



Mobile Robots: Sensor & Navigation

AGV – Automated Guided Vehicles

AMR – Automated Mobile Robots

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Application Manager Robotics

2022 Edition



Infineon is a globally leading semiconductor player



top 10

- › semiconductor company

~46,700

- › total employees

~7,800

- › R&D employees

leading player

- › in automotive, systems for power management and drives, sensor systems, connected secure systems, wireless combos, differentiated memories

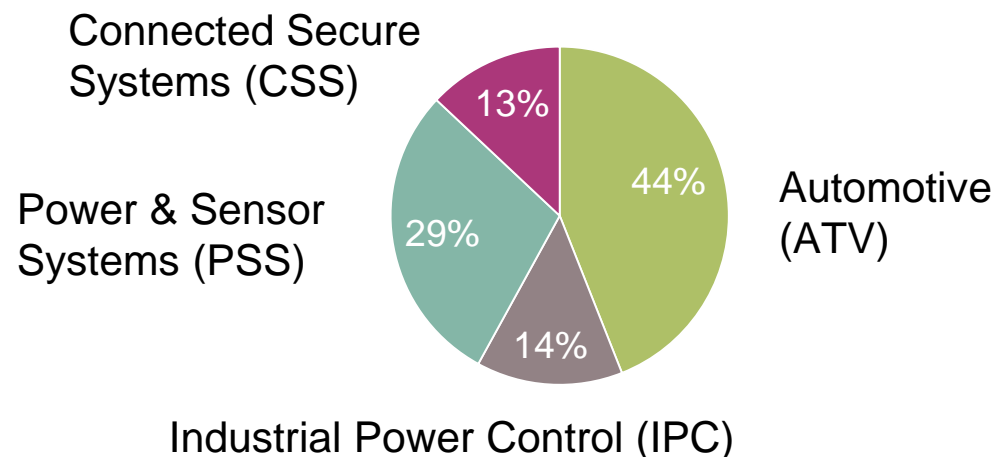
9%+ | 19% | 13%

- › target operating model*

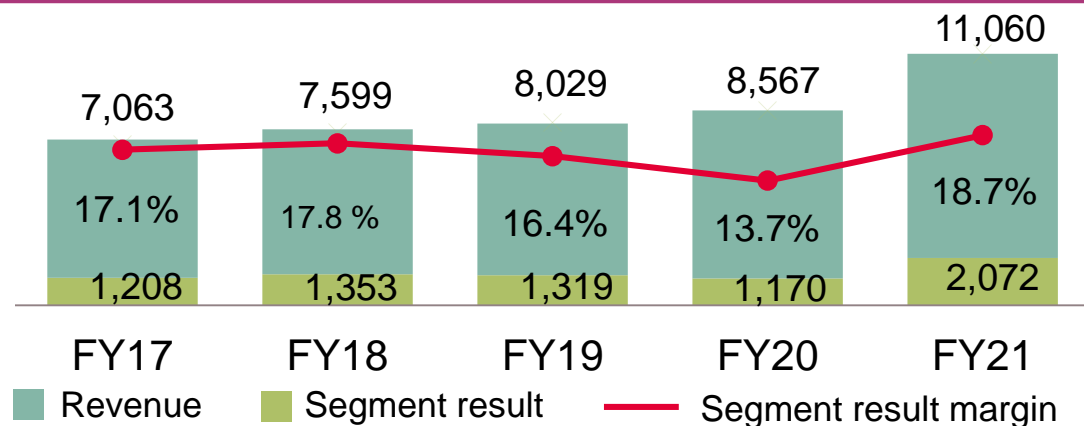
* over the cycle 9%+ revenue growth; 19% Segment Result margin; investment-to-sales ratio of 13%; targets to be approached as integration progresses

Infineon at a glance

Business segments revenue*



Financials

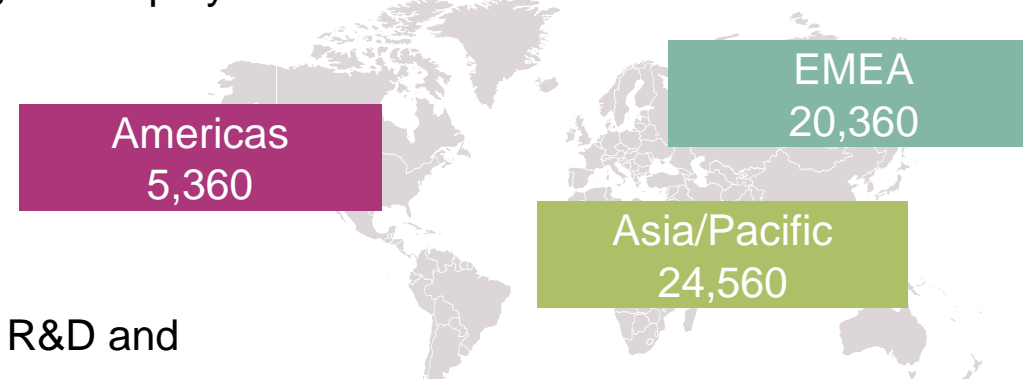


*2021 Fiscal year (as of 30 September 2021)

**as of 30 September 2021

Employees*

50,280 employees worldwide



56 R&D and
20 manufacturing locations**

Market position

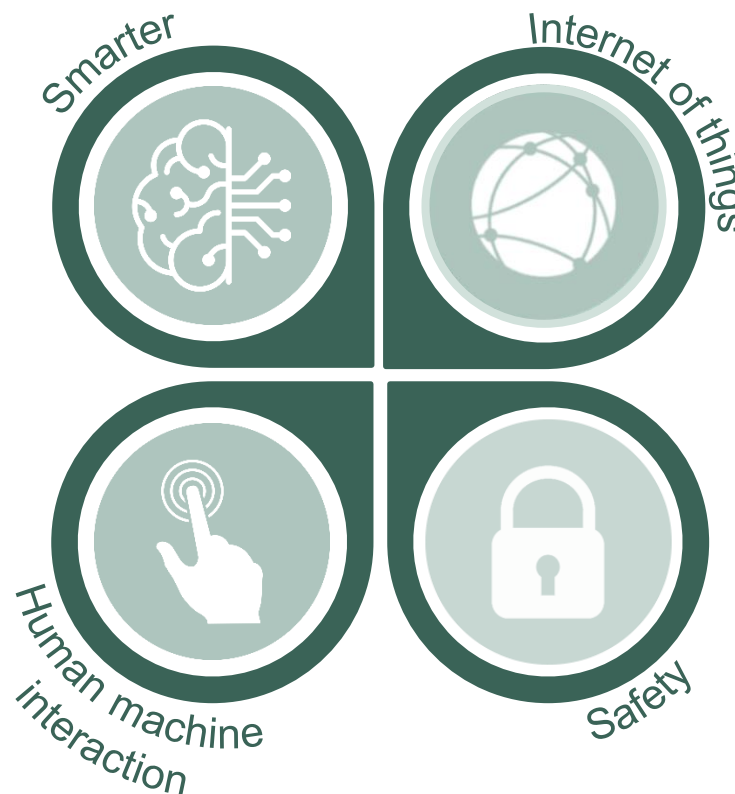


For further information: [Infineon Annual Report 2021](#)

Main trends and challenges in robot applications

Robots are moving toward Industry 4.0. This brings the need for robots to be smarter and interconnected but also calls for the need for standardization.

Human-robot collaboration is one important trend in robotics. The ability to work mutually with humans, enables robots to adapt to a rapidly changing environment.



Connectivity level and the need of data security correlate, so security must be integrated into all existing and new systems, but once again calls standardization needs for diverse robots & systems to interact properly.

Safety is key when robots interact with their environment with a special focus on human safety, work safety, routing accuracy and collision avoidance

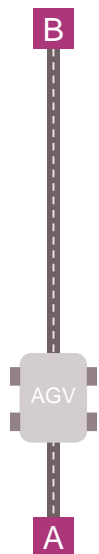
Types and deployment of mobile robots

On high level mobile robots can be categories into AGVs and AMRs

AGV

Automated Guided Vehicle

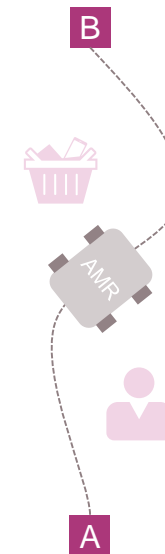
AGVs are “fixed”. They follow predefined paths using lasers, beacons, barcodes or magnetic tape.



AMR

Autonomous Mobile Robot

AMRs are not “fixed” and don’t need external paths. Autonomously mapping and navigating by using sensors



Potential use cases: warehouse & logistic, last mile delivery, robots in hotels, banks, airports etc.

Mobile robots are a fast growing market and need sophisticated system solutions for each functional block

Application requirements

Different types of mobile robots require unique and appropriate solutions

Precise, efficient & compact motor drives

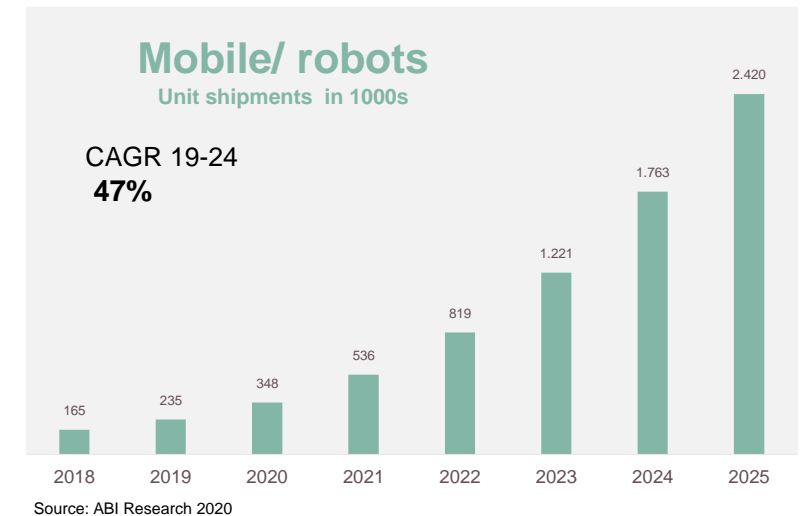
Fast charging reducing charging and idle time

Environmental sensing for navigation and safety

Connectivity enabling AI, real time monitoring and IoT

Connectivity enabling AI and IoT

Market outlook



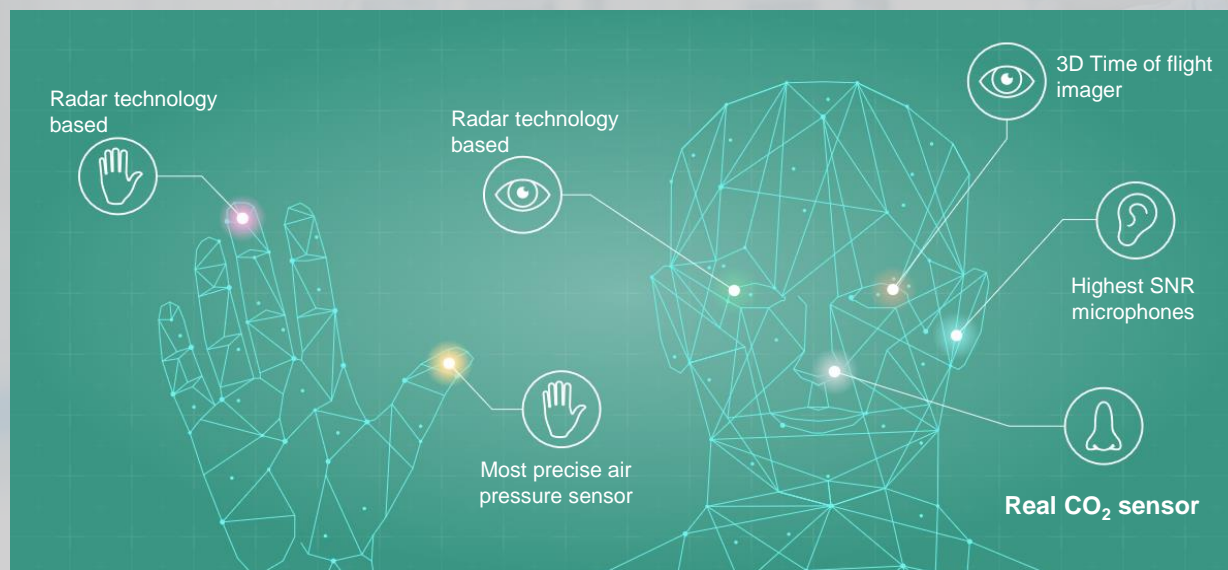
Xensiv™ Sensors

[Back to overview](#)




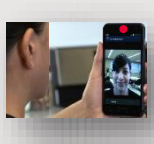



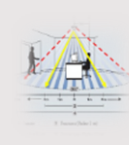


Enable safe and precise object detection, navigation & collision avoidance with Infineon's Xensiv™ Sensor portfolio

Xensiv™ Sensors

- > Radar Sensor
- > 3D Time-of-light (ToF) Sensor



XENSIV™ sensors portfolio & Robotics use cases

Environmental	Pressure	3D Radar	3D iToF	Microphone & ultrasound TR
 6x6mm ²				
World smallest form factor	Best-in-class resolution	24GHz / 60 GHz Application innovation leader	Power efficient Indirect Time of Flight 3D camera	Unique SNR, sensitivity and power efficiency
				
Best accuracy	Energy Efficiency	Best performance & energy efficiency	High resolution 3D point cloud	Crystal clear audio signals

Use cases in robotics

Collision avoidance / obstacle-stairs detection (radar, ToF, ultrasounds)

Improved User Interface & experience (gesture, VUI)

Height/floor positioning

Odometry fusion / positioning / SLAM

Vacuum flow mgt

Material classification

Human Presence/safety

Requires sensor+MPU/MCU+algo/software integrated system offer

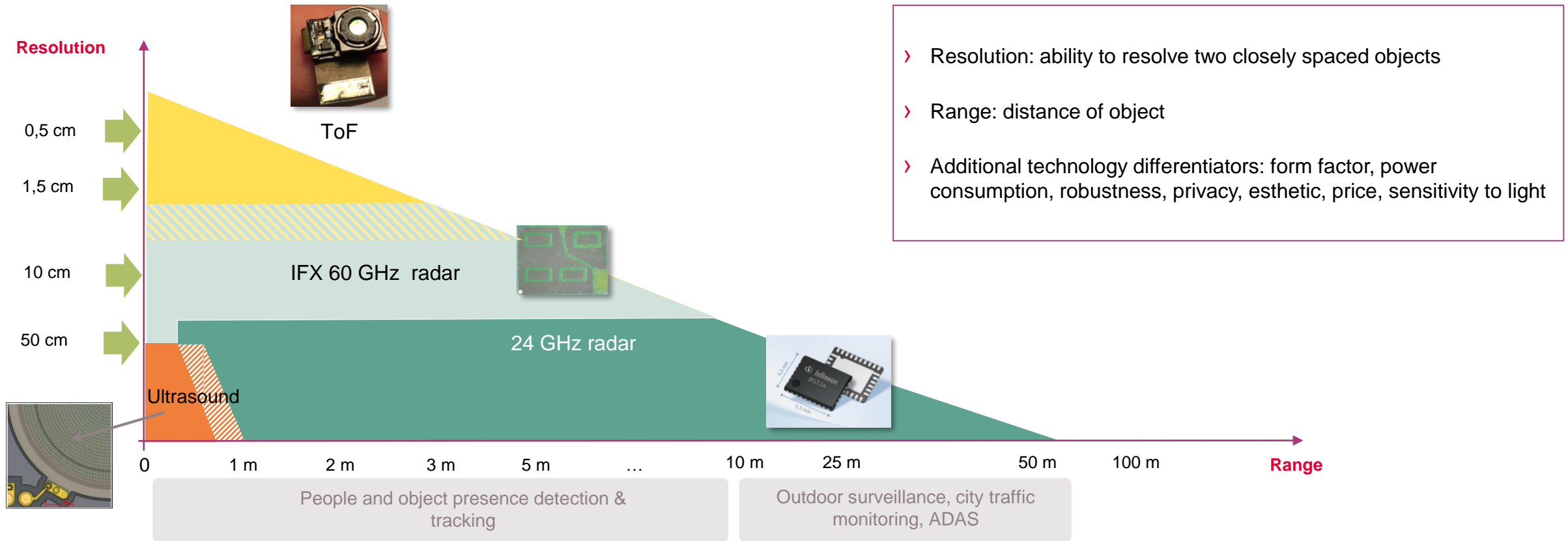
Mobile robot use cases of Sensors

Value proposition



	Collision Avoidance Navigation/Mapping/Odometry	2D/3D Object detection Human presence	Gesture control	Voice recognition
Current solutions	1. Safety laser scanners 2. 3D ToF (IFM)	1. RGB cameras 2. Stereo cameras 3. ToF cameras	1. RGB cameras 2. ToF cameras	1. Microphones
Problem	Safety laser scanners: <ul style="list-style-type: none"> › No positioning in 3D › High costs › Big size 	RGB: Big Size <ul style="list-style-type: none"> › No positioning in 3D › Doesn't work in dark env. › False positives from images Stereo: Big Size <ul style="list-style-type: none"> › Less range accuracy › Limited working distance › Doesn't work in dark env. 	RGB: <ul style="list-style-type: none"> › No positioning in 3D › Doesn't work in dark env. › False positives Stereo: <ul style="list-style-type: none"> › Less range accuracy › Limited working distance › Doesn't work in dark env. 	
Solution	<ul style="list-style-type: none"> › ToF cameras › 24/60 Ghz Radars 	<ul style="list-style-type: none"> › ToF cameras › 24/60 Ghz Radars 	<ul style="list-style-type: none"> › ToF cameras › 60 Ghz Radars 	<ul style="list-style-type: none"> › IM69D Mems Mic
Infineon's Differentiators	3D sensing <u>ToF</u> Precise target localization & detection, special design via module maker partners <u>Radar</u> Precise range & velocity & direction of movement estimation, Real human presence, Human segmentation, Anonymity	3D sensing (works in dark environment) <u>ToF</u> Precise target localization & detection, special design via module maker partners, small form factor <u>Radar</u> Precise range & velocity & direction of movement estimation, Real human presence, Human segmentation, Anonymity, small form factor	<u>Radar:</u> <ul style="list-style-type: none"> › Hide behind cover › Anonymity › Low power consumption 	<ul style="list-style-type: none"> › High SNR › Crystal clear audio signal

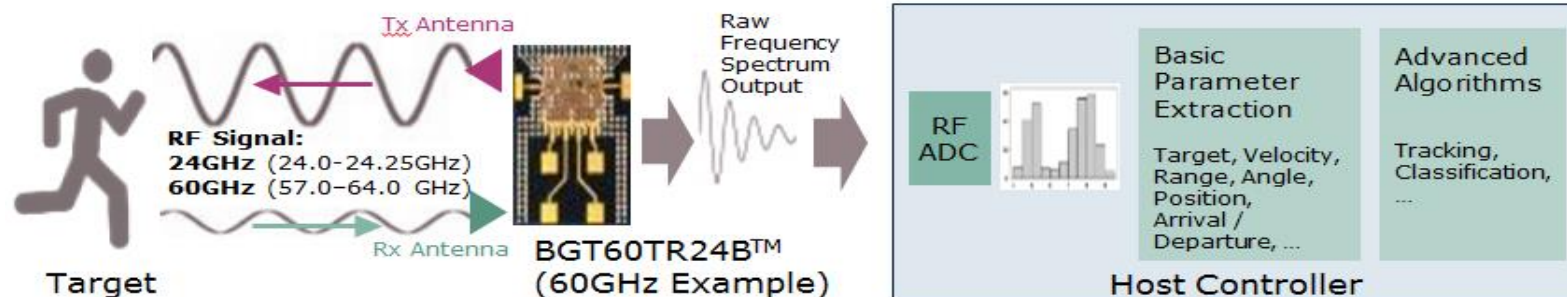
Infiniteon has a broad 3D sensing technology portfolio with ToF, Radar 24 and 60 GHz and Ultrasonic



Working principle of RADAR and ToF camera for 3D sensing

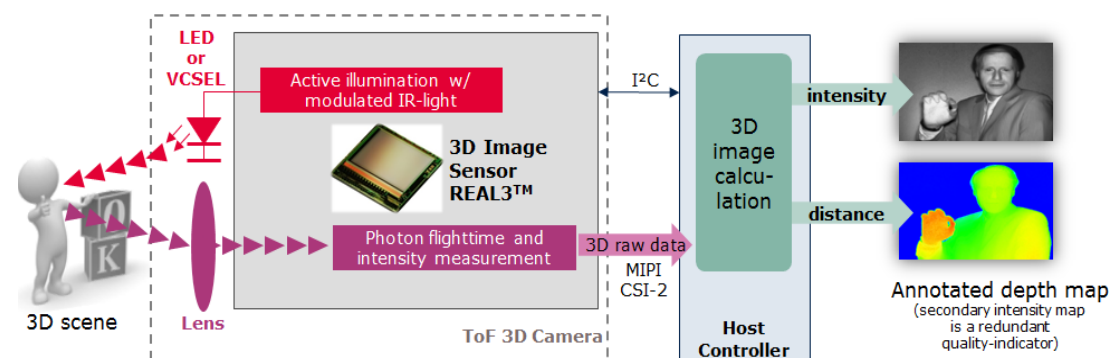
RADAR

RAdio **D**etection **A**nd **R**anging:
Radio frequency energy transmitted and reflected from an object which determines the direction, speed, distance and angle

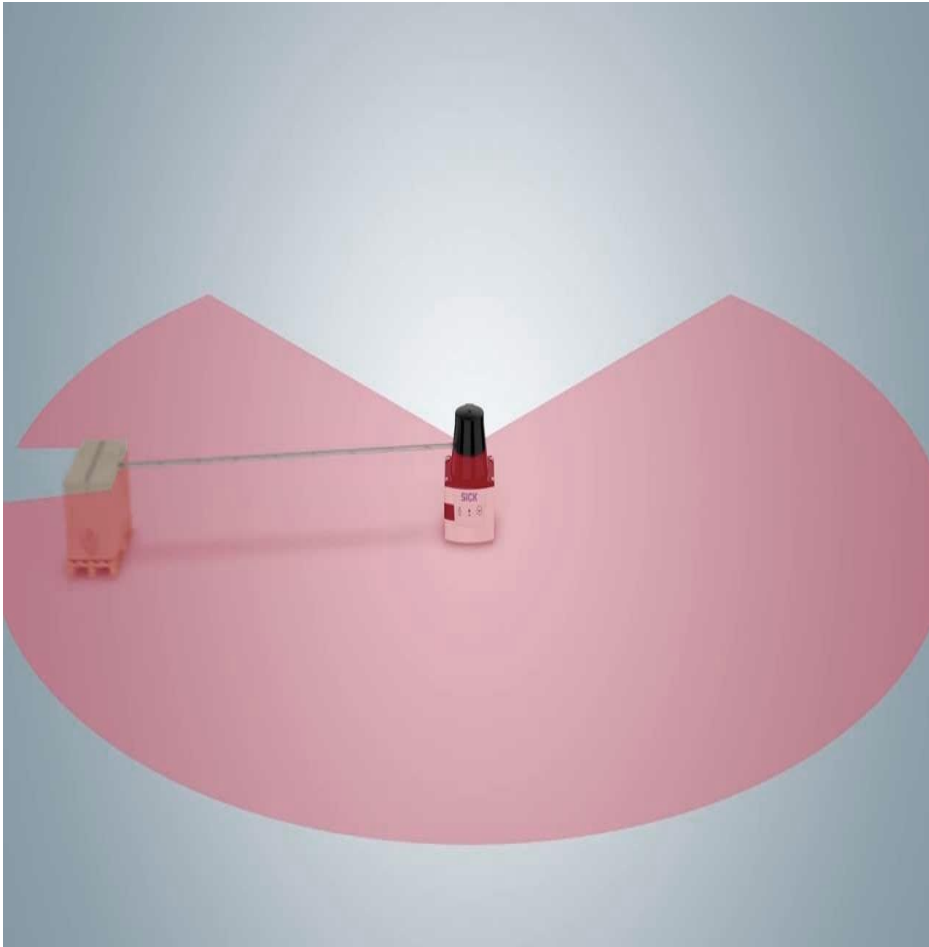


ToF

Time-of-Flight: Modulated infrared-light emitted from camera and reflected by objects. Phase-shift of returned light corresponds to distance to the scene; it is measured in each pixel of the image sensor



Functional overview of classic 2D-LIDAR scanner



Fast

- 25 complete scans per second with average 2D laser scanners

Precise

- 0.5° angular resolution with ± 1.2 mm standard error (<20 m)

Versatile

- 270° Field of View with a maximum distance of 20 m. Compensation of fog, dust, rain etc.

Expensive

- Average cost 4.000 – 5.000€ for standard 2D laser scanner

2-Dimensional

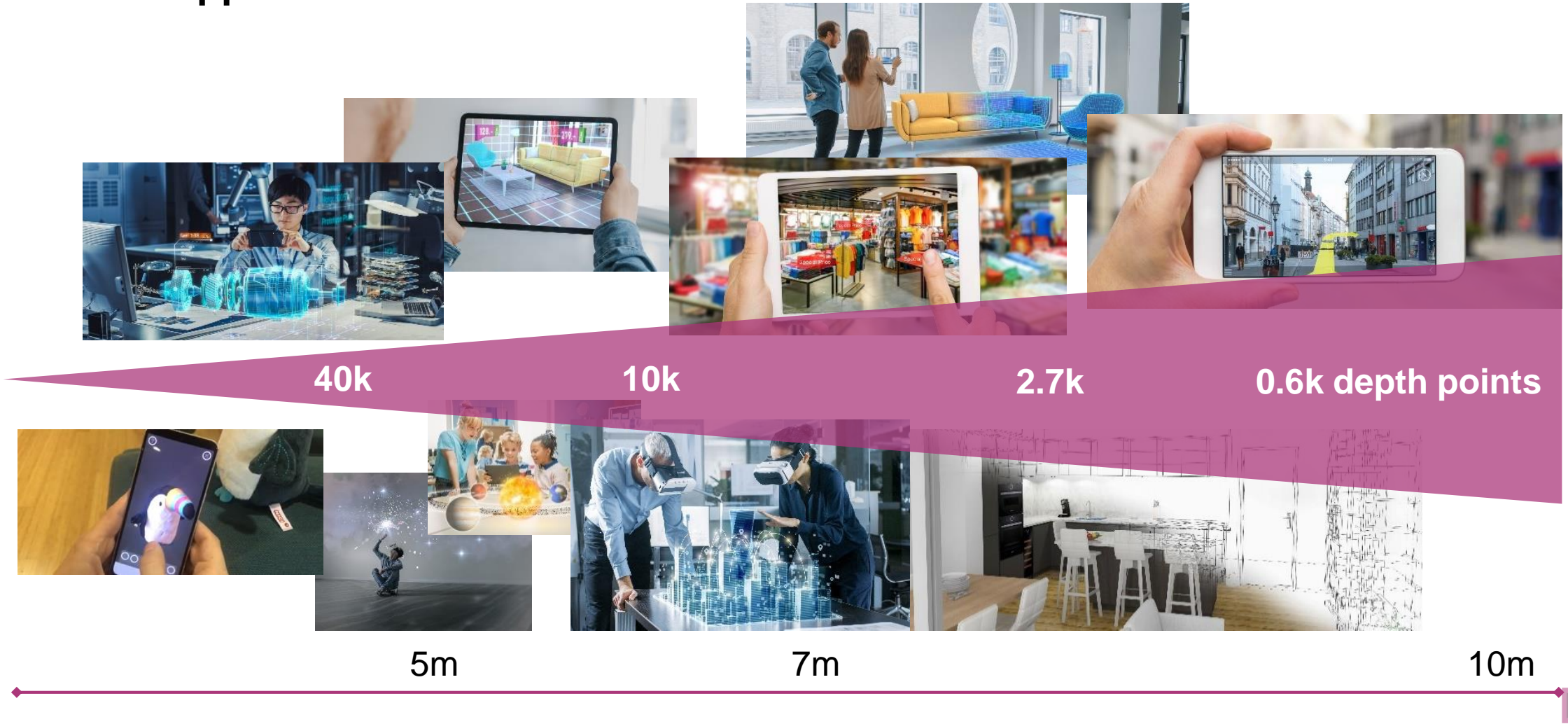
- Only horizontal (vertical) scan

3D sensing selection tree: Choosing RADAR or ToF camera depends on the target use case

Master use cases	Human machine interface (HMI)		Space & motion		
Sub use cases/ Functions	Macro gesture (Leg-kick, hand waving, Body-moves)		Collision avoidance		
	Body tracking		Presence detection/Distance measurement/ Position information		
	Drawing		Objects counting/Tracking/Density map		
	Hand tracking	Finger tracking	Indoor/Outdoor Range up to 100 m	Indoor/Outdoor up to 7 m	Indoor ~10 m Outdoor ~4 m
	Tiniest finger movement in sub-millimeter range (micro-gesture)	Counting fingers Finger tip mouse	Low range-resolution (70 cm)	High range-resolution (2 cm)	High accuracy (1% of range) Environmental scanning
Capabilities/ Features	Power optimization by duty cycling	Distinguish each finger or body part	Presence detection	Smallest form factor	Recognizes body contour
	Hidden in case No privacy concerns	To get picture of target shape		System-cost-benefit	Picture of shape
			Measurement independent to environmental conditions		
Solution	60 GHz	ToF	24 GHz	60 GHz	ToF

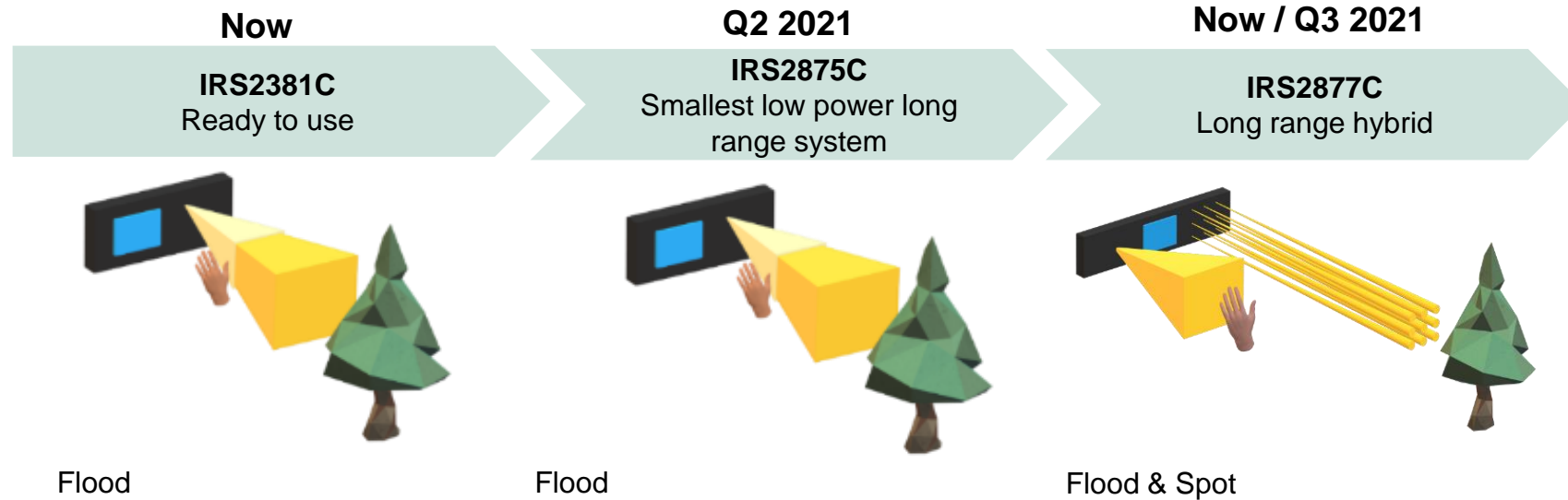
The new REAL3™ imager system provides best depth data quality & resolution for best user experiences

Full scale of AR applications



REAL3™ Long Range Time of Flight offer

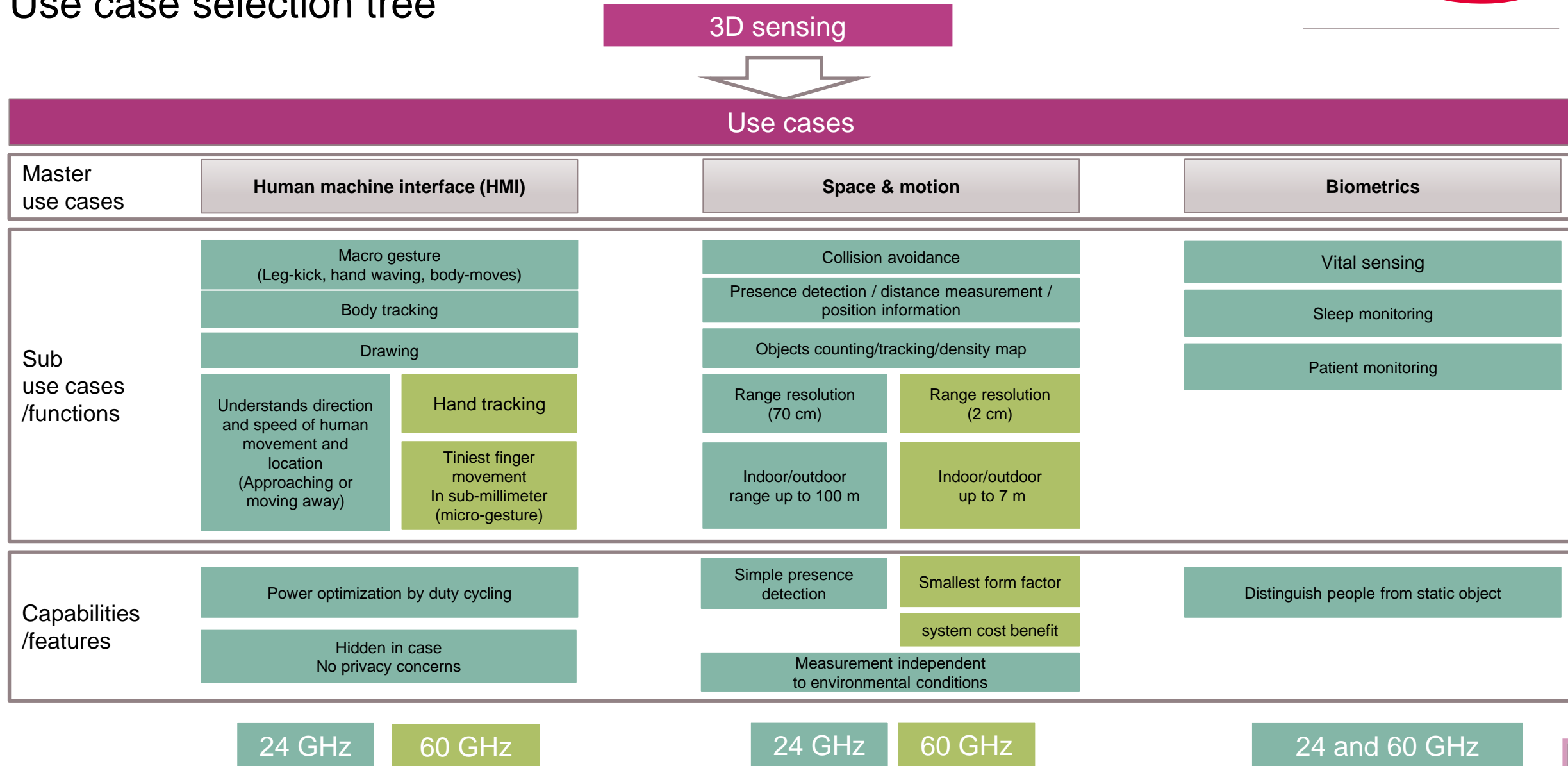
Get the right solution for your product



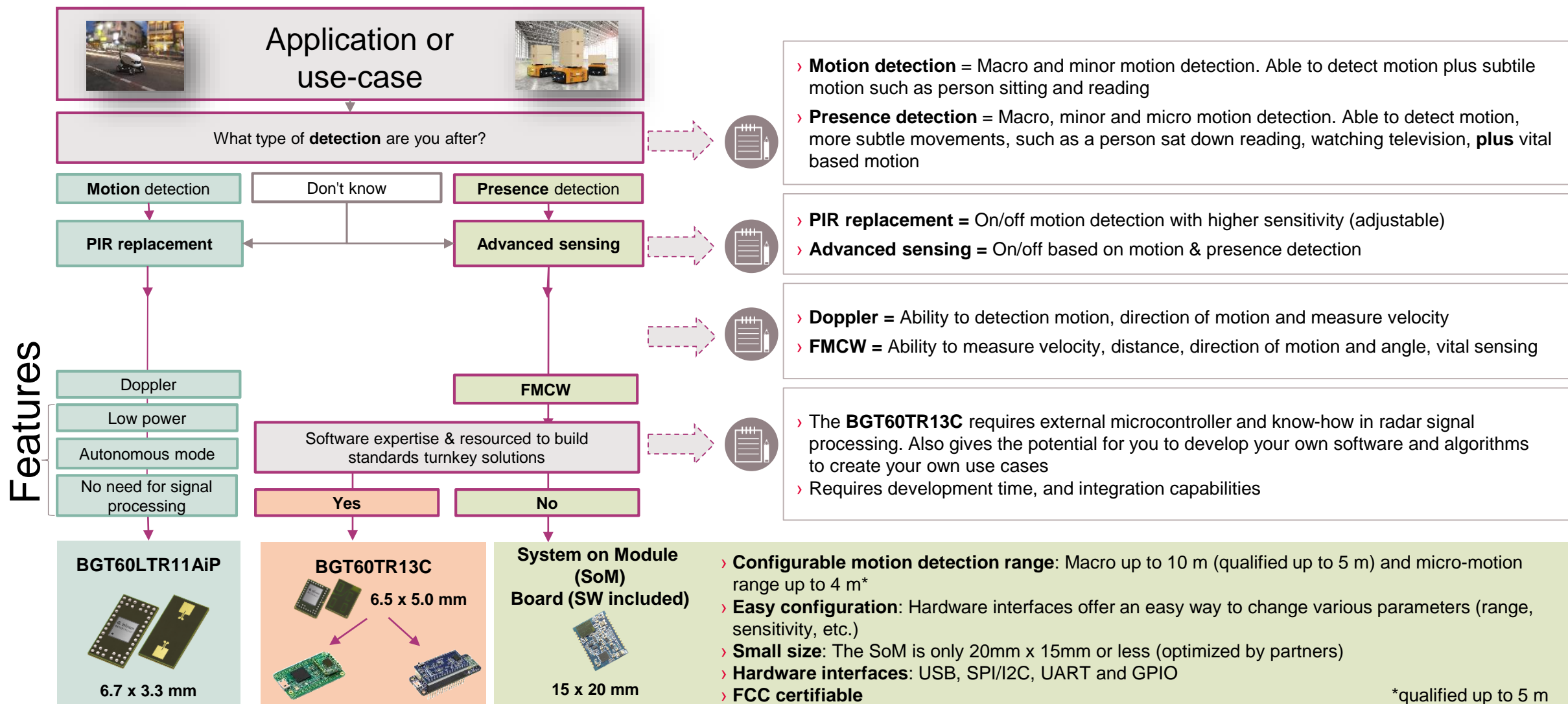
Resolution	38 k pixel up to 3 m 9,6 k pixel up to 5 m 2,4 k pixel up to 10 m	43 k pixel up to 3 m 10,8 k pixel up to 5 m 2,7 k pixel up to 10 m	307 k resolution up to 3 m 4.5k dots up to 6 m
Power	250 mW for 5 m range 350 mW for 10 m range	200 mW for 5 m range 300 mW for 10 m range	500 mW for 3 m (VGA) 500 mW for 6 m (4.5k dots)
Module Size (ES)	14,5 x 8 mm	10,6 x 7 mm	14,9 x 9,4 mm
Availability	available today	EES Feb 21 Production June 21	IRS2877C available today Hybrid solution: Demo Q1/21

Radar sensor

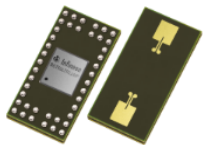
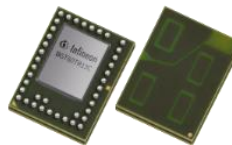


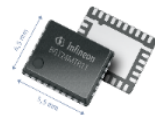



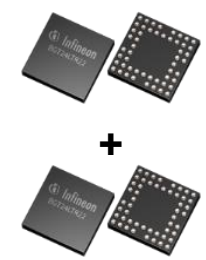
Use case selection tree



Selection guide: presence/motion detection with 60 GHz

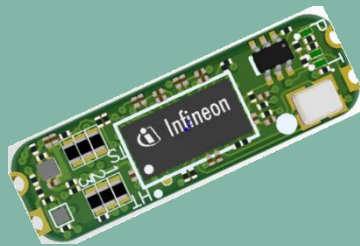

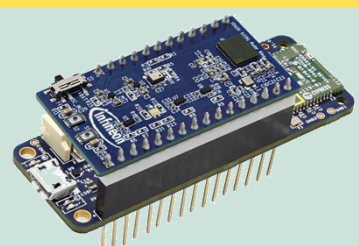



Broad Product Portfolio for 60GHz and 24GHz

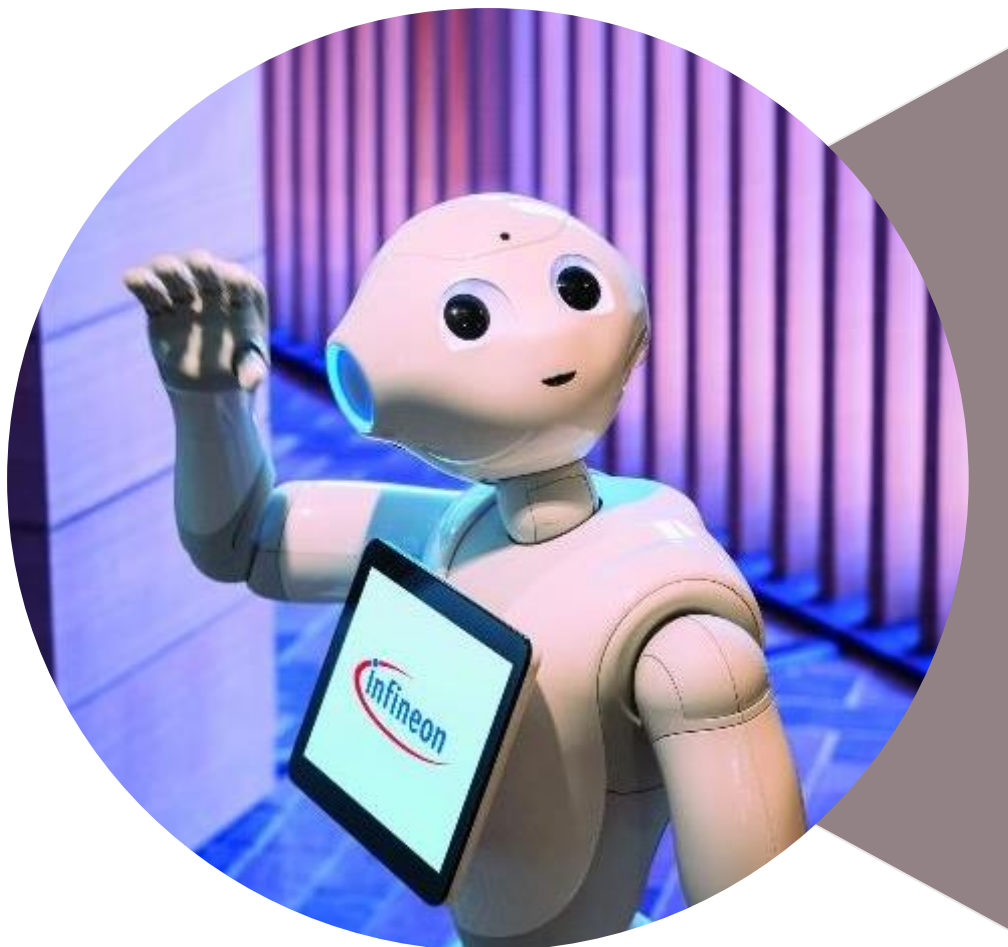
	1Tx / 1Rx	1Tx / 2Rx	1Tx / 3Rx	2Tx / 2Rx	2Tx / 4Rx
60GHz	<div>PIR replacement</div>  <p>3.3x6.5 mm²</p> <p>BGT60LTR11AIP Doppler Radar Antenna-in-Package</p>		<div>Consumer</div>  <p>5 x 6.5 mm²</p> <p>BGT60TR13C FMCW Radar Antenna-in-Package</p>		<div>(Automotive)</div>  <p>6 x 6 mm²</p> <p>BGT60ATR24C FMCW Radar Without Antenna</p>
24GHz	 <p>2.4 x 2.4 mm</p> <p>BGT 24LTR11</p>  <p>4.5 x 5.5 mm</p> <p>BGT 24MTR11</p>	 <p>4.5 x 5.5 mm</p> <p>BGT24MTR12</p>	 <p>BGT24MTR11 + BGT24MR2</p>	 <p>3.6 x 3.6 mm</p> <p>BGT24LTR22</p>	 <p>+</p> <p>Cascading BGT24LTR22</p>

Choose the best evaluation and implementation tool

- Ready to go radar
- Radar development
- Systems development with radar
- XENSIV™ BGT60TR13C SoM

	 <p>BGT60LTR11AIP Autonomous mode</p>	 <p>DEMO 60 GHZ TR13CAIP w/ RADAR SDK for presence</p>	<p>ES available. Mass Market Launch – Q1 CY2022</p>  <p>Connected Sensor Kit FW in ModusToolbox®</p>	 <p>XENSIV™ BGT60TR13C System on Module (SoM) (Via Partners)</p>
Presence sensing	Simple motion detection	Micro/macro motion detect, ranging	Micro/macro motion detect, ranging	Micro/macro motion detect, ranging
Additional functions	None	Segmentation, tracking, vital sensing, gesturing	Smart entrance counter	Programmable to also do Smart entrance counter / Advanced presence*
Networking capable	Through Arduino MKR	Through Arduino MKR	Feather board with CYSBSYS-RP01 SoM	Through separate connectivity board
Solution size	20 mm x 6.25 mm	17 mm x 12.7 mm (RF shield)	75 mm x 25 mm	20 mm x 15 mm
Range and field of view	5 m (at 0°) +/- 40 degrees	10 m (at 0°), +/-45	10 m (at 0°), +/-45	10 m (macro motion at 0°) (qualified up to 5 m) , +/-45
Intended usage	PIR replacement	Eval & testing use cases, development, ref. design	Self-contained IoT system, PoC starter, ref design	Entrance counter presence/motion detector

*Dependent on application and system



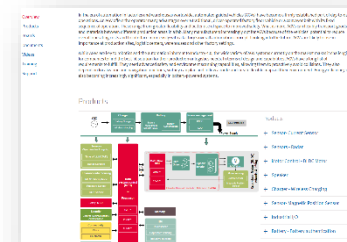
Portfolio and further information can be found here:

[Link](#) → Sensor Selection Guide

- [Link](#) → Radar
- [Link](#) → Time-of-Light (ToF)



Learn more on our [webpage](#)





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