



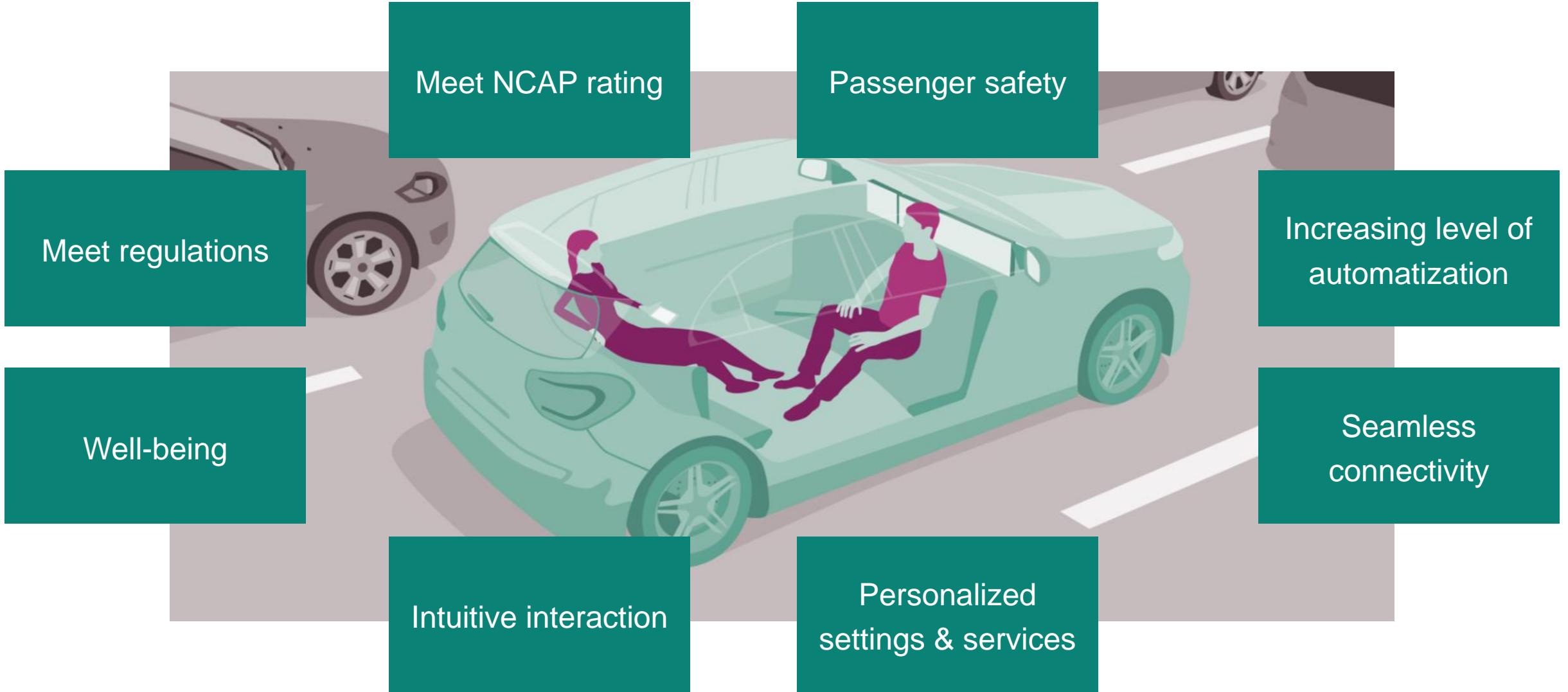
Automotive In-Cabin Sensing Monitoring with Infineon 60 GHz Radar



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February 2025



Market Drivers for In-cabin Monitoring Systems (ICMS) – Regulations + High level of automatization + OEM brand differentiation



ICMS Growth Driver

Major legislation and regulation activities

Legislation / Regulation



NCAP: better safety ratings by direct child detection and classification (**CPD**) by 2025. Latest NCAP initiatives increases focus to occupancy detection and classification (2025/2026) for seat belt reminder and smart airbag deployment.



OEM Alliances self-commitments to equip all cars with **CPD** by 2025.



World Forum for Harmonization of Vehicle Regulations (GRSP & WP.29) is discussing complementing Euro NCAP with new **CPD** signalling feature as part of the **vehicle type approval in 2025**.



Moving Forward act (US law) introducing safety provisions for **DMS** and **CPD**.



General Safety Regulation (EU) 2019/2144 for the protection of vehicle occupants and vulnerable road users now amended with **additional DMS** requirement to include Driver Drowsiness and Attention Warning, Advanced Driver Distraction Warning by 2024/25.



Hot Cars Act 2021 include **CPD** and detection of pets.
Stay Aware for Everyone (SAFE) act of 2020.



Controlling implementation of Hot Cars Act to decrease the number of casualties (**CPD**)

Euro NCAP

New Rating Scheme

Based on 4 stages of a crash (from 2026)

Safe Driving		Crash Avoidance		Crash Protection		Post-crash Safety	
Occupant monitoring	30	Frontal collisions	60	Frontal impact	40	Rescue information	40
Driver engagement*	30	Lane-change collisions	20	Side impact	35	Post-crash intervention	25
Vehicle assistance*	40	Acceleration prevention	20	Rear impact	5	Extrication	35
				VRU impact	20		
Weight: 20%	100	Weight: 20%	100	Weight: 50%	100	Weight: 10%	100

*For vehicles with assisted driving systems, scoring is subject to the AD Grading Driver Engagement assessment.

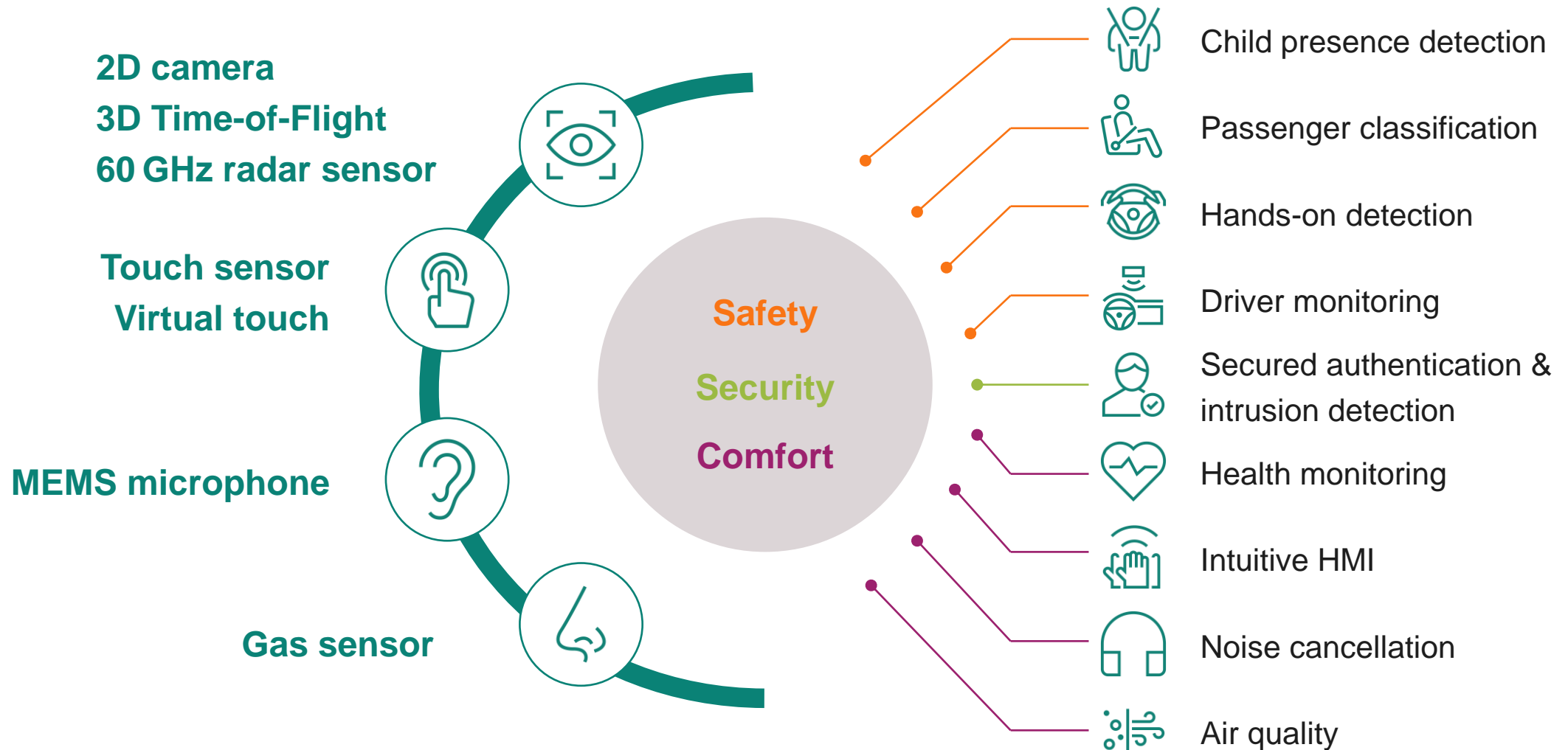
(Tentative points distribution)



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Sense the car like a human

Different sensor technologies to realize different ICMS use-cases



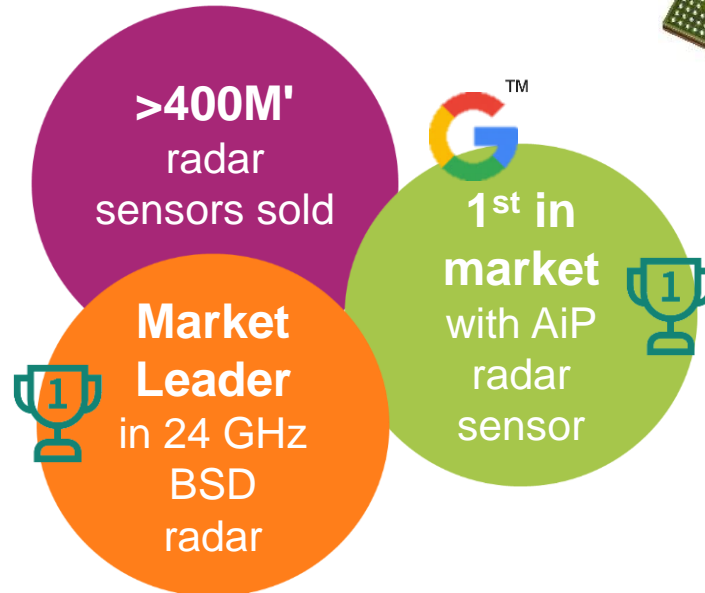
XENSIV™ 60 GHz Radar

Innovative technology with many benefits



Radar Technology Benefits

- Operates without line-of-sight and behind materials: **aesthetic designs**
- No privacy concerns
- **Low power** consumption
- Low processing efforts
- Smallest size
- **Lower cost** than cameras
- **Mature** technology



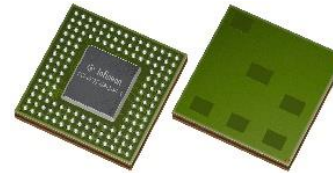
Products & Benefits



BGT60ATR24C

- Non-AiP (Antenna in Package)
- 2Tx – 4Rx
- 6mm x 6mm

in mass production



BGT60ATR24AIP

- AiP (Antenna in Package)
- 2Tx – 4Rx
- 8mm x 8mm

SOP Q4'25

- **Excellent thermal** management
- Fully FCC compliant
- Sensor power consumption **~50 mW**
- **System solution** with AURIX™ TC3xx μ C
- Robust algorithms with **strong partner eco-system**

XENSIV™ 60 GHz Radar for In-Cabin Monitoring System

4-in-1 solution



One Radar sensor in the overhead compartment enables:

- 99% reliable lifeform detection inside car cabin (incl. footwell area) + classification
- Localize passengers within car cabin to enable features like seat belt reminder
- Protect the cabin interior contents with continuous ultra low power monitoring
- Heart rate and respiratory rate measurement for driver's health indication

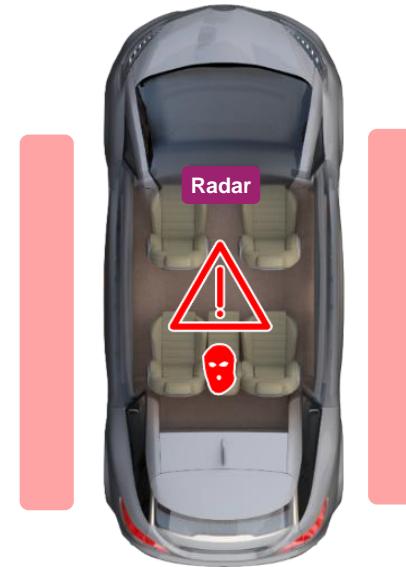
Child Presence Detection



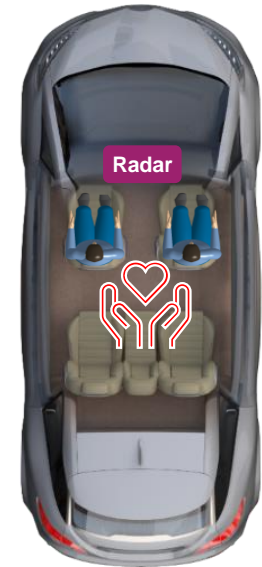
Seat Occupancy Detection



Intrusion Alarm



Vital Sign Sensing



Child Presence Detection (CPD)

Measured detection accuracy >99%



Detection accuracy		
3 months	>99%	
6 months	>99%	
24 months	>99%	
36 months	>99%	



– Child Presence Detection (CPD)

Software from Novelic

– CPD is tested for **all seat and footwell** locations with child emulator (3, 6, 12, 24, 36 months-old)

– Two different child seats are used for evaluation:

- Maxi Cosi Cabrio Fix is used for 0-1 years-old
- Römer King II LS is used for 1-3 years-old

– Detection accuracy: Proportion of frames, where the child is detected and classified correctly

SW Evaluation and Testing

Child Presence

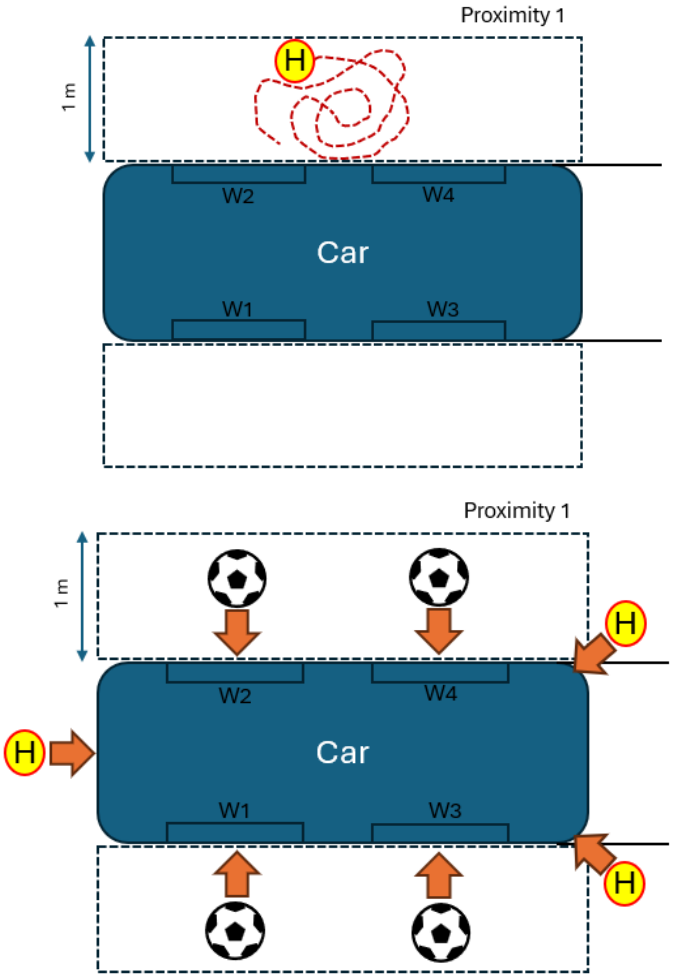


Sensor positioning



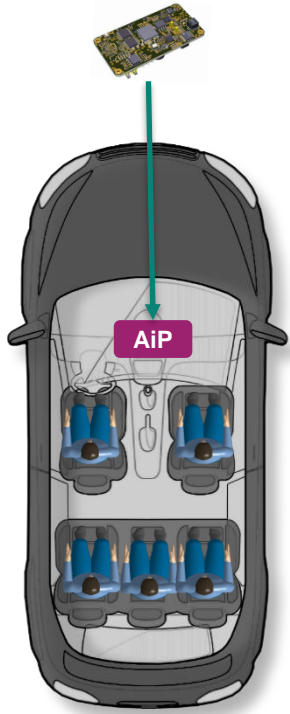
	Test type	No. of test cases
CPD	Child present	63
	No child	39
IPA	Proximity	182
	Intrusion	352

Intrusion & Proximity



Seat Occupancy Detection (SOD)

BGT60ATR24AIP



One AIP sensor covers full 5 seater car

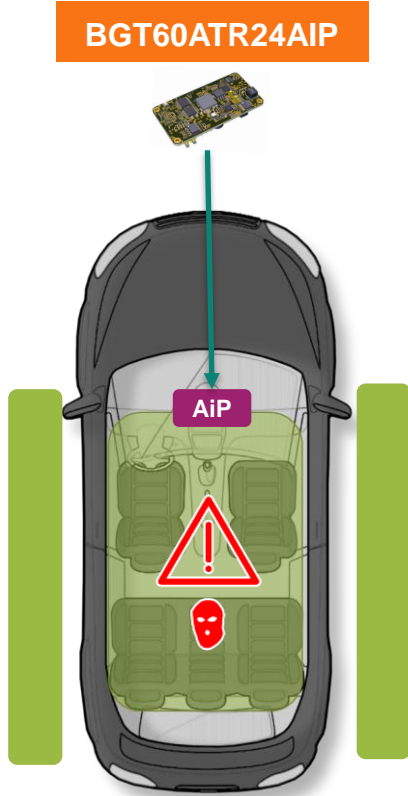
With only one BGT60ATR24AIP radar and Aurix microcontroller up to 5 passengers can be detected and localized reliably in a car.

Occupant localization combined with classification can be used to optimize Seatbelt Reminder (SBR) systems & airbag deployment systems.

Removing weight sensors and wiring harness for the seat belt reminder system result in cost savings of up to 8€ per seat.

Passenger classification, adult vs child can be used to optimize Airbag deployment systems.

Intrusion and Proximity Alert (IPA)



One AiP sensor covers full 5 seater car

Infineon 60 GHz radar sensor enables intrusion alert features to secure the interior contents and protect the car from theft.

The radar sensor detects if someone is approaching the car and can activate additional sensors and cameras.

The zoning capability of the radar sensor can even detect if someone is reaching out through an open window within 300 ms.

The ultra low power consumption of ~100 mW avg. allows continuous surveillance without drawing out the battery.

Next generation ICMS will use sensor fusion (radar + camera)

Today



One Radar sensor in the overhead compartment enables:

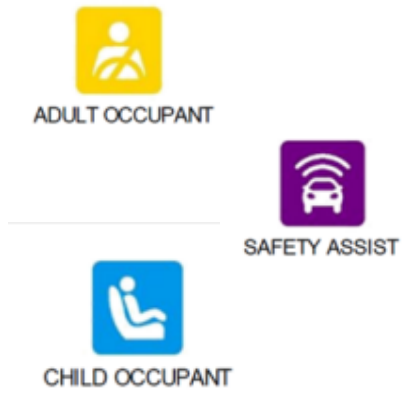
- Child Presence Detection
- Seat Occupancy Detection
- Intrusion Alarm
- Vital Sign Sensing



Next generation 2028/2029

Radar sensor delivers data for sensor fusion with camera for:

- Seatbelt usage
- Occupant classification
- Occupant presence
- Airbag exposure

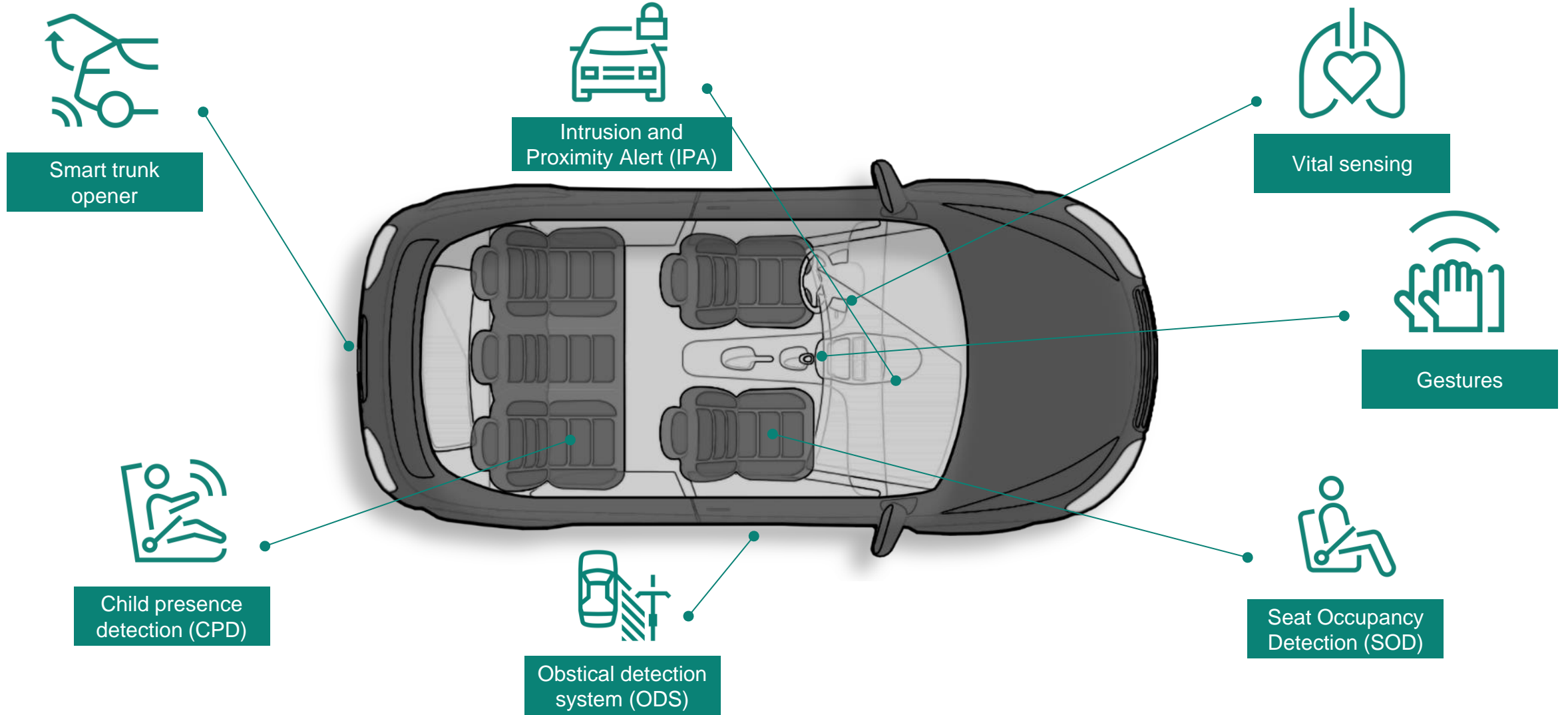


New NCAP rating system (2026+)

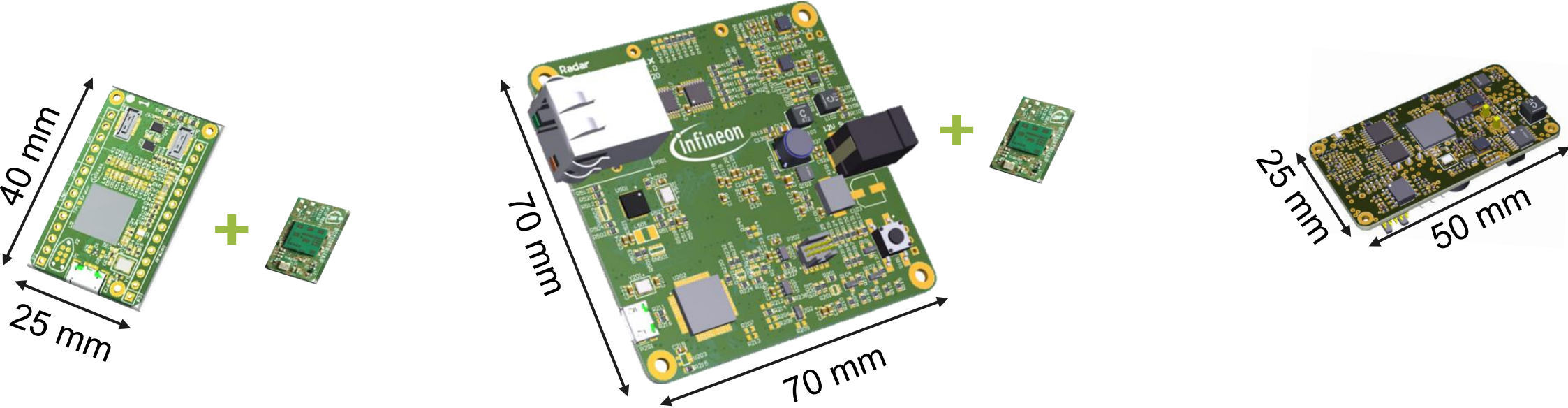


One-fits-all

60 GHz Radar sensor technology enables plenty of applications



From prototyping to compact module



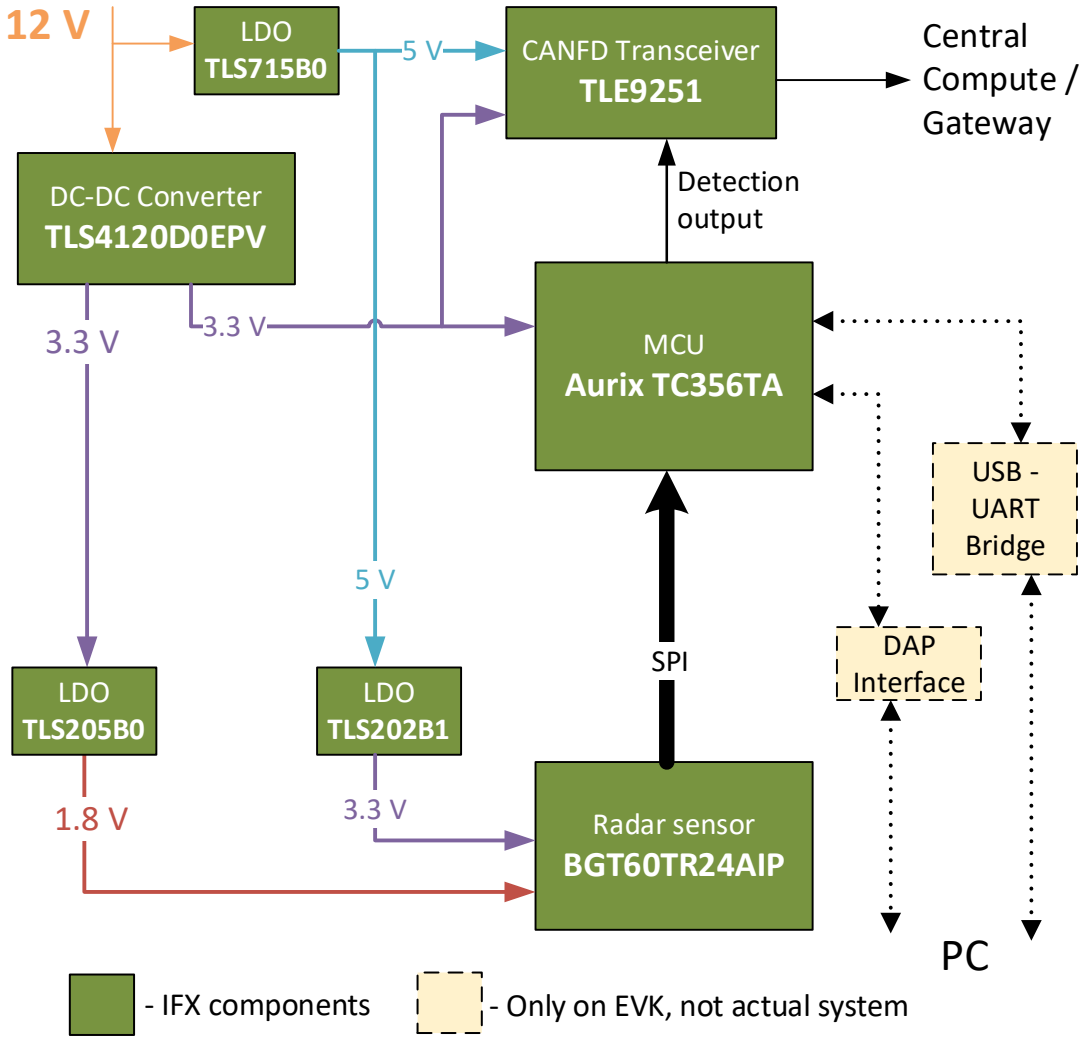
2018 2021 today

- MCU7**
- Rapid data streaming quick prototype
 - Processing on host computing
 - USB Interface

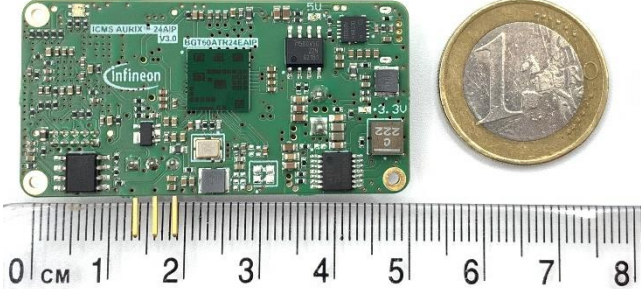
- AURIX™ RBB**
- Aurix TC356TA/336DA based Radar Base Board
 - Embedded signal processing
 - Ethernet and CAN interfaces

- AURIX™ ICMS Module**
- Aurix TC356TA + 24AiP on same PCB
 - USB and CAN interfaces

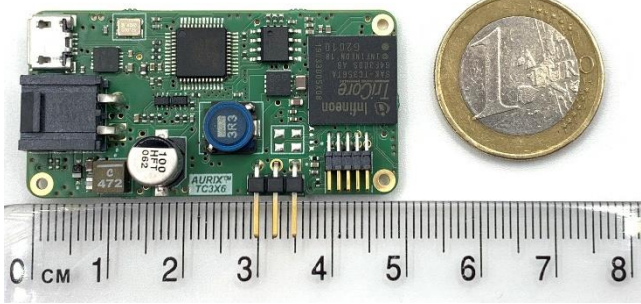
60 GHz Radar – HW System



Front View















Rear View



Competitive Advantage Highlights – IFX 60 GHz Radar with better power consumption, thermal management, HSM and lower cost



		Infineon 60 GHz Radar	Competitor B	Comments
	Power consumption			IFX low system power consumption of < 1 Watt vs. ~1,5 Watt of competition (high power ~ high temp)
	Size and Cost			Competitor needs external memory and HSM → 3 device footprint compared to IFX 2 devices (IFX 20% smaller) Competitor BOM needs thermal absorbers and harmonics absorber, which increases overall system cost
	Flexible Design for processing			For a solution needing 2x Radars e.g. 7 seater car, IFX can use 1x MCU + 2x MMICs compared to 2x full solutions from competition → Space and BOM cost optimized solution
	HSM & Flash			Competition has limited HSM capability while IFX solution already has integrated HSM and on board flash in the Aurix



Why Infineon Automotive Radar

Automotive Market Excellence

One of the market leader in **77 GHz automotive** radar with **> 50% market share & > 400 Mpcs sold** worldwide

Market leader in **24 GHz automotive** BSD radar with over **100 Mpcs sold** worldwide



Consumer Market Excellence

Very successful in **60 GHz consumer** segment with **~20 Mpcs** of BGT60TR13C sold worldwide incl. Samsung smart TV and Google Pixel, Nest Hub & Thermostats

First in the market with **AiP** (Antenna in Package) solution



Infineon In-Cabin Radar

Automotive qualified **BGT60ATR24AIP** & **BGT60ATR24C** belong to same family of our high running BGT60TR13C consumer radar

Automotive **AEC-Q100 Grade2** qualified **BGT60ATR24C** ready for production

The most **flexible** solution on the market due to **modular** approach



