Market and Technology Trends in Automotive ADAS

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YOLE Group

YOLE GROUP

We provide industrial companies, financial investors and R&D organizations, with market research and marketing analysis, technology, supply chain and cost analysis, as well as performance evaluation, to help our customers in their decision-making about their future business and manufacturing strategy in the semiconductor, photonic and electronic sectors.

3 CORE ACTIVITIES BASED ON DEEP SYNERGIES

Market & Technology

- Market, technology, and strategy consulting
- M&A, Due Diligence and evaluation of companies

Teardown Reverse engineering and costing

- Technology, process & cost analysis
- Teardown and reverse engineering
- Comparative analysis

Performance analysis

- Test of electric and electro-optical performance of devices
- Comparison of performances and related technical choice

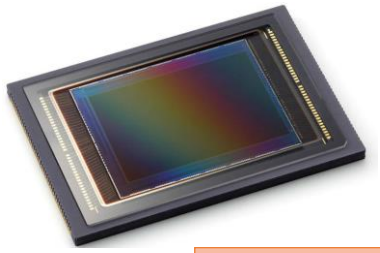
Outline

- Introduction
- Market trends
- Technology trends
- Ecosystem and supply chain
- Conclusion

Introduction

Introduction

ADAS cameras



CMOS image sensor

Viewing cameras

Lens set

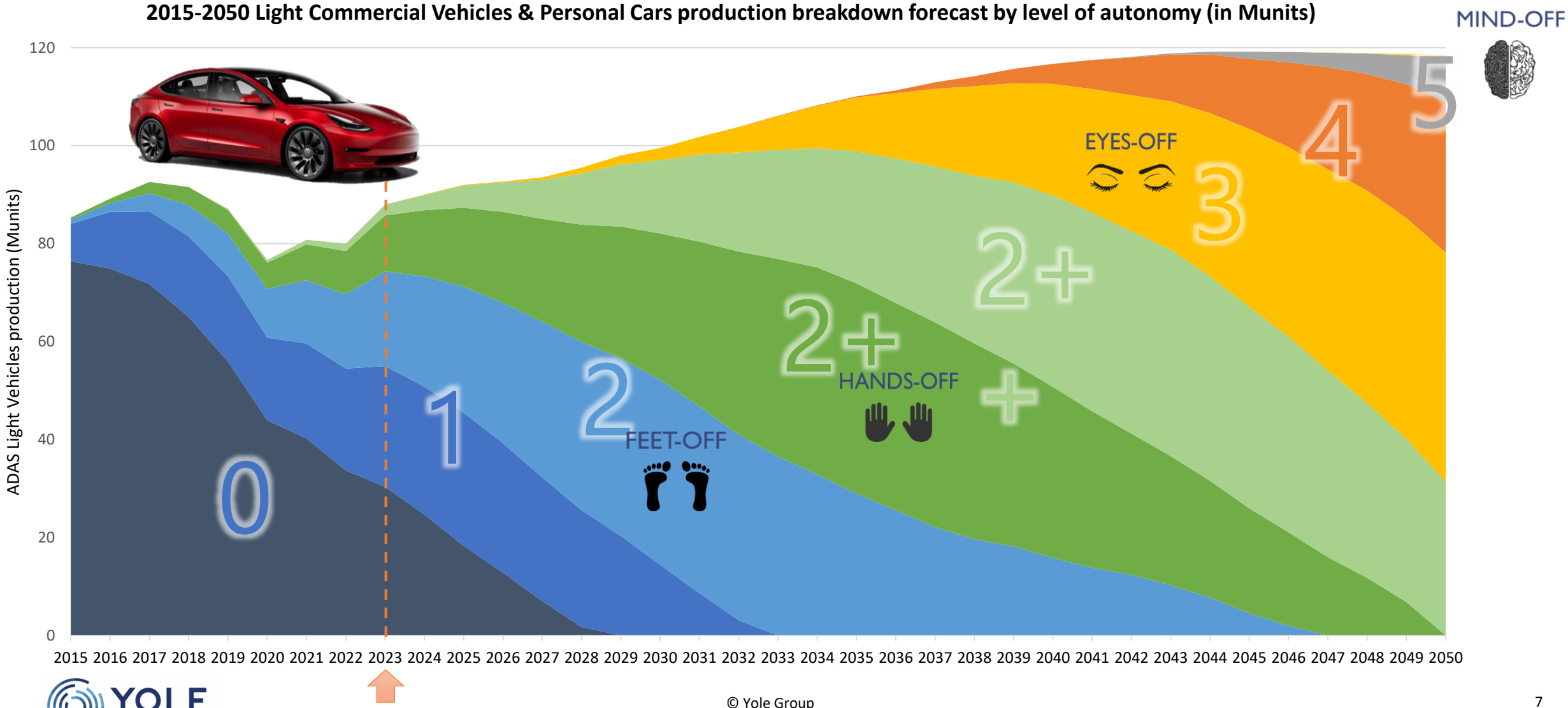
In-cabin cameras

ADAS processors

Scope of the presentation

Market trends

Automotive forecast breakdown by level of autonomy



Level 3 vehicles on the road

ADAS sensors at least:
x 1 LiDAR
x 13 Ultrasonic sensors
x 6 Cameras
x 5 Radars
(+in-cabin DMS camera)

Mercedes-Benz's Drive Pilot L3

ADAS sensors at least:
x 1 LiDAR
x 12 Ultrasonic sensors
x 5 Cameras
x 5 Radars
(+in-cabin DMS camera)

BMW New 7 Series with Level 3 self-driving

Evolution of functionalities towards full autonomy

FEET-OFF

Feet-Off

Adaptive Cruise Control
Advanced Emergency Braking
Cross Traffic Alert

Surround View +
Object Detection

HANDS-OFF

Hands-Off

Traffic-Jam Assist
Lane Centering Assist
Navigate on Autopilot (NOA)

Parking Assist

EYES-OFF

Eyes-Off

Highway pilot

Arterial pilot
(geofenced?)

City pilot
(geofenced?)

Remote Parking

Valet Parking

Driver Assistance

Partial Automation

Conditional Automation

High Automation

Full Automation

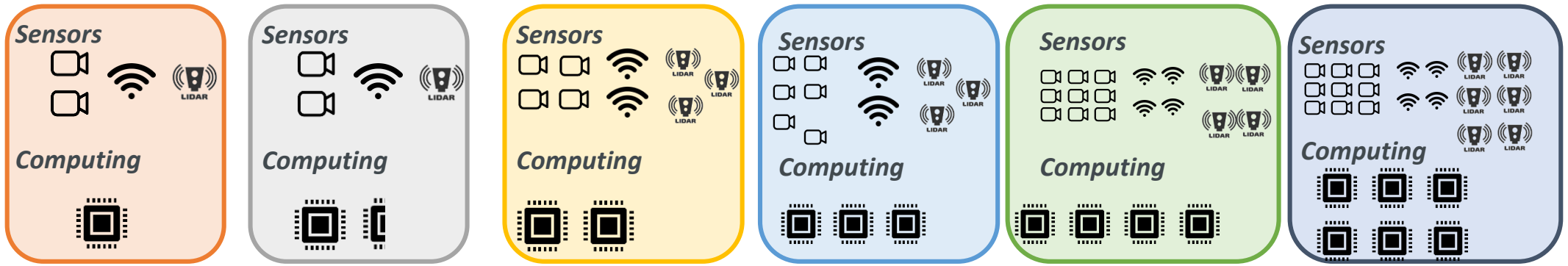
Eyes-off applications: an incremental evolution

EYES-OFF

Use cases

2022	2024	2026-2028?	2030-2035?	2035-2040?	2040-2050?
Highway *60km/h*	**Highway** *130km/h*	**Highway** *On-/Off ramp*	**Arterial** *Junctions and traffic lights*	**Rural** *All junctions*	**Urban** *Full autonomy*

Each use case is an incremental evolution enabled by a new generation of hardware (sensors and computing) and software.



From ADAS to autonomous driving

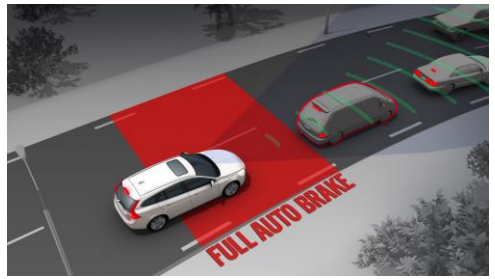
ADAS for Safety

To more autonomy

Autonomy

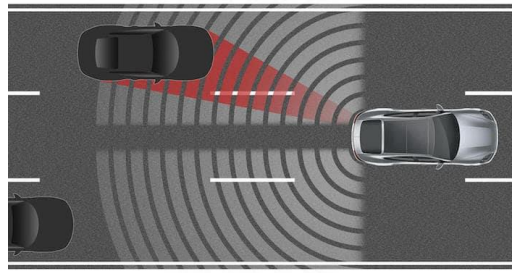
Regulations

Automatic Emergency Braking (AEB)



Pedestrian Detection

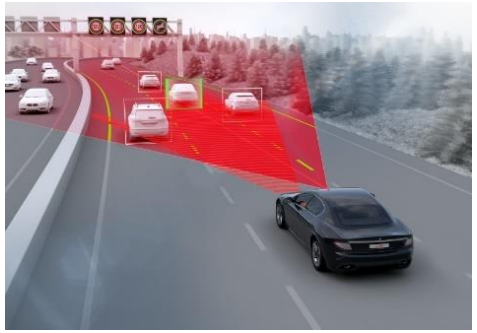
Lane keep assistance



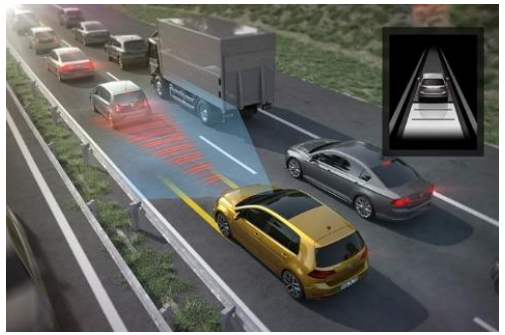
Traffic Sign Recognition

Highway

Highway assist



Traffic jam assist



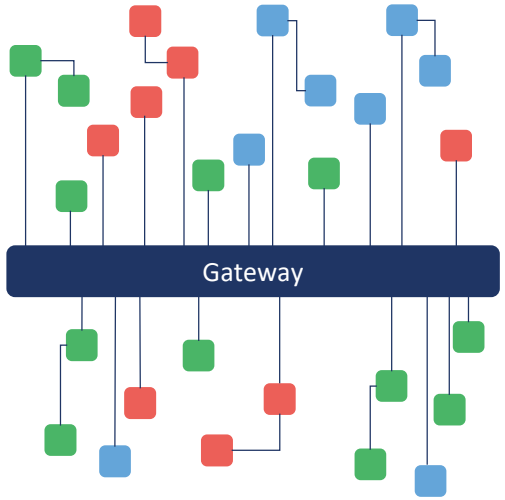
Parking

Autonomous parking

Architecture evolution enabling a software-defined vehicle

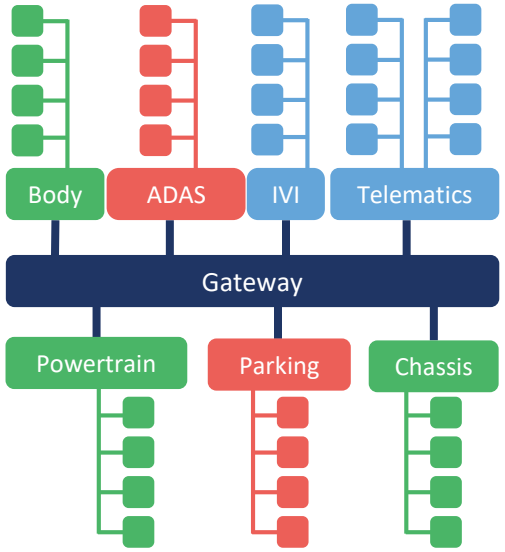
Complex OTA updates → Simple OTA updates

Distributed architecture

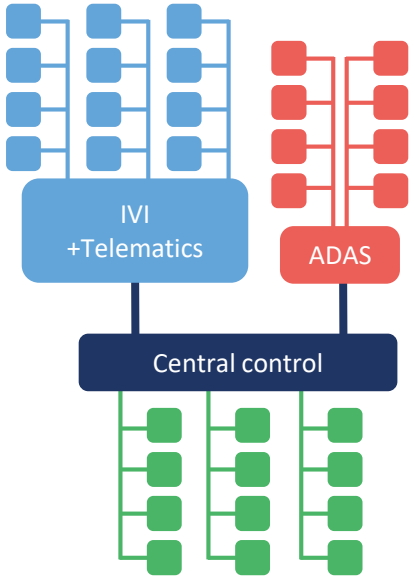


Up to +100 ECUs per vehicle

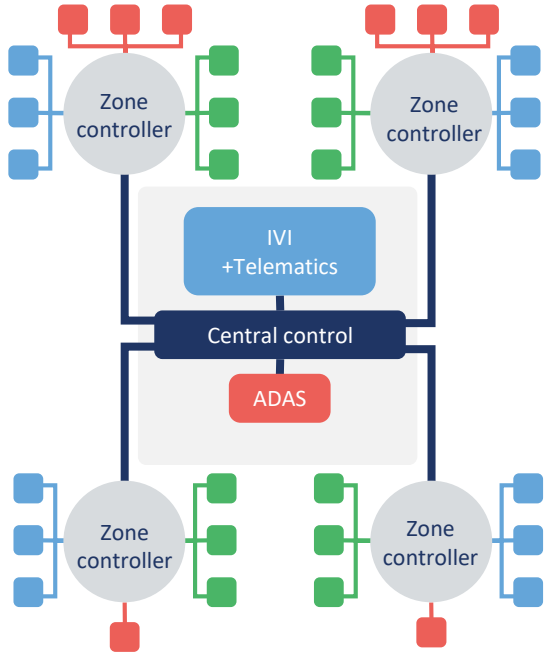
Domain architecture



Clustered domains architecture



Zonal architecture



Incremental transition

Incremental transition

Disruptive transition

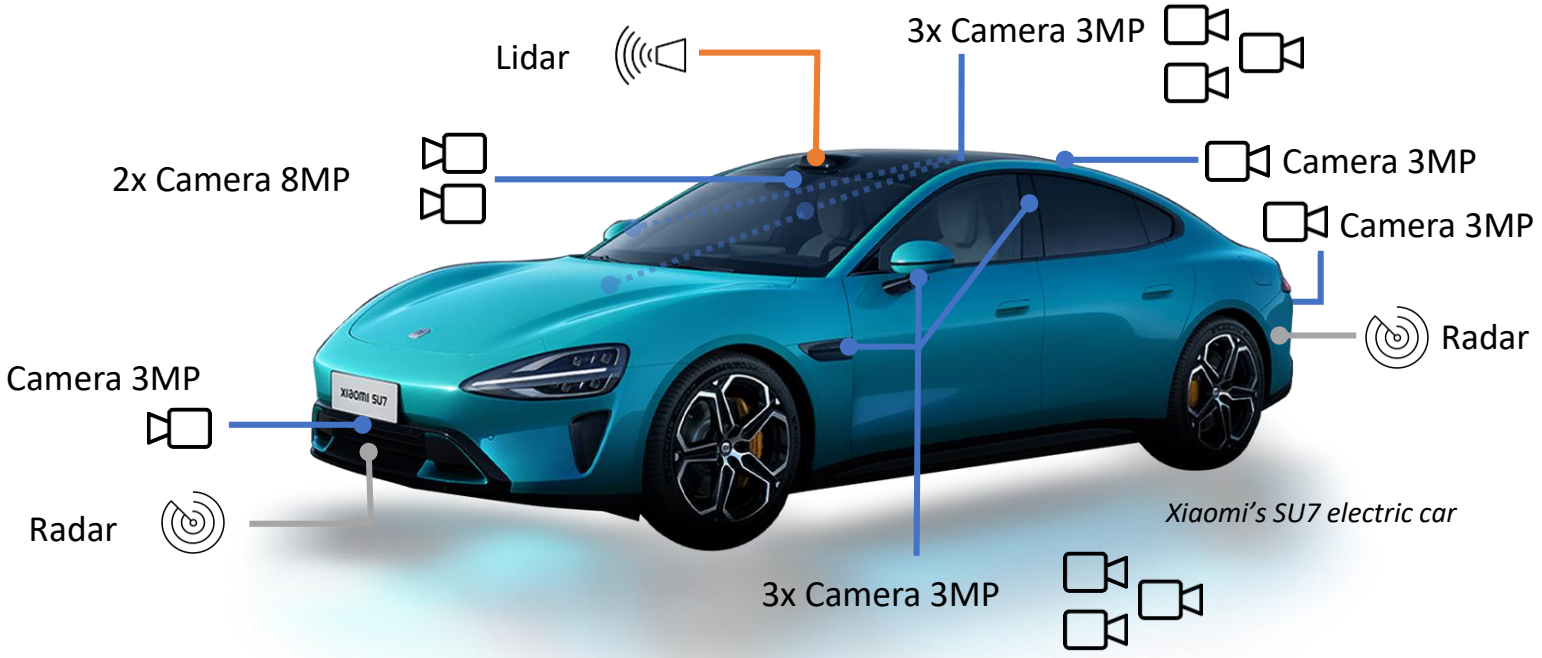
Disruptive transition

*OTA = Over The Air

Xiaomi sold 90,000 SU7 in 24 hours

Xiaomi Pilot Max

Front cameras	8MP x2
Side cameras	3MP x4
Panoramic cameras	3MP x4
Rear camera	3MP x1
Ultrasonic radar	x12
Front mm radar	x1
Rear mm radar	x2
LiDAR	x1
NVIDIA DRIVE Orin	x 2 = 508 TOPS



NVIDIA Centralized architecture

ADAS

Xiaomi Pilot Pro

1x Nvidia DRIVE Orin – 84 TOPS

Xiaomi Pilot Max

2x Nvidia DRIVE Orin – 508 TOPS

Qualcomm

Infotainment

Qualcomm Snapdragon 8295

In just 24 hours, Xiaomi sold 90,000 SU7, representing $2.7B for the cheapest version ($30,408) By comparison, Tesla sold 180,000 Tesla Model 3 in the first 24 hours.

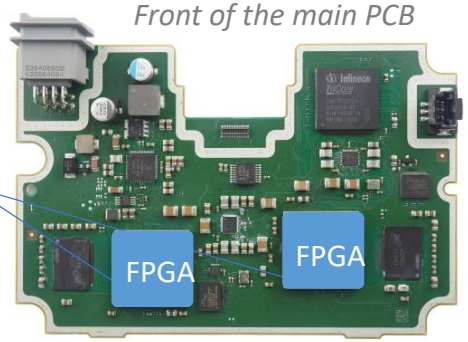
Technology trends

Processors in the front-facing ADAS camera module

Veoneer Mono Vision Gen.4 MV4 Front Camera

Can be found in Polestar cars

Front of the main PCB



Dual Xilinx UltraScale+ MPSoC

AMD XILINX

tsmc

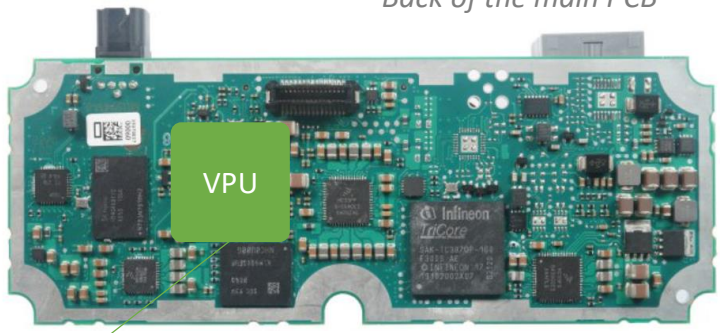
Packaging size Packaging type	441mm² FC BGA
Die area	89mm²
Node	16nm
Estimated ASP	$62
Manufacturer	TSMC

- 64-bit quad-core Arm® Cortex™-A53
- Dual Cortex R5 MCU

Continental Front Camera

Can be found in Changan Shenlan SL03 cars

Back of the main PCB



Horizon Robotics Journey 3

Horizon Robotics

tsmc

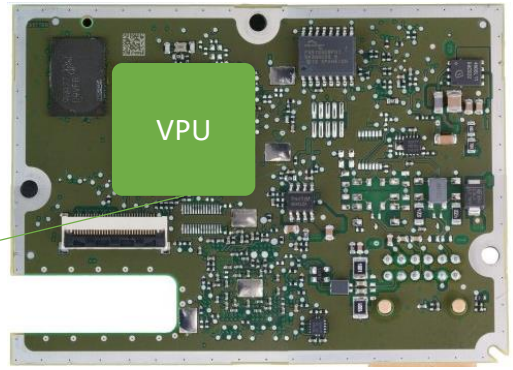
Packaging size Packaging type	210mm² FC BGA
Die area	33mm²
Node	16nm
Estimated ASP	$13.5
Manufacturer	TSMC

- Quad core Cortex A53 CPU
- Cortex R5 MCU
- Dual core Bernoulli-architecture v2 BPU
- *5 TOPS (int8)*

Valeo FAS Front Camera

Can be found in Audi, Honda, Seat, Skoda and Volkswagen cars

Back of the main PCB



Mobileye EyeQ4M

mobileye

life.augmented

Packaging size Packaging type	506mm² FC BGA
Die area	42mm²
Node	28nm
Estimated ASP	$28
Manufacturer	STMicroelectronics

- *1.1DL TOPS (int 8)*

DL= Deep Learning

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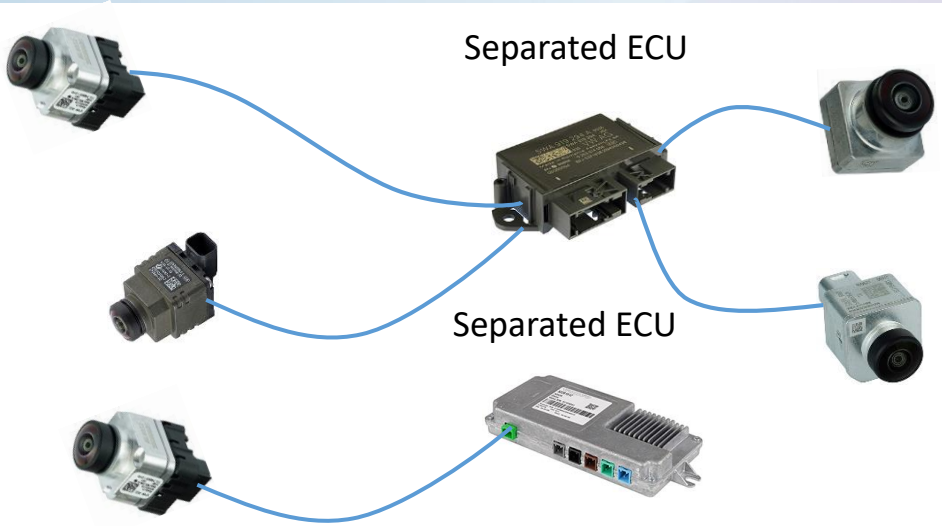
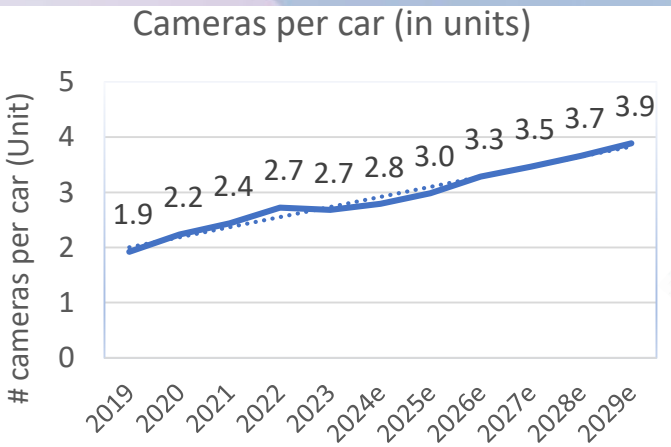
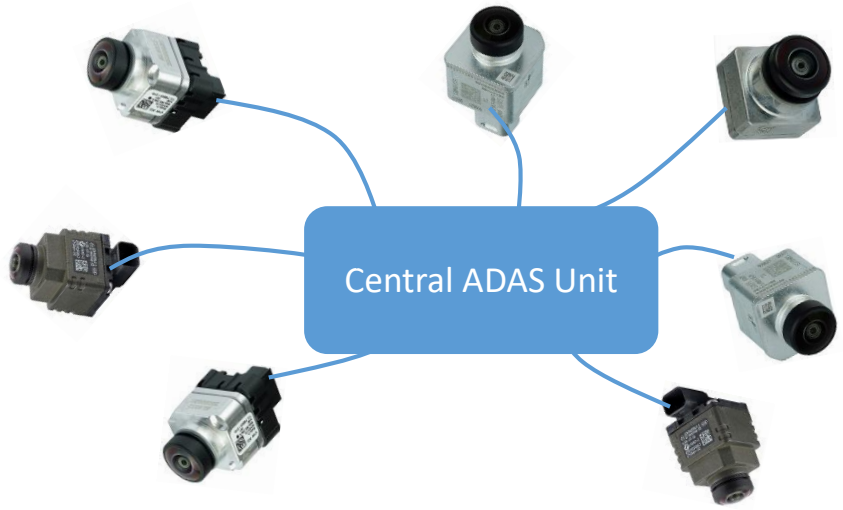
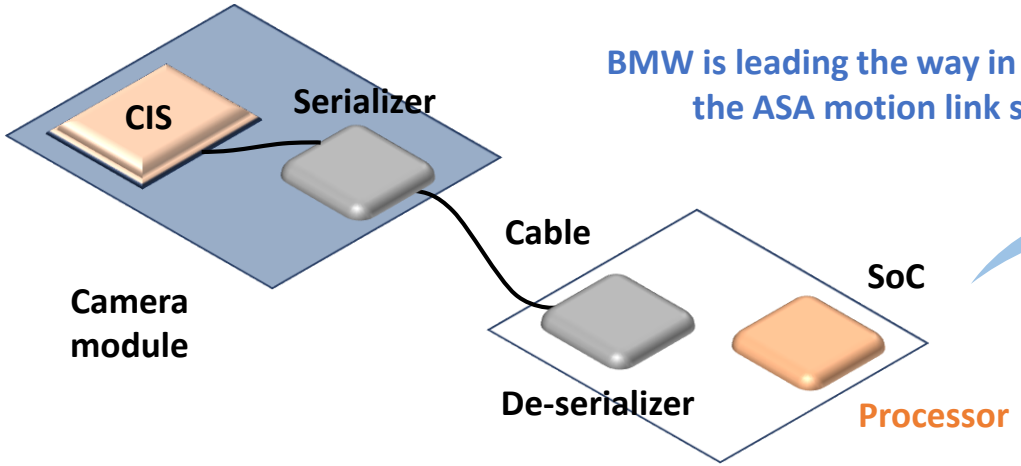
Connectivity is a driver for automotive imaging





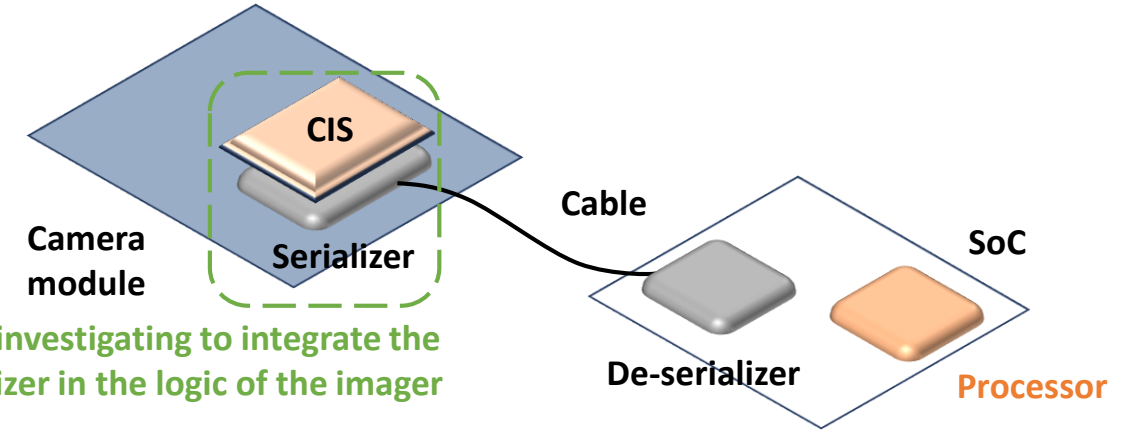


Current trend



BMW is leading the way in investigating the ASA motion link solution

Future trend



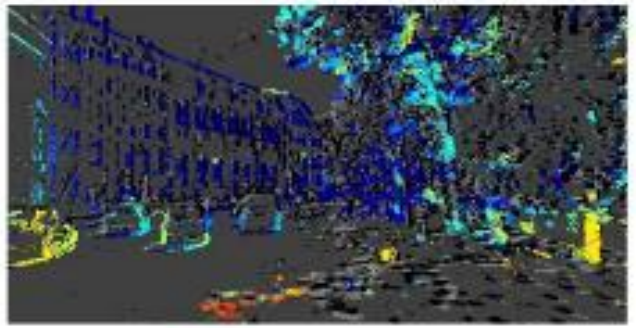
Sony investigating to integrate the serializer in the logic of the imager

Reduce costs

Reduce complexity on the PCB

Neuromorphic event-based cameras

- Event-based sensors use a neuromorphic and asynchronous structure: speed not limited by frame rate, minimal data loading, lower power, better latency, speed, sensitivity, and intra-scene dynamics.
- The goal is to improve the speed at which a critical situation can be understood by a machine or vehicle. It could be expanded to other applications such as 3D sensing.



Source: Prophesee

Neuromorphic sensing ecosystem:

Image sensors "big 3" leaders	Broad range of apps.	Focus on industrial and defense apps.	Focus on 3D sensing for XR & robotics	Differentiated in processing
SONY SAMSUNG OMNIVISION™	PROPHESEE AlpsenTek 锐思智芯 inivation acquisition SynSense	SCD BAE SYSTEMS	VoxelSensors * SUMMER ROBOTICS	oculi ** *** AISTORM

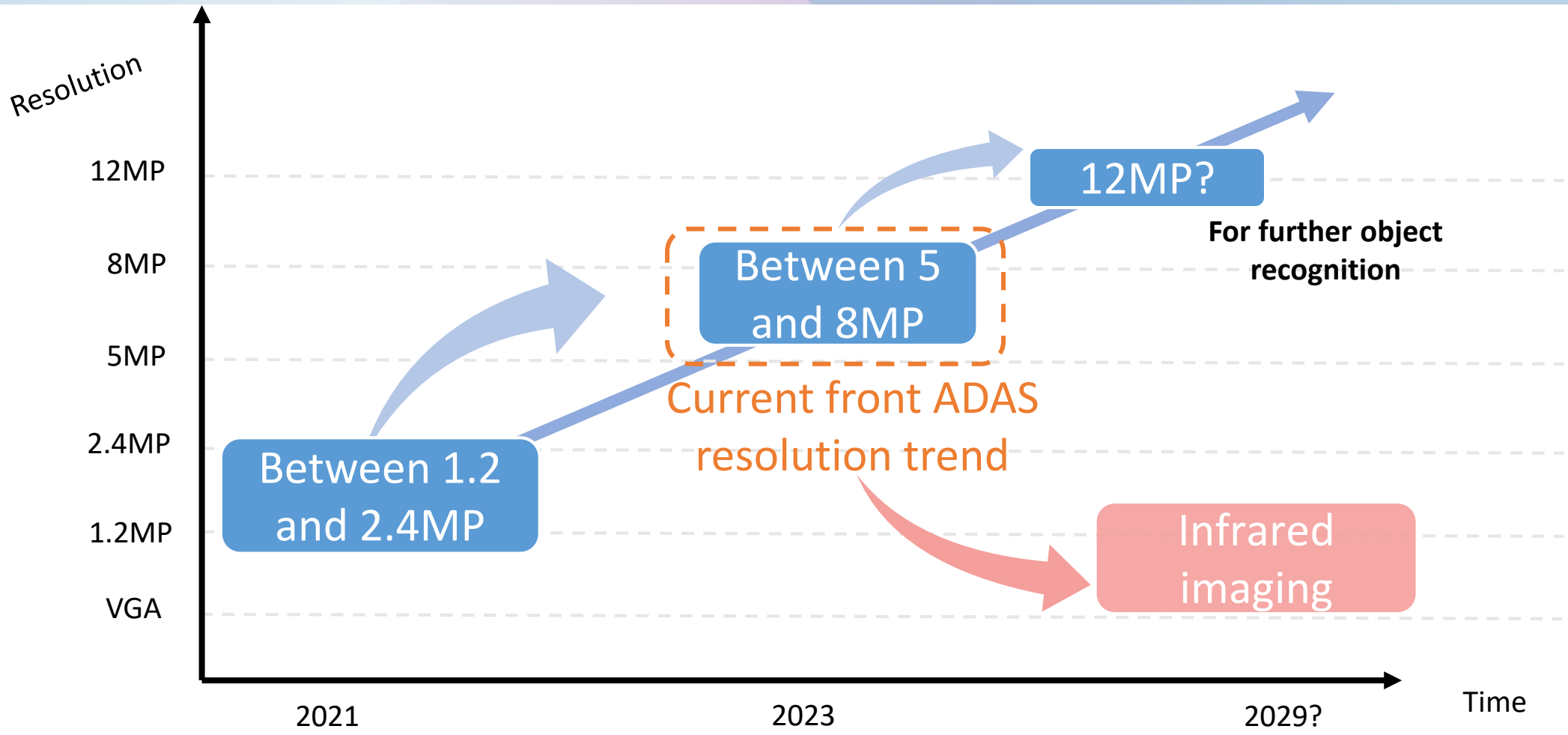
** use Prophesee sensors*

*** +in-pixel processing, and not limited to DVS*

**** DVS+charge domain processing*

Target Automotive market

Automotive ADAS cameras resolution roadmap



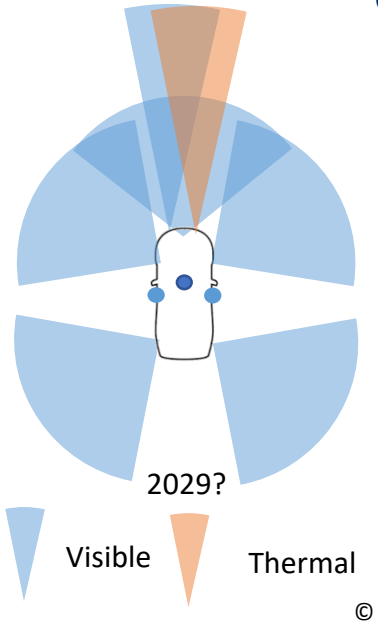
- Increasing the resolution will remain a trend in the coming years to achieve more accurate autonomy features.
- Increasing the resolution will also depend on the computational power.

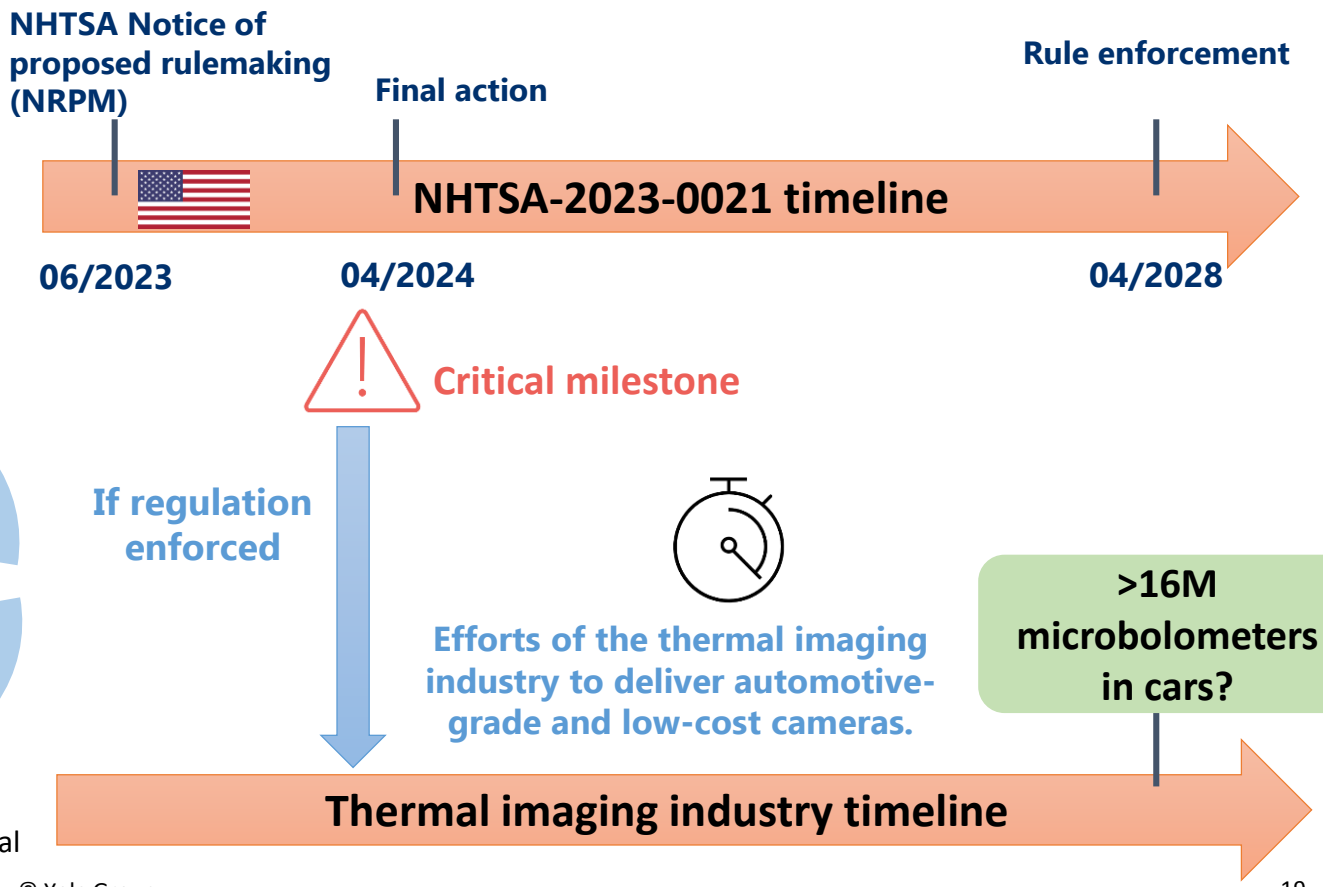
Thermal imaging opportunity for ADAS

- Few 100k thermal cameras in 2023.
- Several rating agencies have highlighted the weak performance of AEB during nighttime with current technologies.
- The thermal imaging industry is closely monitoring regulatory decisions that could trigger significant volumes in the near future.

Trigger for adoption?

Rating and regulation framework for automotive safety





Ecosystem and supply chain

Inside a forward ADAS camera: ZF S-Cam4 TriCam

Type	Tier 1	OEM	Image sensor supplier	Image sensor name	Description CIS	Computing supplier	Lens module	Estimated Cost
Triple	ZF	BMW / Nissan	Omnivision	OV10642	1.3 MP / 4.2 μm	Mobileye	3 x 7G	~$173

YOLE SystemPlus

Source: Yole SystemPlus

SUNNY OPTICAL TECHNOLOGY

Lens modules (x3)

OMNIVISION

CIS sensors (x3)

Infineon

MCU

mobileye An Intel Company

EyeQ4 vision processor

MXIC Macronix International Co., Ltd.

Flash memory

Micron

SDRAM

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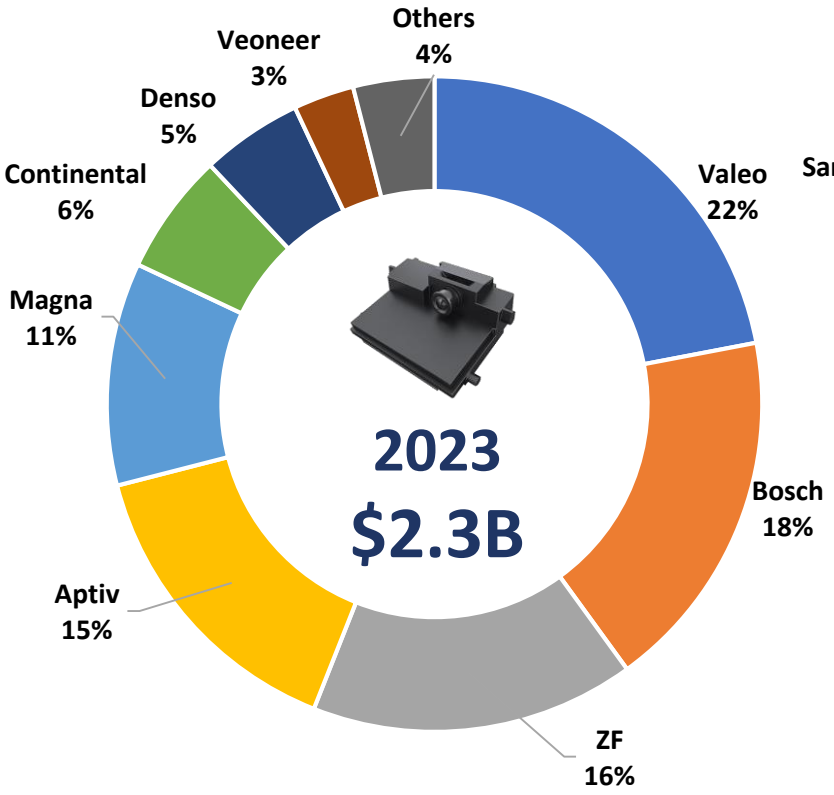
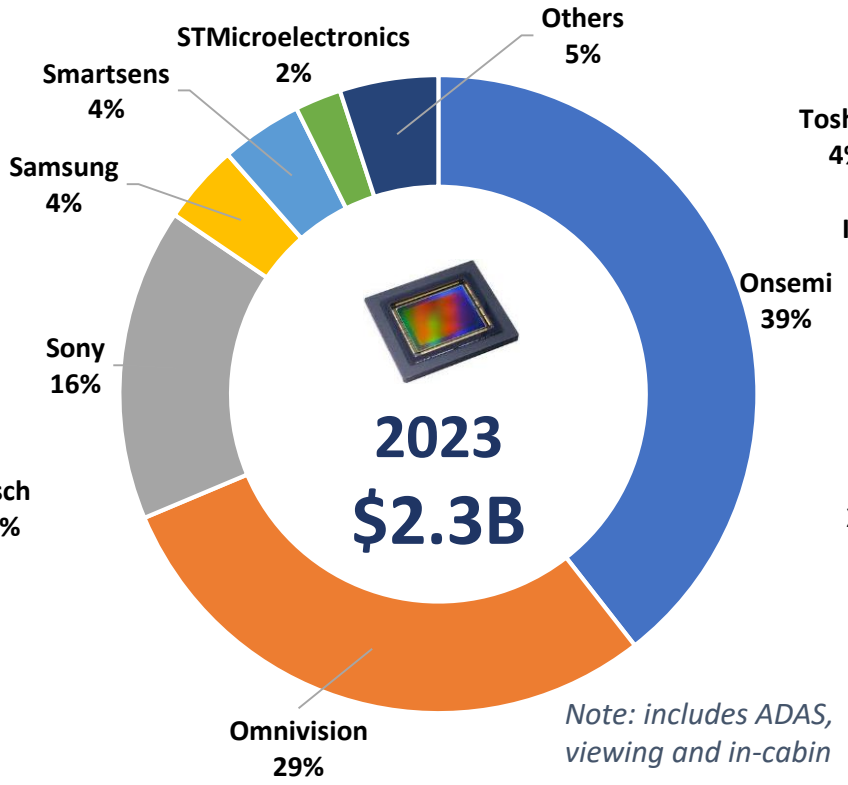
ADAS cameras, image sensors and processors market share

2023 ADAS automotive camera module market share (in $M)

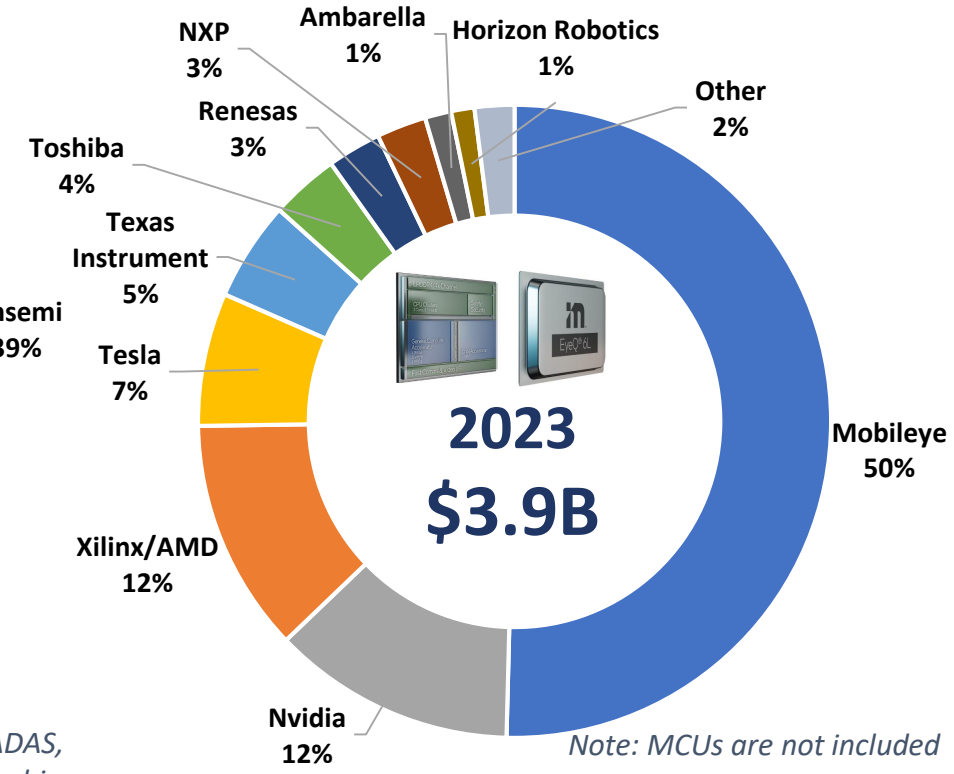


2023 Automotive image sensor market share (in $M)



Note: includes ADAS, viewing and in-cabin

2023 ADAS processor market share (in $M)

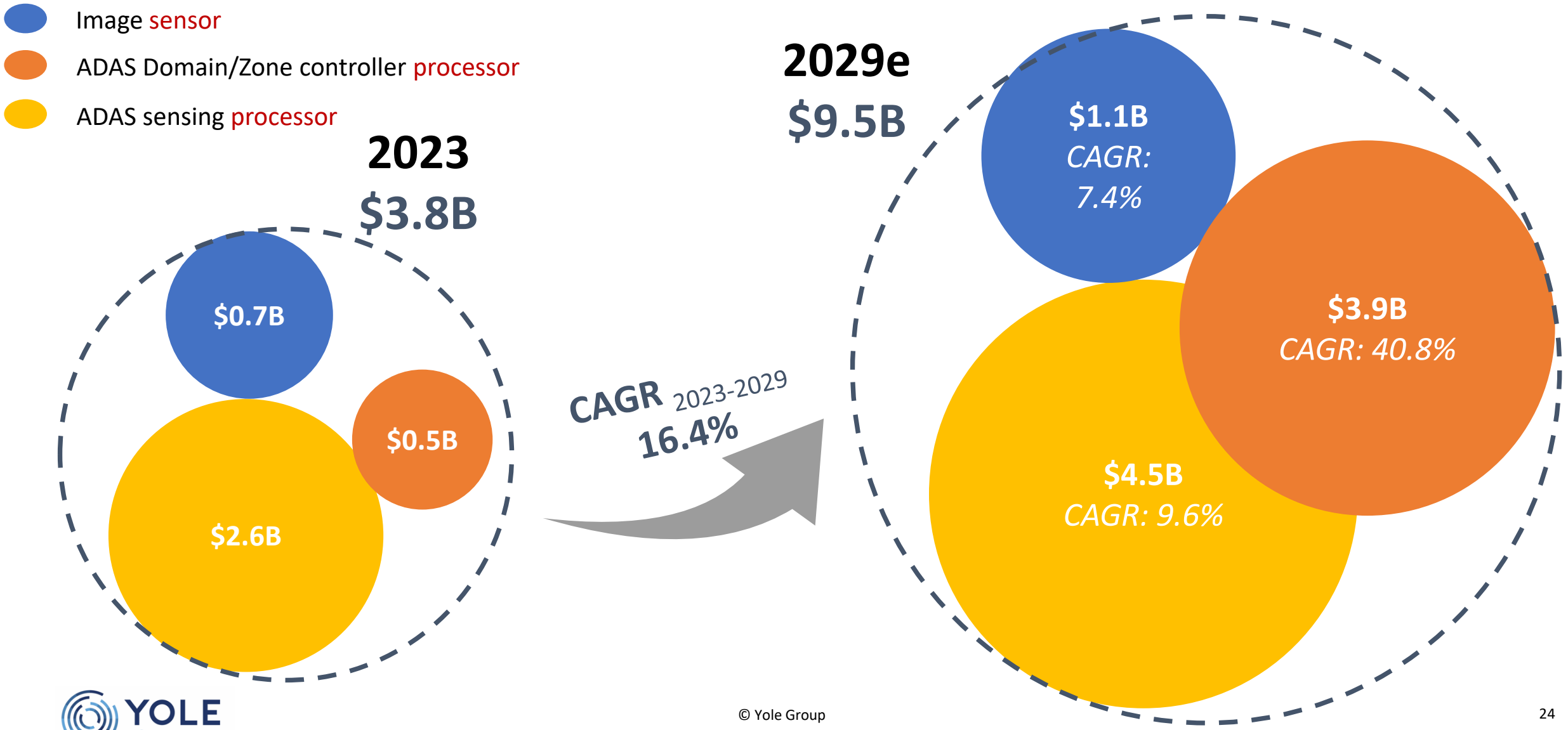


Note: MCUs are not included

- "Others" includes BYD Semiconductor, Pixelplus, Melexis, Galaxycore, Nuvoton, Infineon, Pmd.

Conclusion

2023-2029 ADAS image sensors and processors forecast



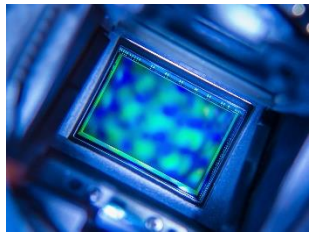
Key takeaways

- **ADAS cameras and image sensors**
  - In 2023, automotive production rebounded with ~**88 million vehicles**, the **ADAS automotive camera market surged to $2.3B**, part of which image sensors reached $0.7B. ADAS market is still led by traditional Tier-1, **Onsemi** is maintaining its leading position in the sensor market followed by **Omnivision** and **Sony**.
  - Automotive image sensors demand high dynamic range, LED flicker mitigation, and wide fields of view. The context of **centralized fusion platforms** drive innovation for **sensor connectivity**. Invisible wavelength cameras remain niche with **thermal cameras driver that could surge by 2029 to meet new regulations on AEB**.
- **ADAS processors**
  - Today, **most VPUs sold for automotive applications can be found in front ADAS camera systems**.
  - **AI hardware acceleration** is now a must for VPUs and APUs, more energy-efficient than general-purpose compute units, and above all have a much higher computing speed, reducing latency, which is particularly important for safety-critical applications in ADAS.
  - **The trend in ADAS processors is towards centralization.** Historical manufacturers are slower to make the transition, compared to new players. **New generations of processors will be able to run the ADAS software on a single SoC**.

Yole Group Related Products

Status of the Processor Industry 2023

2024 edition coming soon



Status of the CMOS Image Sensor Industry 2023

2024 edition coming soon

Computing and AI for Automotive 2023

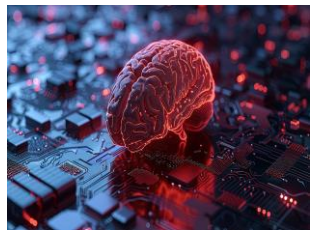
2024 edition coming soon

Imaging for Automotive 2024

Imaging for Industrial - Machine Vision 2024

Semiconductor Trends in Automotive 2023

2024 edition coming soon



Neuromorphic Computing, Memory and Sensing 2024

Feel free to contact us for more information

Resources

Yole Group reports

Imaging for Automotive 2024
https://www.yolegroup.com/product/report/imaging-for-automotive-2024/

Computing and AI for Automotive 2024
https://www.yolegroup.com/product/report/computing-and-ai-for-automotive-2024/

Neuromorphic Computing, Memory and Sensing 2024
https://www.yolegroup.com/product/report/neuromorphic-computing-memory-and-sensing-2024/

2024 Embedded Vision Summit

"Recent Trends in Industrial Machine Vision: Challenging Times"
Dr. Axel Clouet, Thursday, May 23, 2:40 pm