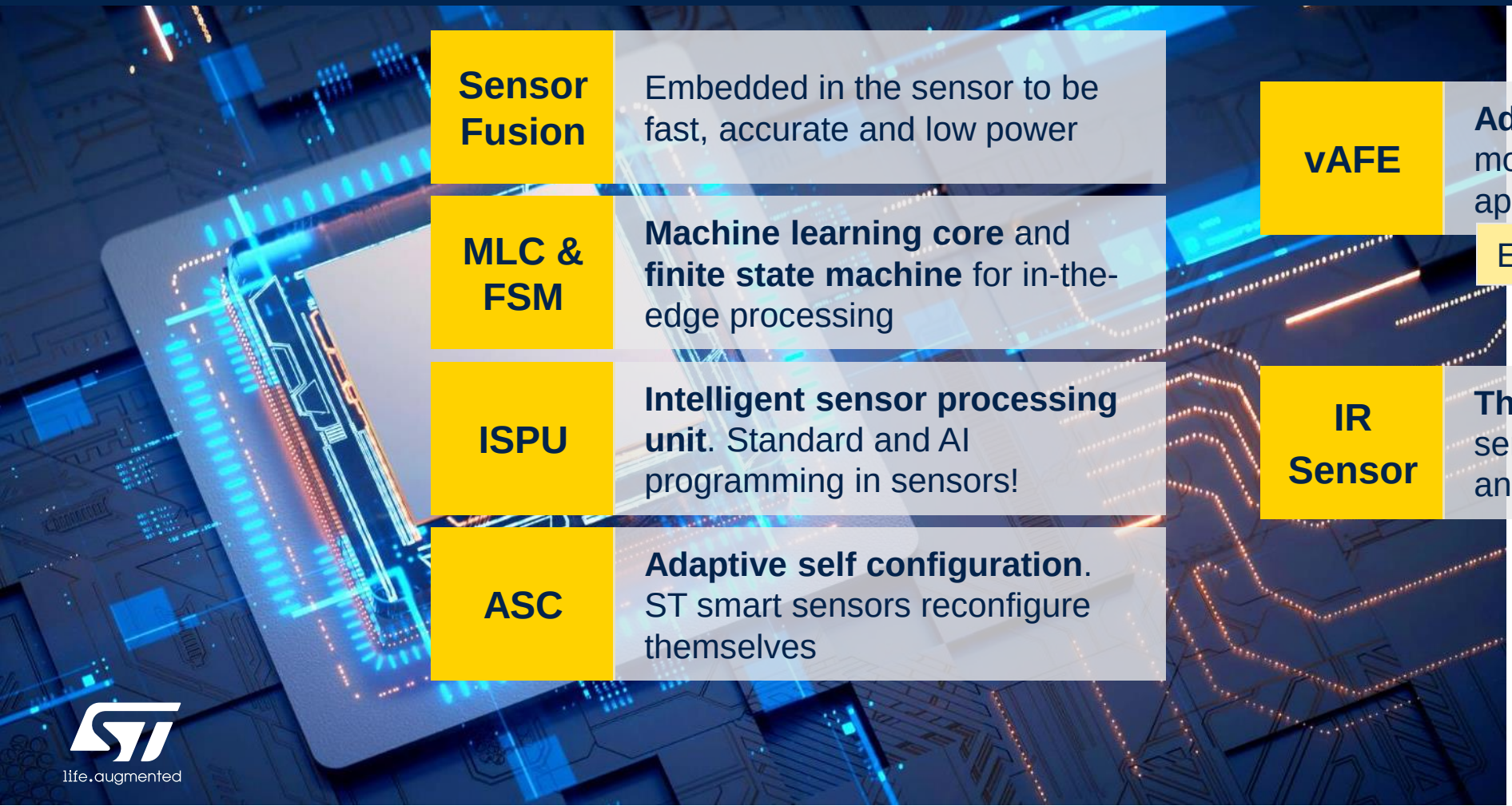
Our enabling technologies

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 reconfigure 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

6x game rotation vector (accelerometer + gyroscope)

High performance and **high-accuracy**

Ultra-low power operation
50% power reduction vs. external MCU(3) processing

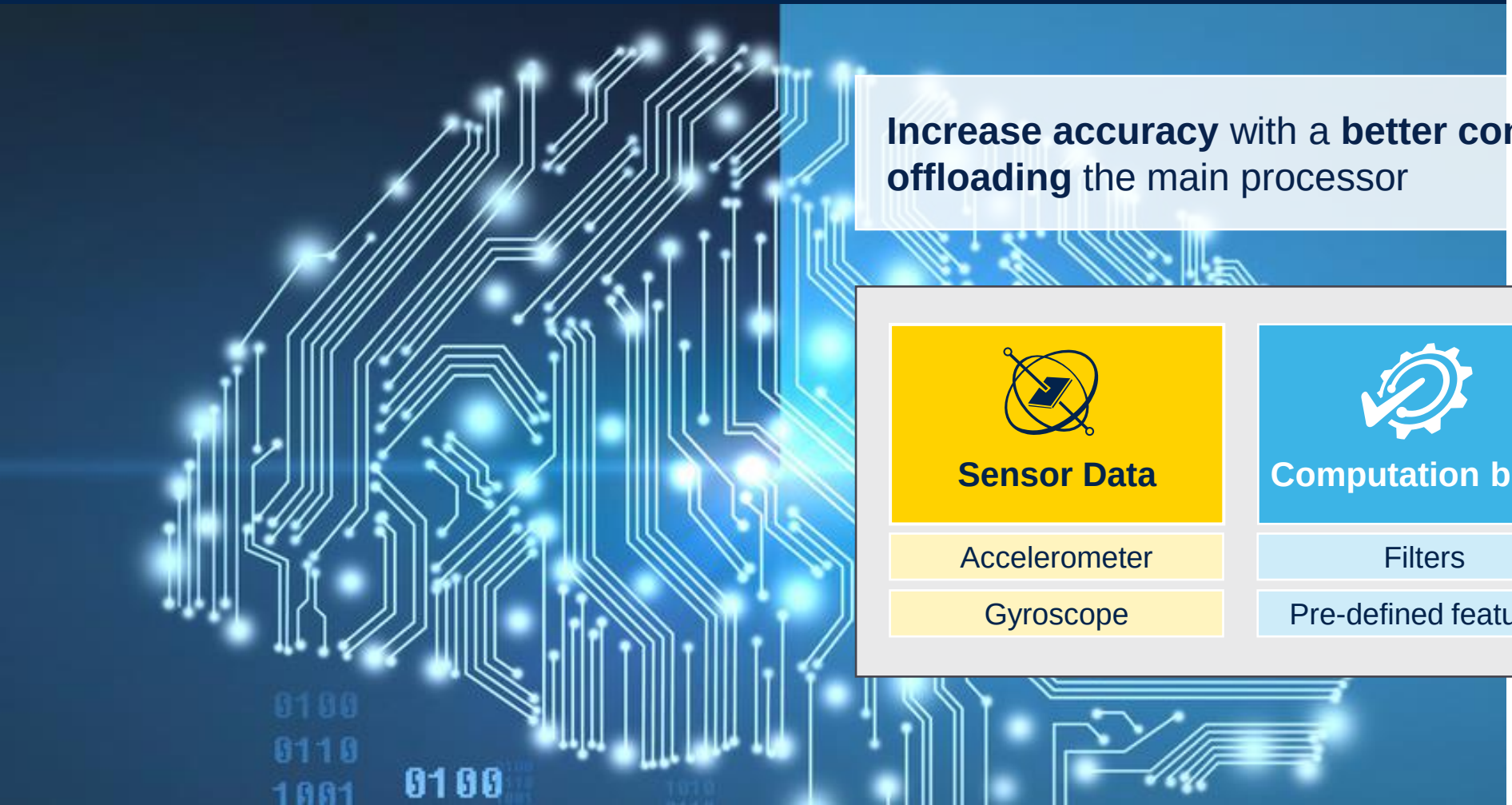
Static accuracy(1): 0.5, 1.5, 1.5 deg
Low dynamic accuracy(1): 0.7, 0.5, 0.5 deg
Calibration time(2):0.8 s
Orientation stabilization time: 0.7 s
Extra power: 30 µA @ 120 MHz

(1) Heading (5min), Pitch and Roll
(2) Time required to reach steady state
(3) Same Sensor Fusion software library running on STM32L476RG cortex M4 @ 65 uA (120Hz ODR)

MLC

Machine learning core (MLC)

MLC is an in-sensor classification engine based on decision tree logic



Increase accuracy with a **better context detectability**, **offloading** the main processor

Sensor Data	Computation block	Decision Tree
Accelerometer	Filters	Meta-classifier
Gyroscope	Pre-defined features	Results

ISPU

Moving the intelligence to 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

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

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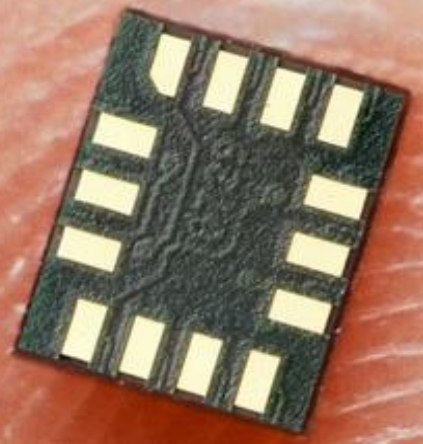
ISPU

Intelligent sensor processing unit (ISPU)

Highly specialized DSP* for machine learning and processing

Super 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

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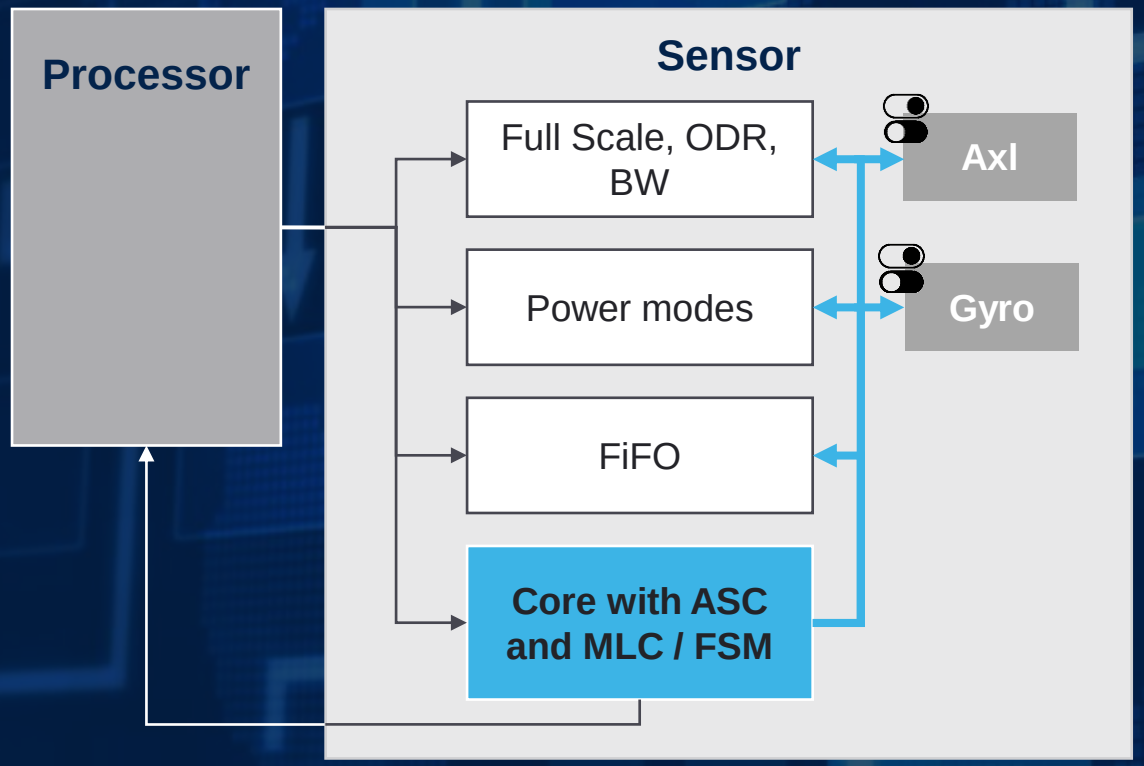
*DSP: Digital Signal Processing

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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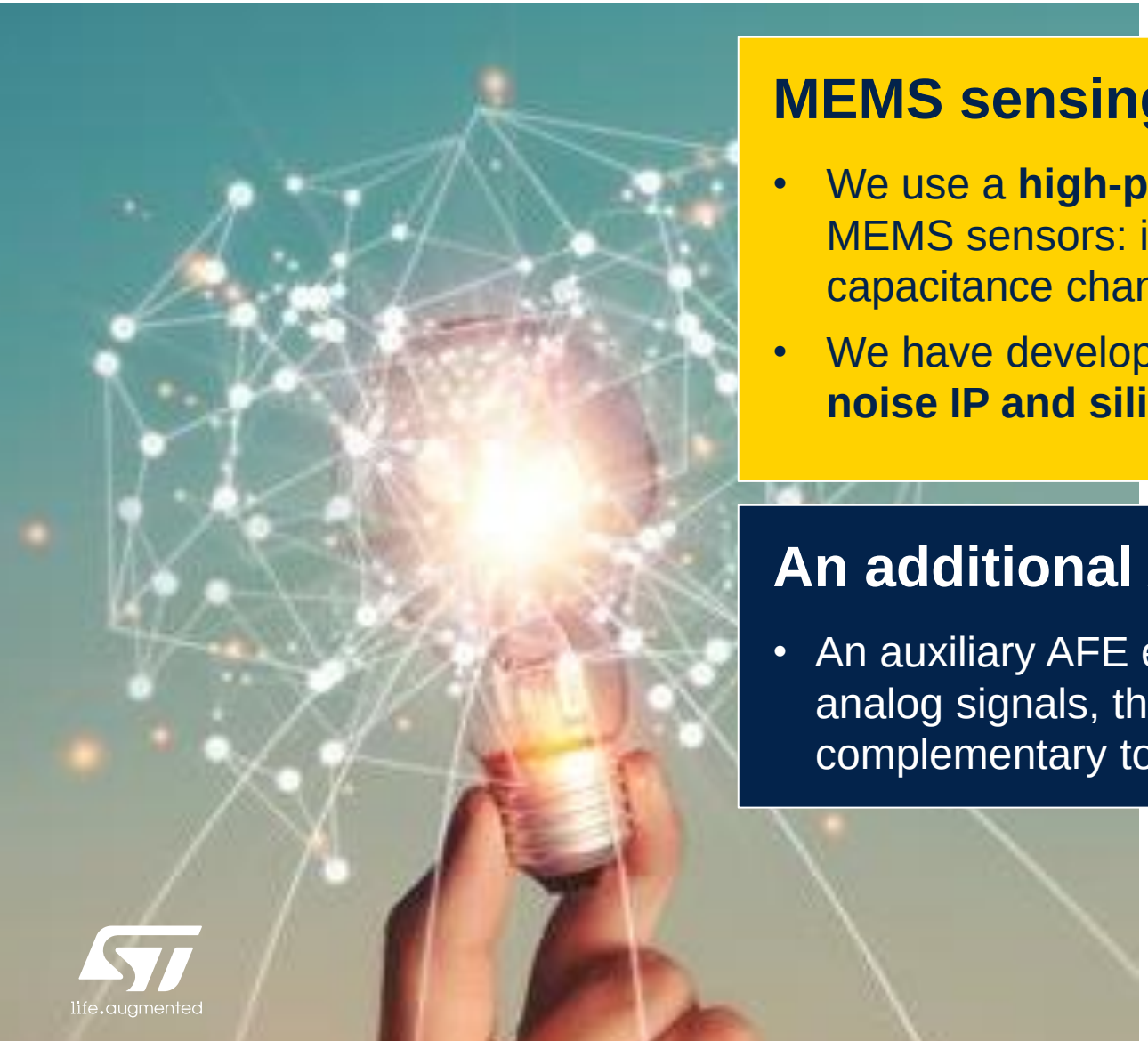
vAFE

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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vAFE

vAFE: Opening new application frontiers

Smartphone & Camera	TWS	Wearable	IoT
Presence detection Activity tracking	In-Ear detection Touch-Multiple Touches Long press	Presence detection Enhanced activity tracking Biometric data	Presence detection Energy Saving

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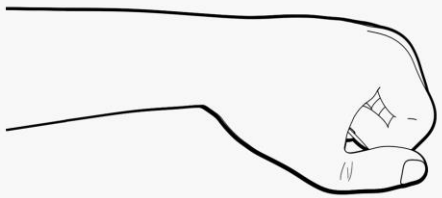
ElectroNeuroGraphy (ENG)

ST sensing development in collaboration with Pison



ENG sensor
Motion sensor

ML Algorithms

Human Intent → **ENG Sensor** → **AI Software**

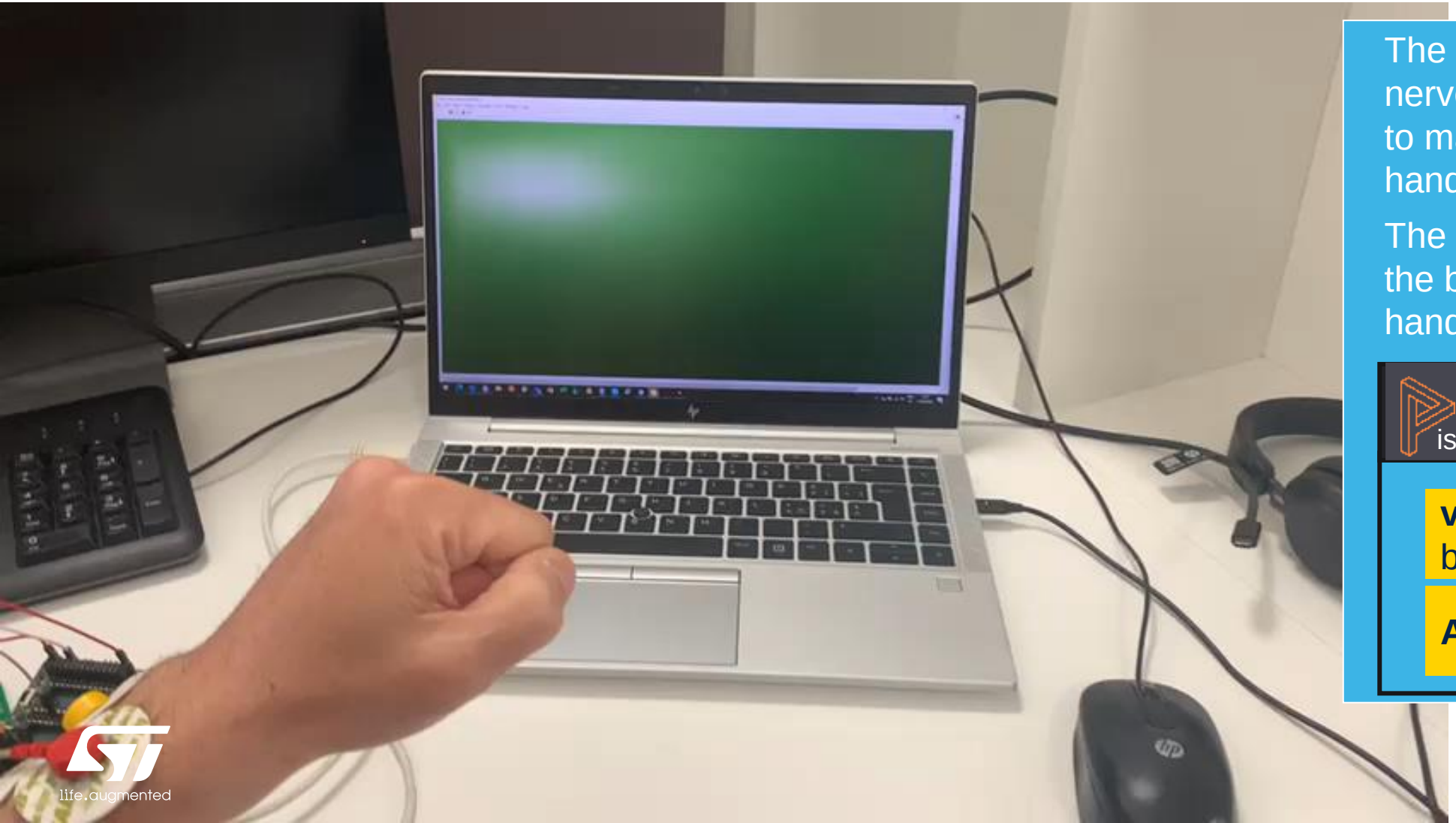
Electroneurography (ENG) derives the intent **30-80ms BEFORE actual movement**

30ms
Negative Latency

Blood Pressure
1.2sec
250ms
Movement Inertia

Natural Gestures
Health
…

ENG to anticipate the movement



The electric signal of the nerves is read and analyzed to map the 27 DoF of the hand.

The signal is present only if the brain sends input to the hand

ison **STENG1** (1st ES)

vAFE for biopotentials

AxI for motion

Smart Ring: the 2023 trend runs ST sensors

Battery constrained solutions require **low power, in-the-edge processing**

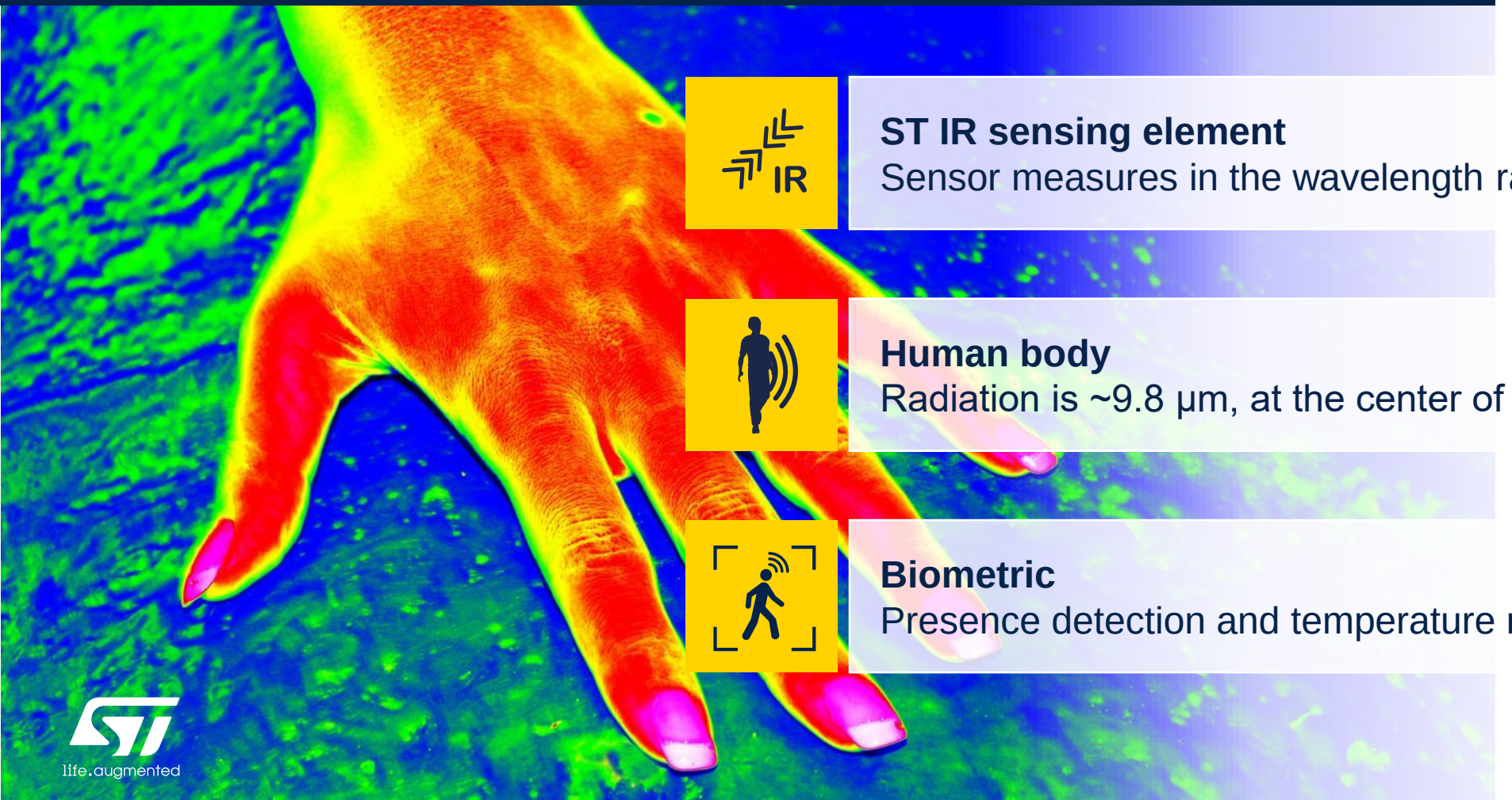
LIS2DUX features single-digit µA power consumption with embedded AI (MLC, FSM, ASC)

LIS2DUXS also features a vAFE
LSM6DSV16X includes a gyro for more functionalities

TMOS

Our IR sensor is ready to go

STHS34PF80 IR sensor based TMOS technology starts finally in mass production, we are ready to go market



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

Human body
Radiation is ~9.8 µm, at the center of the sensor's range

Biometric
Presence detection and temperature measurement

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Consumer
Macro trends and sensor design challenges

Emerging needs coming from market trends and application needs

Mobile	• Accurate motion tracking • Low power consumption • Slim factor & OIS/ EIS
Wearable & TWS	• Smart interface • Edge computing • Context recognition & audio enhancement
XR (AR / VR / MR)	• High stability • High accuracy • Low power
Computer & peripherals	• Context recognition • System efficiency • Presence detection

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Consumer
ST sensors adopted across all macrotrends

Mobile

- Motion tracking
- User interface (I^3C)
- Power optimization
- OIS / EIS
- Context recognition

Wearables

- Activity monitoring
- Gesture recognition
- Power system optimization

TWS

- User interface
- Bone conduction detection for speech enhanced
- Battery saving

AR / VR / MR

- Motion tracking
- User interface
- Navigation

Computer & peripherals

- User interface
- Advanced context recognition
- Battery saving
- Presence detection

A.I. enhancing all applications

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Industrial
Macro trends and sensor design challenges

Emerging needs coming from market trends and application needs

Condition monitoring and predictive maintenance	• Early detection and fast analysis • Sensor to wake-up the system only if requested
Industrial automation	• Accurate and reconfigurable sensors • Sensor reliability
Asset tracking	• Ultra low-power sensor with in-the-edge computation capability
Smart installation	• Smart sensor, accurate and with zero drift

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Industrial
ST sensors longevity program

10-year longevity commitment

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ST focuses on markets requiring long lifecycles

Protecting the investments of our customers which need state-of-the-art sensors but have long development, certification or field life cycles

10-year longevity from product introduction date

Design and manufacturing for higher robustness

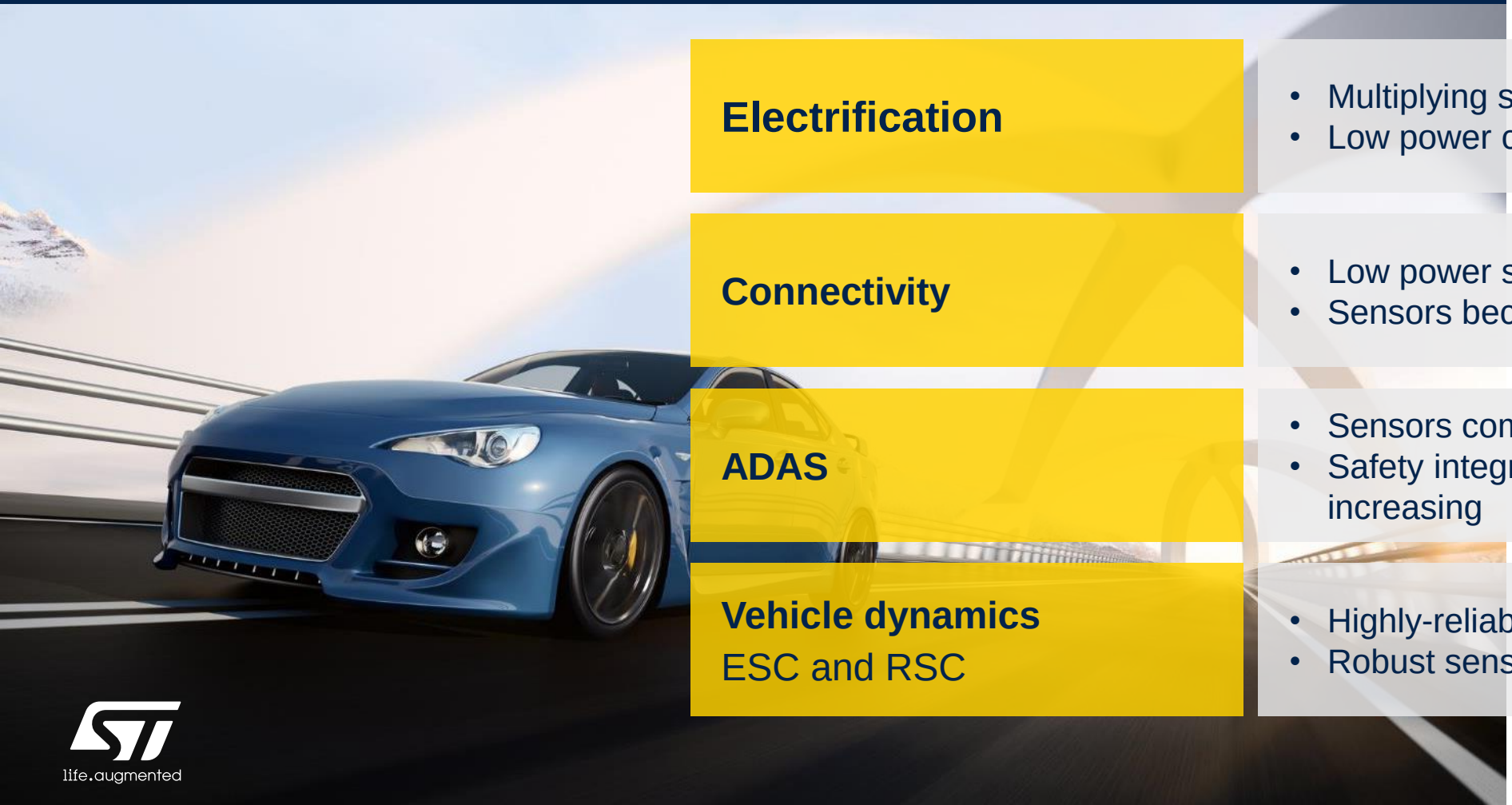
Calibration & testing for higher accuracy & quality

Higher endurance to shock and vibration

Extended temperature range

Automotive
Macro trends and sensor design challenges

Emerging needs coming from market trends and application needs



Electrification	• Multiplying sensors in a car • Low power consumption
Connectivity	• Low power sensors • Sensors becoming smart
ADAS	• Sensors combining stability and accuracy • Safety integrity level (ASIL) keeps increasing
Vehicle dynamics ESC and RSC	• Highly-reliable ASIL certified products • Robust sensors for harsh environment

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Automotive
Sensors adopted across all macrotrends

Electrification

- Motion tracking
- User interface (I^3C)
- Power optimization
- OIS / EIS
- Context recognition

Connectivity

- Activity monitoring
- Gesture recognition
- Power system optimization

ADAS

- User interface
- Bone conduction detection for speech enhanced
- Battery saving

Shared mobility

- Motion tracking
- User interface
- Navigation

Vehicle Dynamics

- ESC (Electronic Stability Control)
- RSC (Roll Stability Control)

A.I. enhancing all applications

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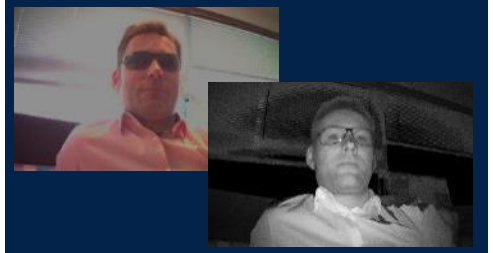
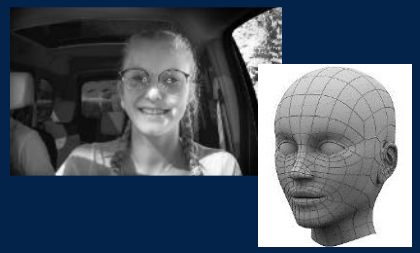
Automotive
Global shutter image sensors for in-cabin monitoring

Innovative and mature technologies derived from consumer & industrial applications, **adapted to the latest automotive needs and legislation**

NIR imaging	RGB NIR imaging	2D & 3D imaging
		
Face analysis to detect potential driver distraction & drowsiness	+ color imaging for extended user experience as well as larger FoV	+ 3D imaging for people and object localization Emerging DUI, VSM

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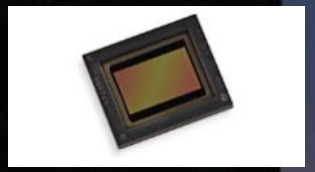
ST optical sensing solutions for consumer, industrial & auto applications

FlightSense™ ToF Time-of-Flight sensors & Global shutter image sensors for multiple applications and use-cases

All-in-one Time-of-Flight modules
Longer ranging, wider field-of-view

Time-of-Flight 3D sensors
Higher resolution, depth-map



Global Shutter image sensors
2.6 µm down to 2.2 µm pixel

Ambient Light Sensors
Small size, low power, flicker detect

Factory automation

Factory management
Conveyor belts
Smart storage
Lighting
Logistics

Access control
Home Appliances
Sanitary
Smart Services & retail Automation

Faucets
Vending machines
Locks
Bins
Lamps
Lockers
Smart home
Parking
Sanitary
Dispensers

Robots

Pet Robots
Service Robots
Home assistants
Air purifiers
Cleaning Robots

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Takeaways

Semiconductors will play a **pivotal role** for a **sustainable** future

ST has a **broad portfolio of innovative products** and keeps investing to fuel innovation

ST **ecosystem:** we work with **our partners** to provide a seamless integration experience

Innovation is in our **DNA**, both for software and hardware

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Our technology starts with You

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