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Optical Sensing Solutions Introduction

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Imaging

AP Region, STMicroelectronics



Agenda

1 Quick Imaging introduction

2 **FlightSense™** introduction

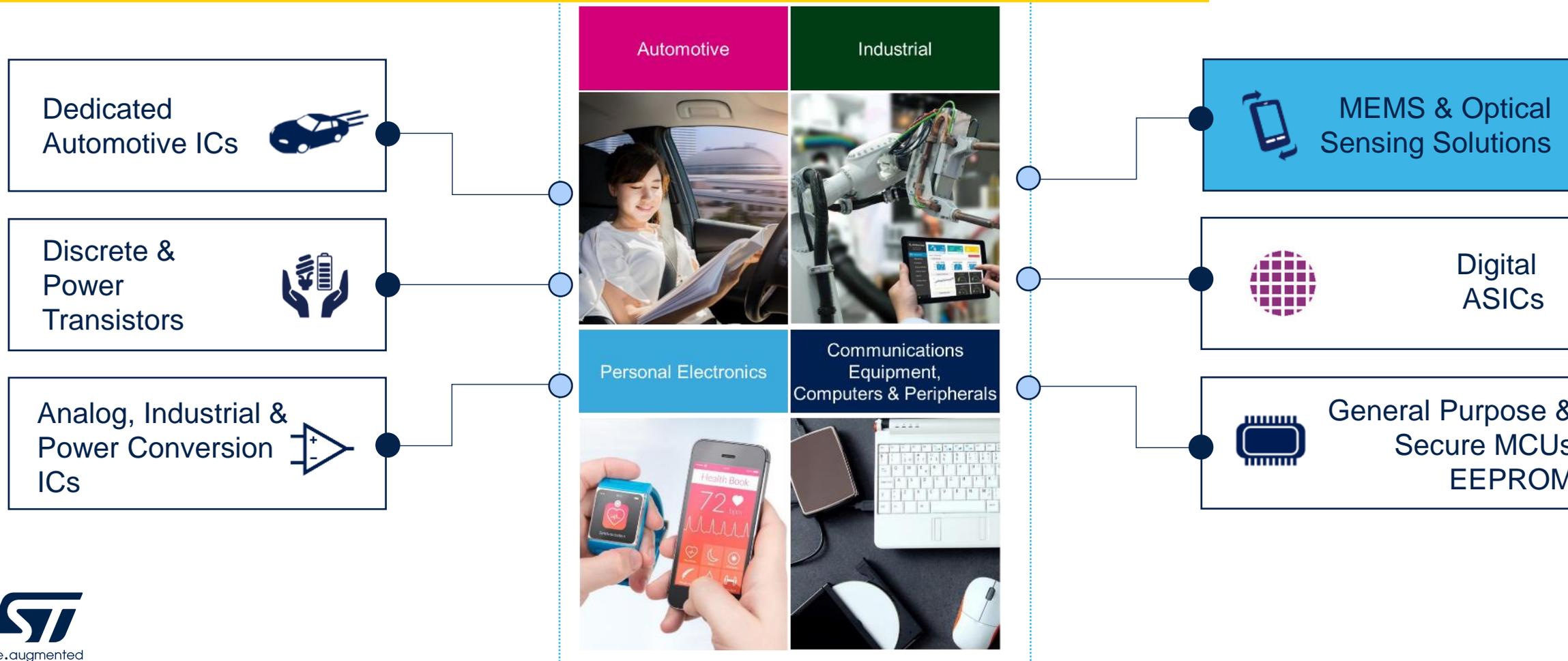
3 **FlightSense™** Mass Market use-cases & examples

4 **FlightSense™** Mass Market roadmap & eco-system



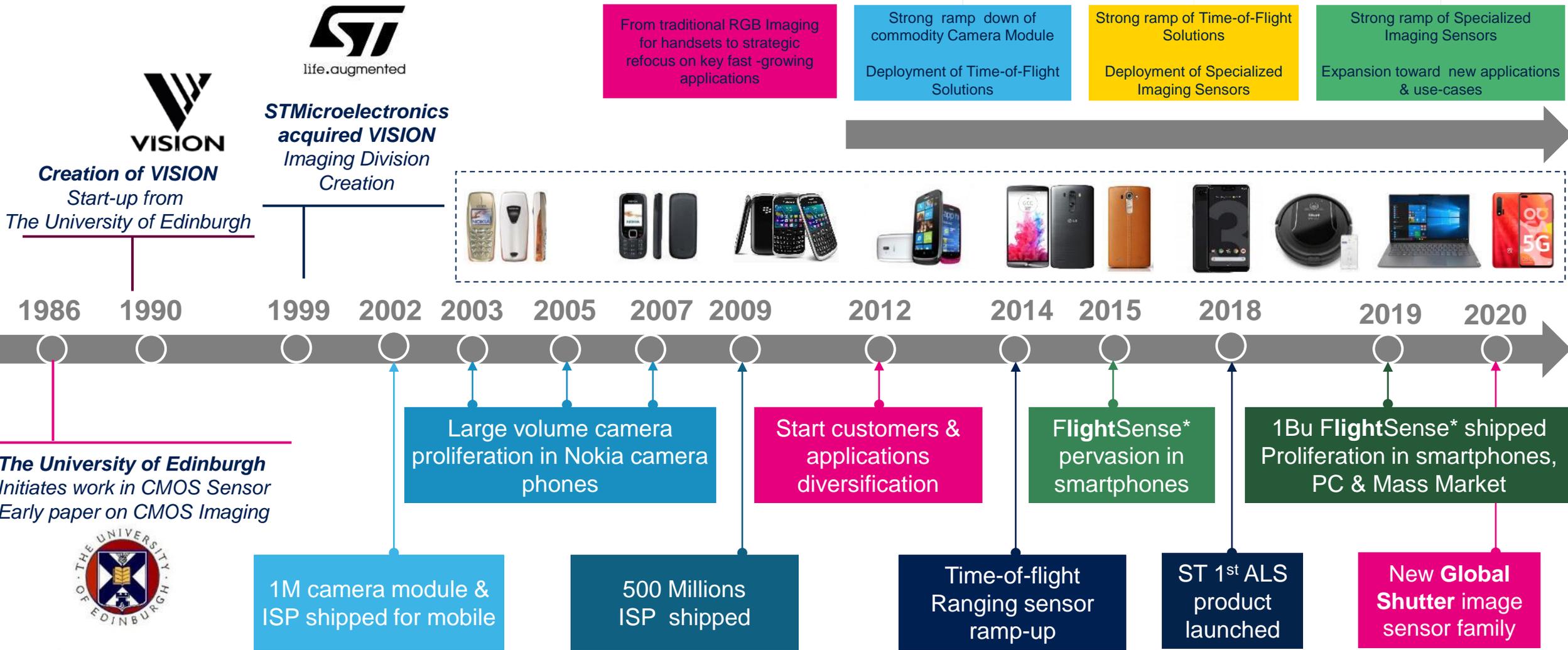
End market focus & ST product families

IMG portfolio delivering complementarity for ST target end markets & synergies in R&D and manufacturing



Imaging & Optical Sensing Solutions

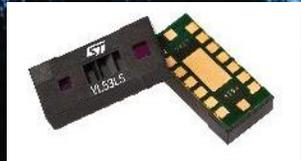
20+ years offering innovation to market



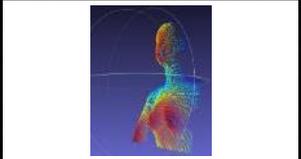
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Optical sensing solutions for Industrial

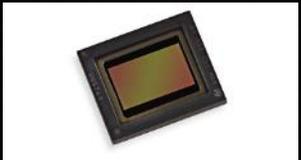
Time-of-Flight sensors & Global shutter image sensors for multiple applications and use-cases



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



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



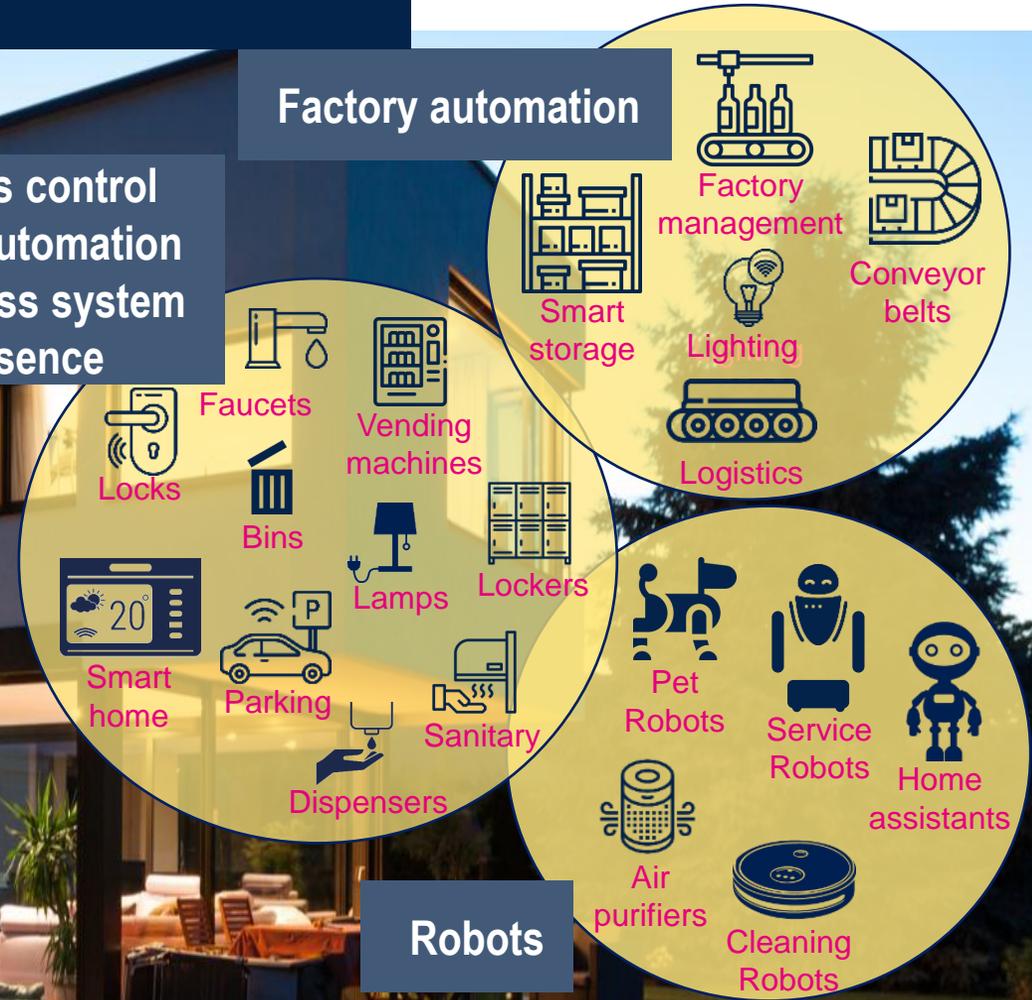
Global Shutter image sensors
2.6 μm down to 2.2 μm pixel



Ambient Light Sensors
Small size, low power, flicker detect

Access control
Home automation
Touchless system
Presence

Factory automation



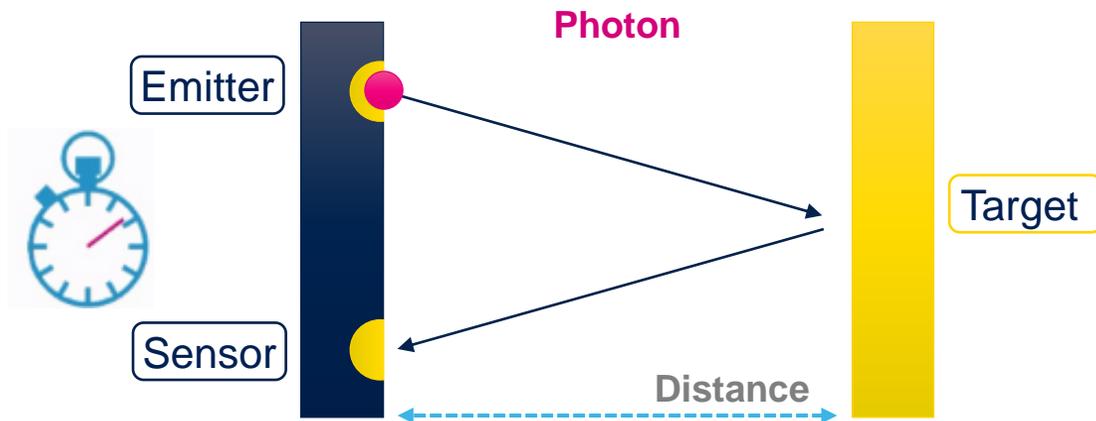
FlightSense™ Time-of-Flight proximity and ranging sensors



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FlightSense* ... Making Light work

Time-of-Flight Principle



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

1cm round-trip takes 67ps

● ST proprietary FlightSense* technology

● True distance measurement
Independent of target size, color & reflectance

● Fast and low power

● Truly invisible 940nm illumination



FlightSense™

ST pioneer and leader in Time-of-Flight

ST is #1 Worldwide Time-of-Flight sensor supplier

ToF Pixel Expertise
SPAD/FPD

Advanced Photonics
CMOS Process
(40nm/3D)

Micro-Optics
& Supply Chain

Illumination Expertise
& Supply-chain

Embedded ToF
Processing
& Depth ISP

Advanced Packaging
know-how
& manufacturing

5 Generations

of all-in-one ToF solutions deployed since 6 years

>50 OEMs

Over 200 phones with ST's Time of Flight technology
Several hundreds of non wireless end products on the market
Unlimited variety of use-cases beyond smartphones

>47,000

Evaluation kits deployed

1 Billion

ToF units shipped in November 2019, high volumes continuing.
Mastering end-to-end supply chain



VL53L5

5th generation FlightSense™



FlightSense™ Typical module overview

All-in-One (illumination & sensor) Time of Flight System
Optimized Size, Performance, Cost mix

Advanced optics with
integrated IR filters

State-of-art assembly & testing
ST manufacturing line in Shenzhen

**All FlightSense™ products are
Laser Class 1 certified, to typically
higher standards than competitors**



**Monolithic ToF SoC, SPAD Array,
RAM/ROM & high safety Class 1
VCSEL driver**

**Full Class 1 safety
high efficiency VCSEL**



- IEC/EN Class 1 laser product certified:
 - For both 60825-1 2007 and 2014 editions
 - Under all operating conditions
 - Under single-fault failure conditions
- SAFEST laser class



Product Service



Smart optical sensing & FlightSense™ ... making light work



Camera Assistance

- Laser autofocus
- Touch-to-Focus
- Scene understanding
- AWB assist based on 940nm content

Ranging & Proximity

- True ToF distance
- High accuracy
- Up-to 4 meters

Multispectral & Flicker

- True tone color display & ALS
- Camera AWB
- Light flicker measurement and correction

Face Identification

- Face anti-spoofing
- Cost, power, size optimized
- All-in-one depth sensing

Presence, User Detect

- Security
- Comfort
- Power saving
- Eye protection
- Wellness

Depth Map & AR/VR

- All-in-one Module
- High resolution receiver
- Gesture
- Consumer LiDAR

FlightSense™ product portfolio



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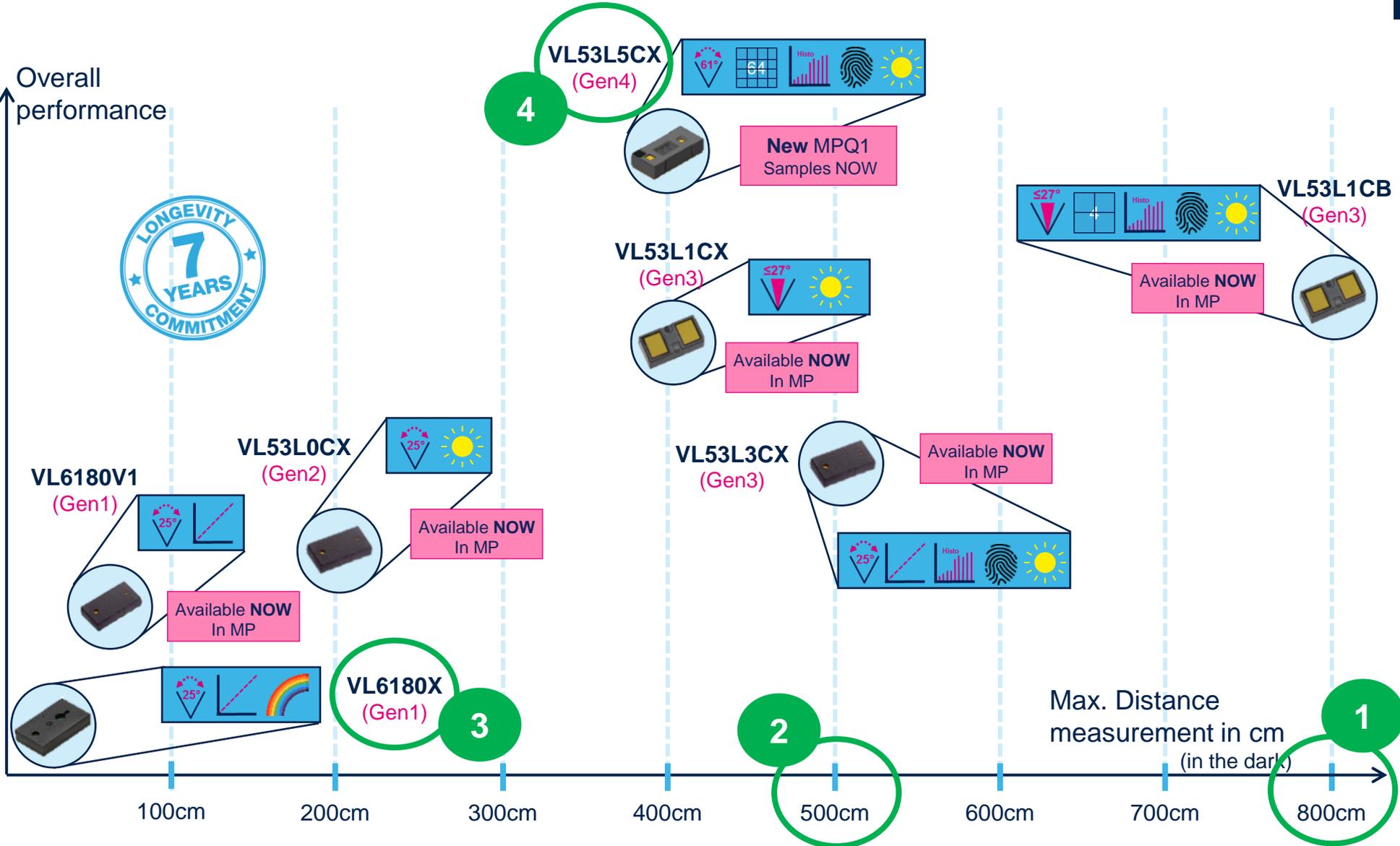
FlightSense™ mass-market roadmap

NEW

Overall performance



-  XX° FoV
-  Programmable FoV
XX° Max
-  Up to 4 zones sequentially
-  Up to 64 zones
-  Histogram
MultiObject detection
-  Perf. Under Ambient
-  Smudge correction
-  Close distance
Linearity
-  Ambient Light
Sensing



FlightSense™ portfolio

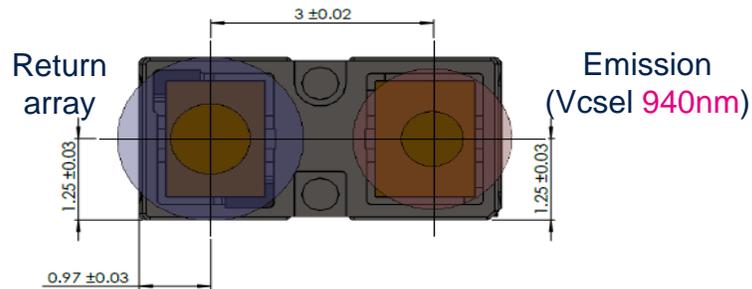
A wide FlightSense™ portfolio ready to meet unlimited market and application requirements



Distance measurement	Proximity up to 60 cm	Proximity up to 60 cm	Ranging up to 2 m	Ranging up to 4 m	Proximity + ranging up to 5 m	Long distance ranging, up to 8 m	Mini depth map up to 4 m
Resolution	1 zone	1 zone	1 zone	1 zone	1 zone	1 zone or sequential Multi-zone	64 Zones 8x8 or 4x4
Field-of-View	25° No Lens	25° No Lens	25° No Lens	27° (SW configurable) Lens on Rx	25° No Lens	27° (SW configurable) Lens on Rx	61° Lens on Rx Lens on Tx
Multi-target detection	No	No	No	No	Yes	Yes	Yes
Small all-in-one modules	4.8 x 2.8 x 1.0 mm	4.8 x 2.8 x 1.0 mm	4.4 x 2.4 x 1.0 mm	4.9 x 2.5 x 1.56 mm	4.4 x 2.4 x 1.0 mm	4.9 x 2.5 x 1.56 mm	6.4 x 3.0 x 1.5 mm

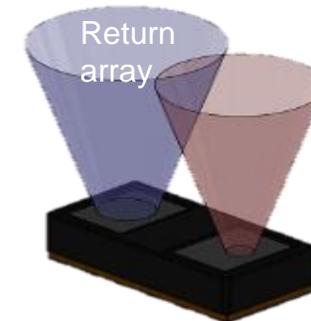
FlightSense VL53L1CX System FoV (Field of View)

Compatible VL53L0CX, VL53L3CX & VL53L1CX footprint allowing flexibility and easy migration



VL53L1CX

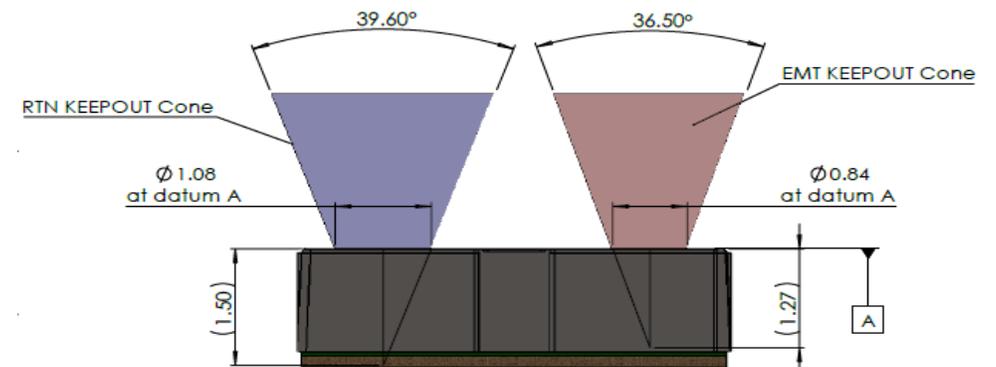
- OLGA12 Package
- **XY Dimensions: 4.9 x 2.5 mm**
- **Z Height : 1.56mm +/- 40um (max 1.6mm)**
- Re-flowable (IPC/JEDEC JSTD-020-C)
- **Includes 30° lens on the return aperture**
- Lens increases return signal reaching SPAD sensing array x8 versus VL53L0CX
- **Increased ranging performance and accuracy as a result**
- No lens on the VCSEL emitter
- **Emitted optical power is identical to VL53L0CX**
- Full laser class1 certification



Typical System
Field of View : **27°**

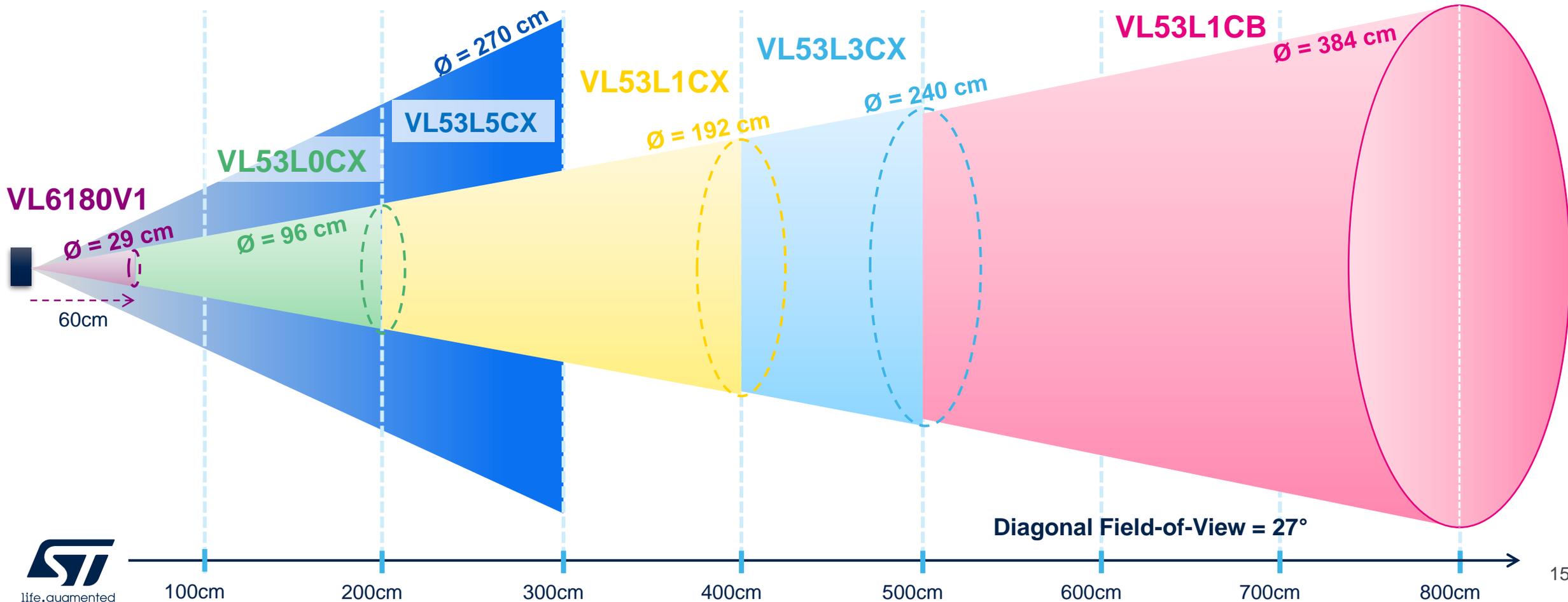
Emission
(Vcsel 940nm)

Exclusion cones for
mechanical integration



Detection Cones & Optical Field-of-view (FoV)

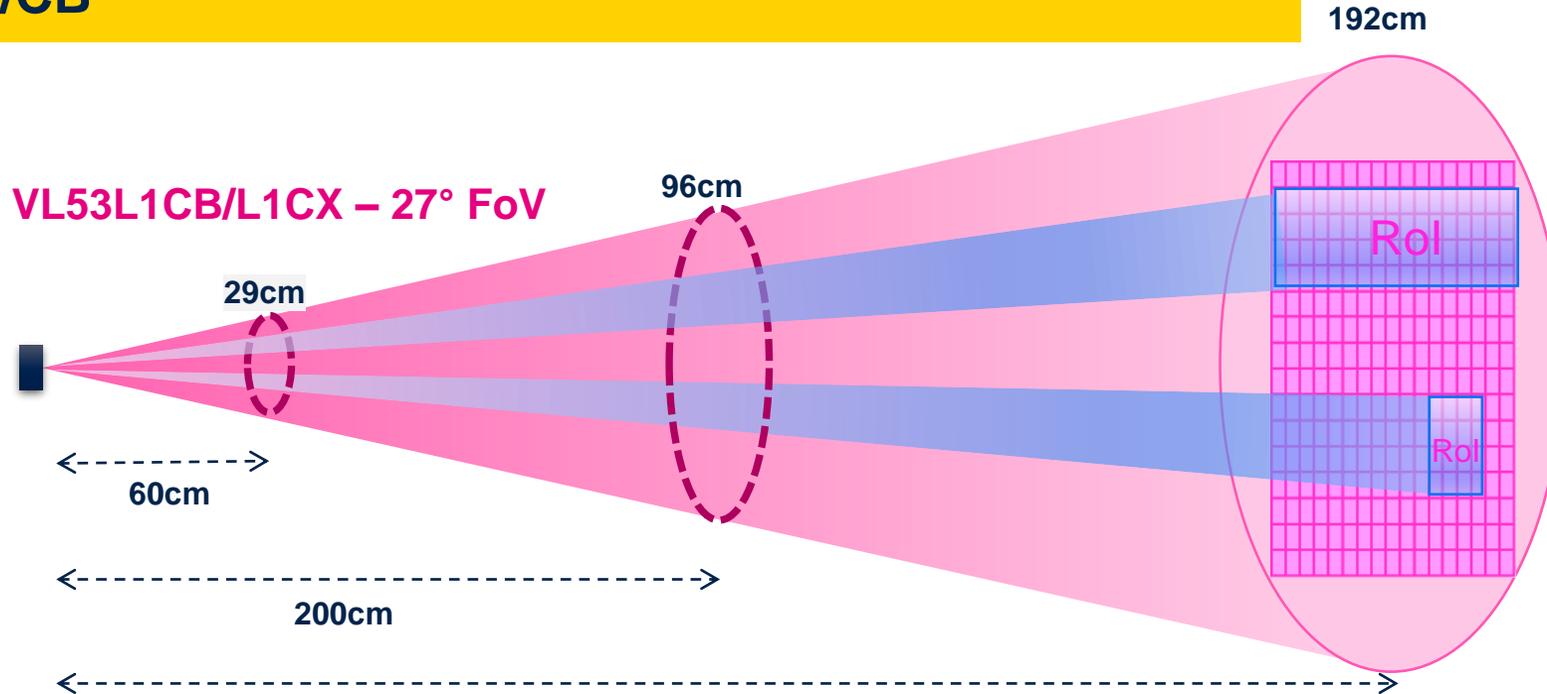
Extended ranging distance enables (very) large target detection area, to be fit application by application



FlightSense VL53L1CX & CB programmable Field of View

Programmable Region of Interest (ROI) enables flexible Field of View (FoV) on VL53L1CX/CB

-  XX° FoV
-  **Programmable FoV**
XX° Max
-  Up to 4 zones sequentially
-  Histogram
MultiObject detection
-  Perf. Under Ambient
-  Smudge correction
-  Close distance
Linearity (+: Excellent)



VL53L1CX - ROI application note
(AN5191 on st.com)

ROI zone size	Virtual Diagonal FOV coverage
4x4 spads	15° (smallest)
8x8 spads	20°
16x16 spads	27° (largest, full FoV)

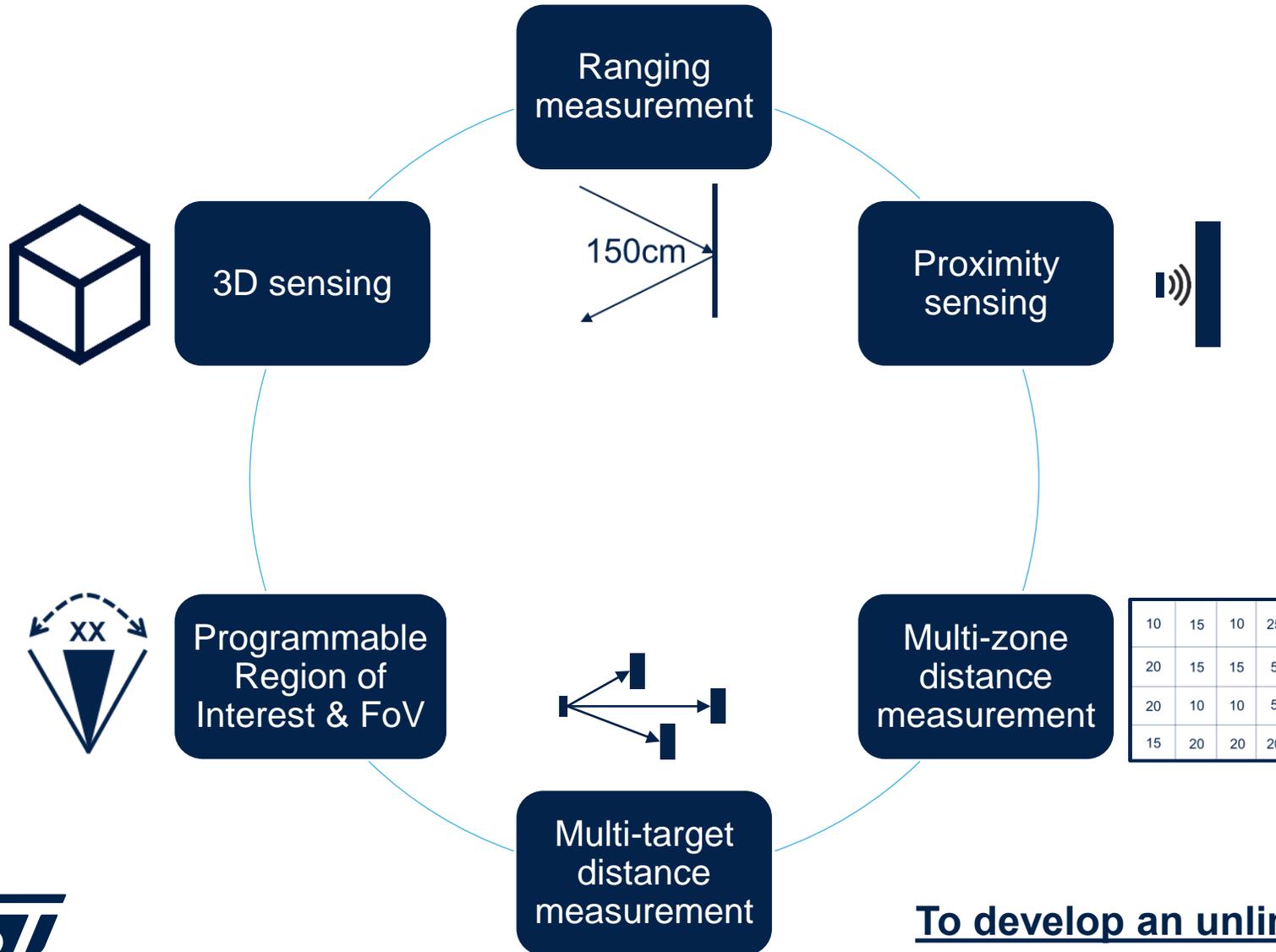
FlightSense™ Industrial applications



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FlightSense™ main sensor functions



Enabling multiple use-cases :

- Ceiling detection
- Content analysis
- Cliff detection
- Gesture control
- Hands-free operation
- Light control
- Load management
- Object detection
- Obstacle avoidance
- Occupancy detection
- Parking occupancy
- Presence Detection
- People counting
- Power saving
- SLAM
- Touch-less operation
- Volume control
- Wall tracking

To develop an unlimited number of markets...



Unlimited markets & applications





FlightSense™

Focus on proximity sensing

Low-power mode & small footprint enabling best user experience



Tablets



Lighting



Mirrors



Sanitary



Faucets



No touch button



Dispensers



Bins



Parking



Printers



Glasses



Medical



White Goods



Wearable & IoT



Safety



Lamps

Typical applications

- Home appliances & Smart Home
- Sanitary systems & premises
- Educational tablets & child smart glasses
- Home automation controls, displays & smart switches
- Touchless systems
- Smart Parking
- Smart Farming

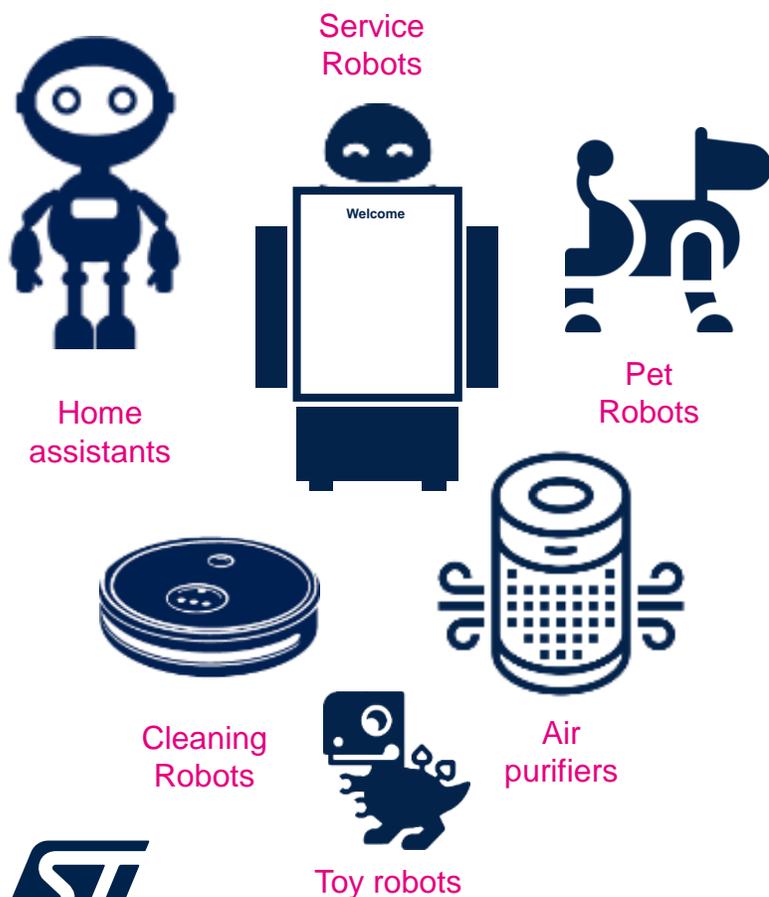
Core benefits

- Performance proven for challenging industrial designs
- High IP integration ready
- Immune to color and texture
- Works with many optical cover materials
- Volume (or else) control
- Small footprint
- Cost-effective system



Focus on cleaning robots & service robots

Supporting multiple functions in one robot



Typical applications

- Obstacle avoidance
- Wall tracking
- Cliff or ceiling detection
- Touchless operation

Core benefits

- Low-power environment sensors
- Performance proven for challenging industrial designs
- Multiple sensors in one robot for ease of integration
- Low memory footprint
- Cost-effective systems

Focus on access control / Presence detection

Full product range from close distance to 8 m detection

Typical applications

- Home appliances
- Access control systems
- Smart speakers
- Smart displays & panels
- Home automation controls, displays & switches
- Occupancy detection
- Touchless systems

Core benefits

- Immediate presence detection
- Effective ON/OFF saving power
- Accurate distance measurement
- Added value features
- Multiple maximum distance offer
- Small footprint
- Cost-effective system



Smart home
Smart Building



Lockers



Service
Robots



Lighting



ATM



Vending
machines



Smart
locks



Transportation



FlightSense™

Focus on factory automation

A wide range of sensors ready for flexible multi-usage integration



Industrial robots



Conveyor belts



Factory management



Smart storage

Typical applications

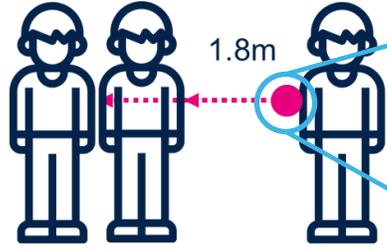
- Conveyor belts
- Safety curtains
- Rolling machines
- Logistics management
- Bar-code readers
- People counting

Core benefits

- Long distance ranging
- multi-object detection
- Fast ranging mode (100 Hz)
- Configurable FoV (RoI)
- High accuracy
- Smudge resistance
- Liquid level detection
- High sensor count integration
- Low power



FlightSense™ use-cases COVID19 opportunities



Social distancing awareness

Social distancing

Accurate distance measurement
Keeping safe distance between people in public spaces

Content management

Inventory control
Check how many masks remain

Monitoring in real time
Avoiding empty stock



Mask dispenser

Touchless Human Machine Interface

Presence detection
Turn on equipment when someone is present

Touchless Buttons

Basic gesture recognition
Avoid contact with screen

Public display
Access Control

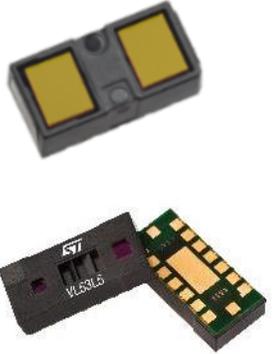


Public transportation

Presence detection

Presence detection
Turn on/off the thermometer if a user is detected

User distance Control
Ensuring user is at the right distance



Thermometer
Thermal camera
Access Control



Shop/Restaurant entrance



Liquid level management

Liquid level control
Gel tank level management

Real time monitoring
Avoiding empty tank

Hydro alcoholic gel dispenser

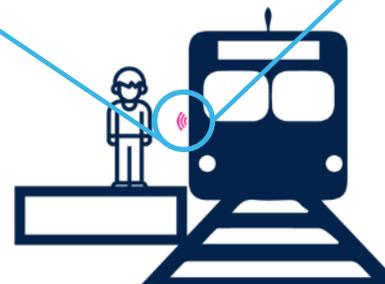


Proximity detection

Basic gesture recognition
"zero-touch" operation

Touchless buttons

Basic gesture recognition
Contact less door operation



People counting

Counting entry/exit
Respecting maximum number of people authorized in premises

High Performance Small Footprint Global Shutter Sensor

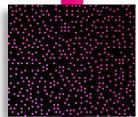


Global shutter sensors

Main machine vision use-cases

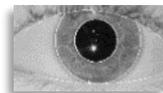
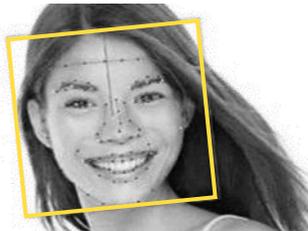
Depth Sensing

- Active Stereo
- Structured Light



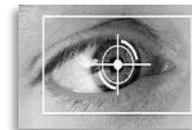
Biometrics

- Windows Hello
- 2D Face ID
- Gesture detection
- Human detection
- Iris recognition



AR/VR/MR

- Eye-tracking
- 6DoF
- SLAM



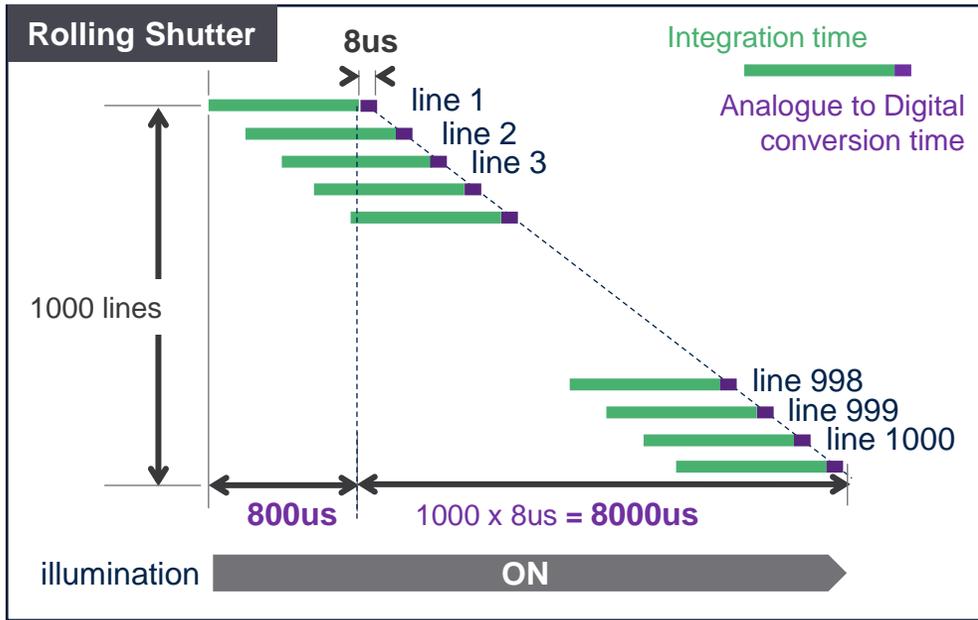
Robotics & Machine Vision

- Drone
- SLAM
- Scene analysis
- Object detection
- Barcode

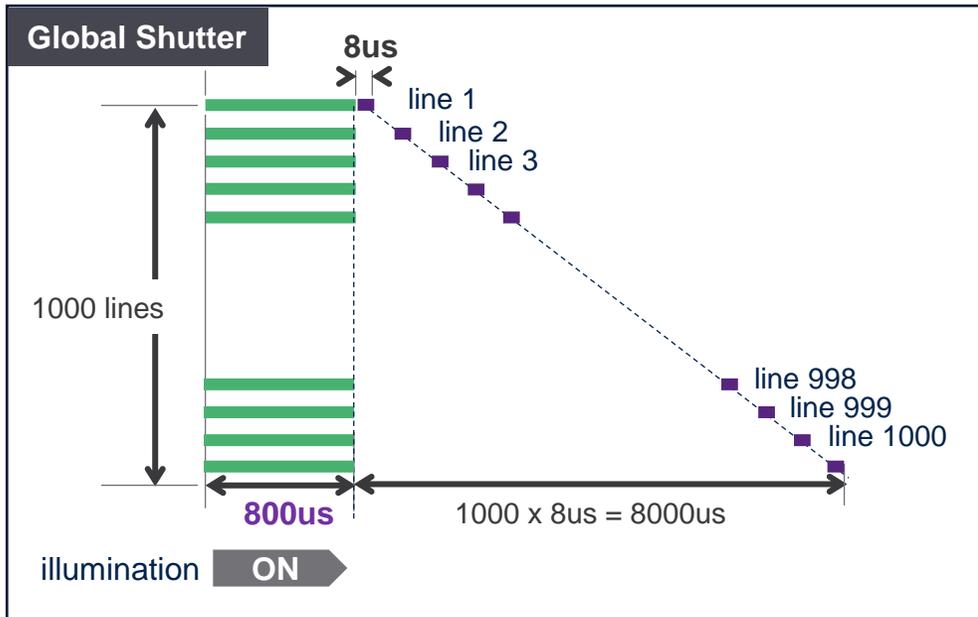


Global shutter sensors

Why global shutter



Pixel array integration time and read-out



Rolling Shutter

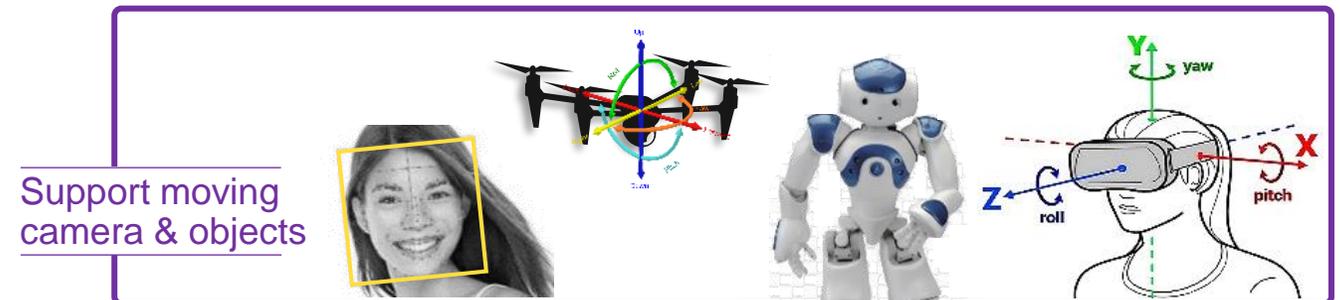


Global Shutter



Rolling Shutter Exposure line after line, with a delay

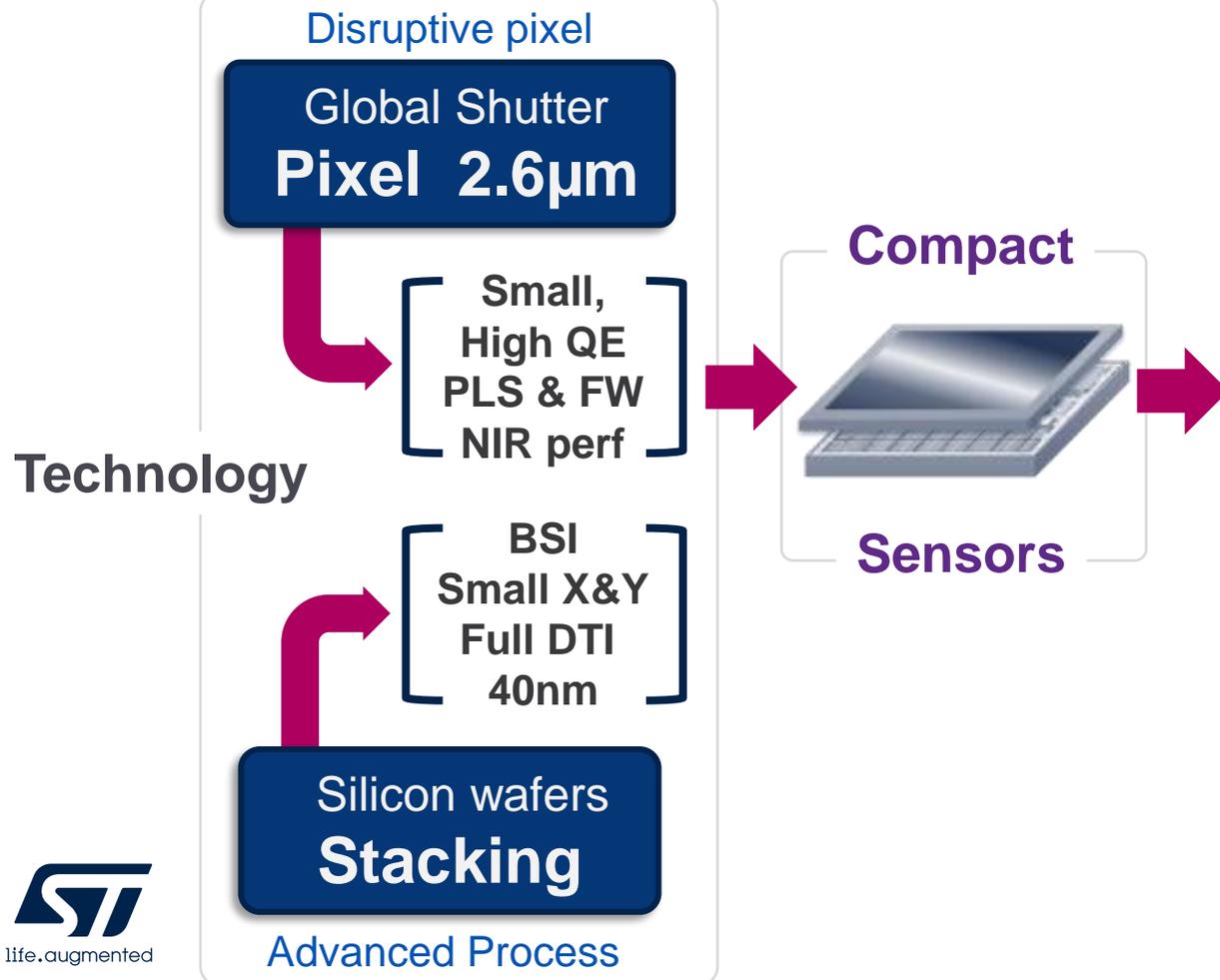
Global Shutter All lines exposed to the light at the same time



Global shutter sensor for Industrial

Main features

The smallest high performance 1.5mp and VGA + resolution global shutter sensor on the market



2.6um Global shutter	VD56G3	VD55G0
Resolution	1.5Mp 1124x1364	0.4Mp 644x604
Optical format	1/4"	1/9"
Optical Flow	✓	✗
Dynamic Defect Correction	✓	✓
Statistics	24x14 zones	8x8 zones
Auto-Exposure	✓	✓
Frame contexts	4x	4x
Flexible IO PWM, Strobe, Frame start, Vsync , Gpio	8x IOs	4x IOs
User available NVM	3072 bits	1024 bits
Sensor dimension	15.9mm ² (3.6 x 4.3 mm ²)	6.5mm ² (2.6 x 2.5 mm ²)
Mipi CSI-2 interface	2x 1.5Gbps	1x 1.2Gbps
Mirror/Flip, Crop, Binning (2x/4x)	✓	✓
Temperature Sensor	✓	✓

FlightSense™ Takeaways



Key takeaways

Time of flight, 3D sensing & global shutter image sensors: A wide product offer for Industrial applications

- ST **FlightSense**[™] leads in TOF product shipments, quality and services
- ST **FlightSense**[™] provides true distance measurement independent of target color & reflectance
- ST **FlightSense**[™] meets most stringent laser safety class 1 requirements
- A wide **FlightSense**[™] product offering ready to meet unlimited markets & applications requirements
- ST offers high-performance **compact global shutter sensors** for machine vision applications

Thank you

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