Sensors Converge

STMicroelectronics presence detection technologies: **TMOS and ToF**

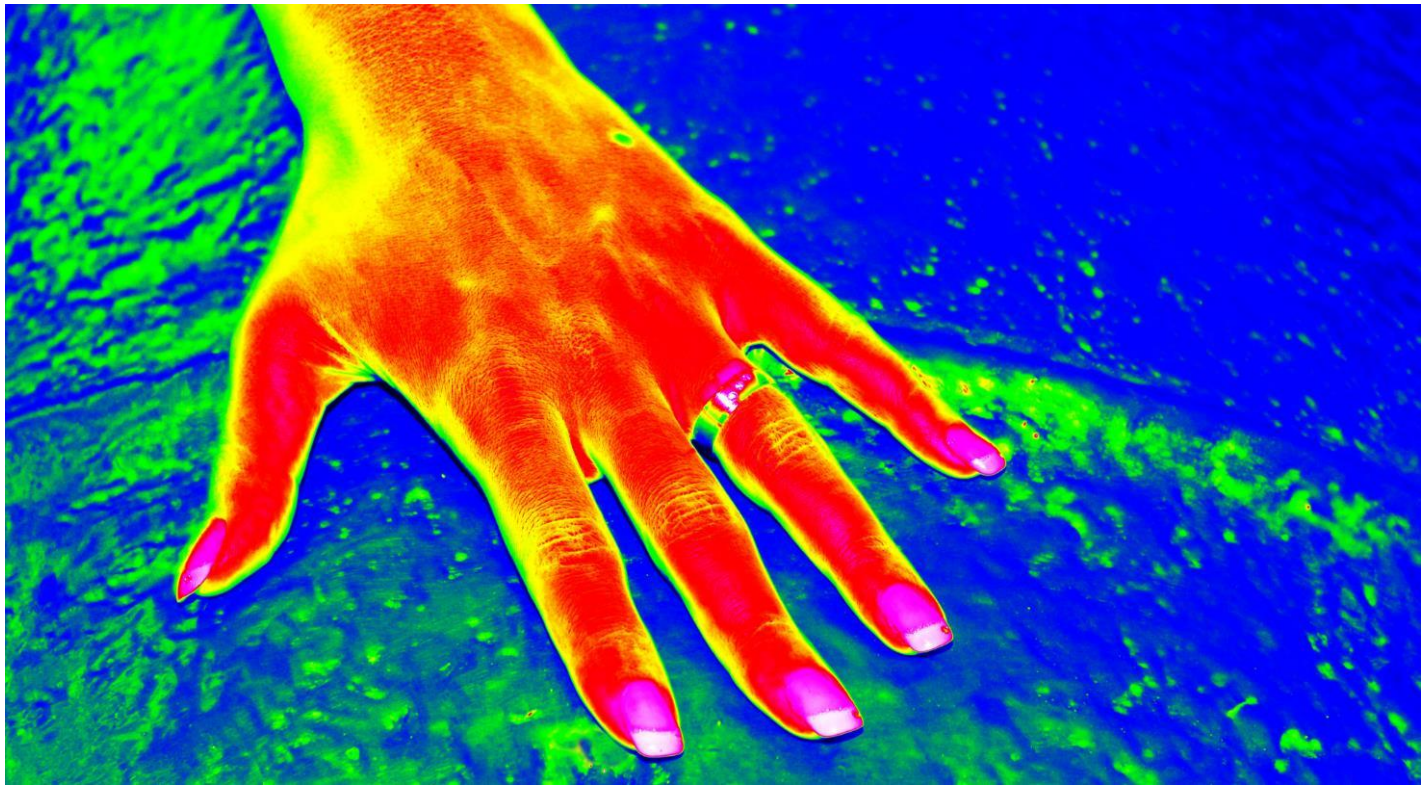
Alexandra Gogonea & Ruchi Upadhyay
STMicroelectronics

June 20–22, 2023 | Santa Clara, CA

Visit us in Booth #936

#SensorsConverge

Thermal MOSFET (TMOS)



TMOS - Sensing element

CMOS + MEMS technology

Human Body

Infrared radiation (heat) at 9.8 µm

Presence / Motion detection

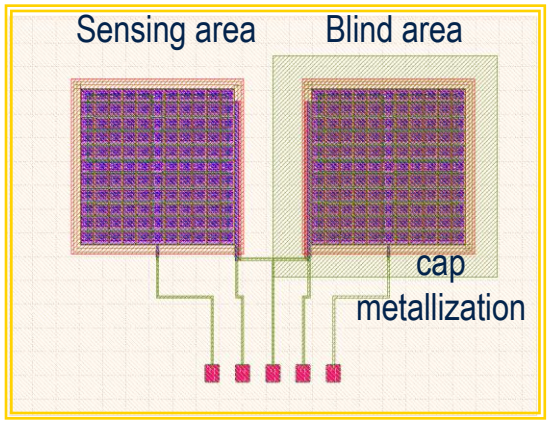
Remote heat sensor

CMOS = Complementary Metal Oxide Semiconductor
TMOS = Thermal Metal Oxide Semiconductor

life.augmented

What is the TMOS sensing technology

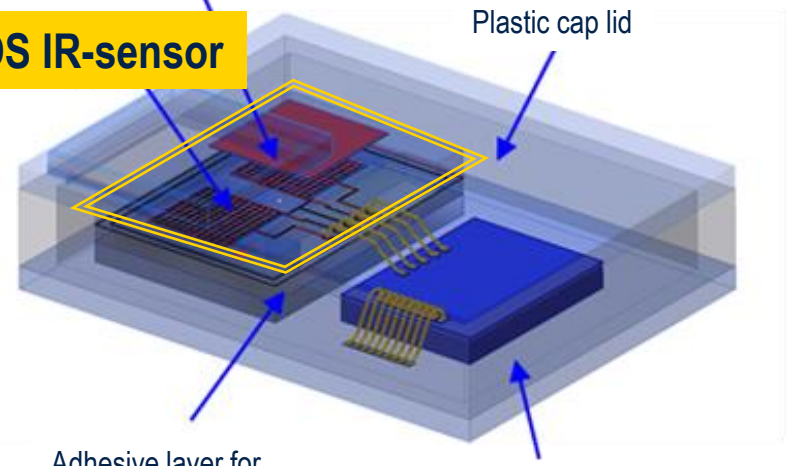
ST MEMS technology



TMOS Sensing element

Optical window for IR radiation between **5µm to 20µm wavelength**

TMOS IR-sensor



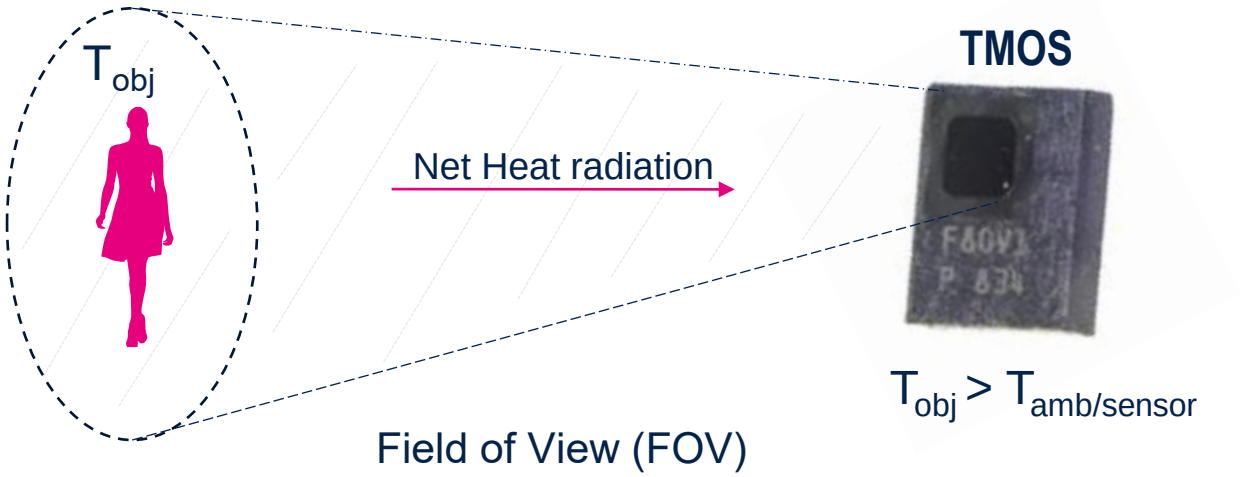
- Based on CMOS transistor, thermally isolated
- Integrated MEMS absorber to improve sensitivity
- High vacuum in wafer level packing

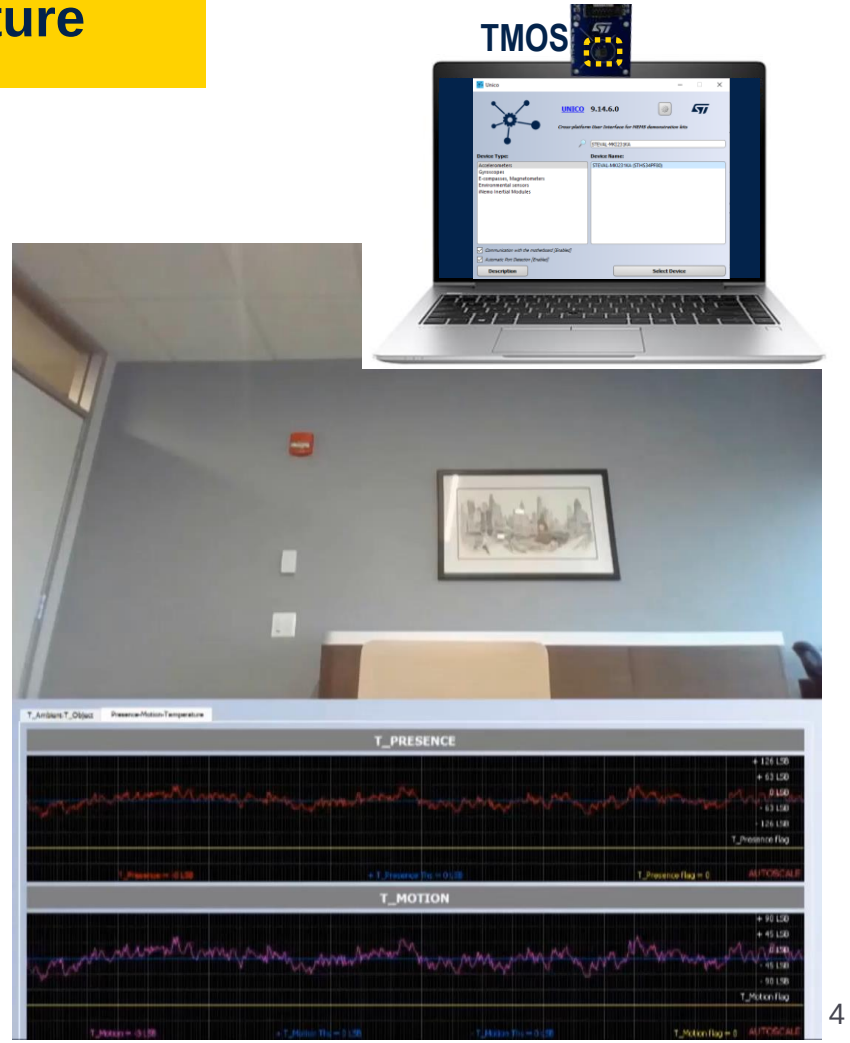
CMOS = Complementary Metal Oxide Semiconductor
TMOS = Thermal Metal Oxide Semiconductor
MEMS = Micro Electro-Mechanical Systems

life.augmented

How TMOS sensing technology works

Every object emits thermal radiation depending on its temperature





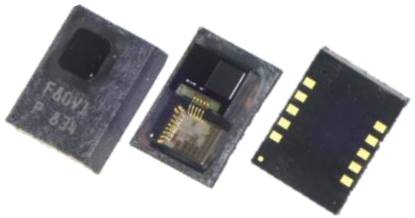
Sensor measures the **net amount of infrared radiation that is collected in the FOV**

Presence and motion detection

life.augmented

TMOS technology highlights

Low-power, high-sensitivity infrared sensor (5µm to 20µm wavelength) for presence and motion detection



✓Small size
✓Factory calibrated

Digital I2C / 3-wires SPI interface
Supply voltage: 1.7V to 3.6V

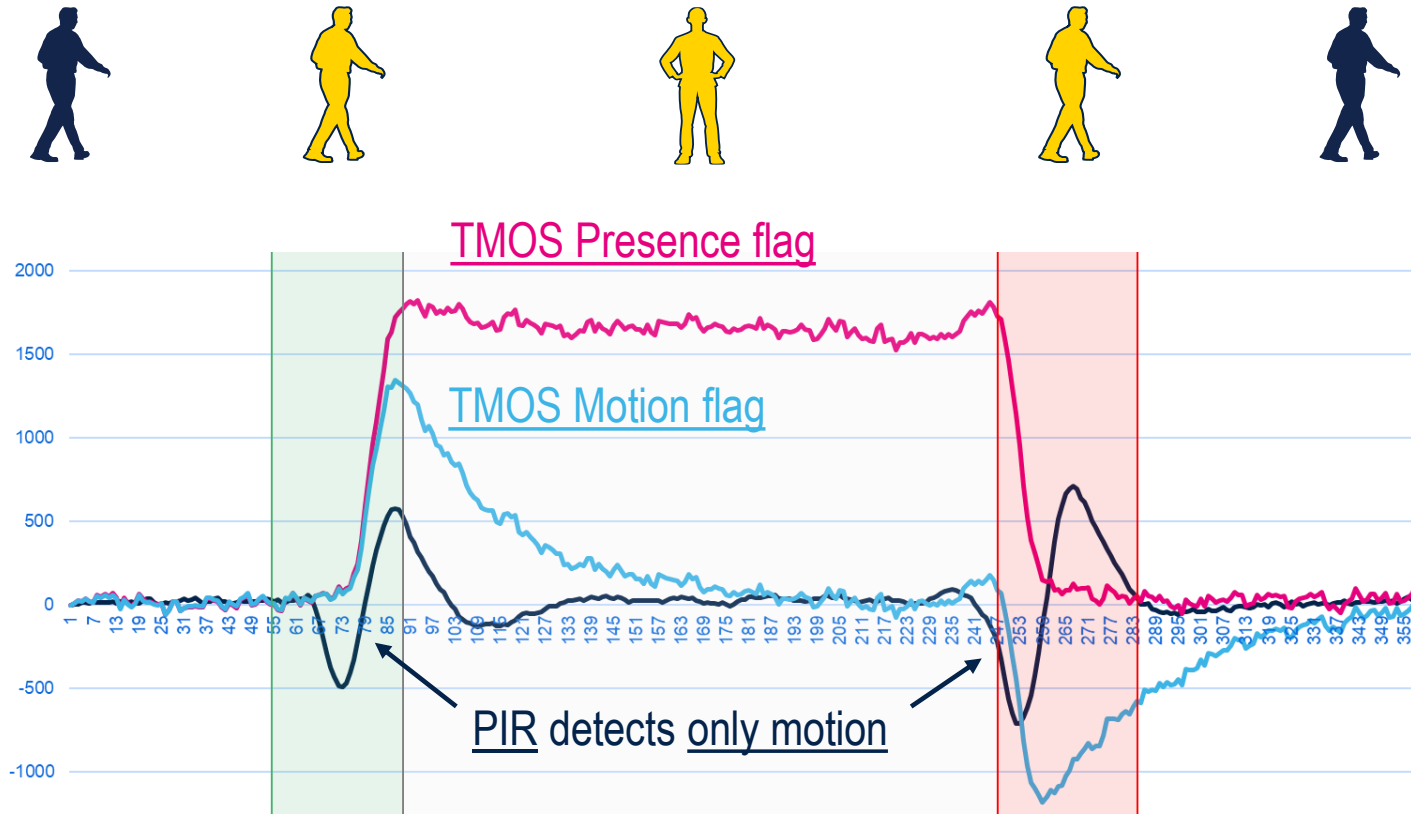
Supply current: 5µA (32 average @ 1Hz output data rate)
Power down current: 1µA

80deg Field of View (FOV) with 50% intensity
Presence / movement detection up to 4 meters

life.augmented

TMOS vs PIR

Superior performance – presence and motion detection with TMOS



Why TMOS

- ✓ Smaller package
- ✓ Simpler HW design
- ✓ Digital features
- ✓ Robustness

TMOS = Thermal Metal Oxide Semiconductor
PIR = Pyro-electric / Passive Infrared

TMOS can detect **stationary and moving** person in the field-of-view

life.augmented

Time-of-Flight (ToF) introduction

life.augmented

Time-of-Flight (ToF)

Optical depth sensors measure the time during which photons bounce off objects in the field-of-view

$$Measured\ distance = \frac{Photon\ travel\ time}{2} \times Speed\ of\ light$$

Non-intrusive presence detection

Based on invisible infrared light

Photons based

Speed of light is 300 000 km/s, allowing for very accurate and reliable measurement

Advanced computing

Multiple outputs to create smart use-cases

life.augmented

Proximity and ranging sensors

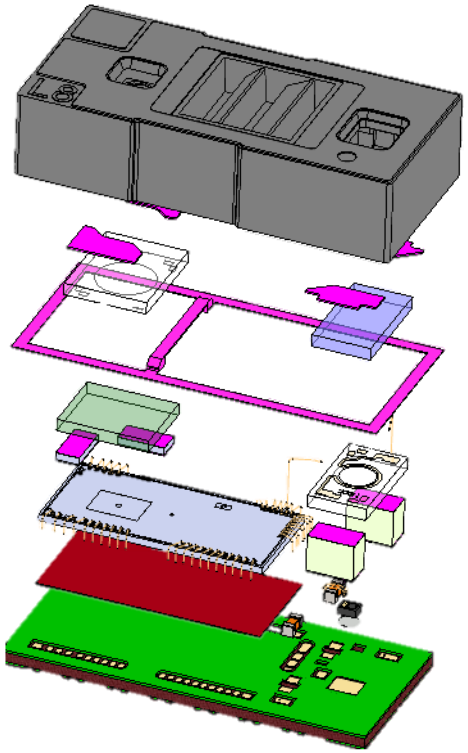
What's inside a FlightSense™ module

Time-of-Flight SoC
SPAD receiver
Laser driver

Highly efficient VCSEL
940nm IR emitter
Class 1 safety

Advanced optics
IR lens and filters
Meta-surface optics (new sensors)

State-of-art assembly & testing
ST manufacturing line
In-house meta-surface optics



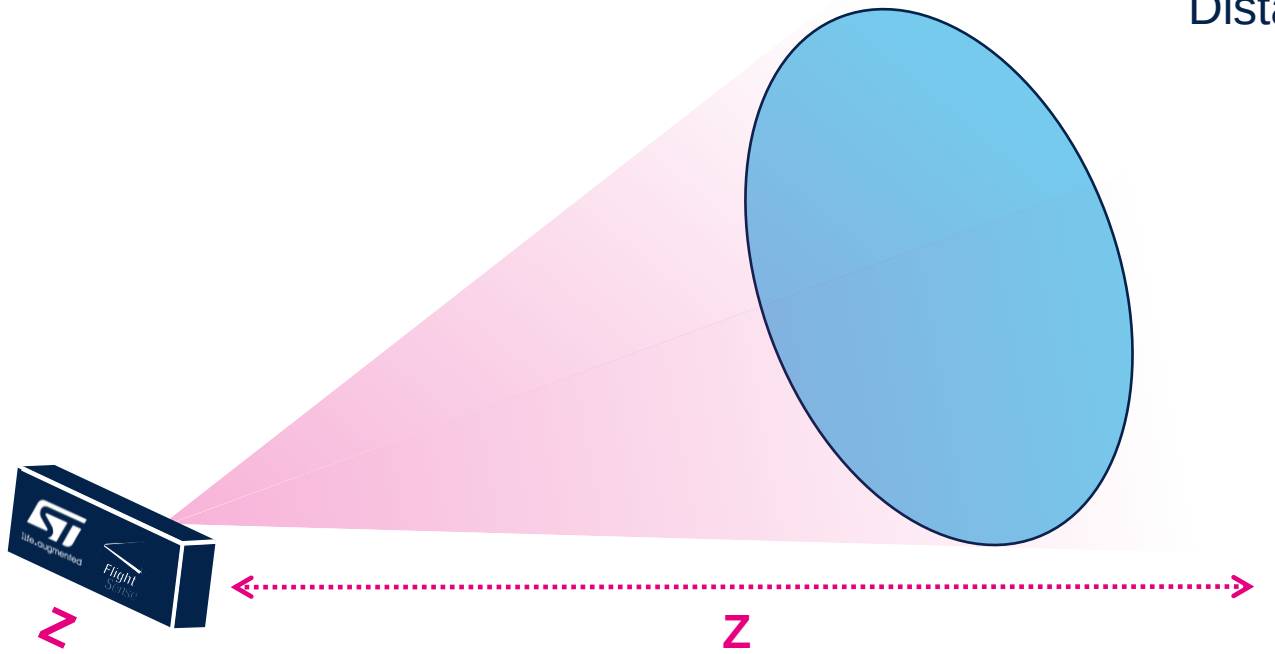
life.augmented

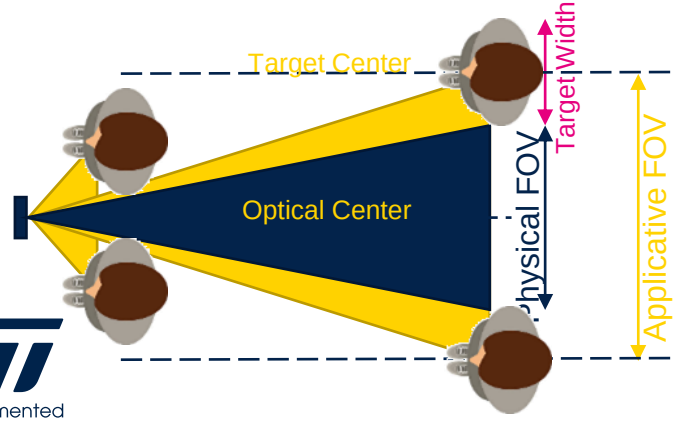
Single and multi-zone Time-of-Flight sensors

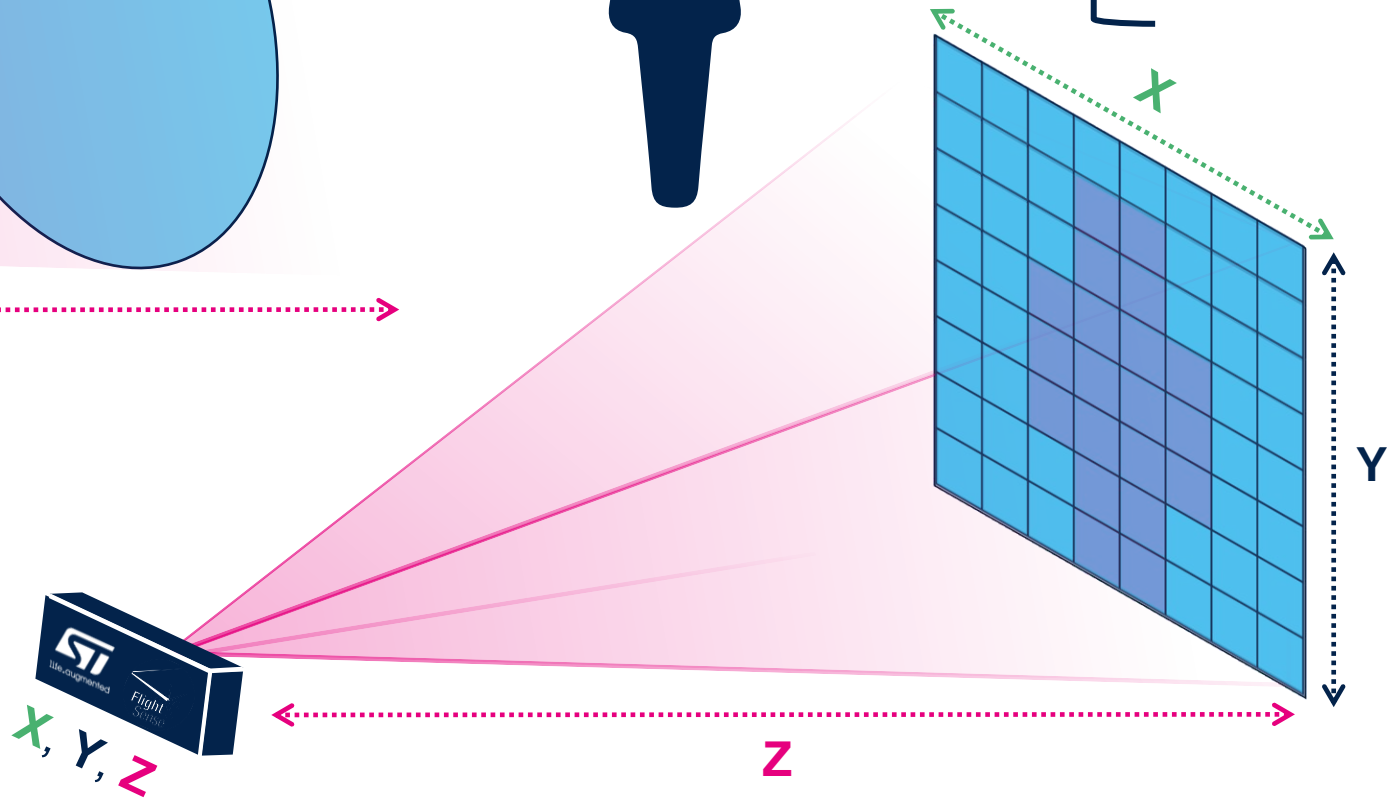
Distance: **1280 mm**

Some understanding:

3152	…	3240
…	1286	…
…	1279	…
2880	…	2761







Time-of-Flight sensor key applications

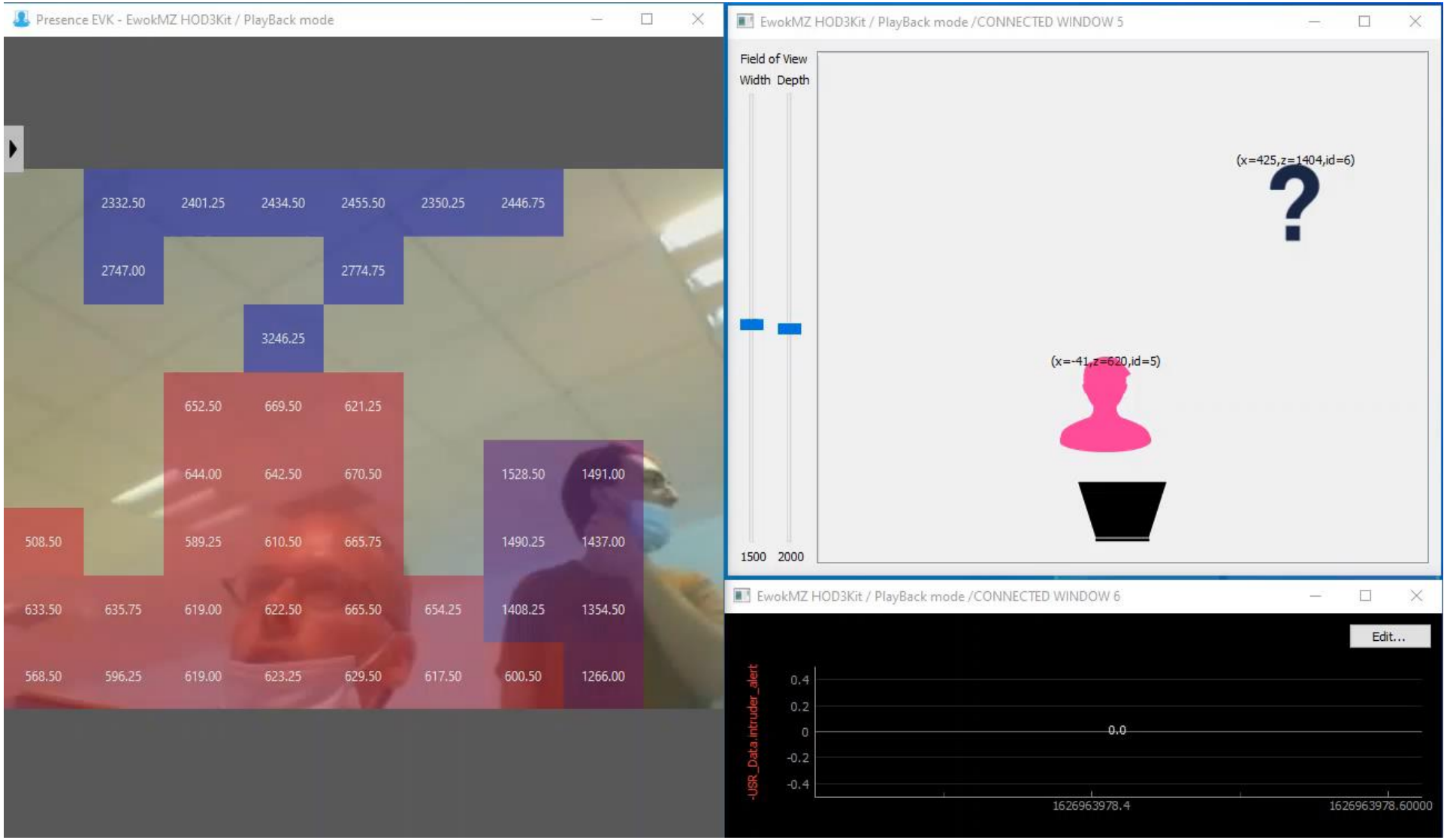
Key applications
Hand tracking & gesture recognition
Presence detection
Surface type sensing
Liquid level monitoring
Content management
AR / VR / MR
Room mapping
Face authentication
Object detection

Presence detection
System activation
People counting
People recognition
Occupancy analytics
Face authentication

life.augmented

Gesture recognition & presence detection

Multiple object presence detection



Enhanced capabilities with TMOS and ToF sensors

life.augmented

Building & home control

Indoor surveillance cameras & wireless room sensors

life.augmented

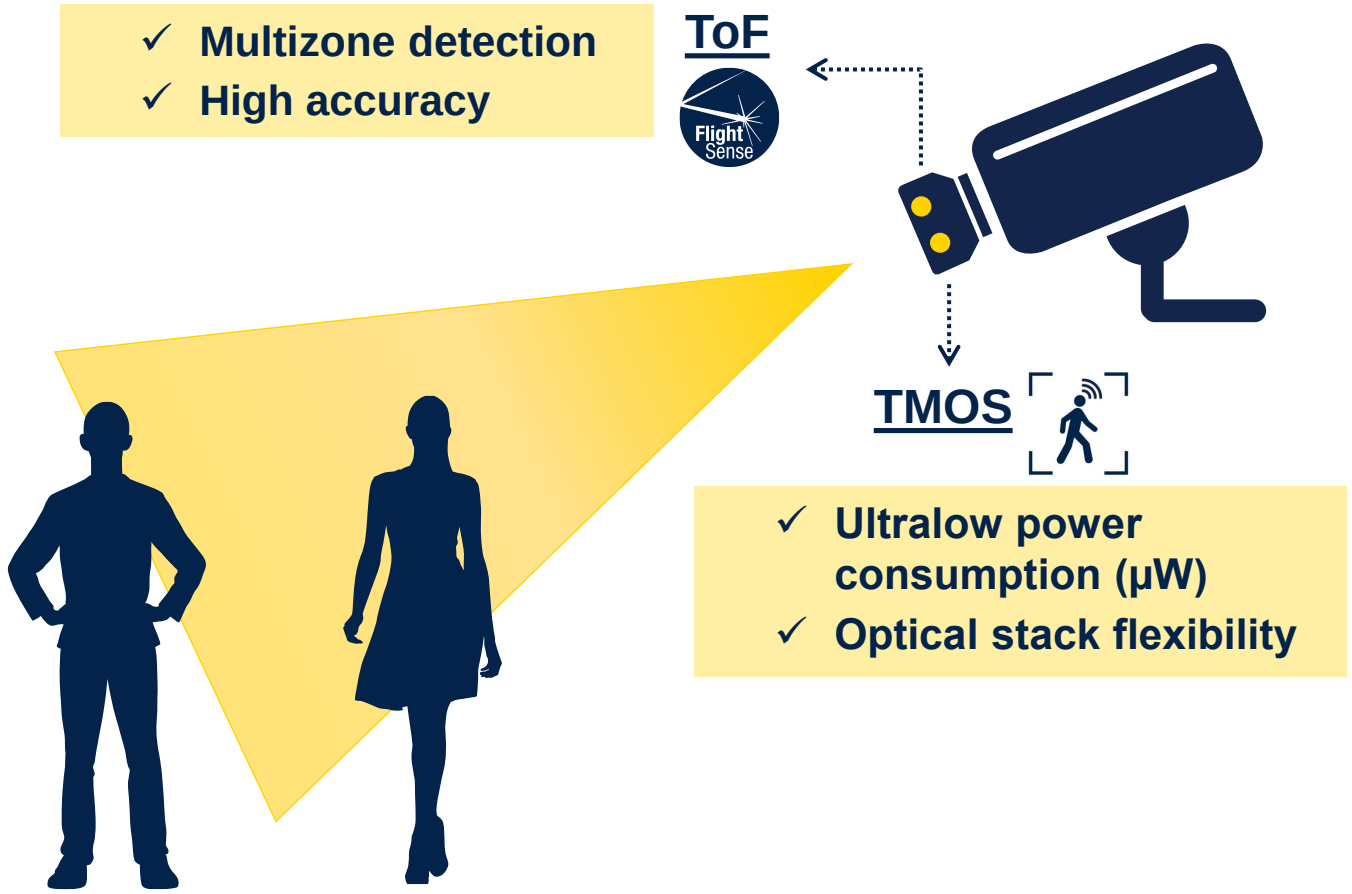
Building & home control

Indoor surveillance cameras & wireless room sensors

Presence and movement detection

Detect if presence within a given distance

Collect data to improve energy efficiency



Wide area system activation for home security

Building & home control

Smart thermostat

life.augmented

Building & home control

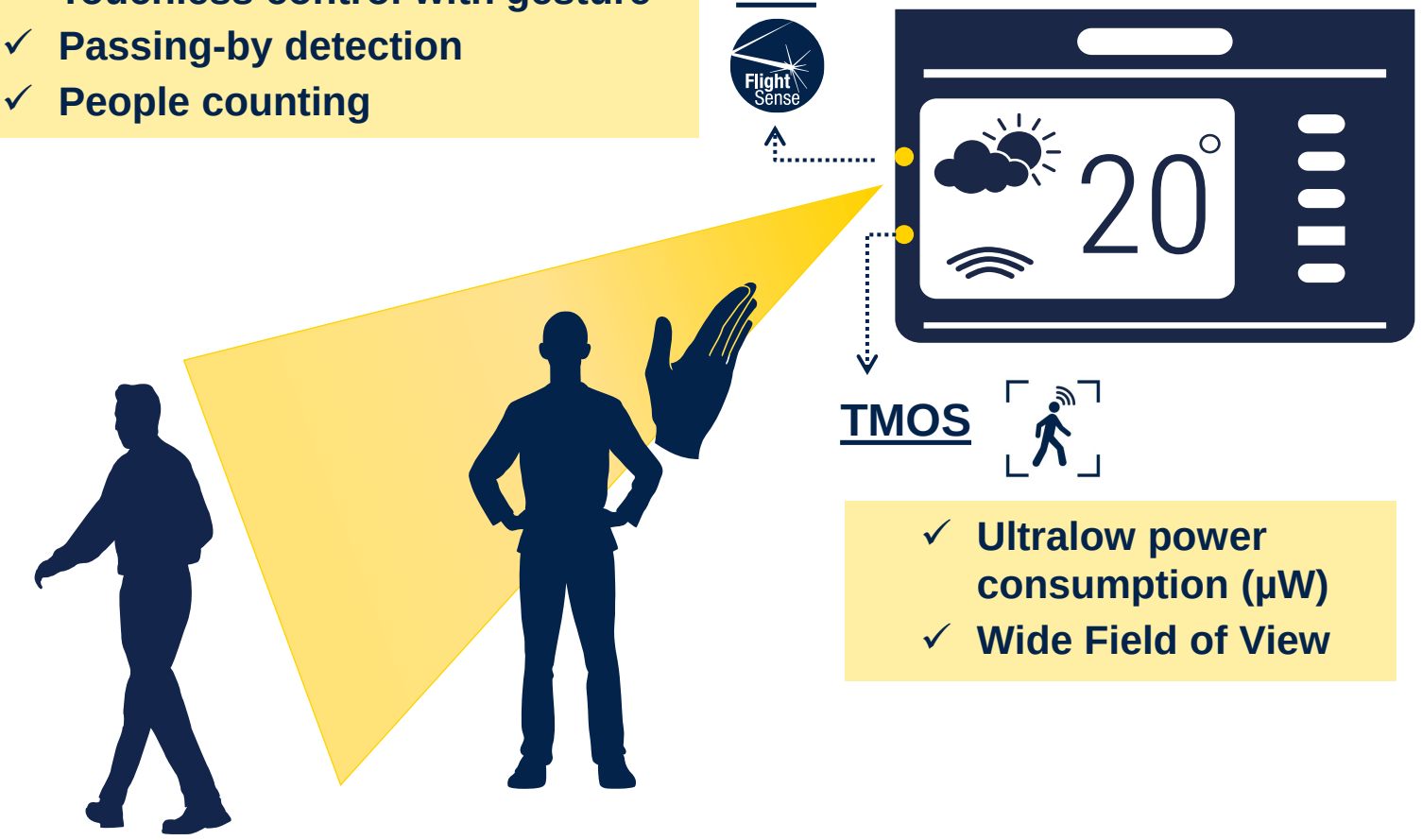
Smart thermostat

Presence and movement detection

User detection & interaction with the device

- ✓ **Touchless control with gesture**
- ✓ **Passing-by detection**
- ✓ **People counting**

ToF



TMOS

- ✓ **Ultralow power consumption (µW)**
- ✓ **Wide Field of View**

A longer life for battery operated thermostats with enhanced features

life.augmented

Takeaways

ST offers multiple technologies to enable presence, motion detection and ranging applications

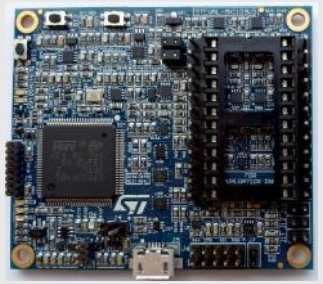
Turnkey solutions: from reliable presence detection to complex gesture and motion recognition

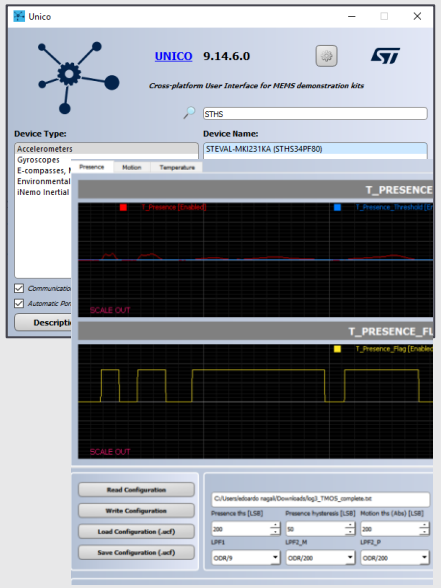
Flexibility: from ultralow power to high performance sensing solutions

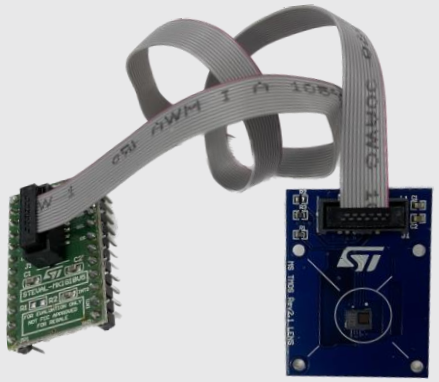
life.augmented

TMOS and ToF evaluation and development platforms

Professional MEMS motherboard & adapter board







TMOS

Expansion Boards & Adapter boards

ToF

STM32 Open Development Environment

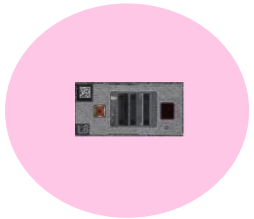
life.augmented

Find out more at www.st.com

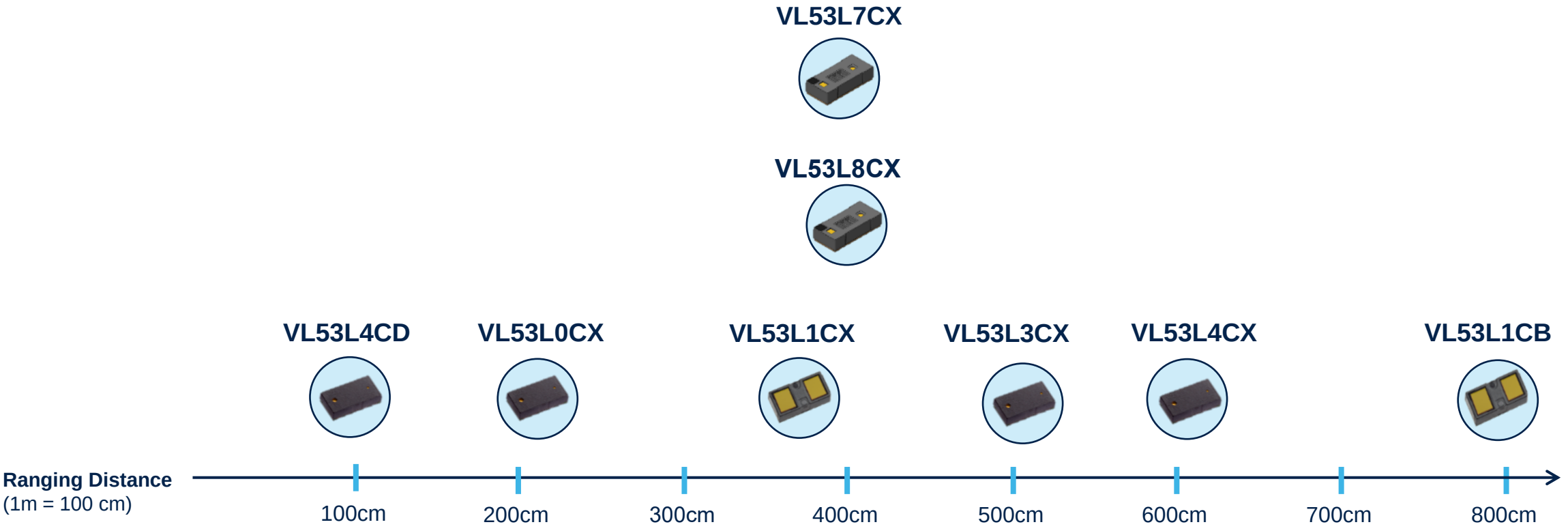
© STMicroelectronics - All rights reserved.
ST logo is a trademark or a registered trademark of STMicroelectronics International NV or its affiliates in the EU and/or other countries.
For additional information about ST trademarks, please refer to www.st.com/trademarks.
All other product or service names are the property of their respective owners.

life.augmented

Time-of-Flight Portfolio



Time-of-Flight (ToF)



life.augmented