



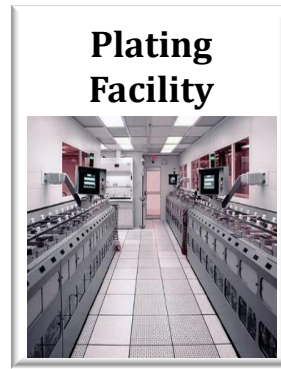
Sensor-Packages für das autonome Fahren

Prof. K.-J. Wolter

70. SAET Treffen bei Xenon Dresden, 07.02.2018



- Technical Vision consistent with Market needs
- Advanced Systems Packaging Technologies beyond Industry's 3 Year horizon
- Complete Eco-system: supply chain to end users
- Seamless from R&D, prototype, Tech transfer Enabling Commercialization
- > 50 person co development team: Full-time researchers, mfg industry partners, graduate students, faculty, and On-Campus industry engineers
- Only 300 mm cleanroom panel facility in the academic world



A micrograph showing a series of vertical, rectangular structures. The width of one structure is labeled as 20μm. The distance between the centers of two adjacent structures is labeled as 40μm. The height of the structures is labeled as 10μm.

2.5D with 40um Pitch

1st Demo at 20um Pitch

Figure 1 consists of two micrographs. (a) shows a single device on a substrate, with labels 'WG' and 'BCB cladding opening'. (b) shows a dense array of devices, with a red arrow pointing to a specific device.

1. Trends in External Sensing

2. Automotive Camera

3. Radar

4. Lidar

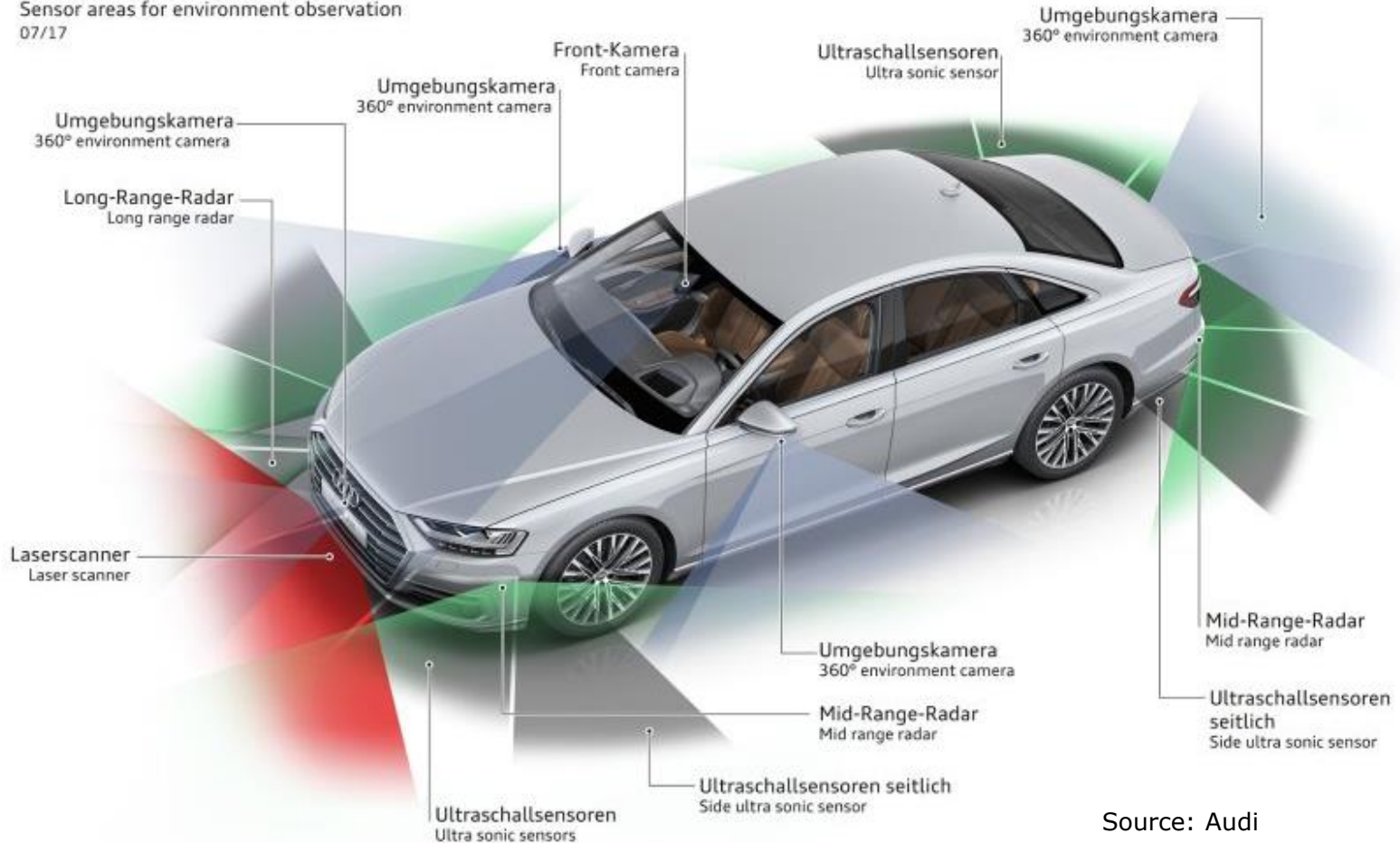
5. US-Sensor

6. Sensor fusion

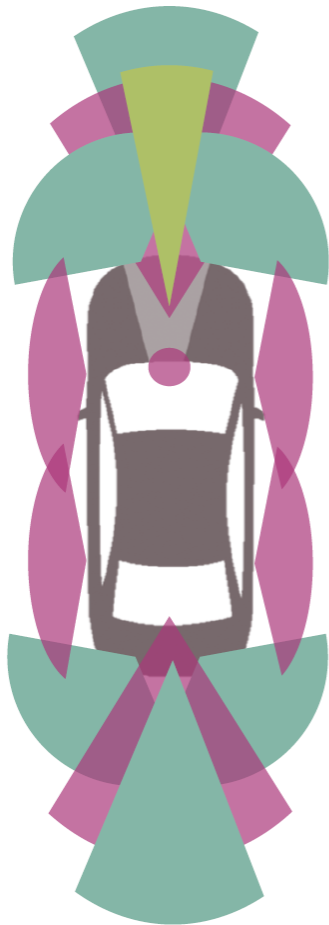
Sensorfelder der Umfeldüberwachung

Sensor areas for environment observation

07/17



Source: Audi



■ Radar ■ Camera ■ Lidar

Sensor technologies	2015 Euro-NCAP*	2018 Euro-NCAP*	Level 2	Level 3	Level 4/5
Front looking camera	}1	1	1	1	1
Front looking Radar		1	1	1	1
Front looking Lidar		–	–	–	1
Surround camera	–	–	–	–	4
Corner Radar	–	2	2	4	4
Surround Radar	–	–	–	–	4
Rear looking camera	–	–	–	1	1
Rear looking Radar	–	–	–	–	1
Driver monitoring Camera	–	–	–	1	1
Ultrasonic sensors	10-12 sensors per car				
Surround Radar	8 Radar sensors e.g. for garage parking				

Source: Infineon

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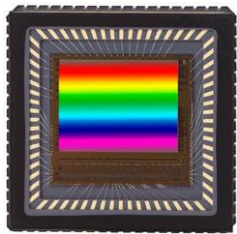
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- FSI and BSI CMOS image sensors
- Ceramic or BGA image sensor package, plastic module
- Low resolution cameras, 30 – 60 fps, high sensitivity due to bigger pixel sizes
- Limited image processing power due to limited thermal management
- Thermo-mechanical deformation influences the reliability and mechanical stability



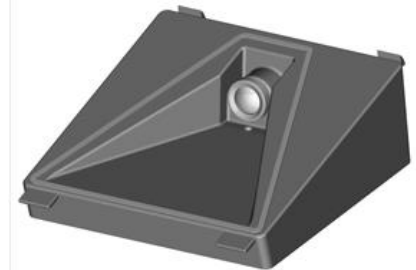
On Semi
Image sensor
in CCC



Panasonic CMOS
34227 Sensor



Magna rear view
camera



Delphi's Intelligent
Forward View
Camera

- Improved sensitivity by backside illumination
- Crosstalk suppression by per-pixel light pipes and embedded color filters
- High speed and low noise imaging by stacked camera image sensors

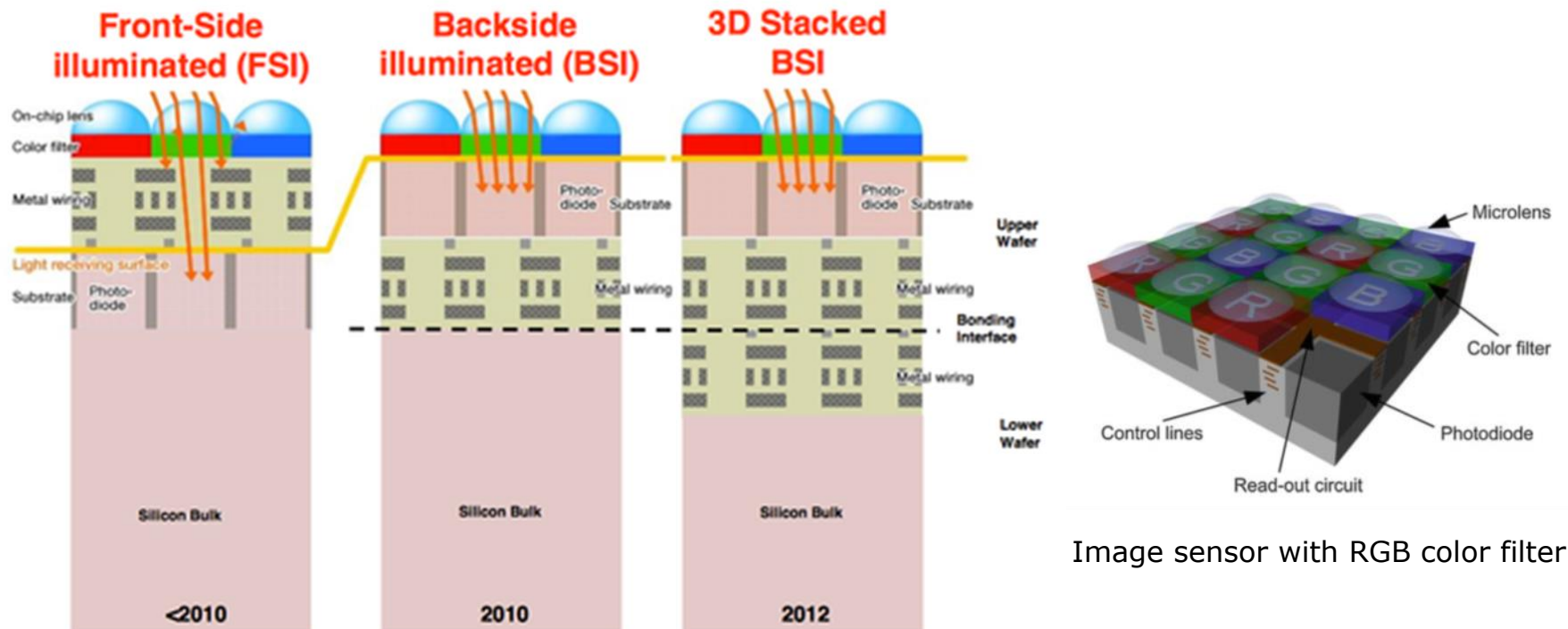


Image sensor with RGB color filter

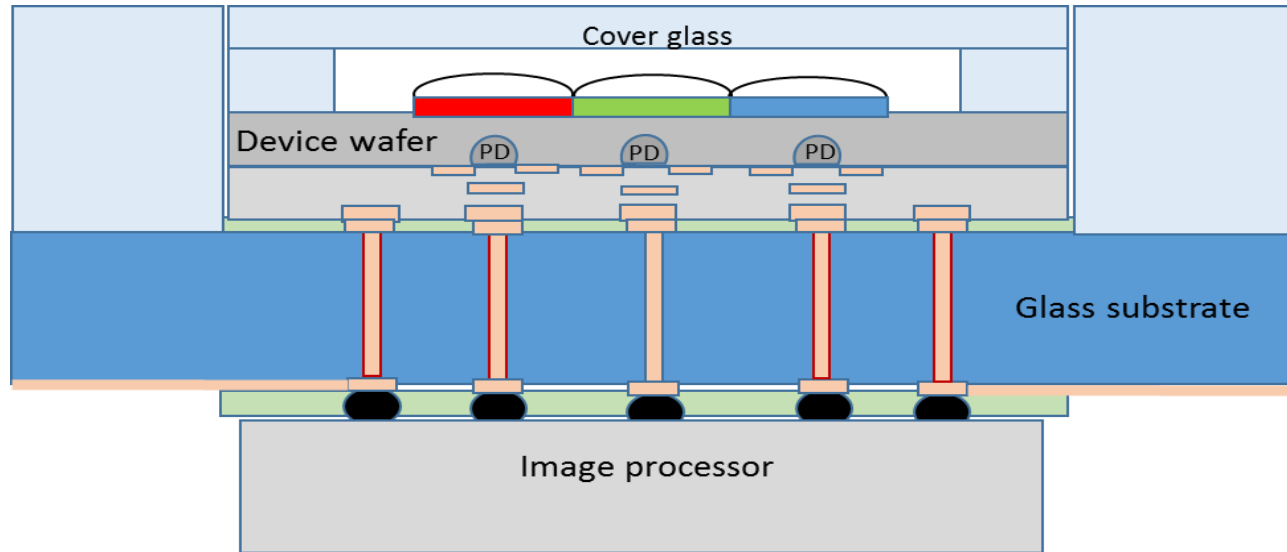
Source: Yole

- The AR0231AT is a 1/2.7-inch CMOS digital image sensor with an active-pixel array of **1928Hx1208V**.
- The AR0231AT uses the latest 3.0 micron **Back Side Illuminated (BSI) pixel** with ON Semiconductor's DR-Pix™ technology, which offers dual conversion gain for improved performance under all lighting conditions, including **LED Flicker Mitigation (LFM)**
- The BSI sensor technology offers **four-times better low light signal-to-noise ratio, a 40% increase in visible light sensitivity**, and greater than **60% improvement in near-infrared** performance than the current FSI CMOS image sensor for ADAS.



- 60 Frames per Second (fps) at Full Resolution, 1/16 pixel number at 960 fps
- On-chip 10-bit Analog-to-Digital Converter (ADC)
- Output data rate ≤ 1 Gbps
- Random Programmable Region of Interest (ROI) Readout
- BGA 121 package

Source: On Semi



Glass package enables:

- BSI image sensor embedded in glass cavity
- FC interconnections to glass substrate
- Glass substrate to integrate
 - image processor and sensor fusion processor
 - Radar module

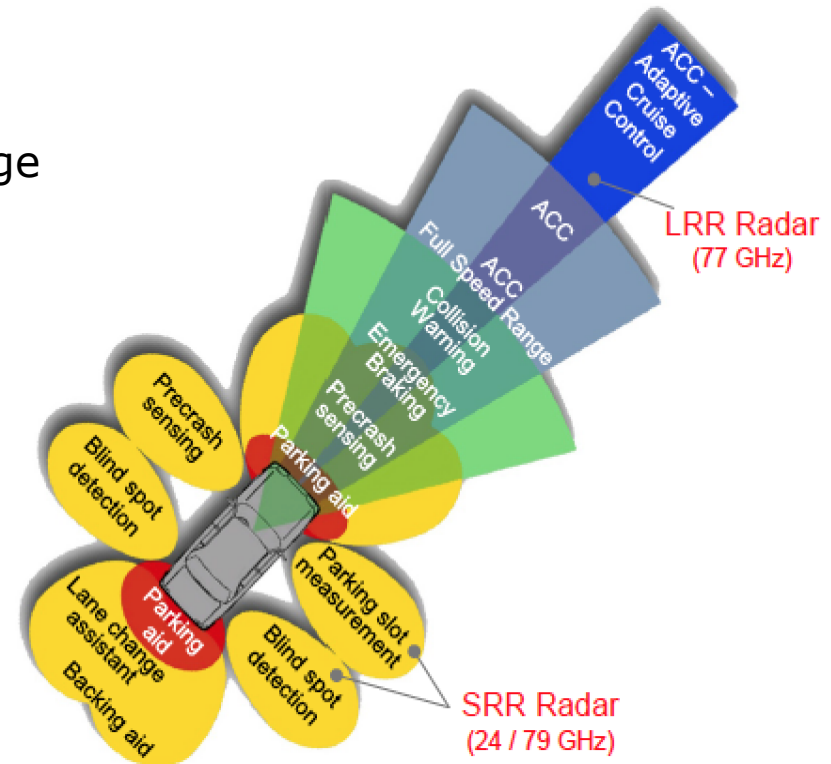
Saving in area by embedding:

**Area of packaged CIS : Area of unpacked
CIS = 2.7 : 1**

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- mm-wave Radar (**RA**dio **D**etection **ANd** **R**anging)
- Emerging as a Major Thrust for Automotive OEMs

- Auto Radar
 - Extended Range (Low SNR)
 - Small form-factor (chip-package co-design)
 - Silicon-based
 - Board-Level Reliability
 - Low-cost
- Three Focus Areas
 - Device Innovation
 - Package Innovation
 - Chip-Package Co-Development



Short, Medium and Long Range RADAR Modules Critical to Fully Autonomous Driving

Bosch MRR Sensor

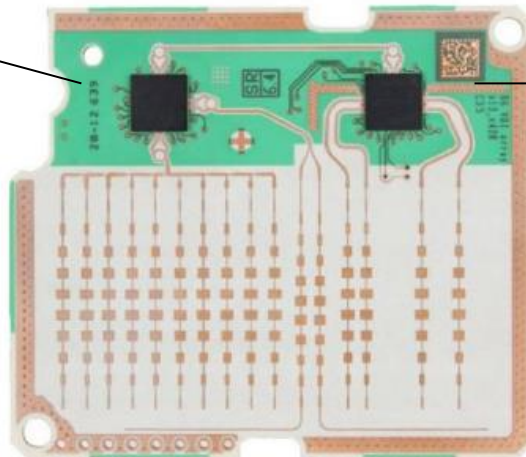


Type	MRR
Frequency band	76-77 GHz
Bandwidth	600 MHz
Distance range	Up to 160m
Aperture angle	$\pm 45^\circ$

Quad channel receiver

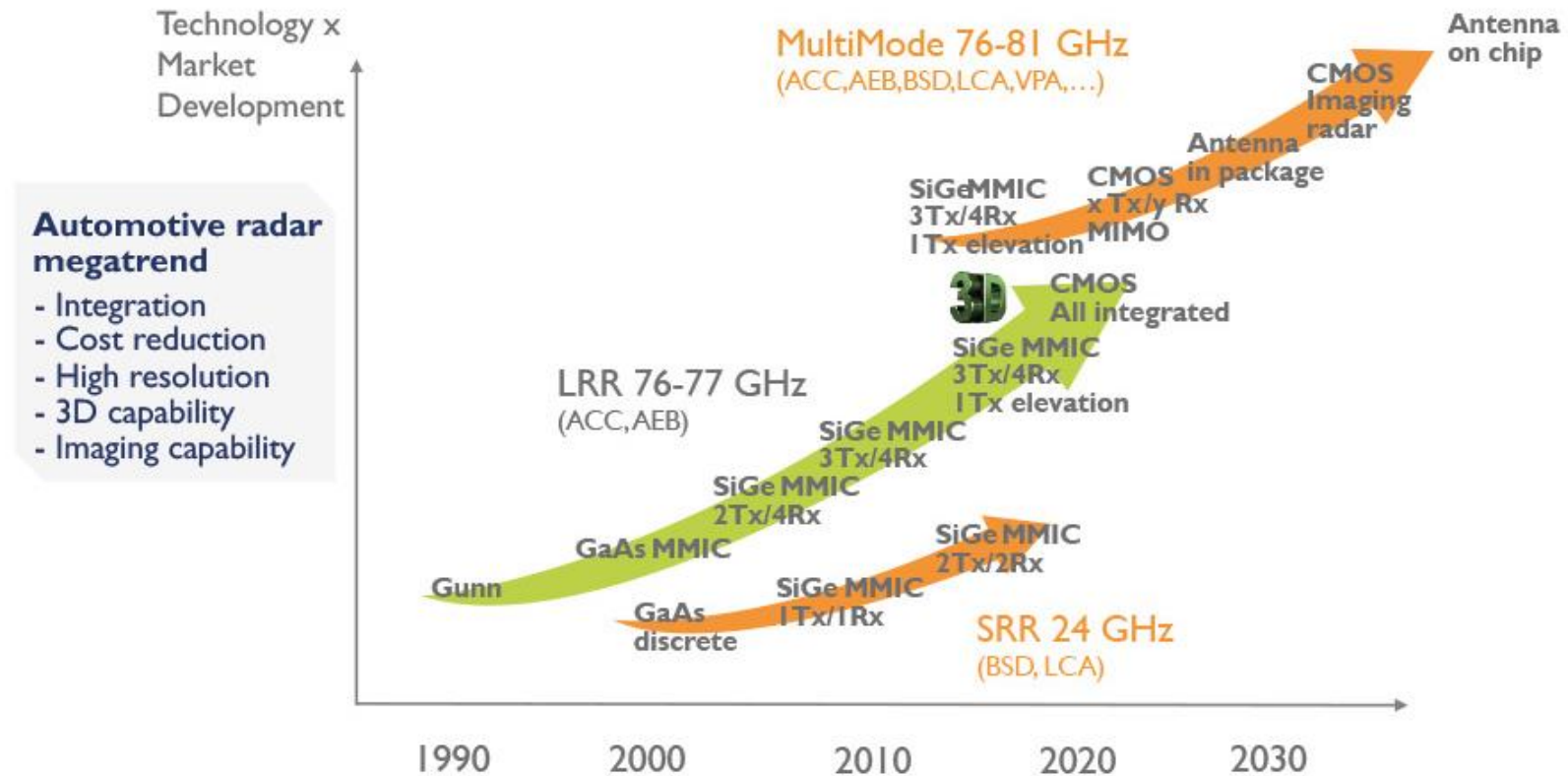
Transmitter and local oscillator

PCB
Antenna



Infineon eWLB packaged 77GHz SiGe Radar Module

Source: Infineon

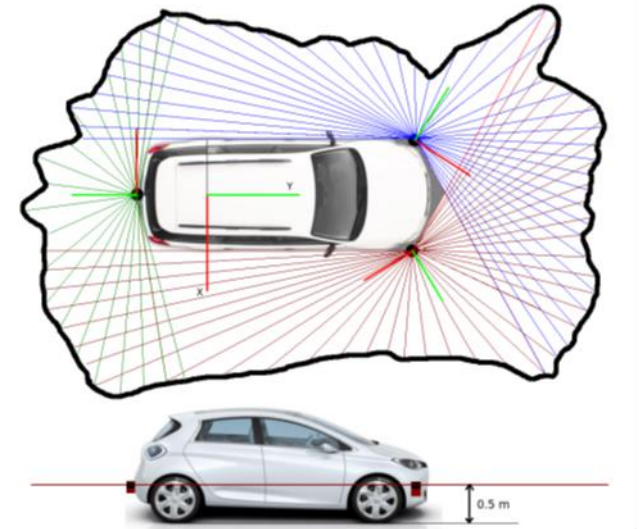


Source: Yole

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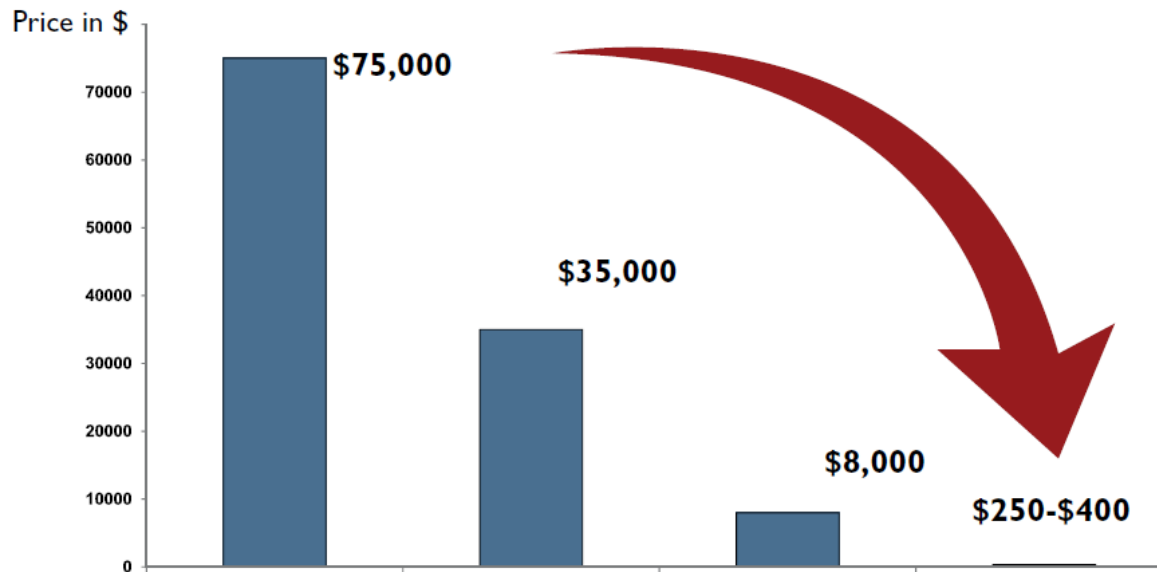


Source: Google



Cameras and radar cannot ensure 100 percent safety.
Radar provides no object detection. Cameras depending from environmental conditions.
Lidar (Light Detection And Ranging) enables **high precision detection in real time with object detection.**

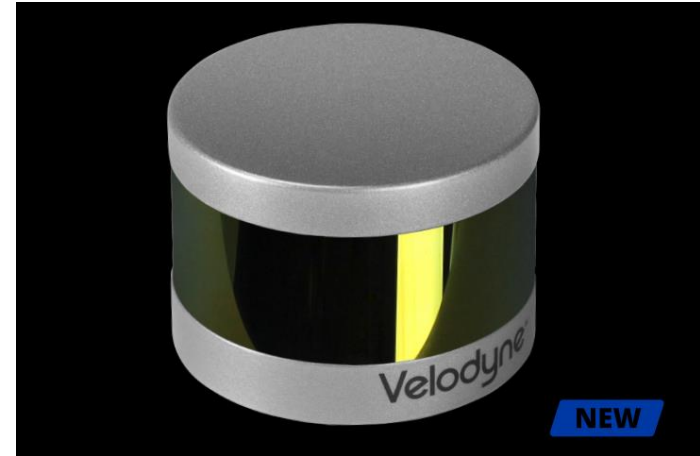
1. Cost reduction (see figure)
2. Miniaturization for easy integration in car body
3. High aperture angle – number of channels
4. Reliability by application of solid state lidar



Source: Frost & Sullivan; Velodyne Inc

Velodyne Lidar

- Range: 100 m,
- Power consumption: ~8 W,
- Weight: 830 grams,
- Footprint: ~Ø103 mm x 72 mm,
- 16 channels, ~300,000 points/sec,
- 360° horizontal field of view, 30° vertical field
- Accuracy: +/- 3 cm (typical)
- Rotating mirror inside assembly,
- Laser: Class 1 – 903 nm wavelength



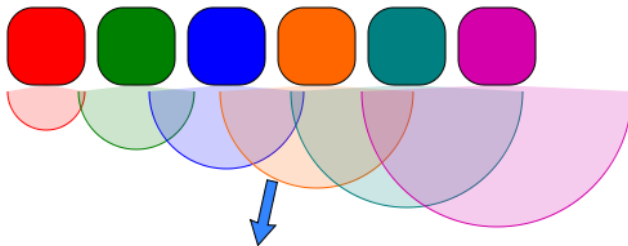
Source: Velodyne

Quanergy Solid-state LIDAR system

Field of view is 120 degrees both horizontally and vertically.

The minimum range is 10 cm, and the maximum range is at least 150 m at 8 percent reflectivity.

At 100 meters, the distance accuracy is +/- 5 cm, and the minimum spot size is just 9 cm.



The beam angle can be set by programming the pulse timings.



Small (9 cm x 6 cm x 6 cm),
no moving parts

Source: Quanergy

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The TI PGA450-Q1 is a System on Chip (SOC) sensor interface IC for automotive Ultrasonic sensors. It provides all signal conditioning and processing for the transducer echo signals and for calculating the distance between the transducer and objects.



Applications:

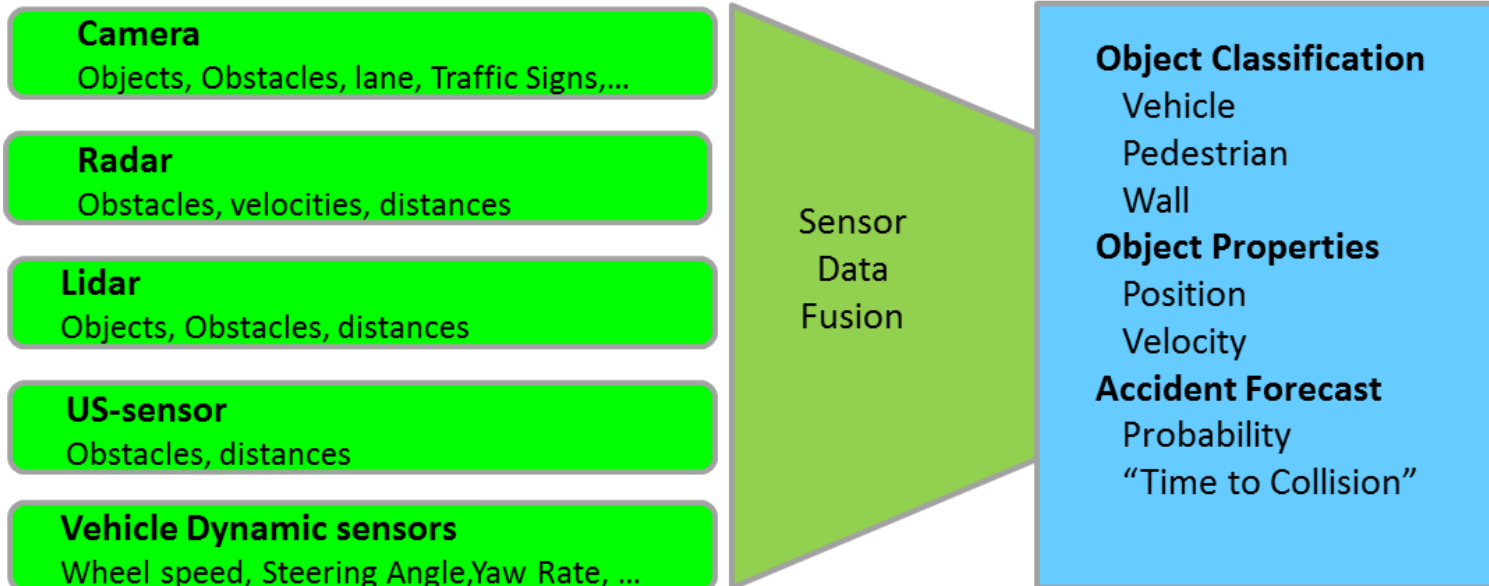
- Ultrasonic park assist
- Self parking
- Blind spot detection
- Park distance warning

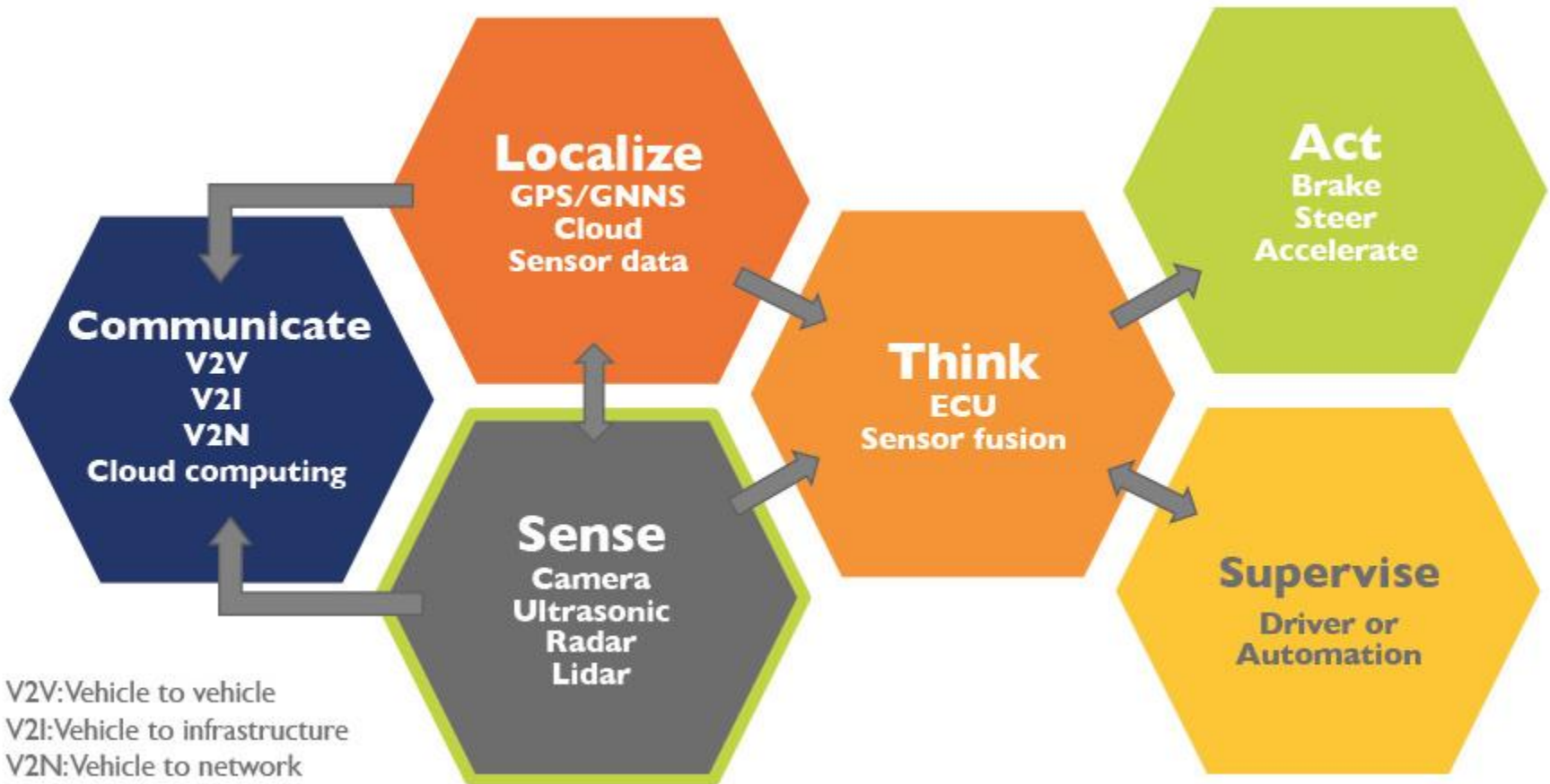
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Sense

Understand

Act





Source: Yole

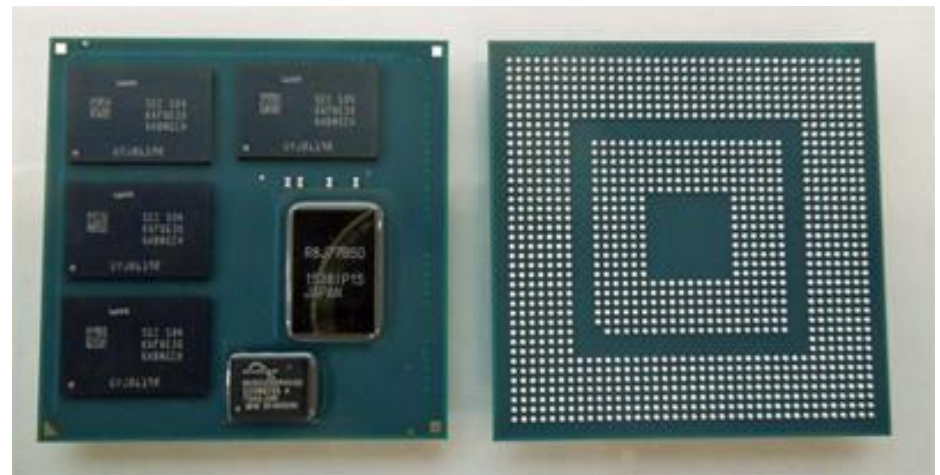
Infineon AURIX TC3xx

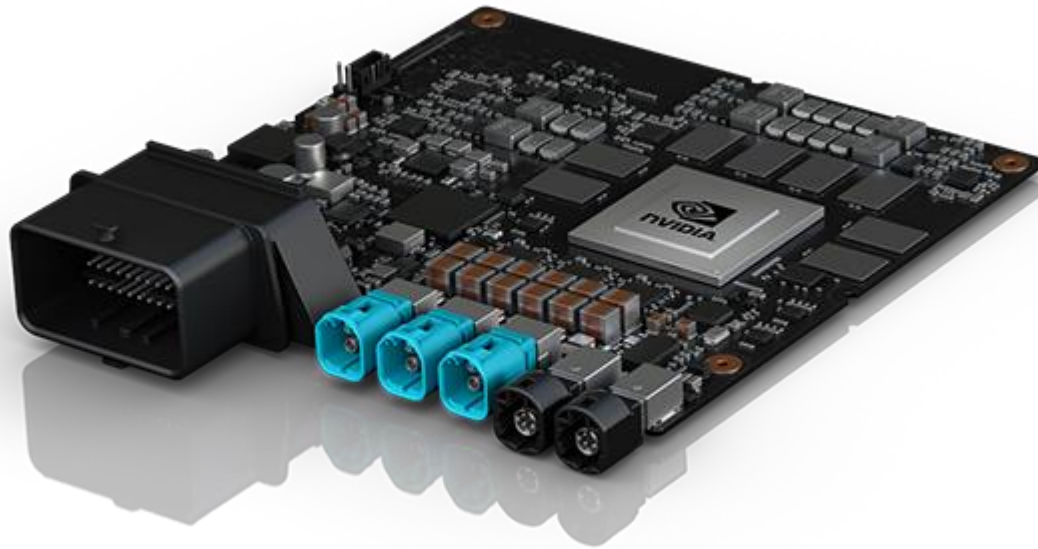
Microcontrollers for real-time performance, serving the requirements of automated cars and electric vehicles.



Renevas R-Car H3

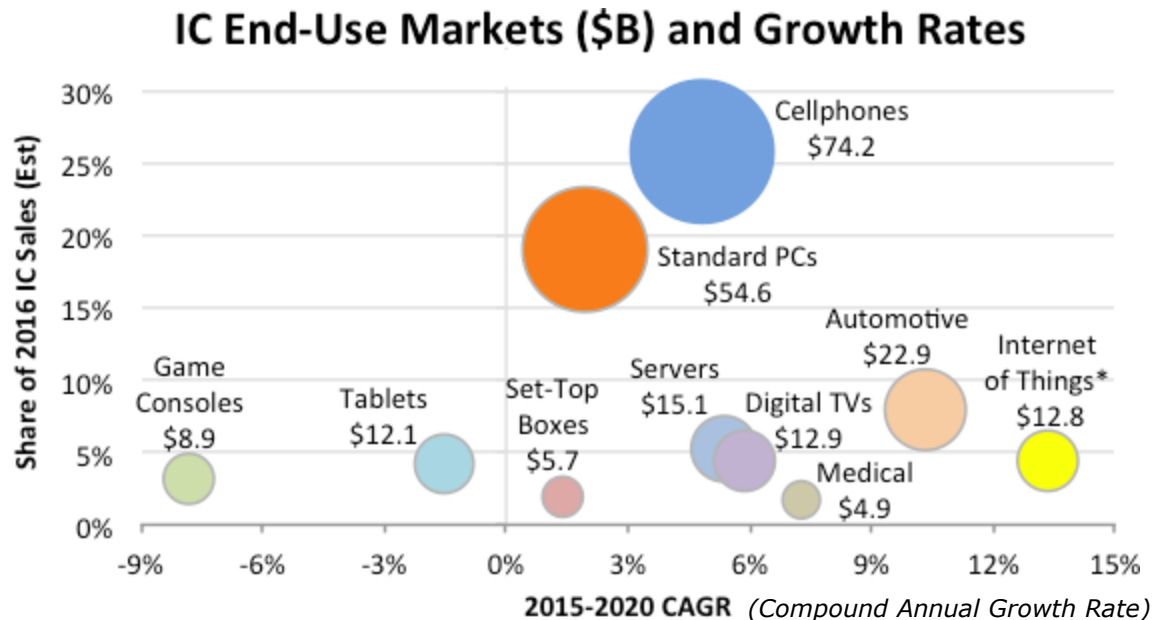
Automotive computing platform for driving safety systems, Infotainment systems, Image processing.





DRIVE PX Pegasus

With an unprecedented 320 TOPS of deep learning calculations and the ability to run numerous deep neural networks at the same time, this high-performance AI computer will provide everything needed for safe autonomous driving.



*Covers only the Internet connection portion of systems.

Source: IC Insights

Automotive drives the growth of IC market

Thanks for your attention

Question?