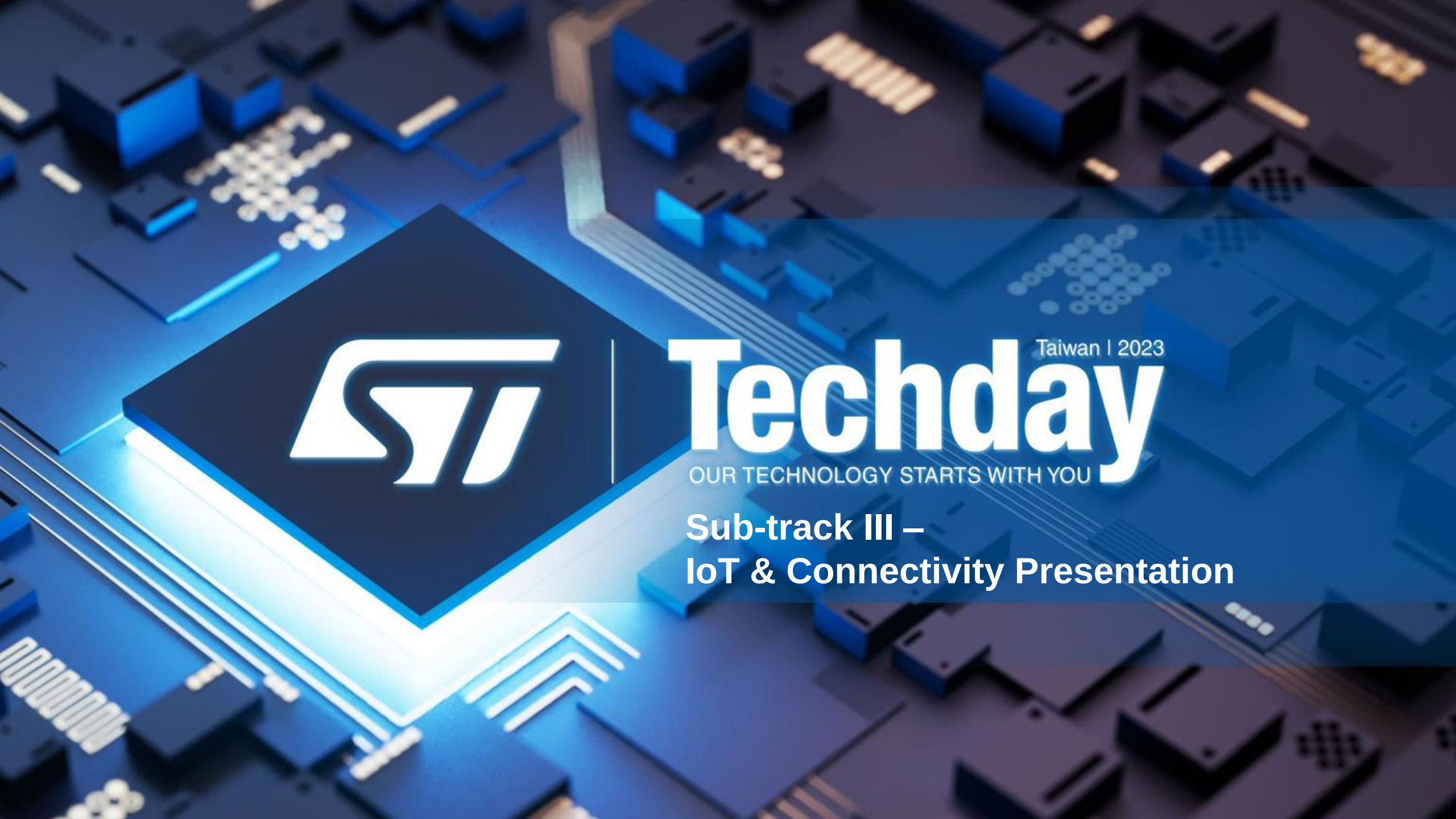

Sub-track III –
IoT & Connectivity Presentation

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ST sensor solution for AR glasses

Johnny YANG

Smartphone Competence Center

STMicroelectronics

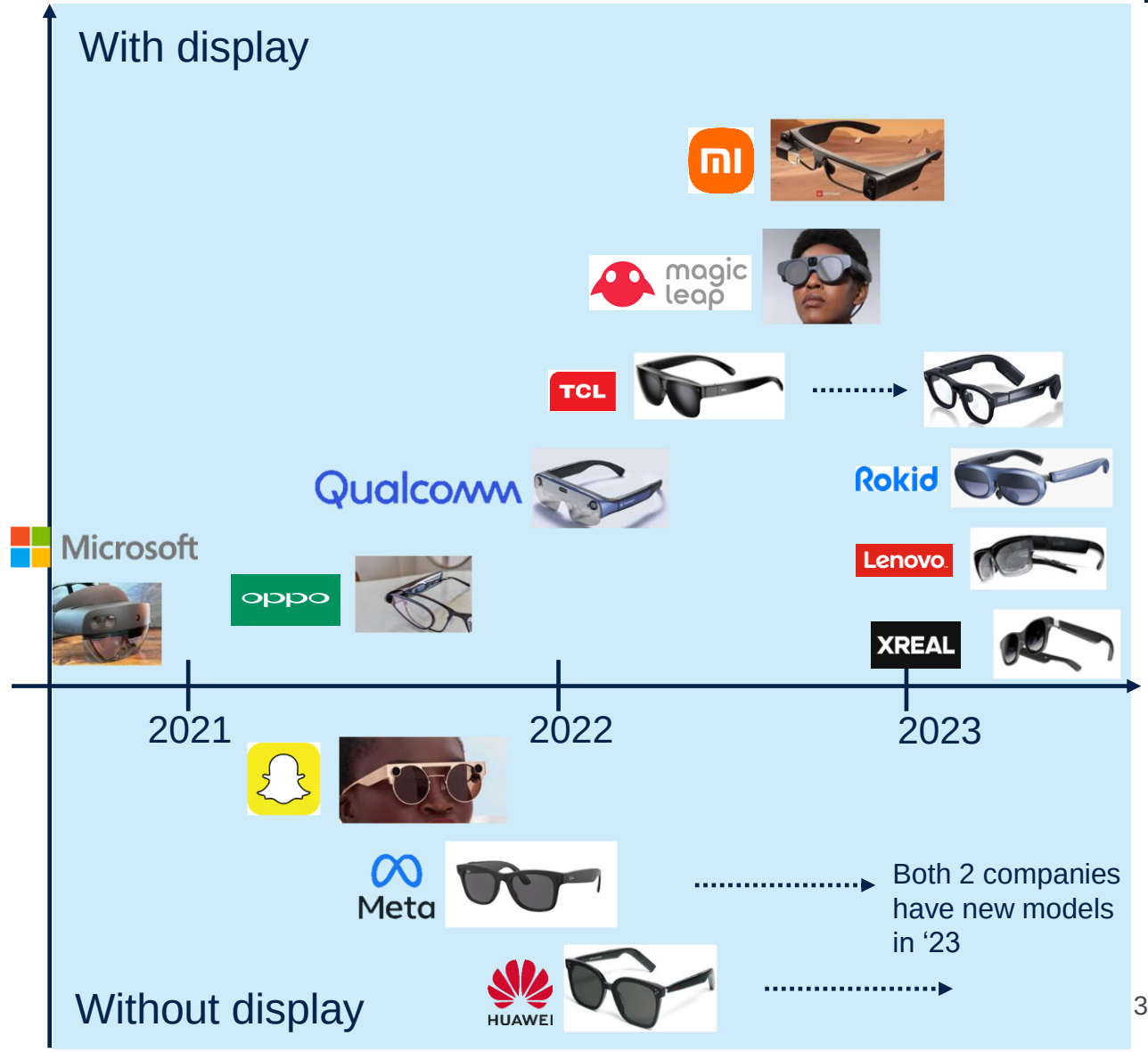
The trend – smartphones and AR glasses

Most of the Big Tech companies are racing to create AR/MR glasses

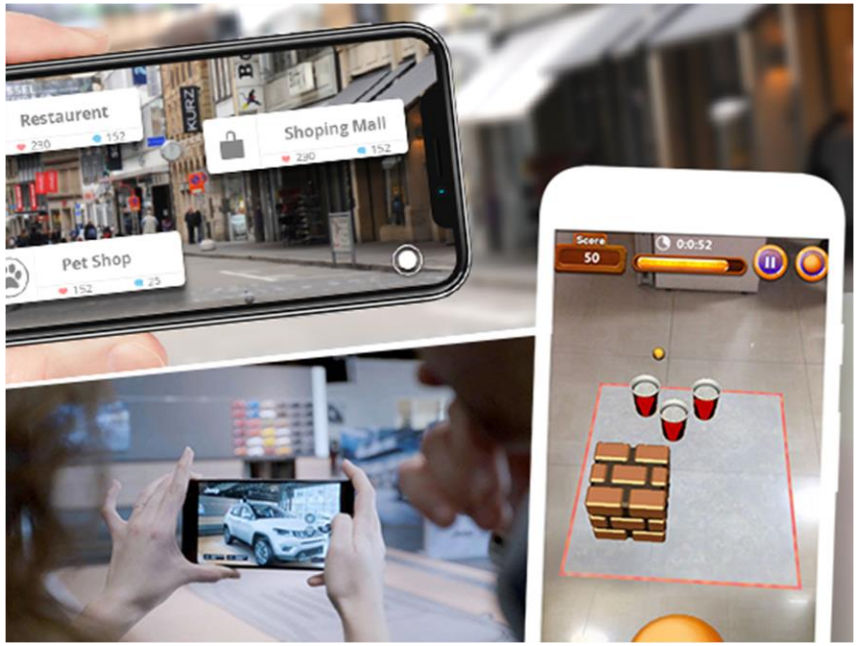
All the smartphone companies are working on some form of smart glasses or headset

Instead of a phone to talk to people or interact with apps, we may do these things simply by speaking to, and looking through, a set of glasses.

There's a race to be the first to make a set of glasses that everyone will wear, which means they have to be fashionable and sleek.



AR glasses enrich the user experience



https://www.juegostudio.com/blog/tech-foresight-augmented-reality

https://www.queppelin.com/ar-glasses-for-navigation/

From “**phone**” to “**glass**”, enlarging the screen to be more immersive!

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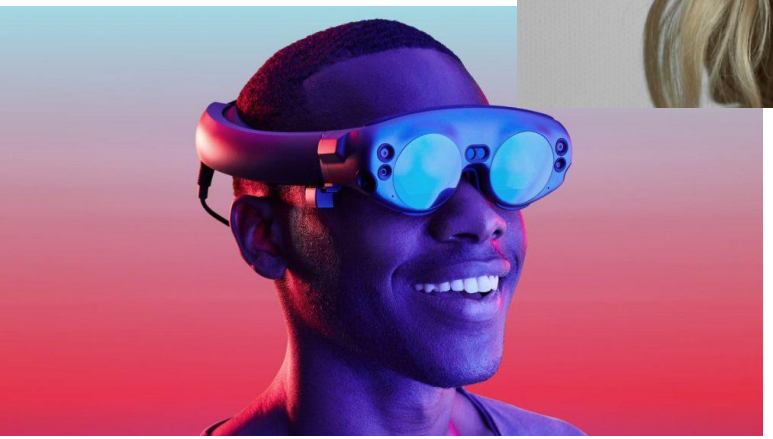
Which glasses would you wear… everyday?



Target	Key factors/enablers
All-Day-Wear	***Lightweight (<60gr)***
All-Day-Wear	Small form factor
Long life battery	***Low Power (<1W)***
Display quality image	***High brightness*** for outdoor use
User friendly	***Advanced UI controls*** (Gesture, voice)
Environment sensing	Cameras + Depth sensing sensor
Easy communication	Wireless communication
Easy charging	Quick wireless charging

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What functions are essential for AR glasses?

HD display & large FOV

Wireless connection

Wireless charging

Gesture control

Audio and Voice control

Image capture

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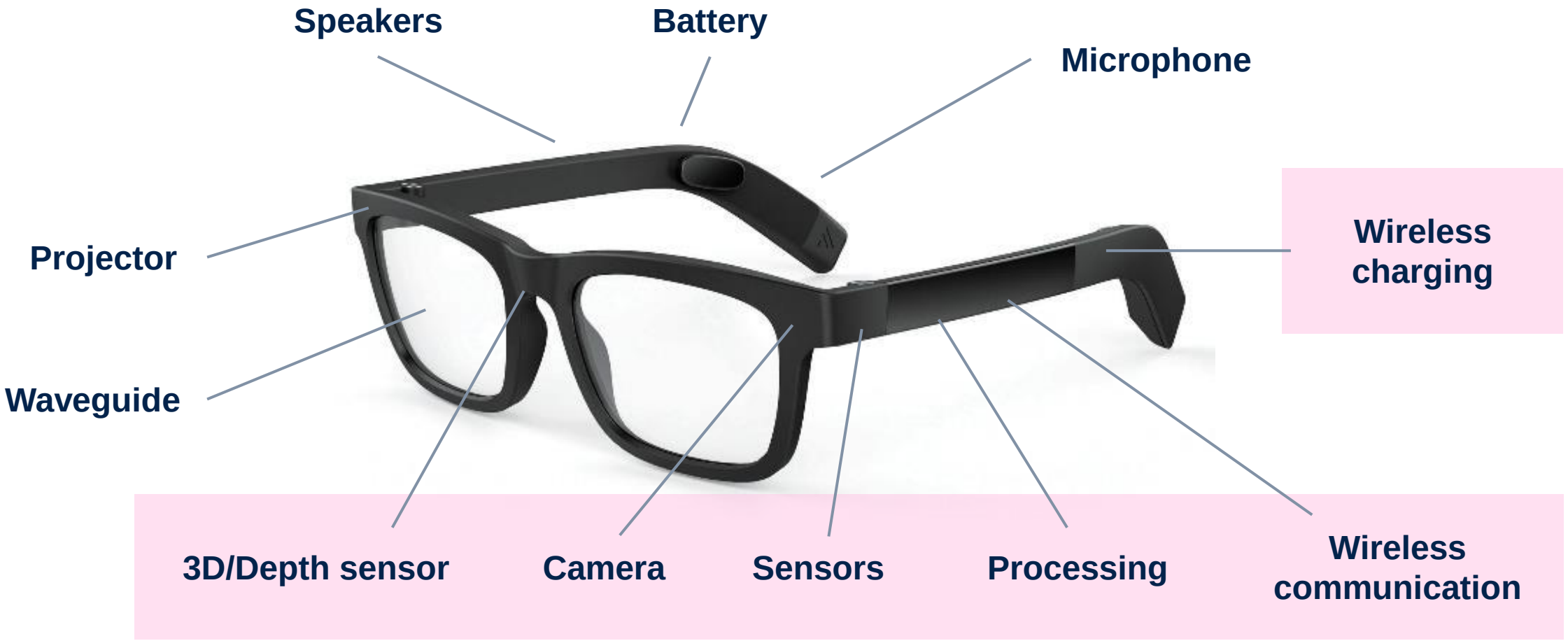
What’s inside the AR glasses?



ST already has much corresponded products for these functions!

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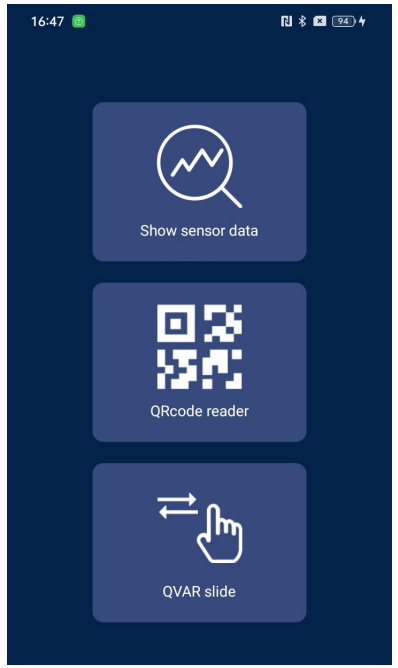
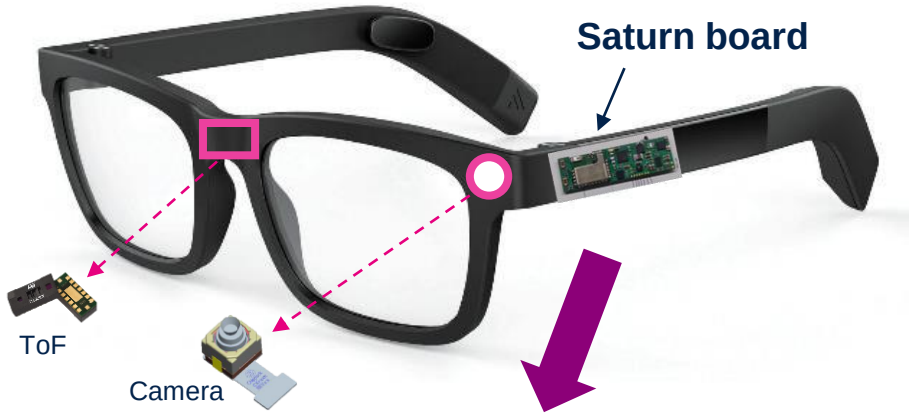
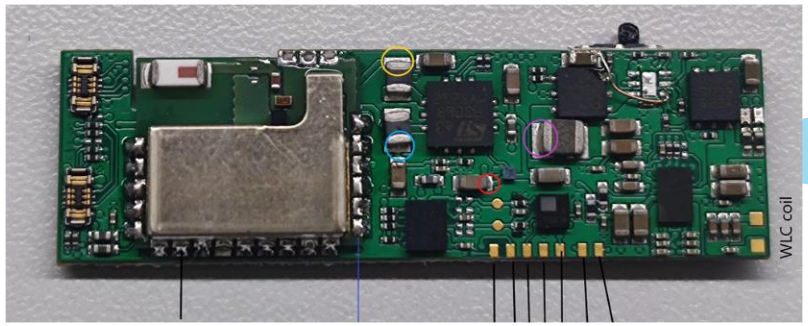
Our sensor solution for AR glasses

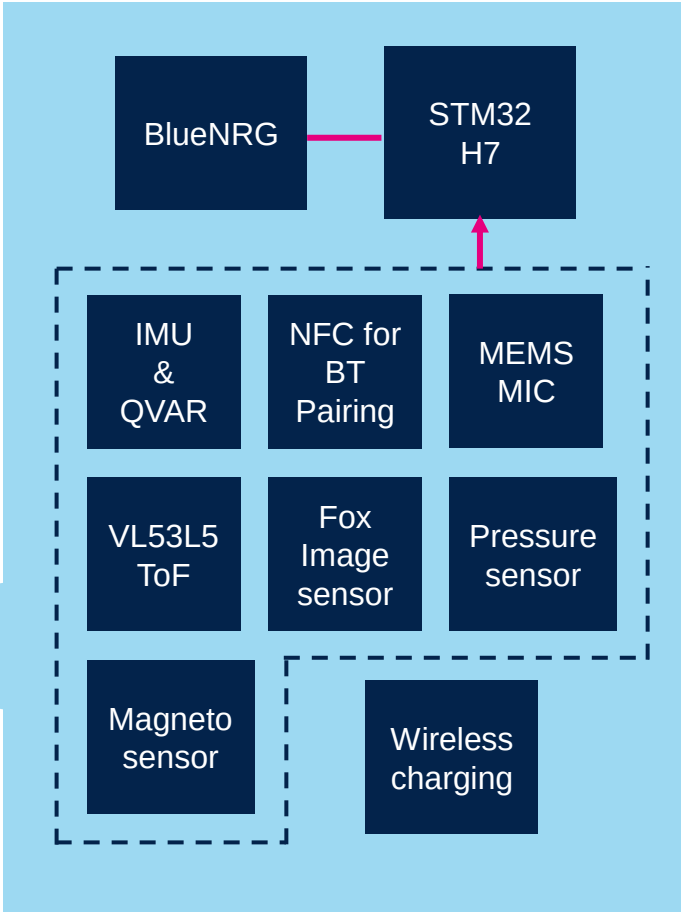


ST demo app





Full ST solution portfolio for Smart Glasses
in such tiny PCB size 43.3 *13.3*3.2mm



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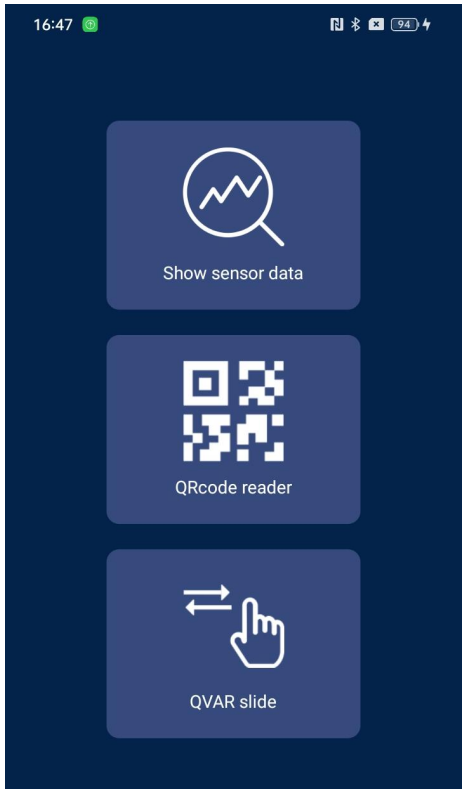
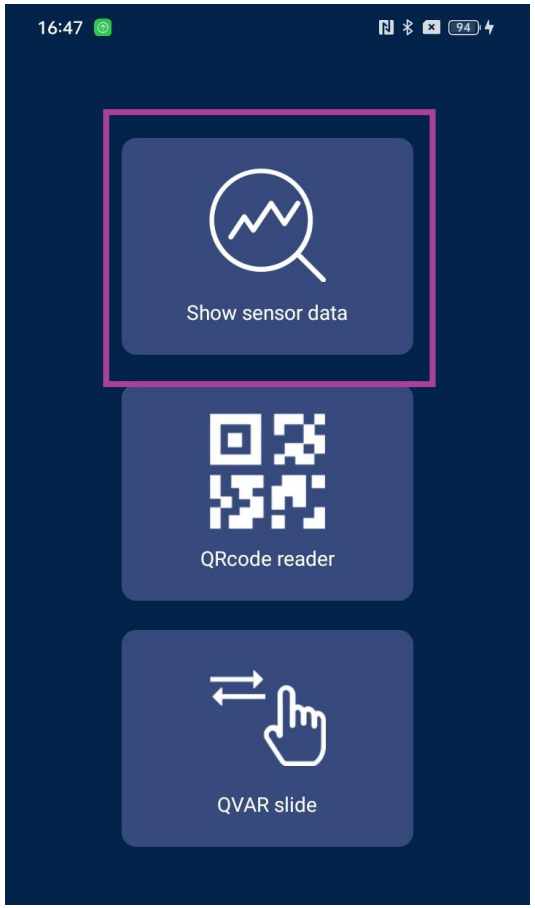
Functionality #1: BLE pairing

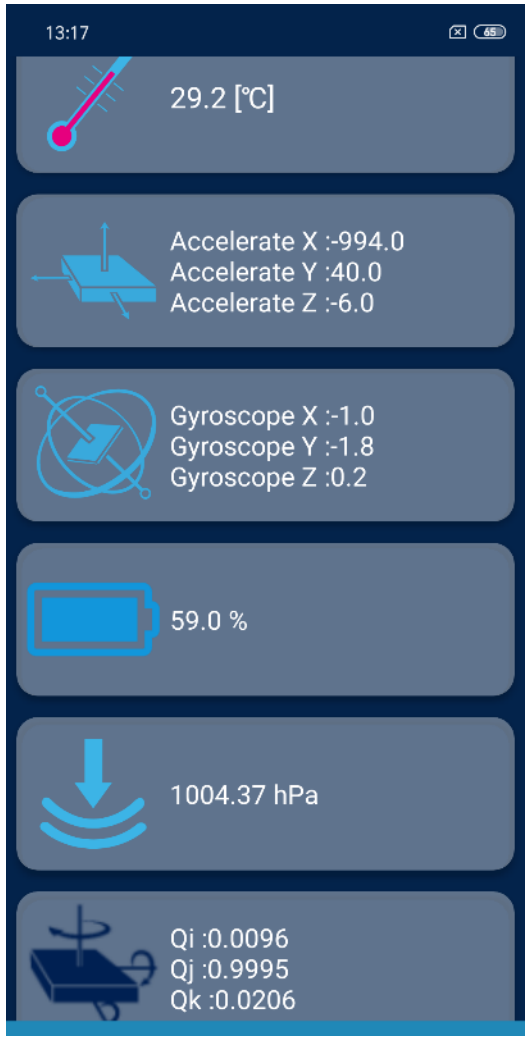
ST25D NFC tag



BLE pairing can be authorized automatically to enter Demo app

Functionality #2: sensor data synchronized by BLE





Visualization of data from ***multiple sensors*** present on board in the app:

- Acceleration & angular rate
- Pressure
- Temperature
- Quaternion
- Battery level
- Magnetic field

Main sensor part number:

- LSM6DSV16BX
- ILPS22QS
- LIS2MDL
- STWLC38

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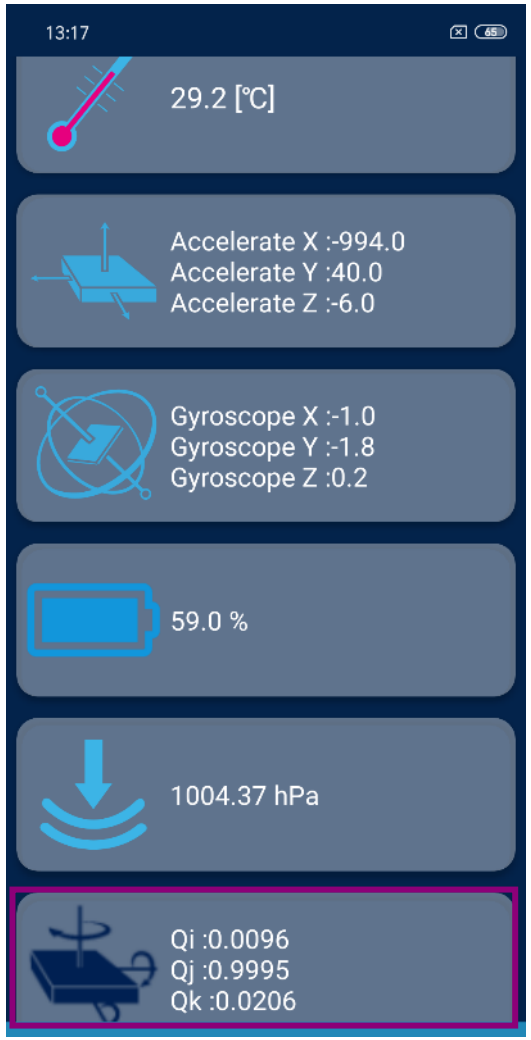
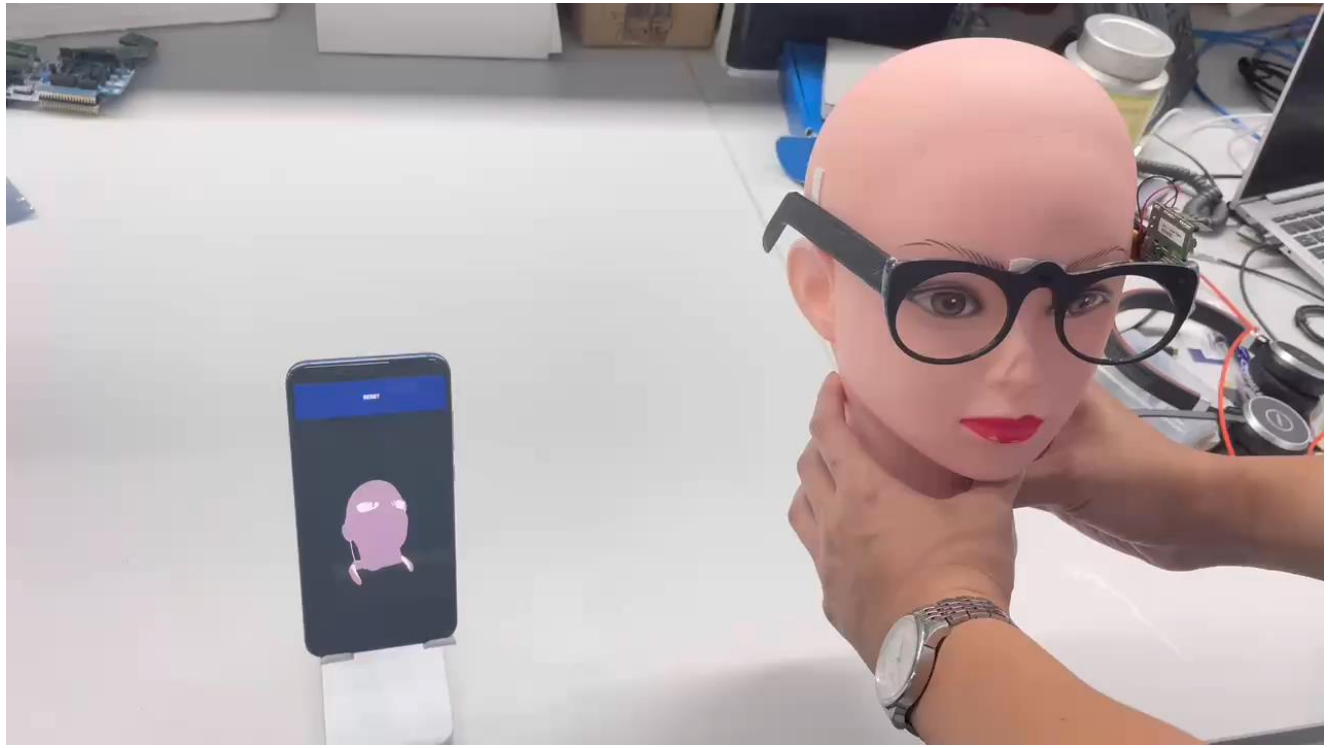
IMU quaternion demonstration





Head movement tracking by LSM6DSV16BX

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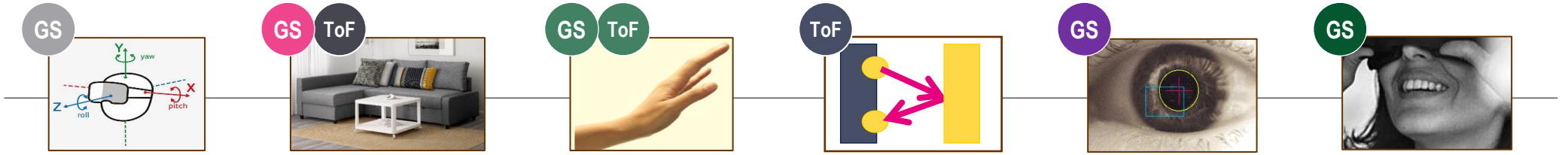
Global shutters – AR / MR glasses

Product – VD55G0, VD55G1, VD56G3, VL53L4CD, VL53L8CX



6DoF
Head positioning

Room mapping & SLAM
See-through
Scene analysis

Gesture

Proximity
Touch control

Eye-tracking

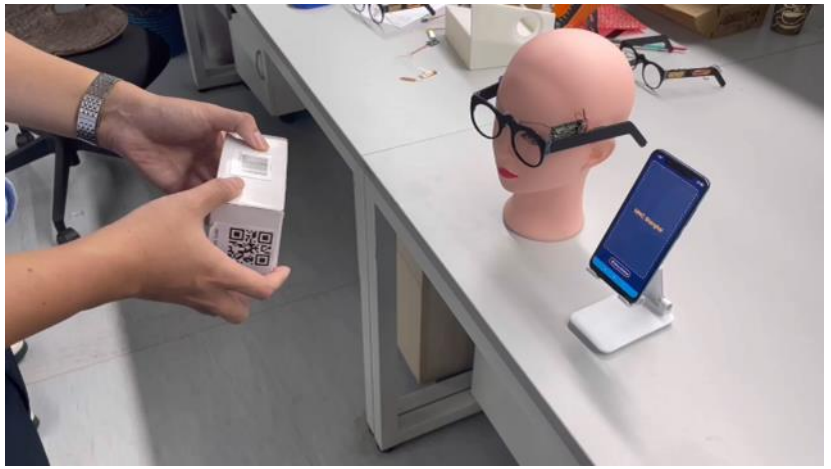
Mouth, Chin & Cheek

Augmented Reality

Mixed Reality

GS: 2D Image Sensor
ToF: Depth Sensor (Time-of-Flight)

Functionality #3: QR code reader



QR code reader supported by sensor

Qvar - Introduction and working principle

Sensing electrostatic charge variation

Qvar stands for:
Electric charge (**Q**) variation (**var**)

Qvar senses variations in the electrical fields in proximity or contact of the product via electrodes

Electrodes on body (In contact with human skin)	**Electrodes in proximity** (Radar function)
Improved activity detection	Presence sensing

Adding functionality of an existing sensor

Pressure

QVAR™ engine

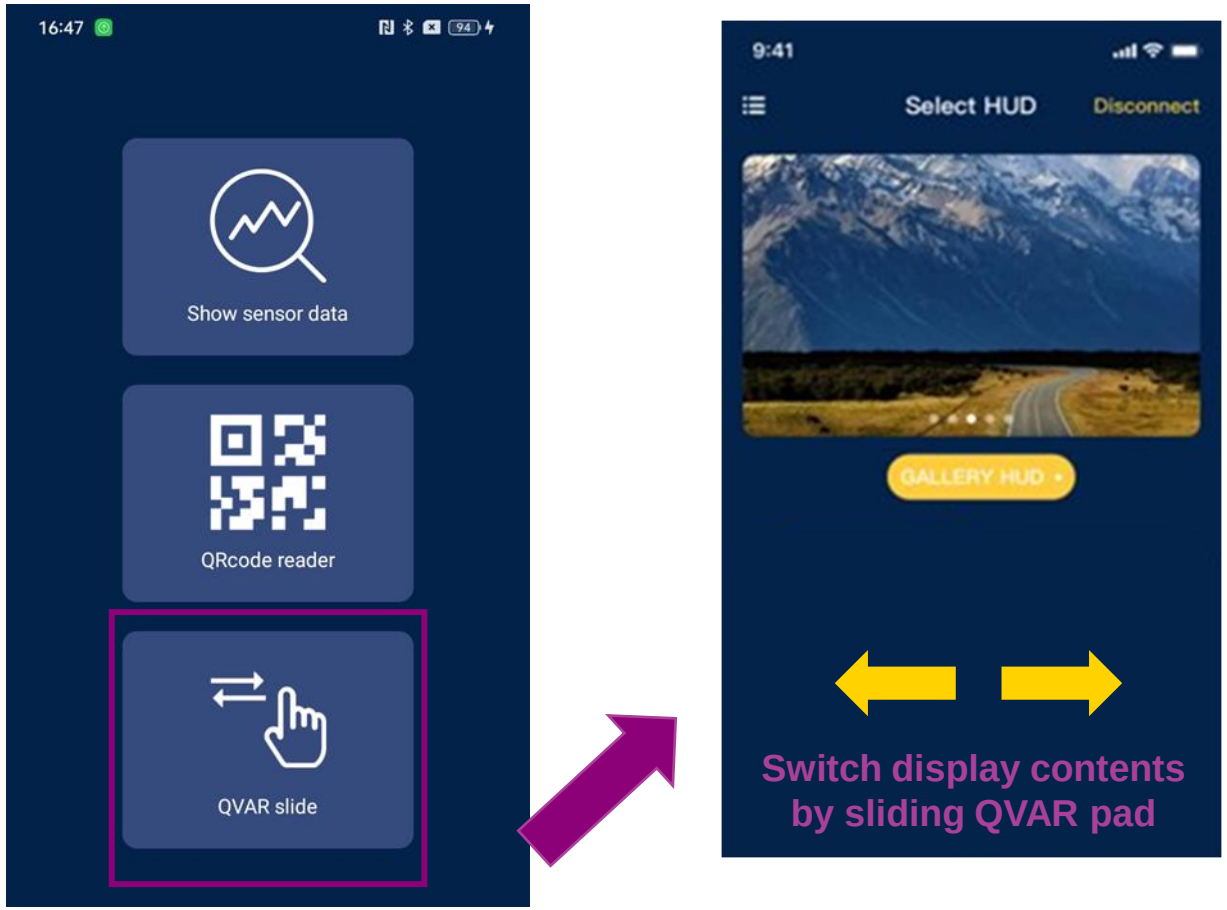
ILPS22QS/ILPS28QSW

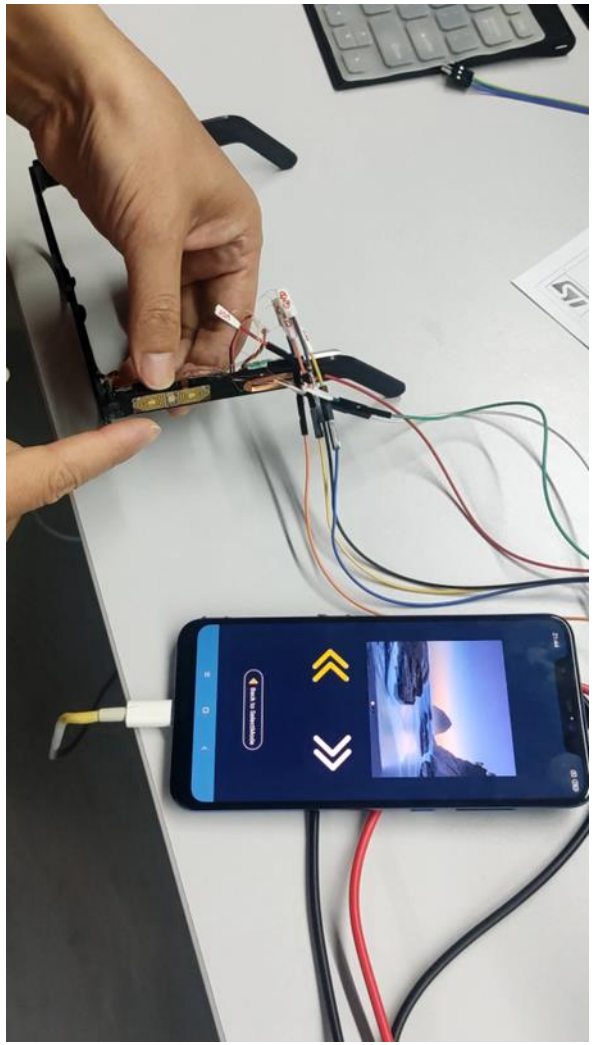
6x IMU
3x Accel

QVAR™ engine

LIS2DUXS12
LSM6DSV16X/BX

Functionality #4: Qvar finger slide controller





Content switch supported by Qvar

Our technology starts with You

Find out more at www.st.com

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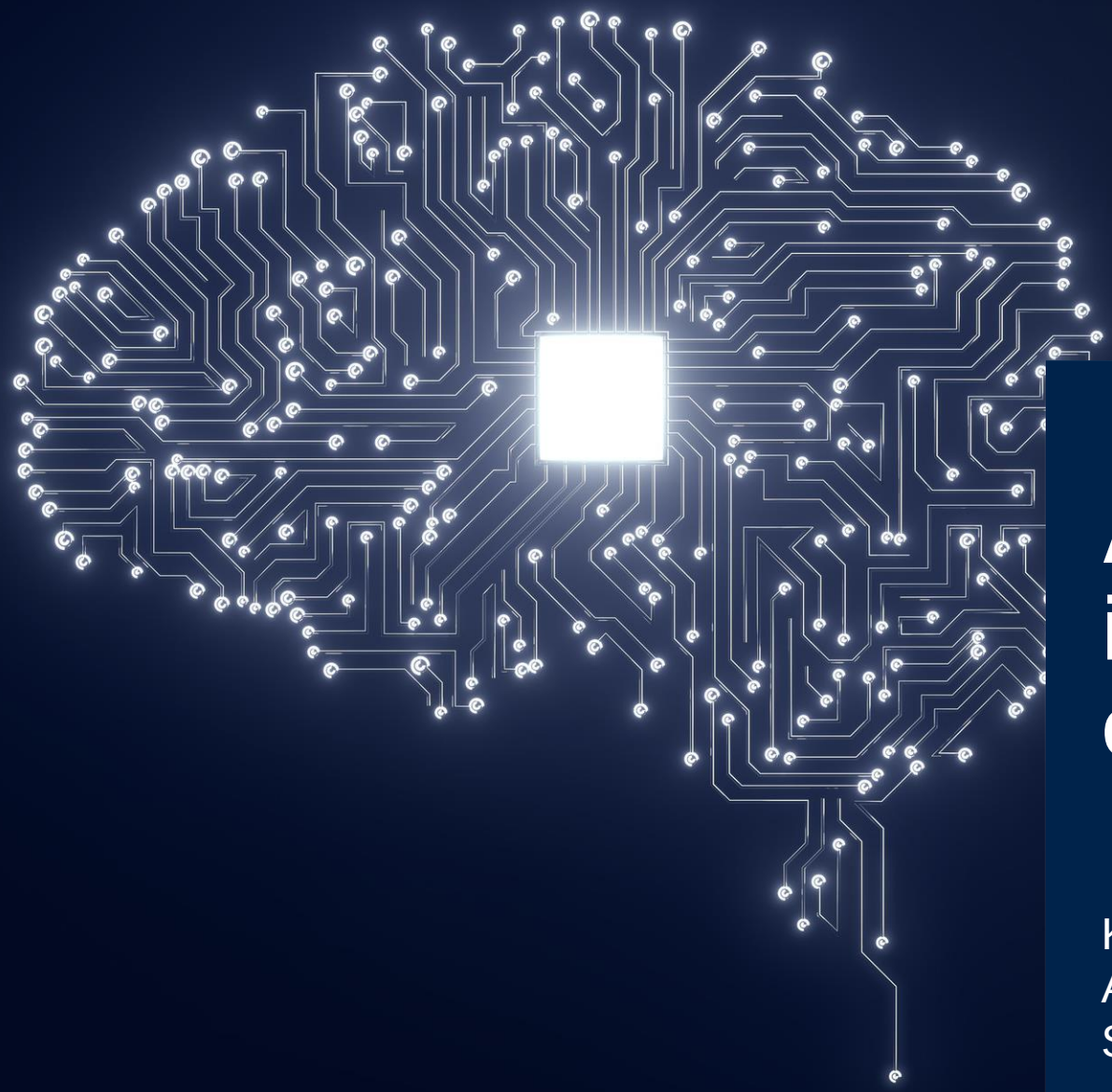

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Advanced MEMS sensors in the sustainable onlife era

Kay LIN
APeC, AMS, MEMS Sub-Group
STMicroelectronics

Smart sensors making our world a better place

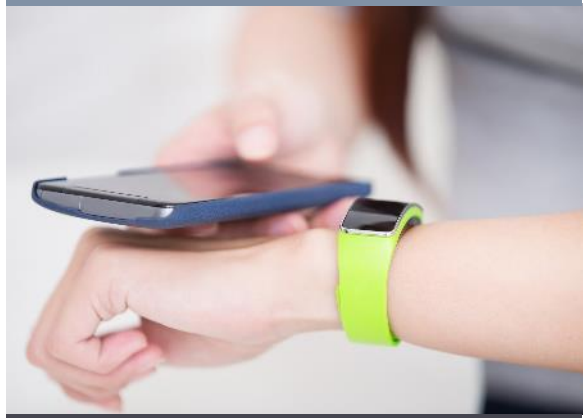
Offline Era

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.

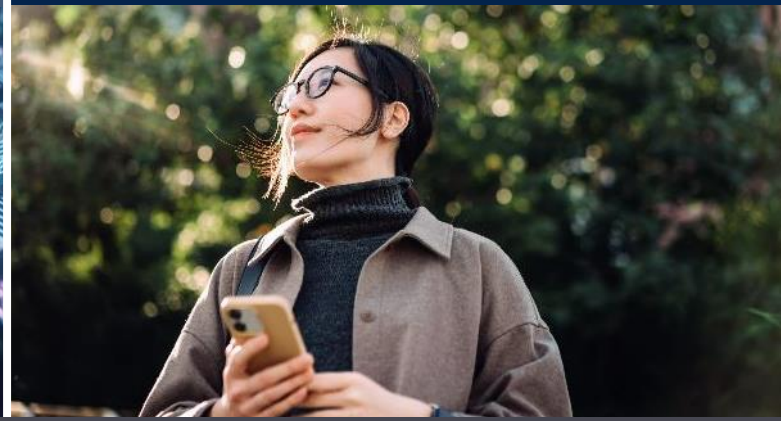
Onlife Era

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 **human expectations** while ensuring a **sustainable future**

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Sensor Fusion

Orientation

Track and monitor orientation in 3D space

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

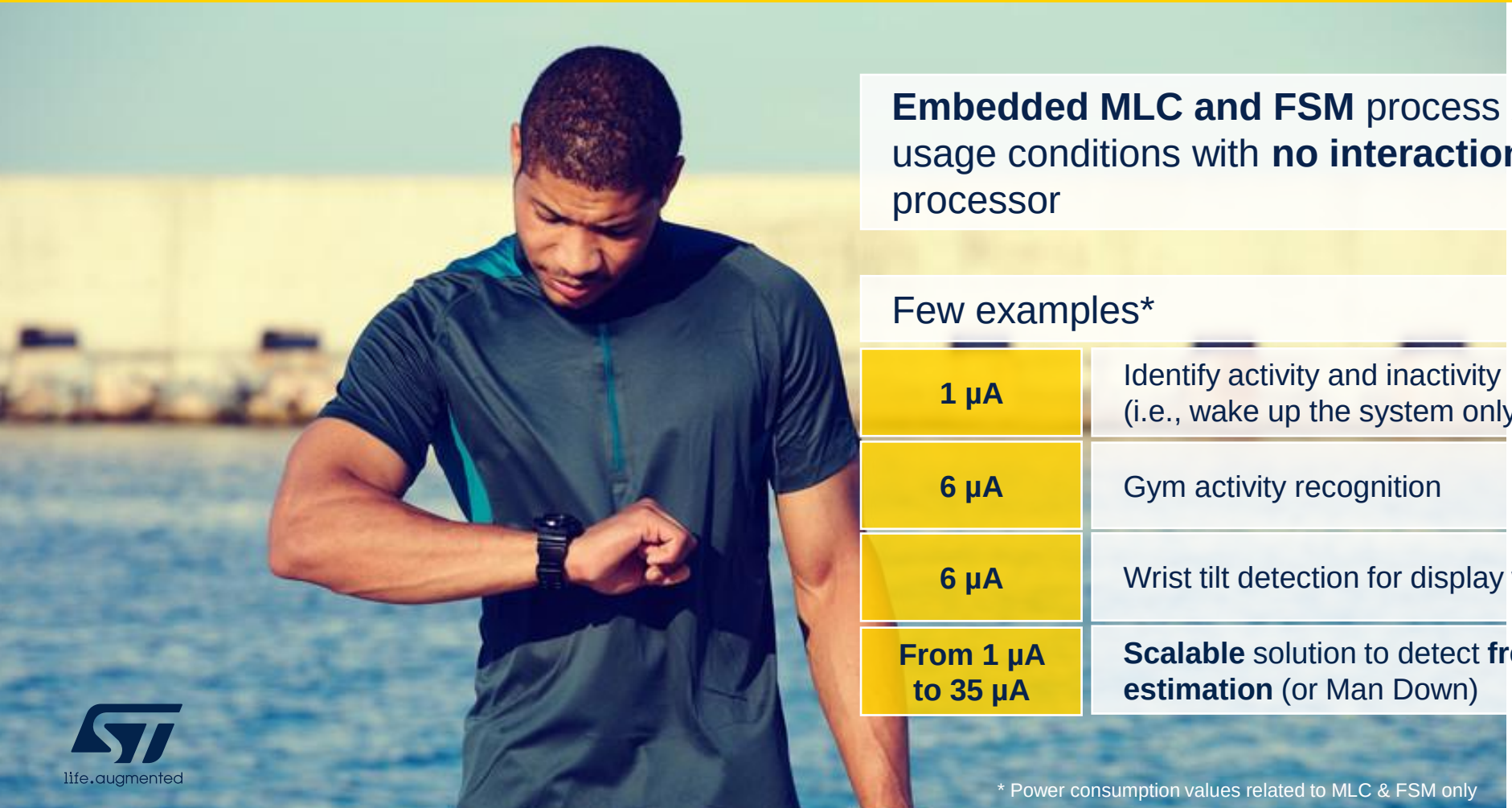
Detect and track device orientation with the **embedded low power sensor fusion** algorithm with **30 µA**

Plug and play solution that provided **6x game rotation vector** (accelerometer + gyroscope) & **Gyro-bias calibration**

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

Context awareness detection

Adding intelligence in the edge with MLC and FSM



Embedded MLC and FSM process XL & Gyro data to detect usage conditions with **no interaction required** with external processor

Few examples*

1 µA	Identify activity and inactivity (i.e., wake up the system only when needed)
6 µA	Gym activity recognition
6 µA	Wrist tilt detection for display wake up
From 1 µA to 35 µA	**Scalable** solution to detect **free fall, shock** and fall **height estimation** (or Man Down)

* Power consumption values related to MLC & FSM only

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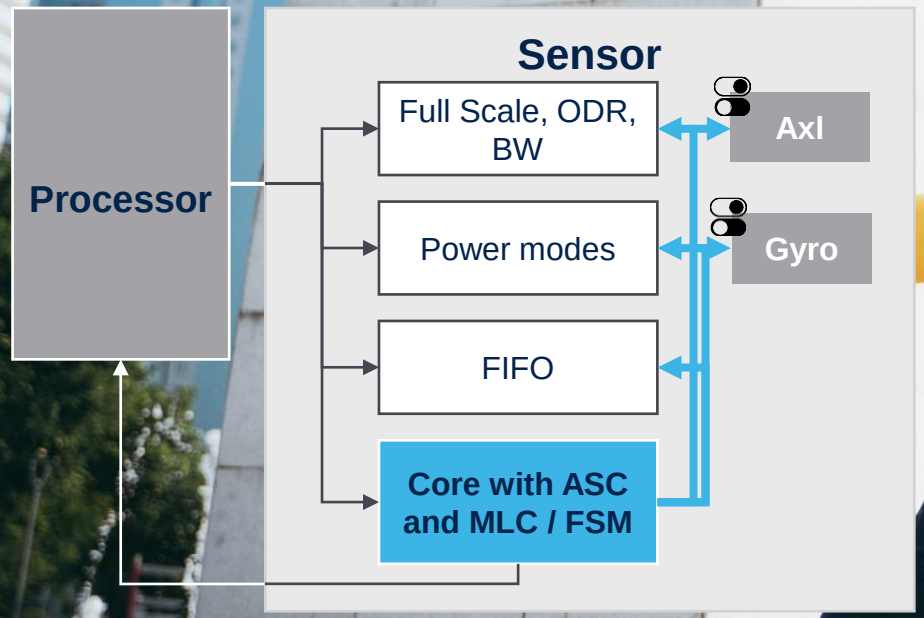
Adaptive self configuration (ASC)

From “Always-On” to “Smart, Always-Aware”



The device automatically **reconfigures itself**, based on the actual context, maximizing the **system efficiency**.

MLC and FSM detect the context without the need of additional data processing

ASC allows to independently configure Gyro and XL channels.
No tradeoff required!

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User interfaces

Qvar electrodes to improve UI: Touch and Swipe

- Sensor fusion between Qvar and 6x IMU improves the user experience accuracy reducing false positives
- Support for single/long and multiple touch and swipe

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Free fall height estimation

Beware: LSM6DSV16X can track your shock!

Scalable solution to detect **shock**, **free fall**, and estimate **height of the free fall**

Embedded processing and **FSM** detect the context without the need of additional data processing at system level

From free fall **height exceedance** detection, to the **accurate height** estimation, from **1 µA** to **35 µA**, always the right algorithm

* Power consumption values are related to the embedded processing

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ISPU

Moving the intelligence at 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

ISPU
intelligent sensor processing unit

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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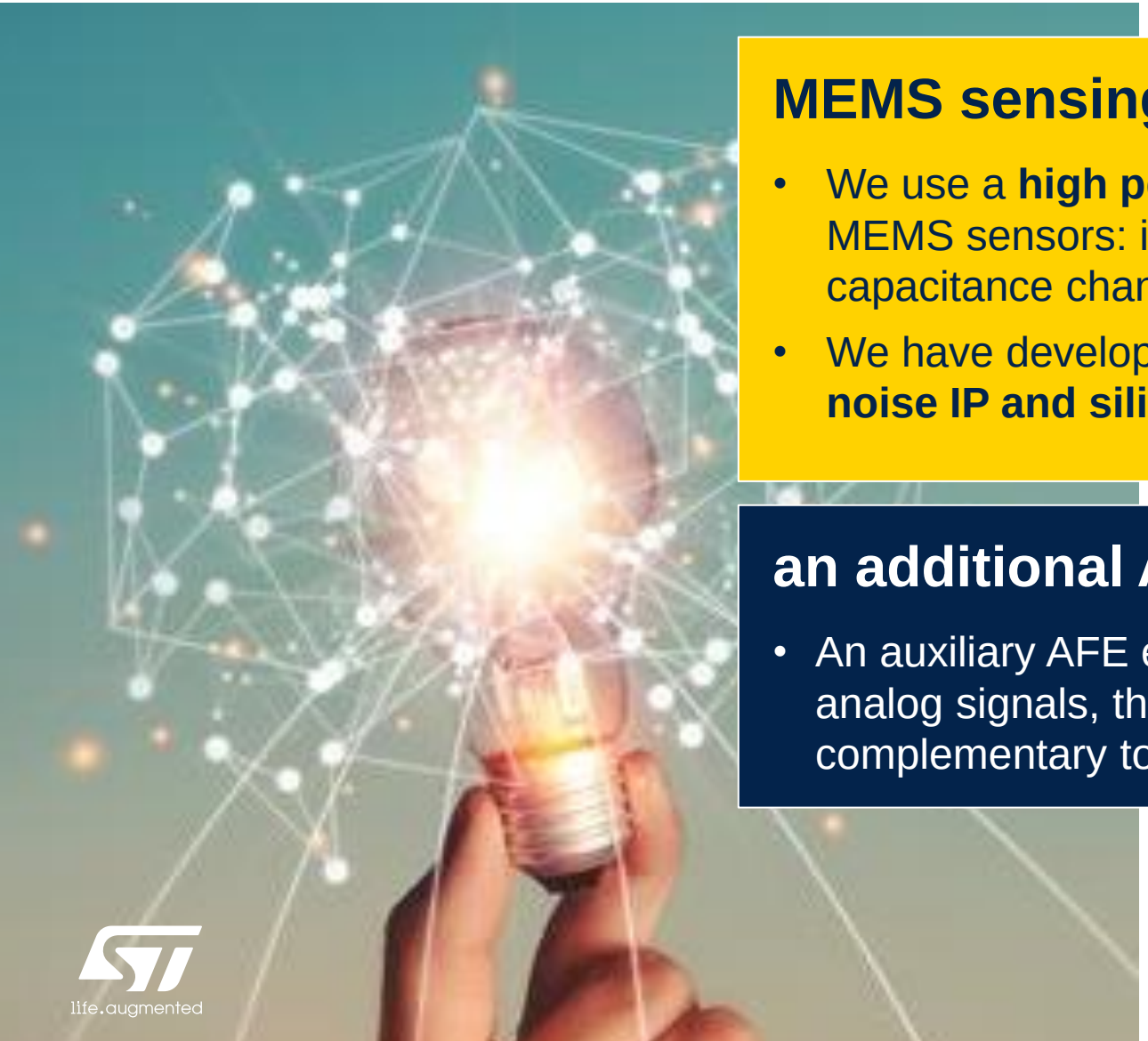
*DSP: Digital Signal Processing

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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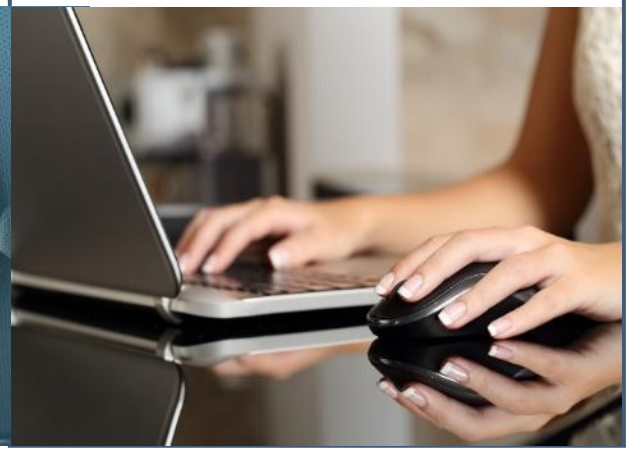
vAFE

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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Smart Ring: the 2023 trend runs ST sensors

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

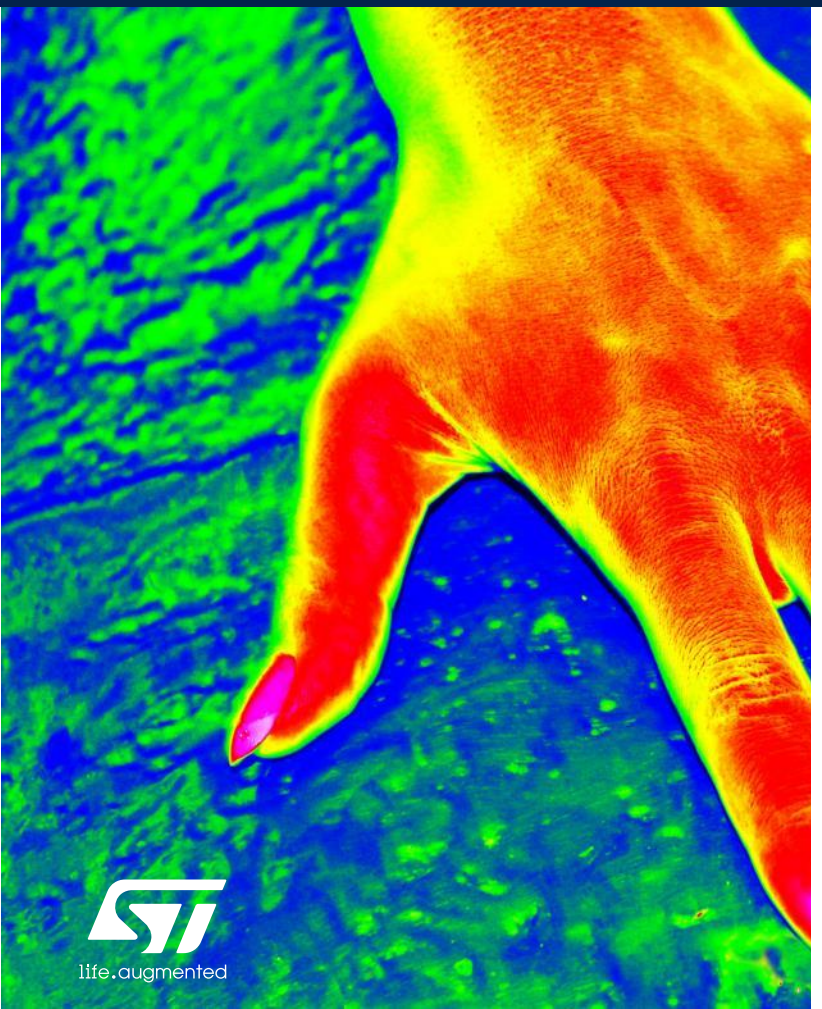
LIS2DUX features single-digit µA power consumption with embedded AI (MLC, FSM, ASC)

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

TMOS

IR sensor STHS34PF80, 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 um

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

Biometric
Presence detection and temperature measurement

MEMS sensors roadmap

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New generation MEMS sensors

	Features	Products	Applications
iNEMO® Inertial Module	Embedded **ISPU** **N** version for **NEAI**	**LSM6DSO16IS** **ISM330IS/N**	
	MLC, **FSM**, **ASC**, **SFLP**, **Qvar**, **Audio AXL, BC**	**LSM6DSV16X** **LSM6DSV32X** **LSM6DSV16BX**	
Accelerometers	ULP, 12b resolution, AAF, 128 samples FIFO ;(i.e. 0.47µA @6Hz ODR) **FSM, MLC**, Pedometer, Qvar™	**LIS2DU12** **LIS2DUX12** **LIS2DUXS12**	
Pressure Sensors	Water resistant & WP, better accuracy, lower power consumption, Dual FS Qvar™	**LPS22DF** **LPS28DFW** **ILPS22QS** **ILPS28QSW**	
IR Sensor	**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

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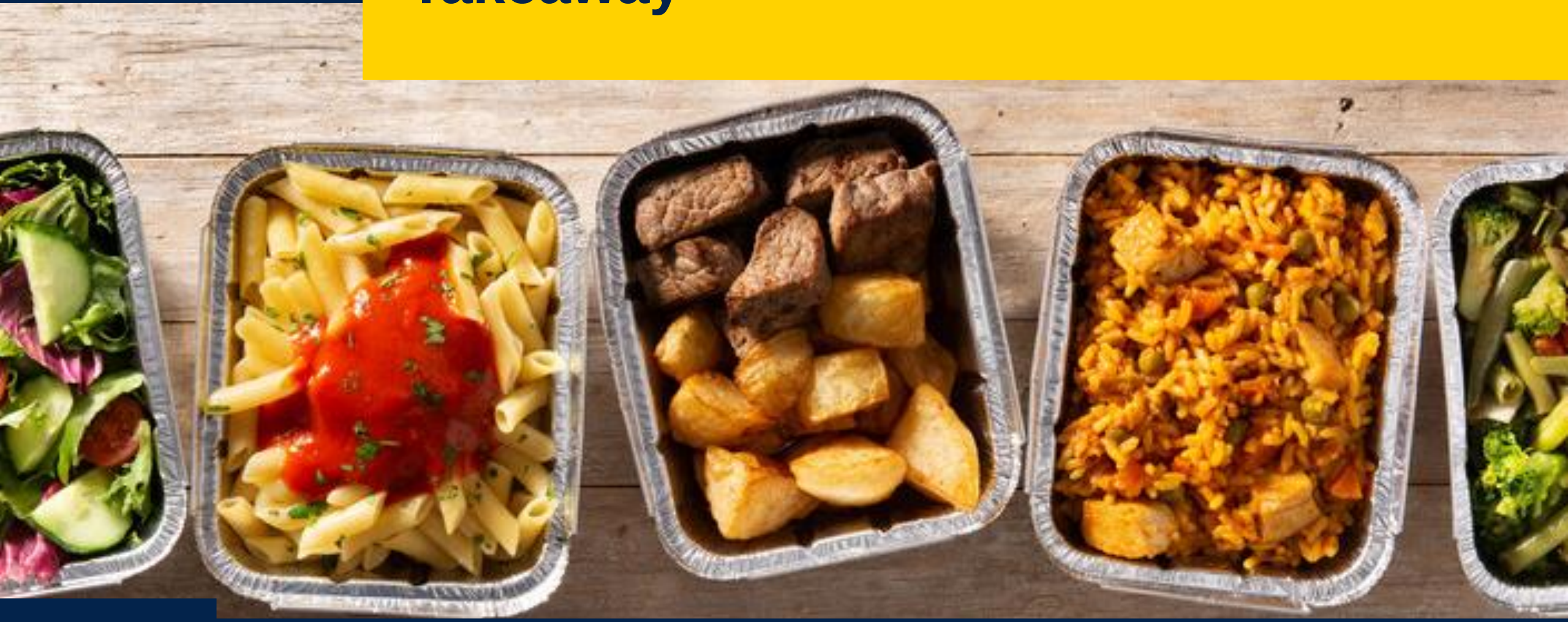
Takeaway



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Takeaways

1	LSM6DSV16X, LSM6DSV16BX, LIS2DUXS12 and ILPS28QSW are innovative sensing solutions with unique IP
2	Qvar is a new sensing capability that opens the door to many new functions such as in ear detection, user interface, water leakage detection without the need of additional sensors
3	Machine learning core, finite state machine, embedded sensor fusion low power move the processing at the edge, in the sensor, allowing great system optimization and performance improvement

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Our technology starts with You

Find out more at www.st.com/MEMS

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STM32 wireless & IoT solutions

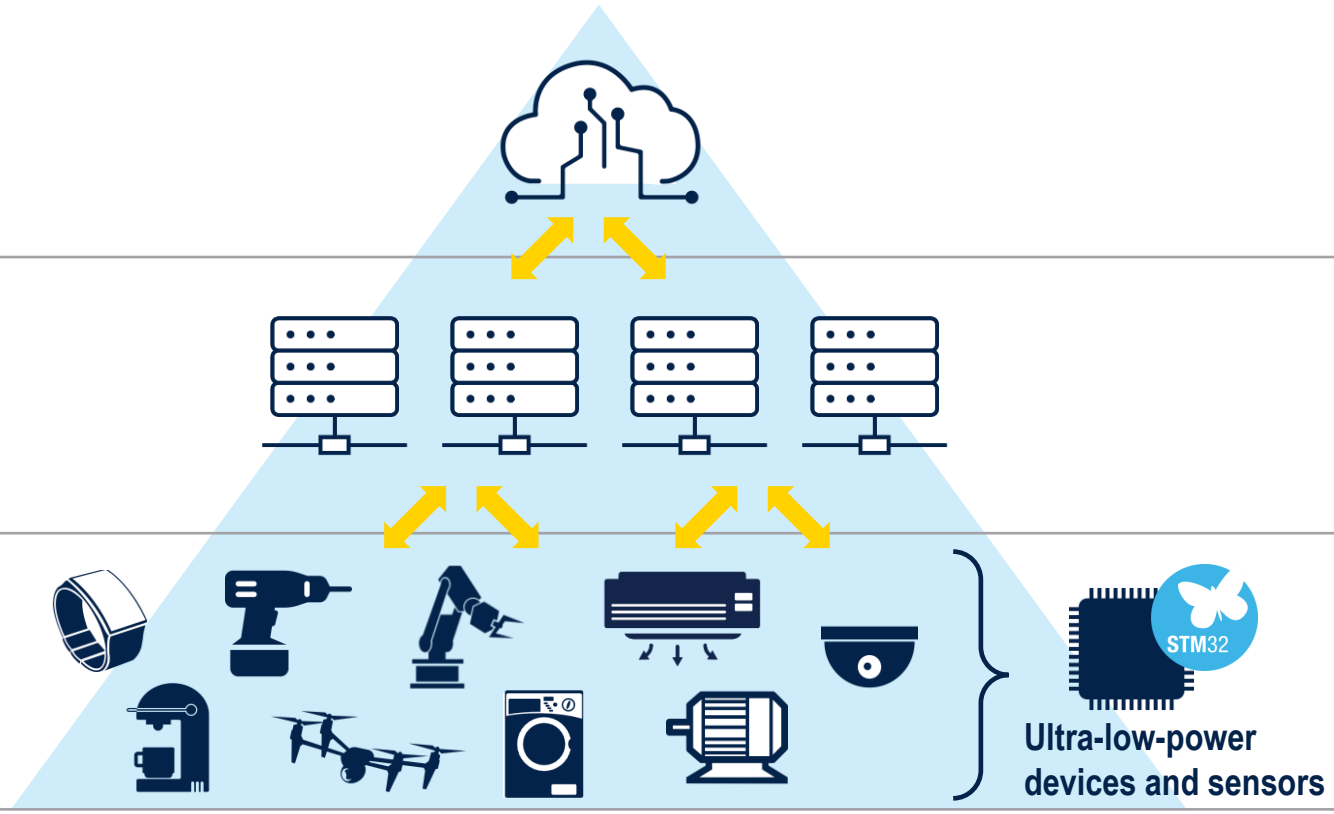
Watson Chang

Wireless Product Marketing, APAC

STMicroelectronics

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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The STM32 portfolio

Five product categories

- **Wireless MCU** — Short- and long-range connectivity
- **Ultra-low-power MCU**
- **Mainstream MCU**
- **High-performance MCU**

32-bit general-purpose microcontrollers: from 75 to 3,224 CoreMark score

- **Embedded MPU** — 32- and 64-bit microprocessors





Enabling edge AI solutions

Scalable security

MPU portfolio

MCU portfolio

ST solutions: Sub-1G, and 2.4G

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Sub-1 GHz markets

Smart industry

Smart city

Smart home

Smart agriculture

Asset tracking

Metering

Alarm system

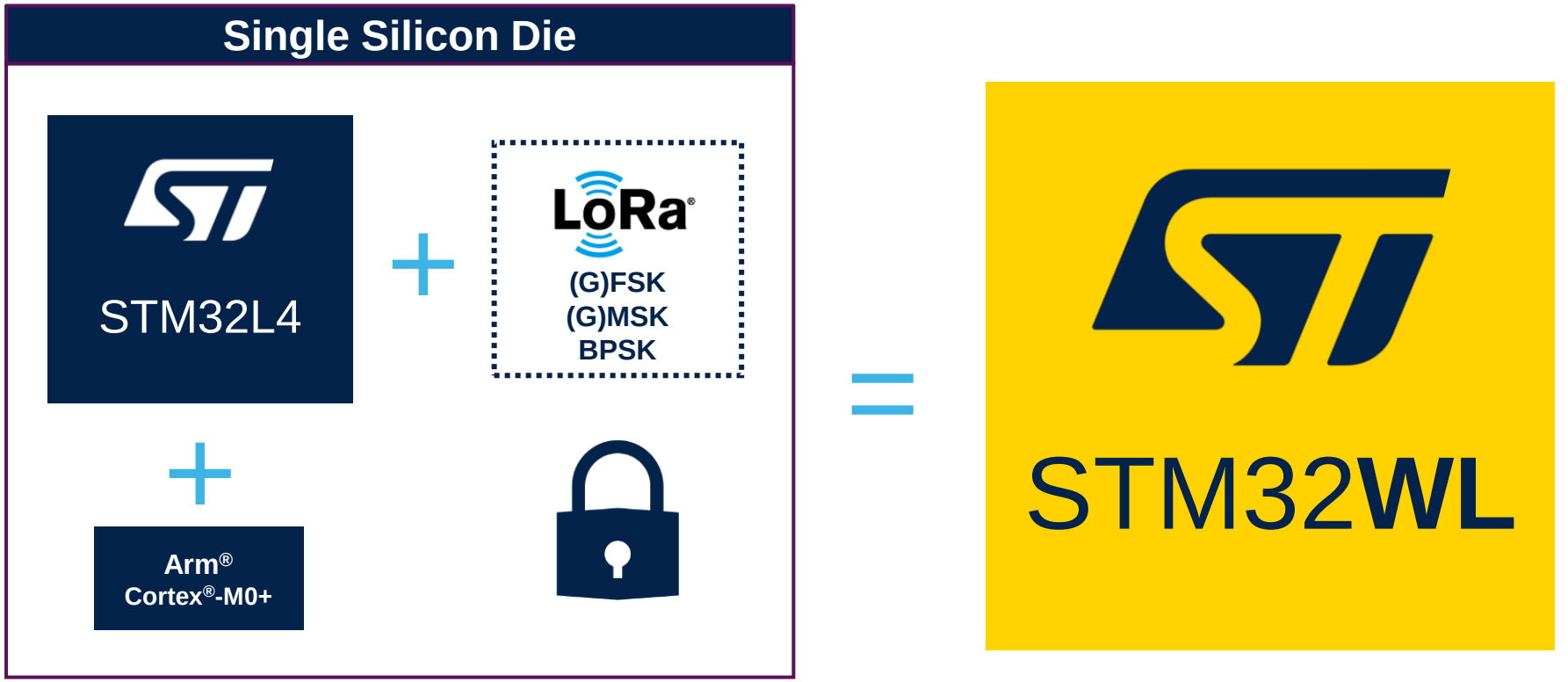
Heat cost allocator

STMicroelectronics serves all markets

System-on-chip made for versatility

A long-range wireless microcontroller: one die, many IoT possibilities

World first!



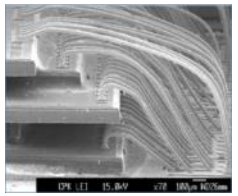
The integration pyramid

STM32WL
Sole LoRa-enabled SoC in the world

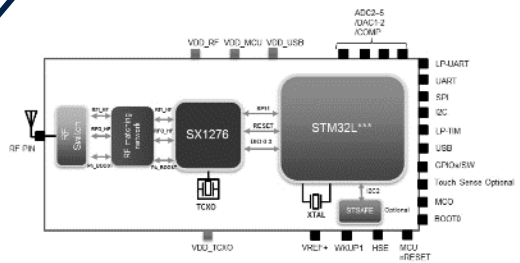
System-on-Chip (SoC)
Only one Silicon die in one package

System-in-Package

*Different **silicon dice** inside the same package*



Source: PTI Blog

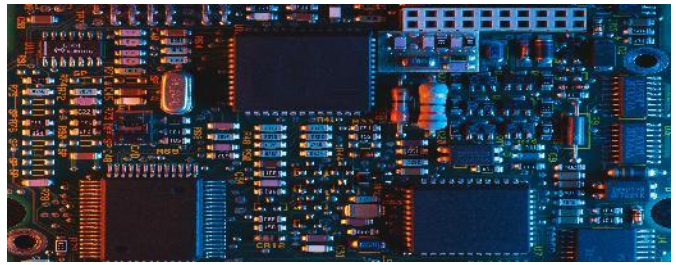


*Different **packages** on a very tiny piece of re-packaged PCB*

Module

PCB

*Different discrete **packages** on a BIG electronic board*



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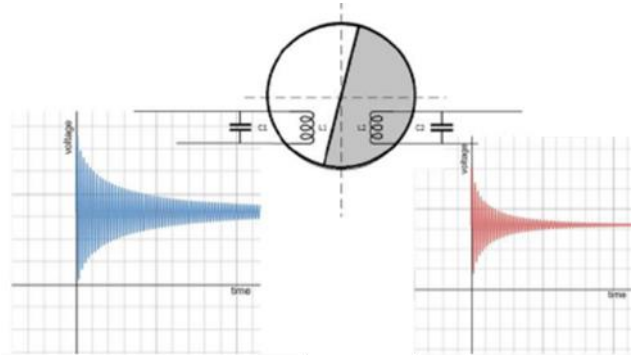
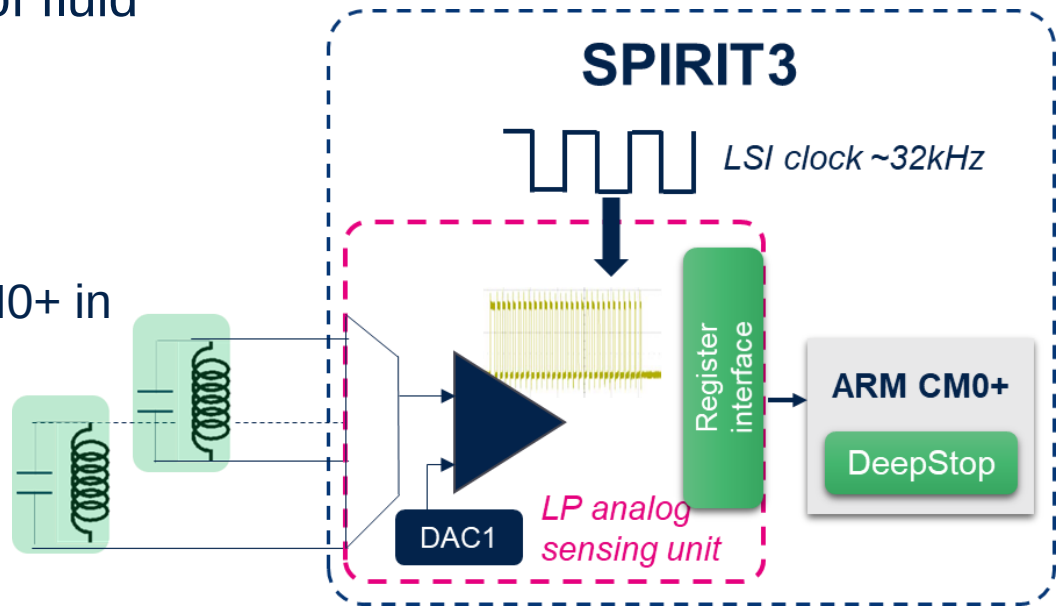
STM32WL
ultralow power LC sensor controller (LCSC)

Ultralow-power ANALOG SENSING UNIT
L-C based measurement of fluid flow metering

- Designed for cost-effective mechanic-wheel fluid metering
  - Measuring of L-C network oscillations enable detection of fluid flow metering
- Feature is based on L-C network oscillation measurement
  - Supporting up to 3x L-C networks
  - Autonomous metering circuitry (no MPU intervention, Cortex M0+ in deepstop)
  - Very few µA average current for continuous L-C metering





STM32WL
Extended battery life: dedicated wake-up radio

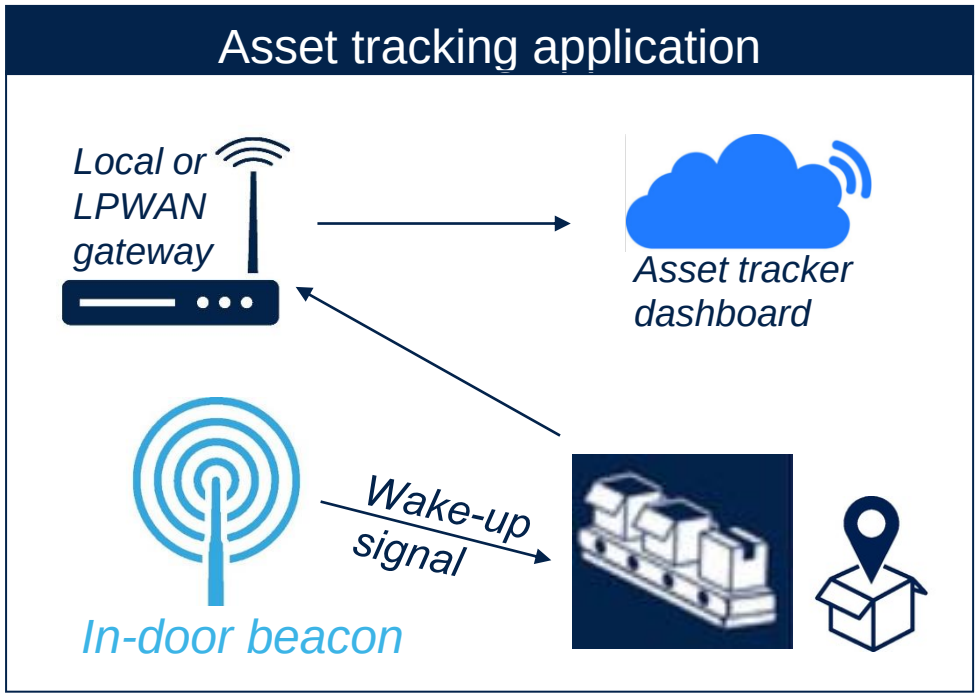
Ultralow-power wireless proximity detection and system wake-up

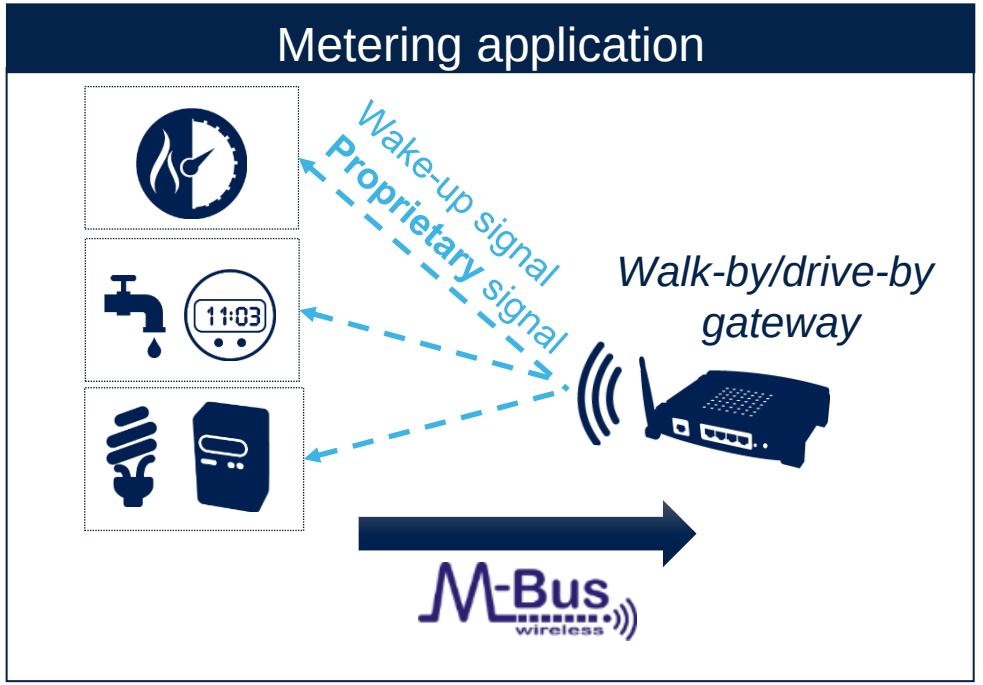
Wide band: 1 single BOM for worldwide ISM (100MHz – 2.4GHz)

<5µA
Continuous RX

Dedicated to proximity detection (tens of meters) ~-50dBm sensivity

OOK modulated packet detection





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2.4G markets
matter makes connected home simple

“Smart home devices should be secure, reliable, and seamless to use. And with Matter, they are.”

The Connectivity Standards Alliance

- **A great user experience**
  Matter ensures connected objects from multiple brands can work together seamlessly
- **Wide adoption**
  Matter is an application layer which addresses many applications in an open-source delivery and certification infrastructure
- **Release V1.0 Q4’2022**

matter

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STM32 MCU 2.4 GHz portfolio

STM32WB series

- **Dual core** & security (Arm® Cortex® -M4 / -M0+)
- Up to **1 Mbyte** of flash memory / **256 Kbytes** of RAM

MCUs: STM32WB55, STM32WB35, STM32WB15, STM32WB50, STM32WB30, STM32WB10

Modules: STM32WB5M, STM32WB1M

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5.4 & Mesh

STM32WBA series

STM32WBA52

5.4

- Arm® Cortex® -M33 / **TrustZone®** 100 MHz
- **1 Mbyte of** flash memory / **128 Kbytes** of RAM
- Up to **+10 dBm** output power

BlueNRG series

- Arm® Cortex® -M0/M0+
- Up to **256 Kbytes** of flash memory / **64 Kbytes** of RAM

System on Chips: BlueNRG-1, BlueNRG-2/2N, BlueNRG-LP, BlueNRG-LPS

Module: BlueNRG-M2SP/SA

5.2 to 5.4 & Mesh

EVOLUTION

STM32WB0 series

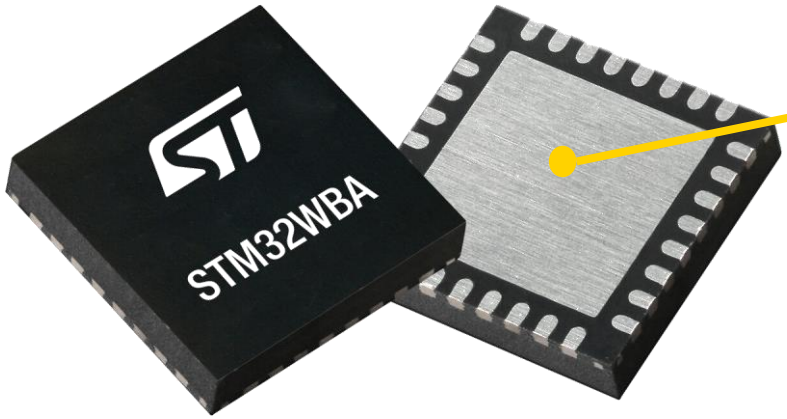
STM32WB09

5.3

- Arm® Cortex® -M0+ at 64 MHz
- **512 Kbytes** of flash memory / **64K bytes** of RAM
- Bluetooth® Low Energy 5.3 (long range, 2 Mbps, Adverting ext, **AoA/AoD, Isochronous channel**)
- Up to **+8 dBm** of output power

An ultralow power Bluetooth® Low Energy 5.4 platform

Bluetooth Low Energy 5.4



Built using **40nm process technology**

Integrated 2.4GHz radio

Bluetooth® Low Energy 5.4 (long range, 2Msps, advertising extension)
+10 dBm output power

High performance

- Arm® Cortex®-M33 at 100MHz
- 407 CoreMark score
- 100 K cycles for 256 Kbytes of Flash

Enhanced security

- TrustZone® technology, **target SESIP Level 3**

Leveraging STM32U5 ultra-low-power platform

- Low-power direct memory access (LP-DMA)
- Flexible power-saving states with fast wake-up times
- Same digital and analog peripherals

STM32WBA increases security in wireless devices

Extensive functionalities to protect your assets

Memory protections
against illegal access control

OTP, **HDP**, WRP, MPU
Secure Debug
Active Tamper, 4 pairs & V/T

Cryptography
for hardware robustness

Side channel AES, PKA
Additional AES, SHA, TRNG,
HUK (Hardware Unique key)

Platform protection
during product lifecycle

RDP: 4 protection level states
Password based regression

Code isolation
for runtime protection

4 isolation stages
Arm® TrustZone® technology

Security services

STM32Trust **TEE TF-M**

Secure boot & secure updates

Secure firmware install

NIST - CAVP certified CryptoLib

State-of-the-art security assurance level

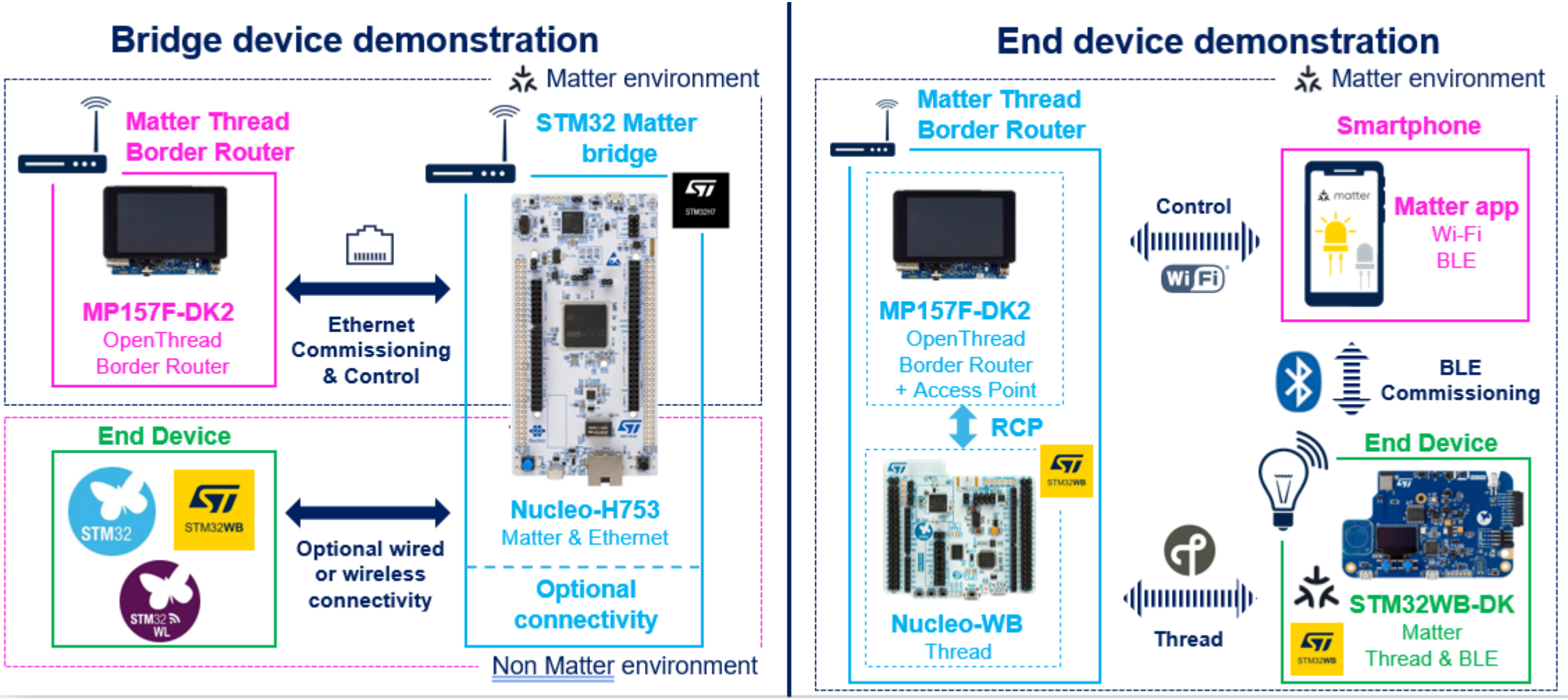
SESIP™3

psacertified™ level three

target certifications

New features for STM32**WBA** are **highlighted**

Matter over thread: ST available demonstration



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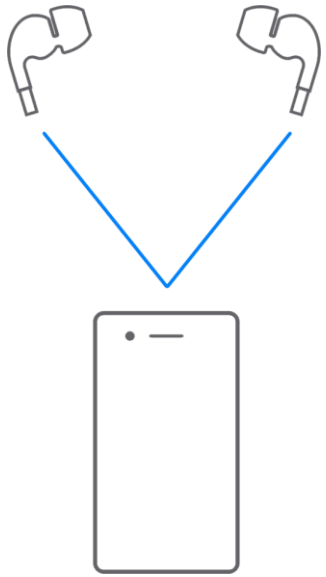
What's more…..
Le audio unicast / broadcast

- Connected Audio Stream
- One-to-One
- Bidirectional

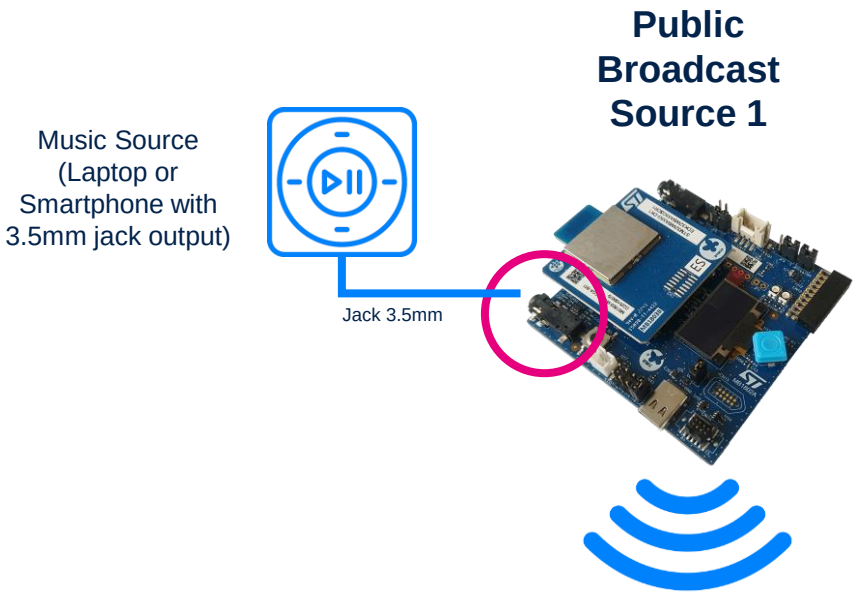
Unicast

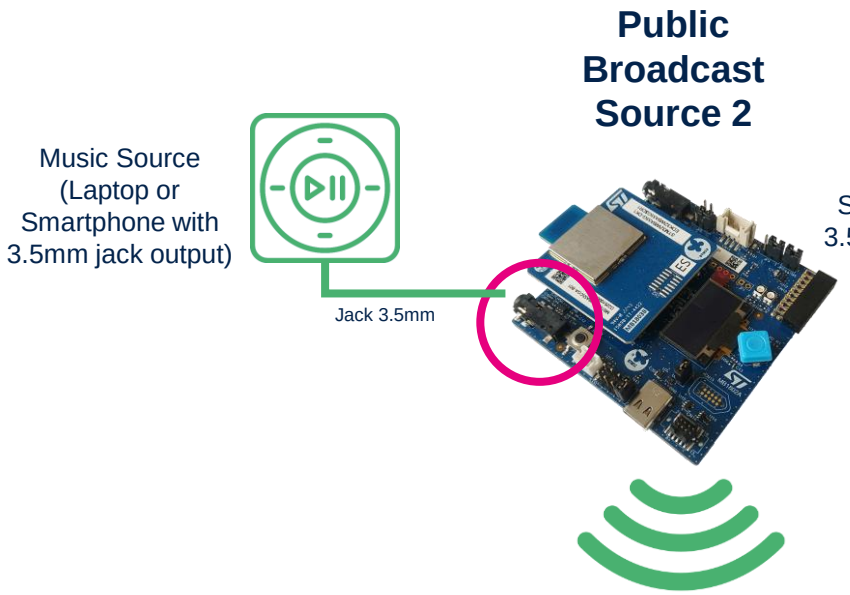


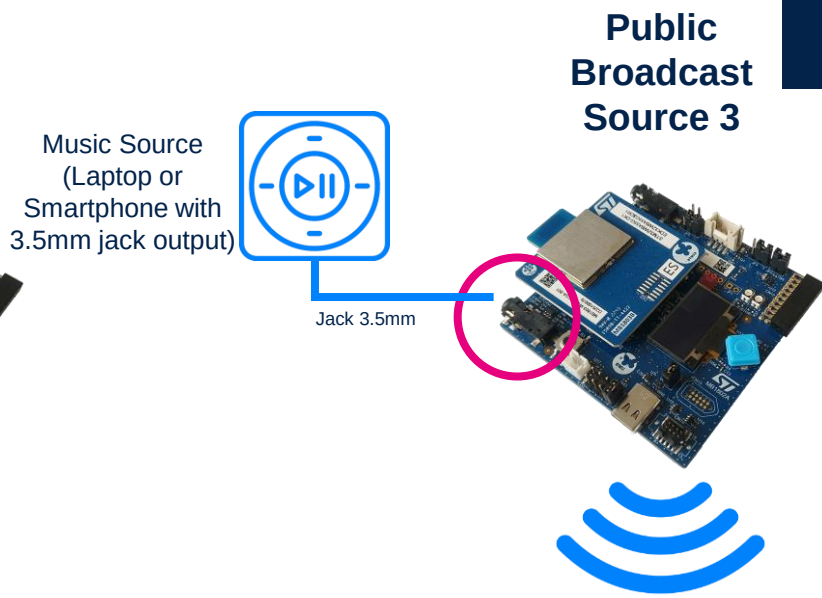
- Broadcasted Audio Stream
- One-to-many
- Unidirectional

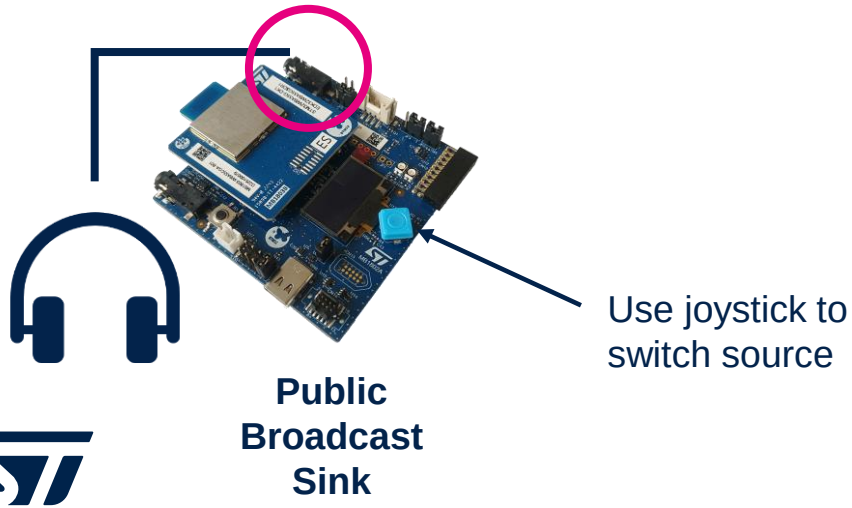
Broadcast

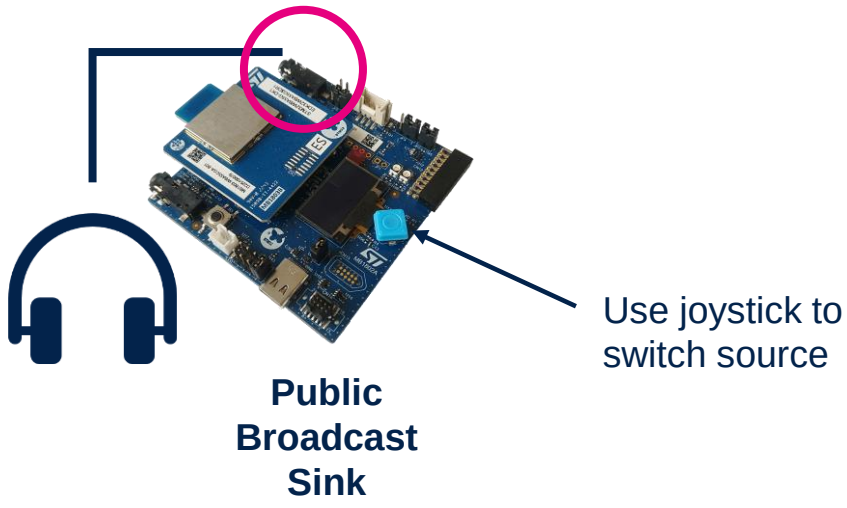
Setup - many source many sink

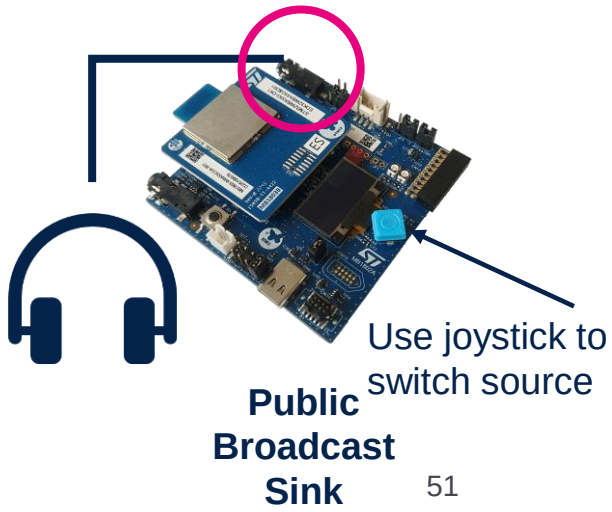












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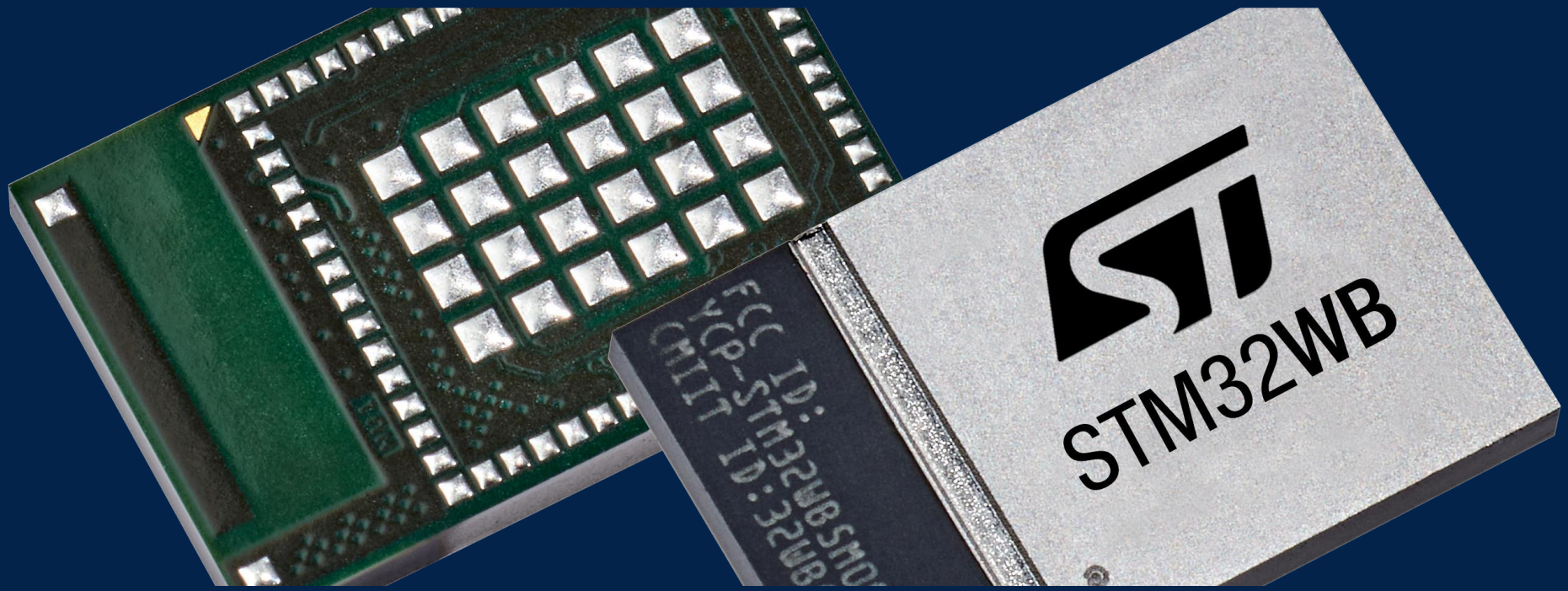
Available as a module to reduce your time to market



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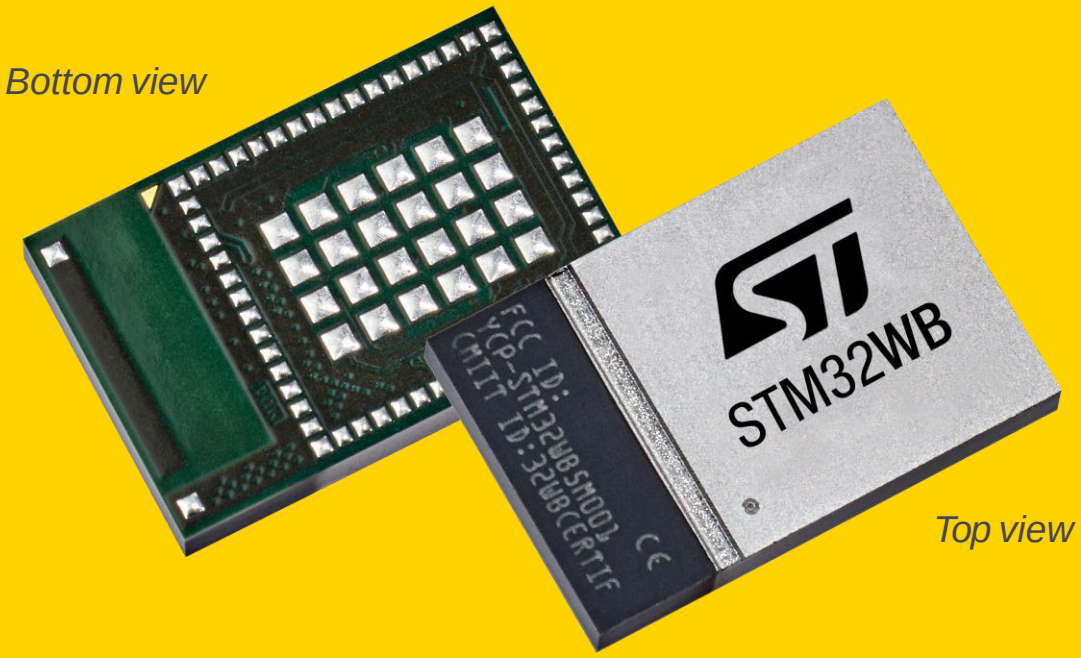
STM32WB5M - module

Easy to integrate - Light certification for customer

Key advantages

- WLCSP100 package integrated
- Maximum of features exposed
- Low-cost PCB for the mother board



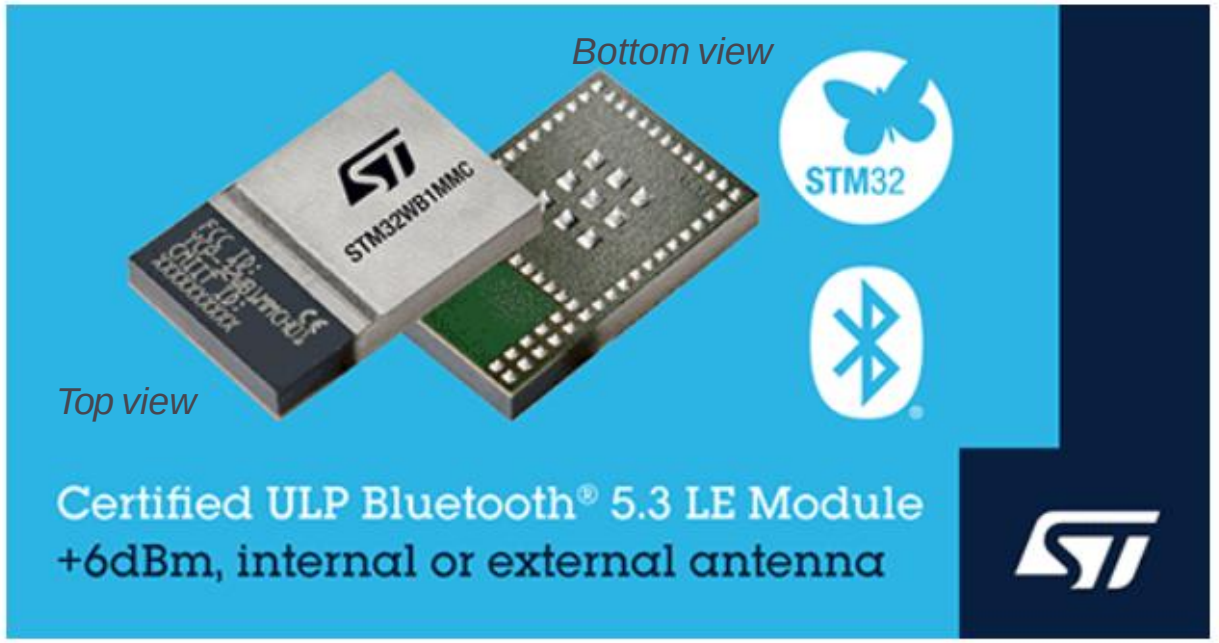
In production

STM32WB1M - module

Easy to integrate - Light certification for customer

Key advantages

- STM32WB15 MCU with 320KB flash and 48KB RAM
- Internal antenna, as well as pins for attaching an external antenna.
- STM32CubeWB MCU package provides resources including hardware abstraction layer (HAL) firmware, Low-Layer APIs, File system, and RTOS



In production

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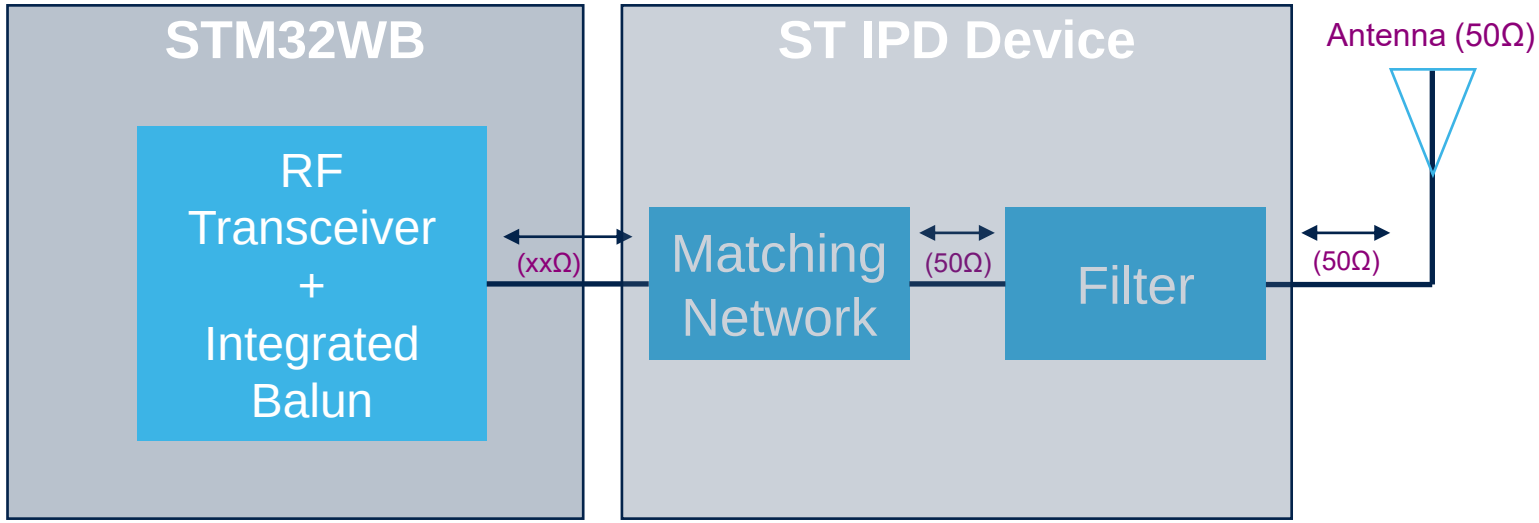
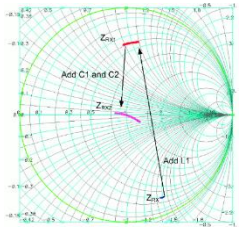
IPD (integrated passive device)

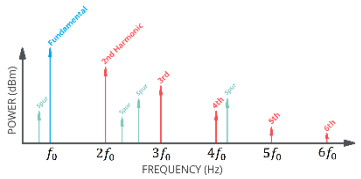
IPD* - basic RF system

Two blocks required

- **Matching Network** – Transformation to 50 Ω impedance
- **Harmonic Filter** – Reduce out-of-band TX harmonic emissions and RX susceptibility







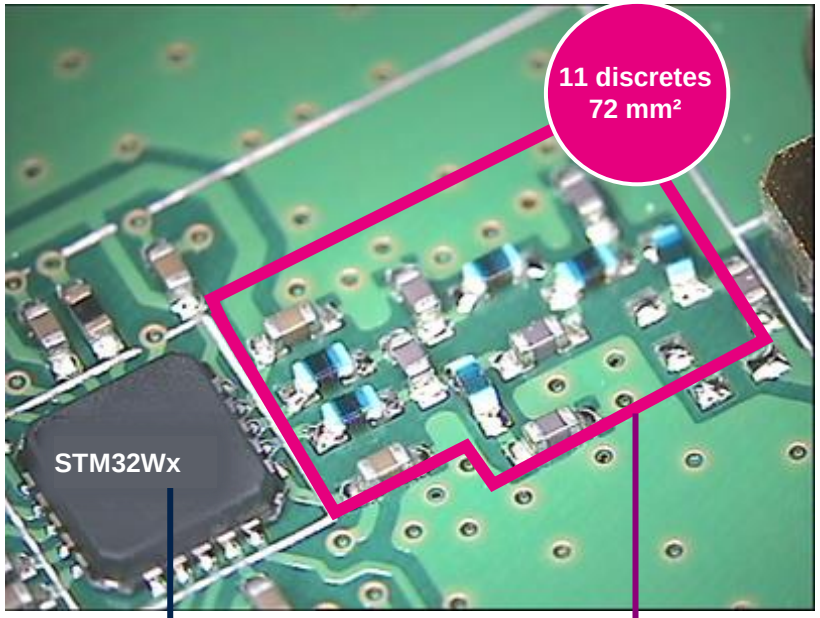
*IPD: Integrated Passive Device

NEW

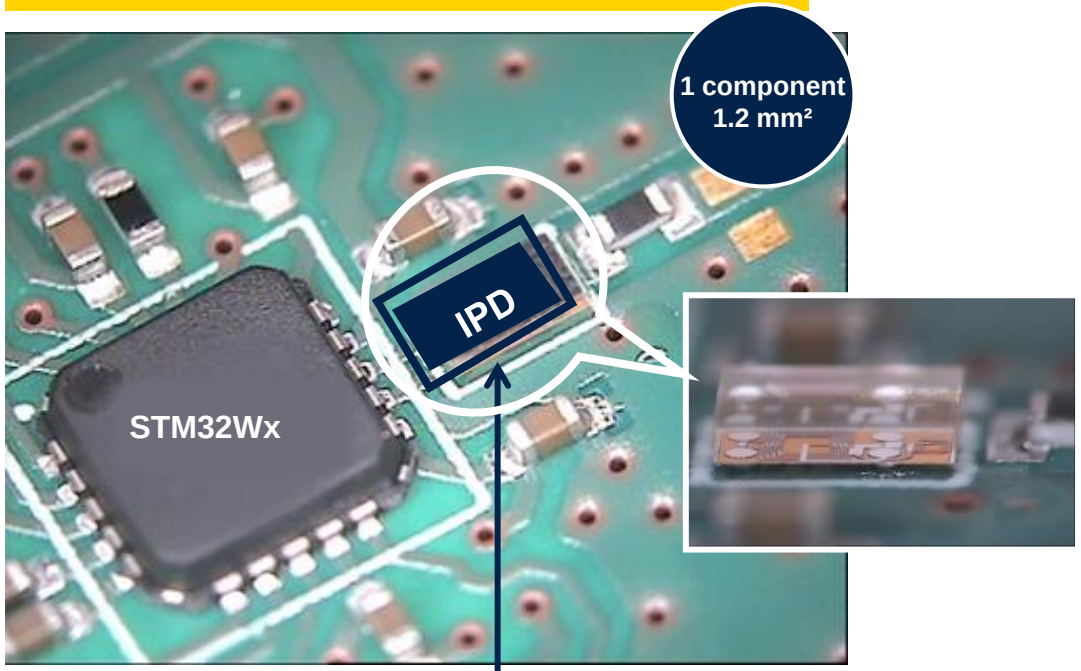
STM32 IPD integrated passive device

STM32WL RF Front end in a 1.2mm²

BEFORE



AFTER



Wireless MCU

Discrete balun & matching network

RF IPD balun & matching network

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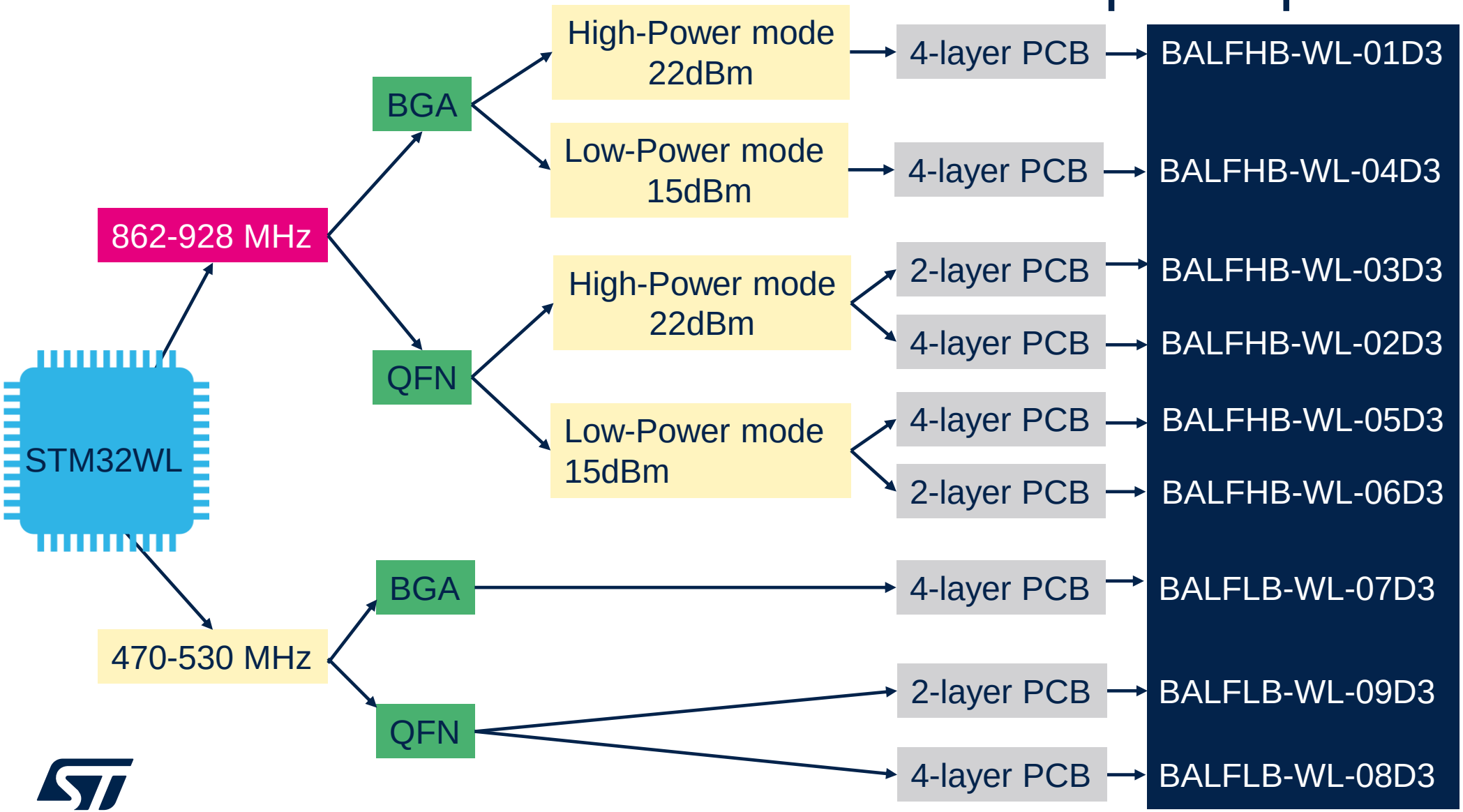
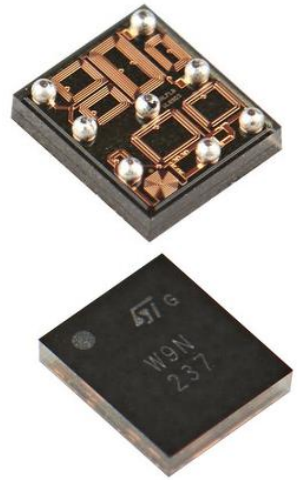
RF IPDs products companion chip to STM32WL how to pick up the right one



BAL=balun
F = Filter
HB = high-band
LB = Low-band
WL=STM32WL
D3= CSP package



N: FE= Tours,
BE=Shenzhen
237: W37- 2022
G: ecopack2/Rohs

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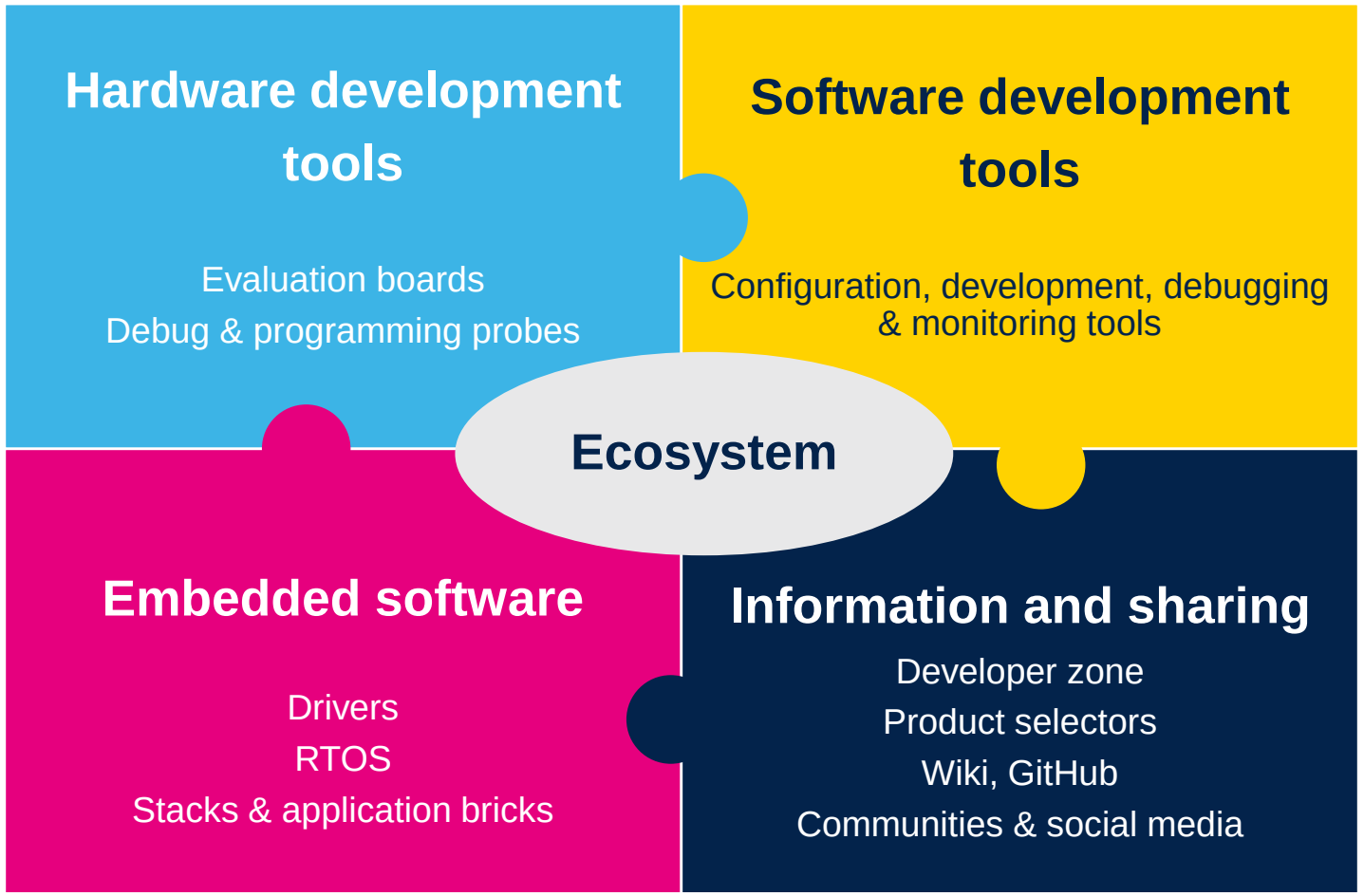
STM32 ecosystem for developers



Open source

Partners

Designed by ST

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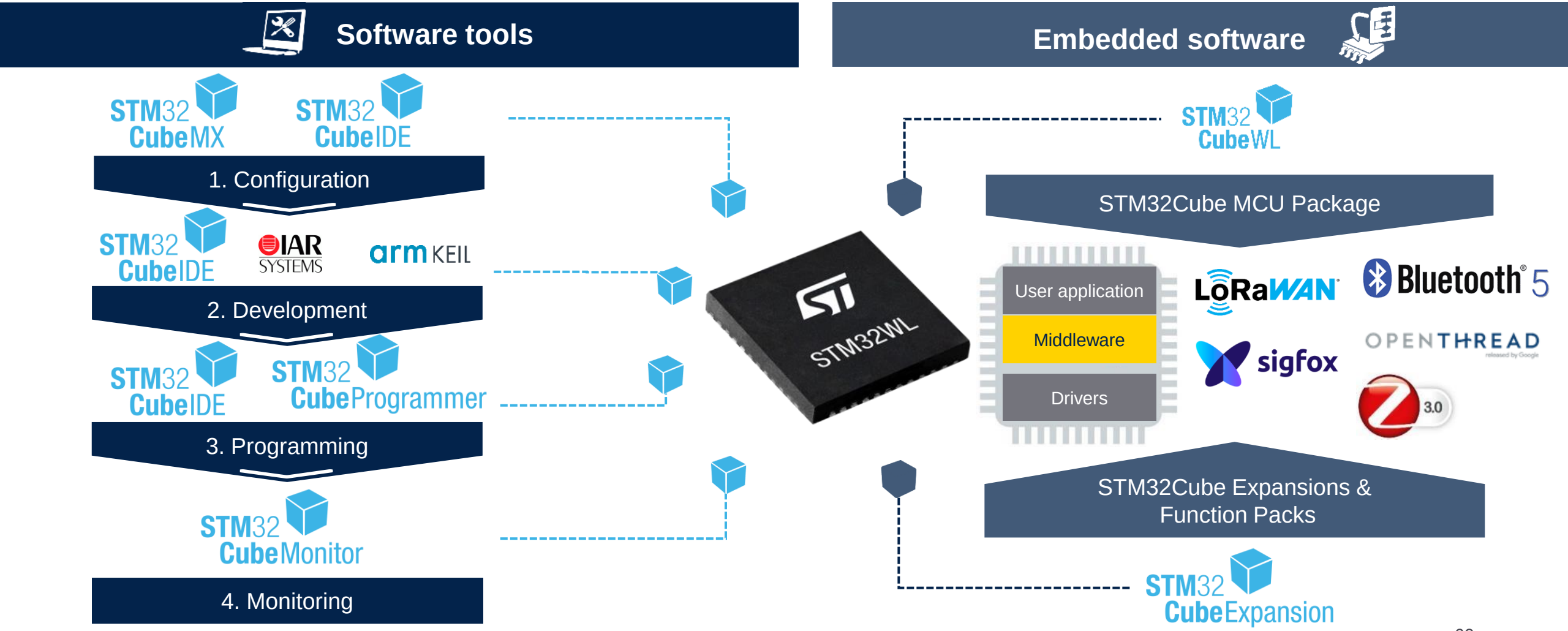
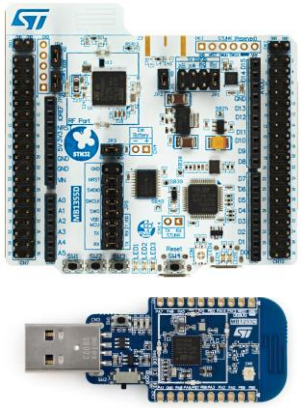
Key takeaway: end-to-end ecosystem



Prototyping made as easy as 1,2,3

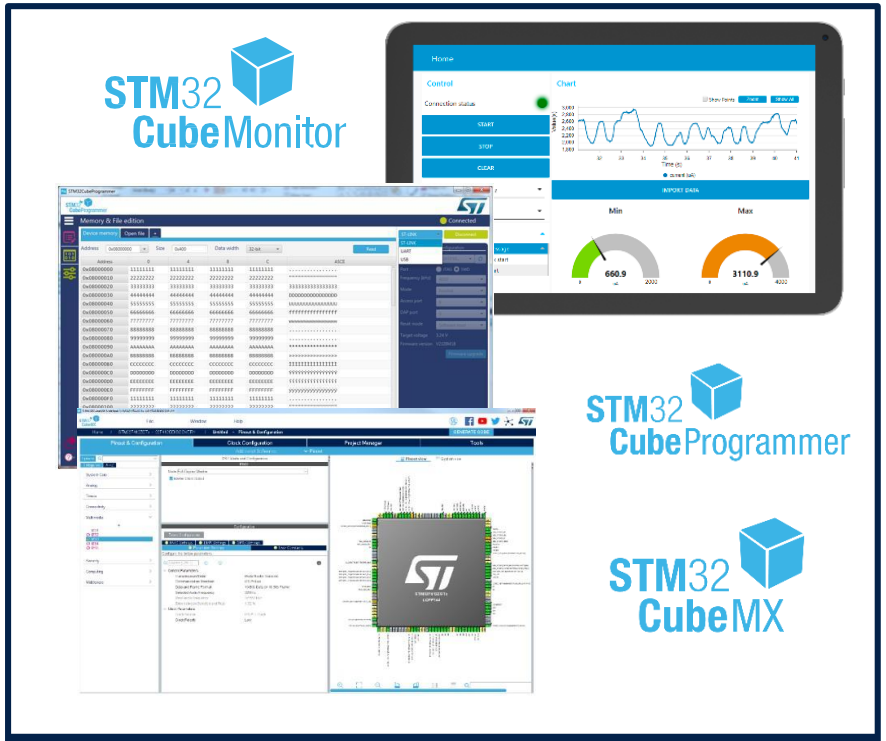


P-NUCLEO-WB55

NUCLEO-WB15

STM32WB5MM-DK

STM32WB



STM32CubeMX/STM32CubeWB/
STM32CubeProg & STM32CubeMonitor
Code generation
Power calculation

STM32 Cube

STM32 CubeIDE

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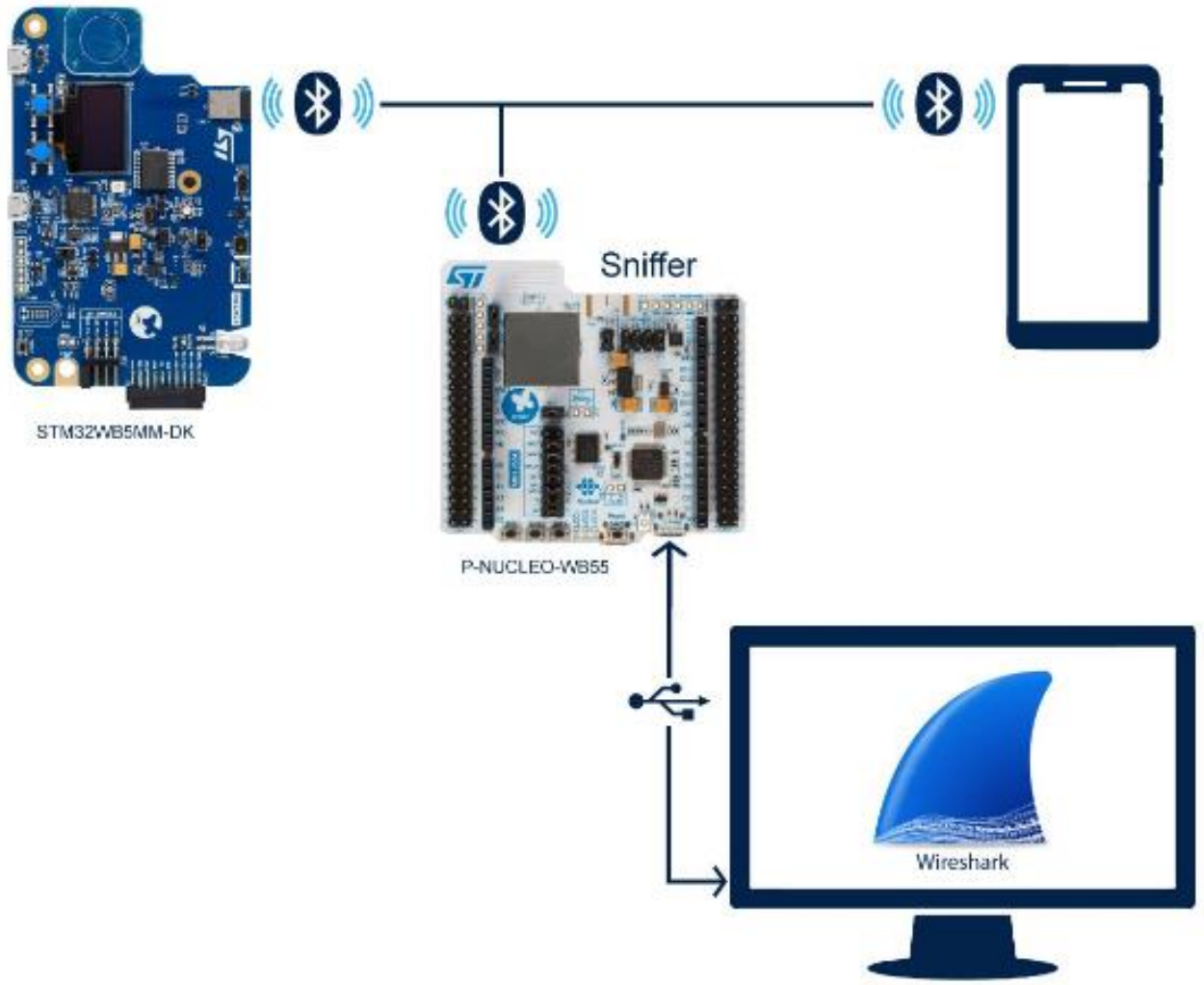
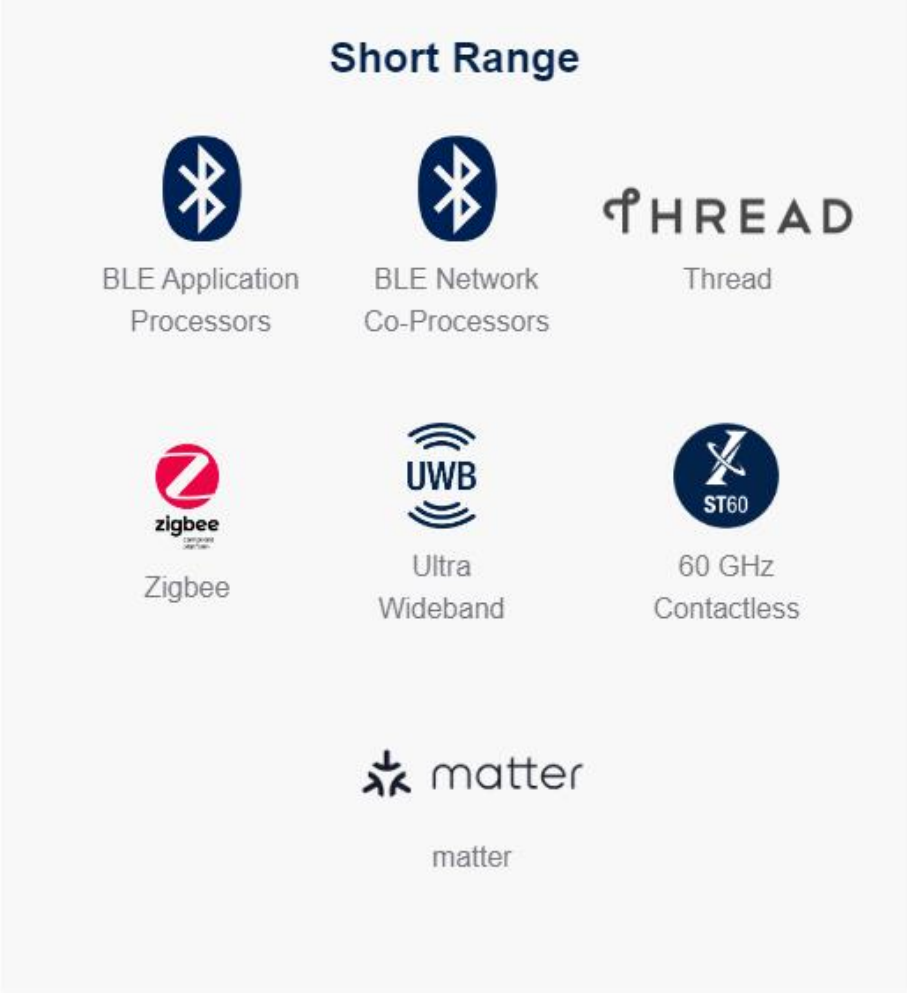
What's more……
BLE Sniffer by STM32WB55-Nucleo EVM



What ST offers (Today'2023)



st.com/en/wireless-connectivity.html

AND MORE…… TO BE CONTINUED

Our technology starts with You

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