Automotive Electronics & Semiconductor Market Trends

LIDARs and sensor fusion ECUs advancing ADAS architectures towards automated driving

The Annual Tokyo SOI Workshop, 2017

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Agenda

- Automotive electronics and semiconductor market trends
- ADAS architectures towards automated driving
  - Current state of ADAS sensor architectures
  - Key technologies enabling next-gen ADAS architectures
  - Market Outlook & Key Takeaway

Addressing strategic challenges with interconnected capabilities

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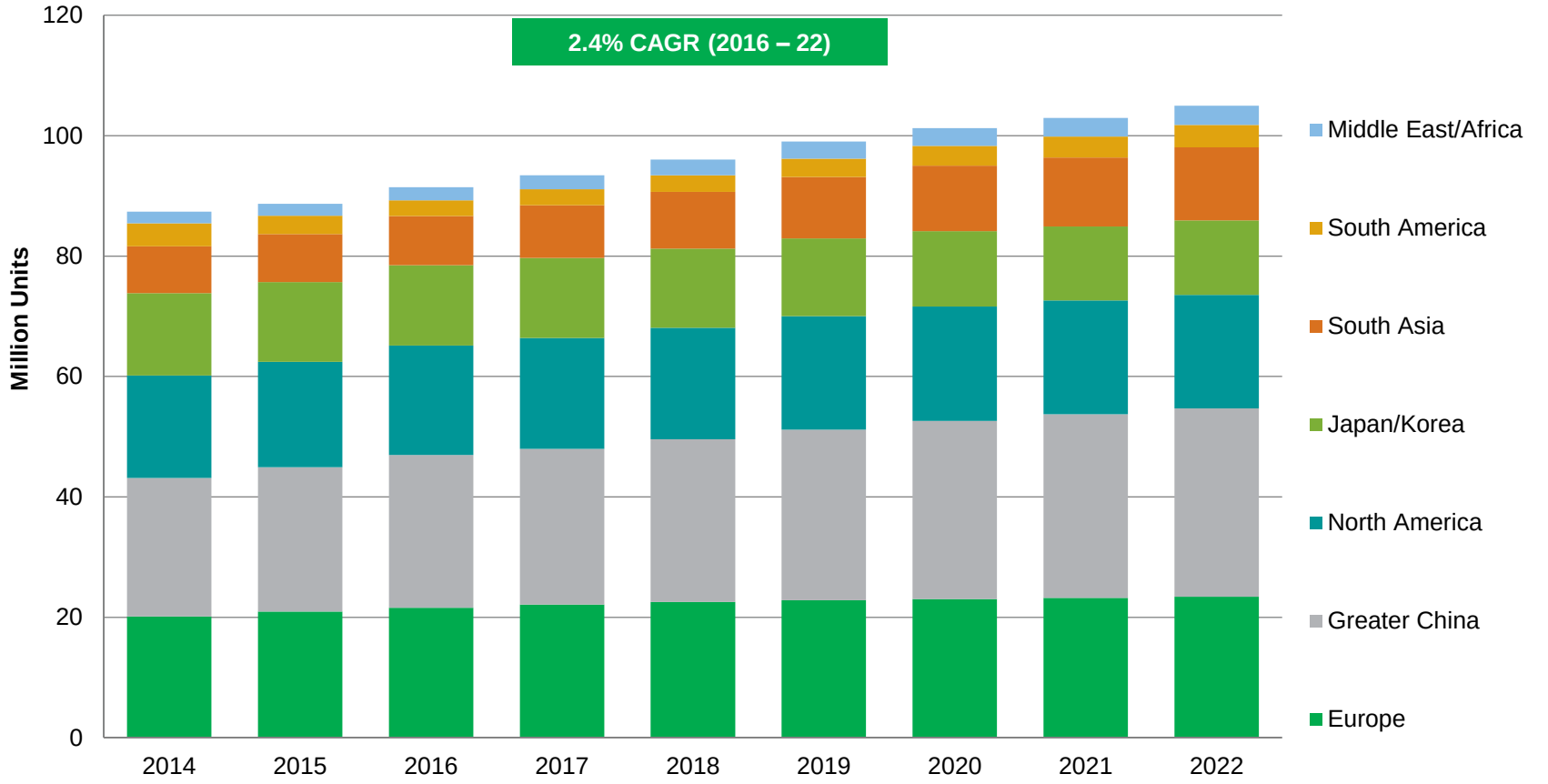
Automotive market trends

Vehicle production rises slowly with various degrees in emerging and established markets

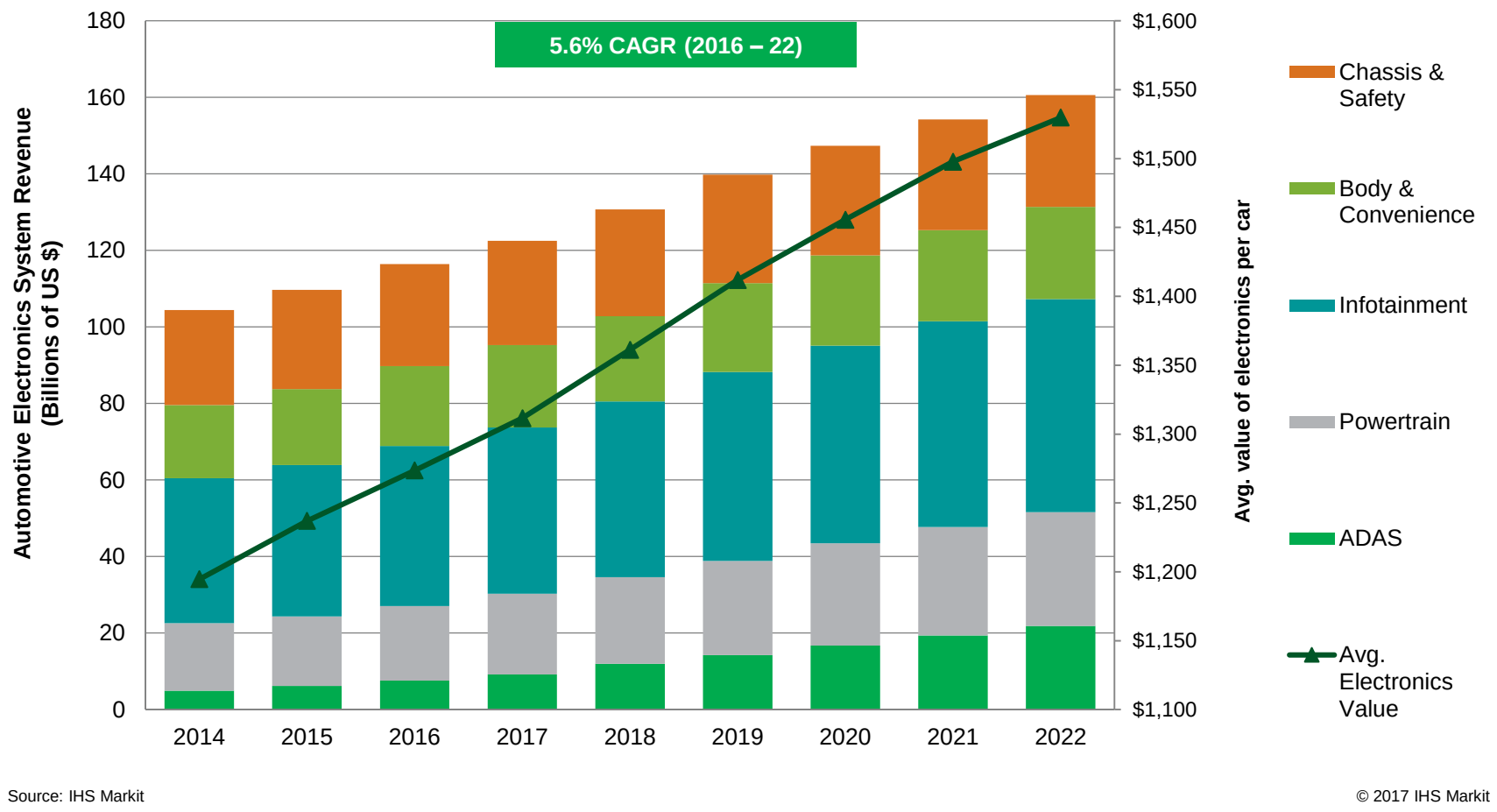
Vehicle production volume forecast in million units



Source: IHS Markit

Average value of electronic systems per car to cross $1500 by 2022

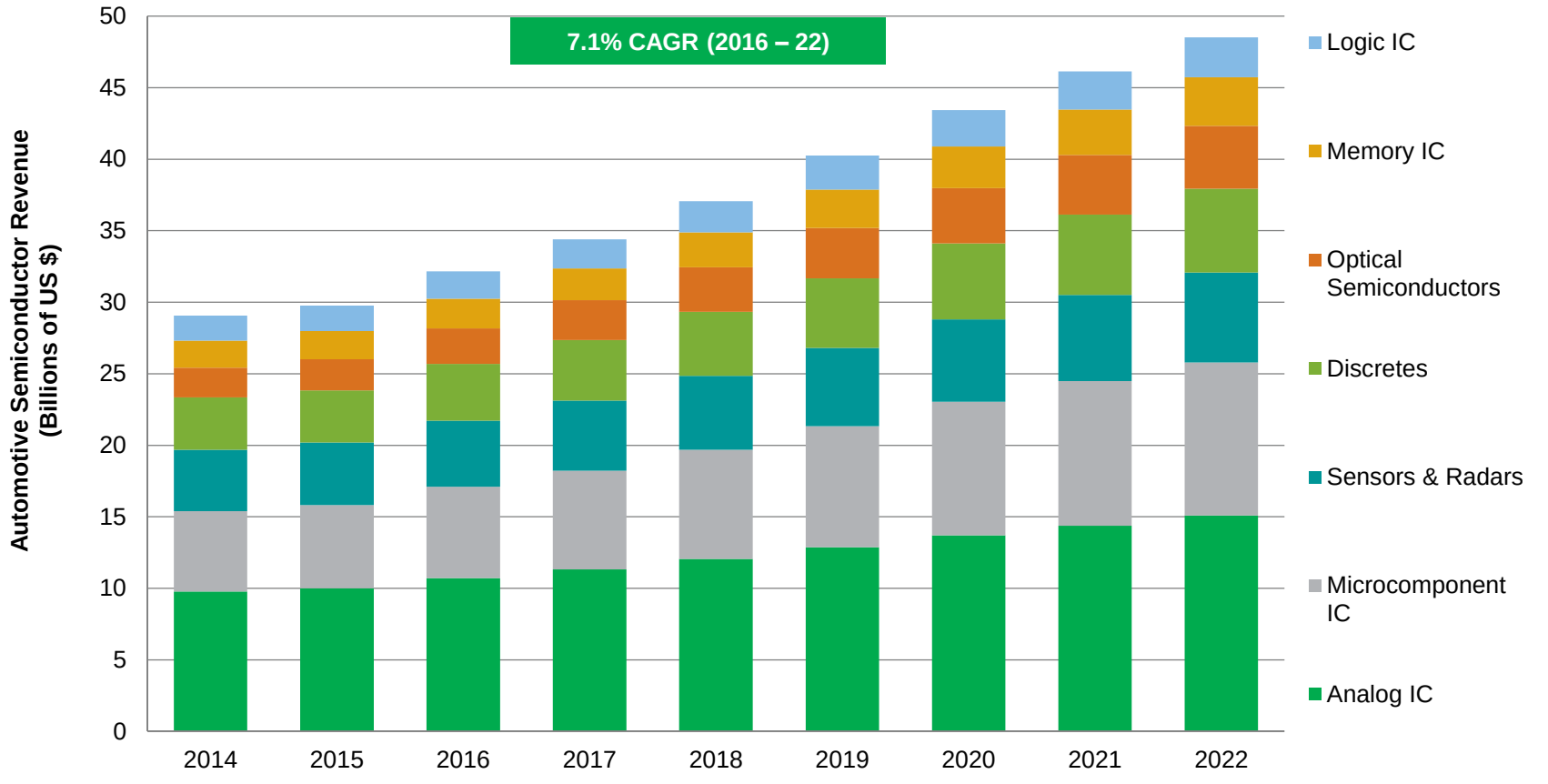
Automotive electronics system revenue



Source: IHS Markit

Automated driving, connectivity and electrification fueling automotive semiconductor growth

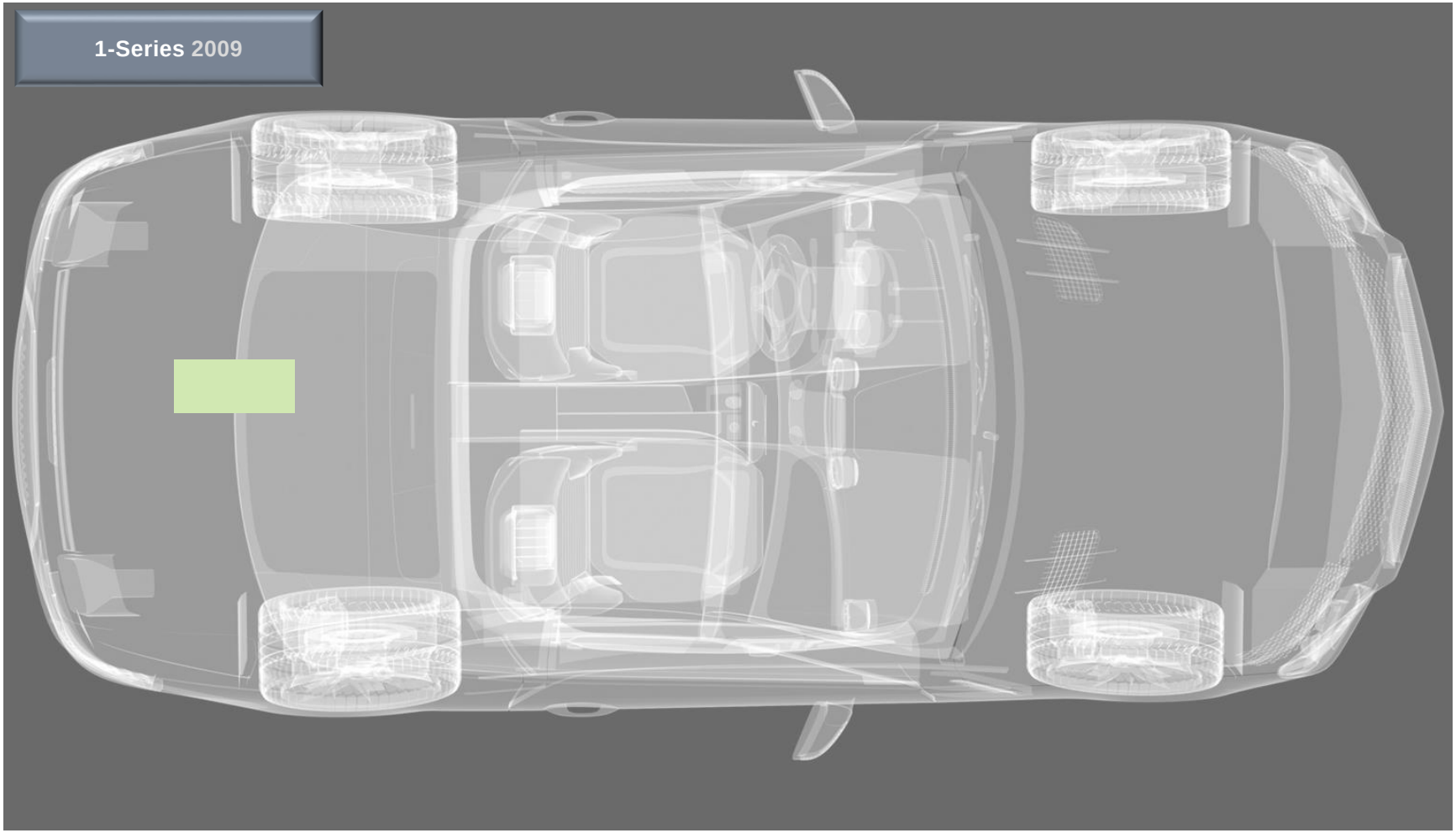
Automotive semiconductor revenue by device



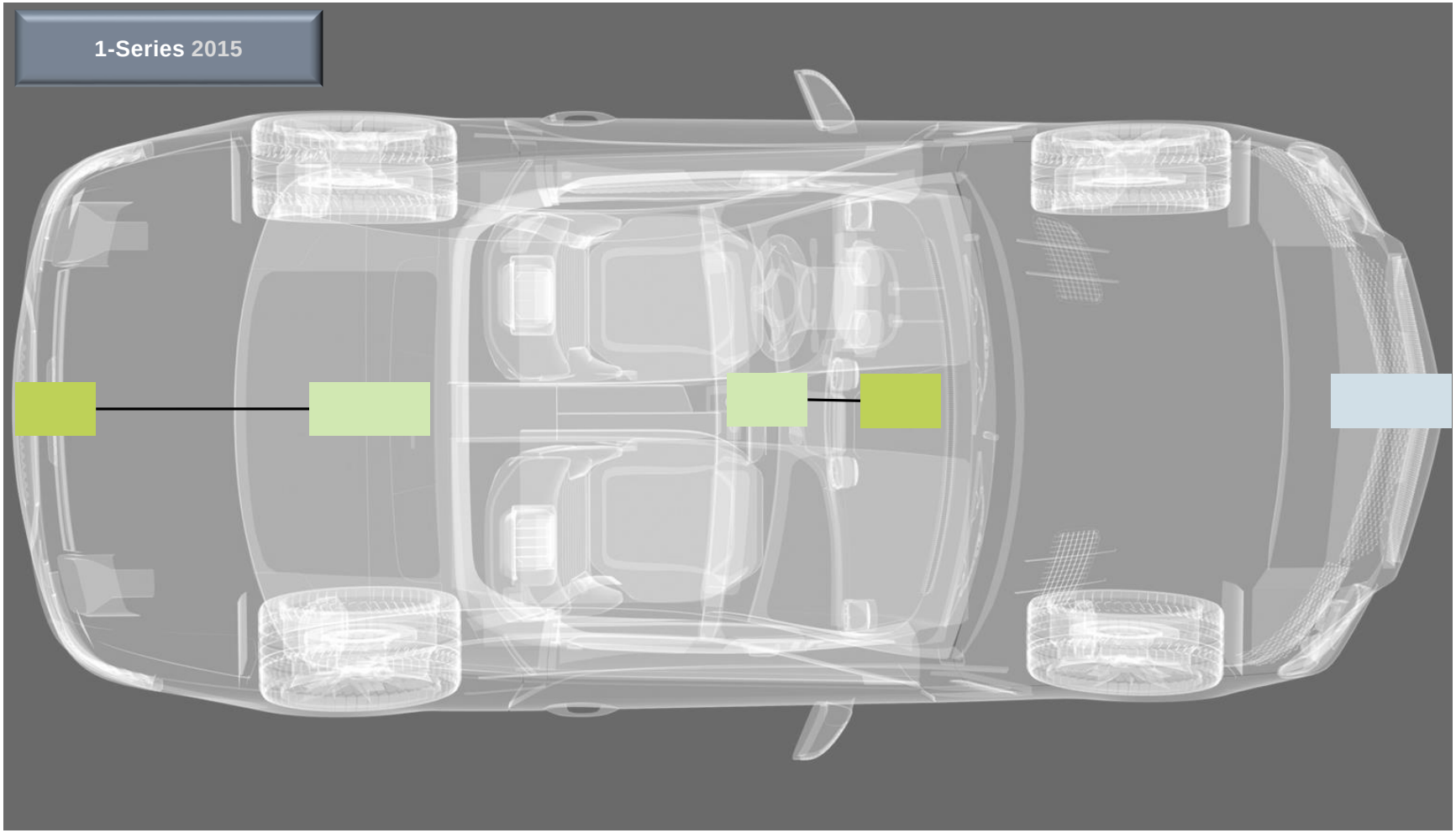
Source: IHS Markit

Current state of ADAS architectures

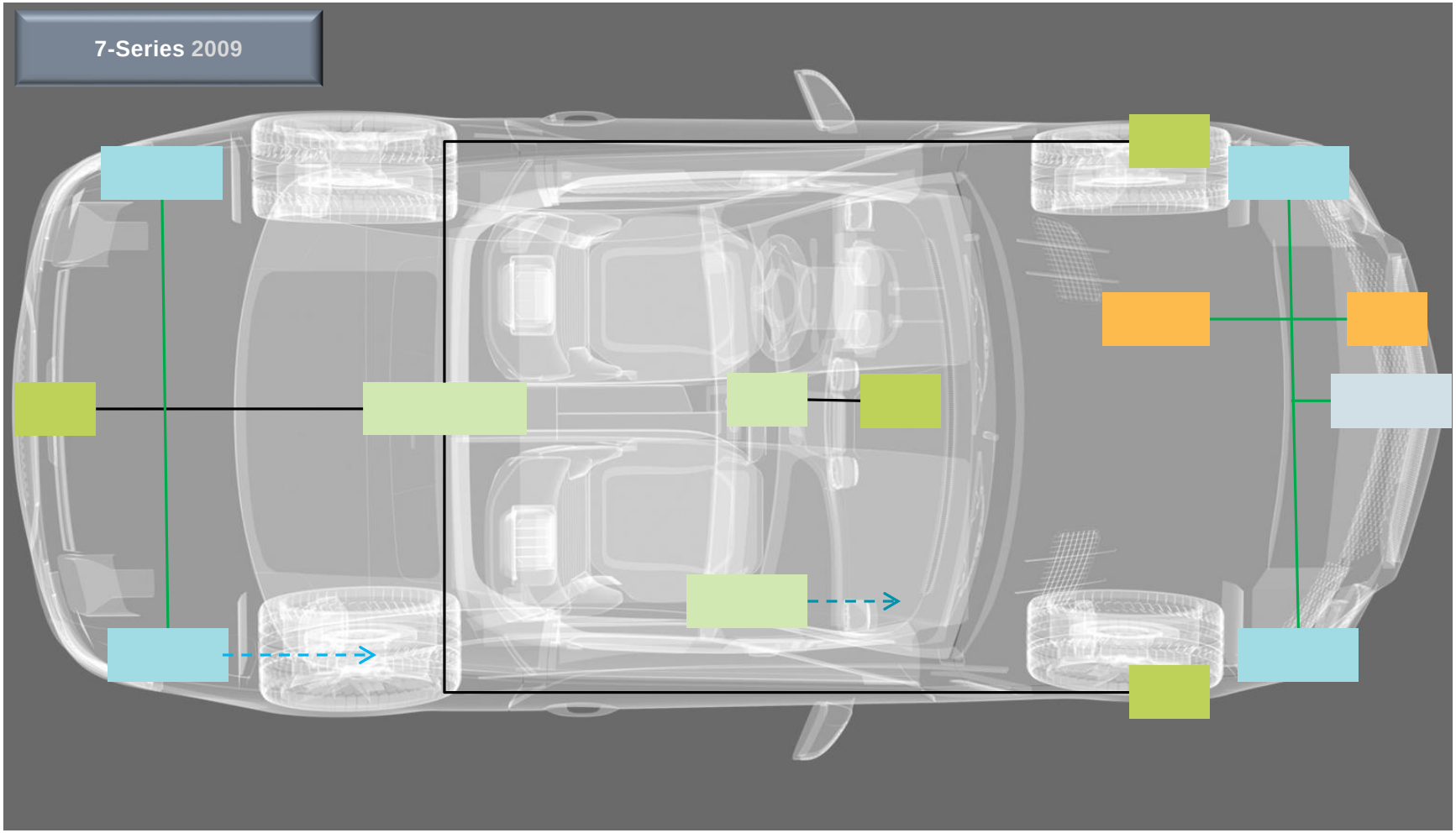
Old generation: C-segment with 1 ADAS ECU



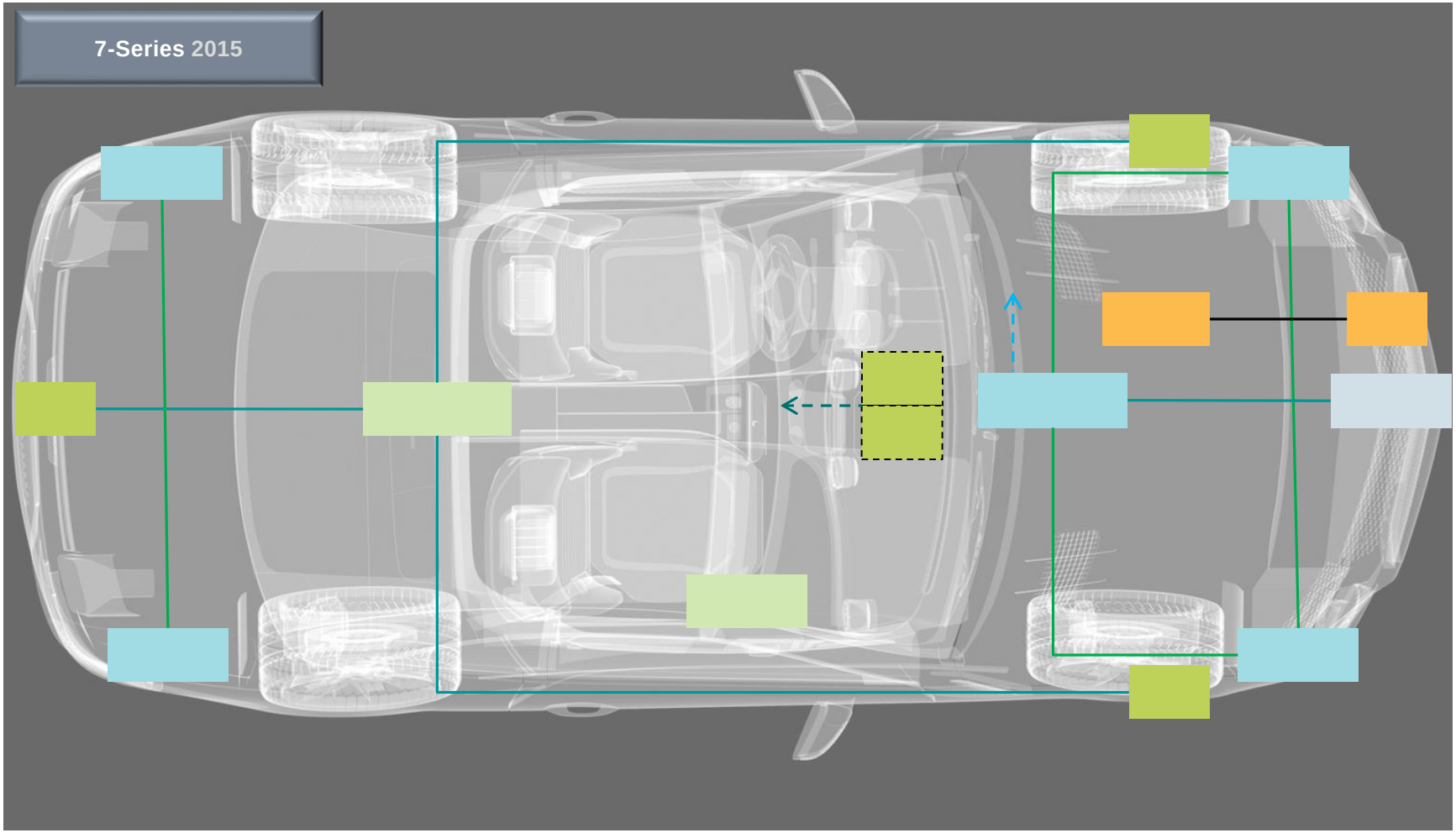
Proliferation of ADAS ECUs on the new platform



Old generation: E-segment with 14 ADAS ECUs



Advancement of features on new platform



Typical ADAS architecture requirements

ADAS Module	Avg. per L3	Avg. per L4	Avg. per L5
Sensor Fusion	1	2	2
Exterior Camera	5	8	8
Interior Camera	1	1	1
Short/Mid-range Radar	4	6	6
Long-range Radar	1	2	2
Long-range LIDAR	1	1	1-2*
Short-range LIDAR	2*	2-4*	4

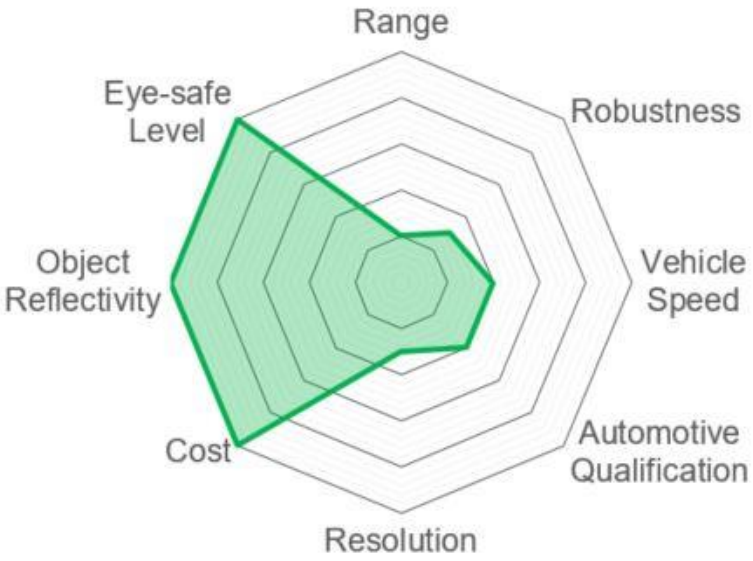
***Architectures based on existing pilot car platforms**

Key technologies enabling next-generation ADAS architectures

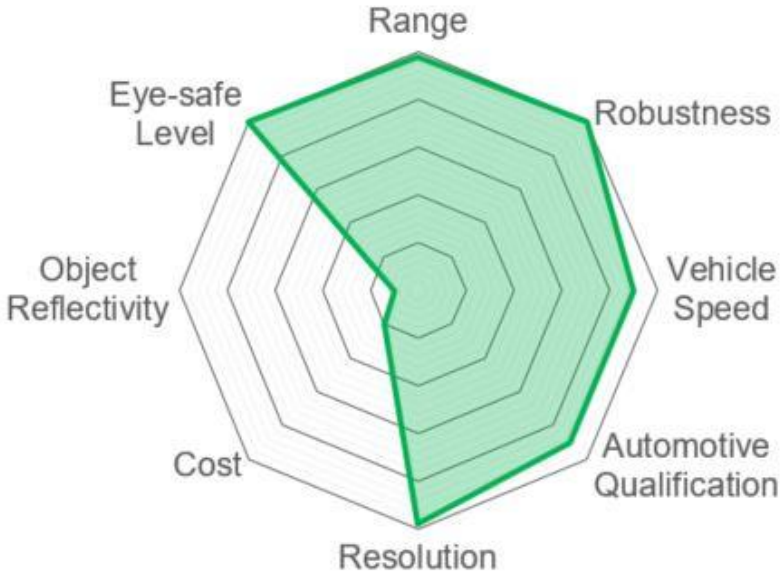
Addressing the gaps in automotive LIDAR technology

Typical gap in LIDAR performance specifications

Current Standard



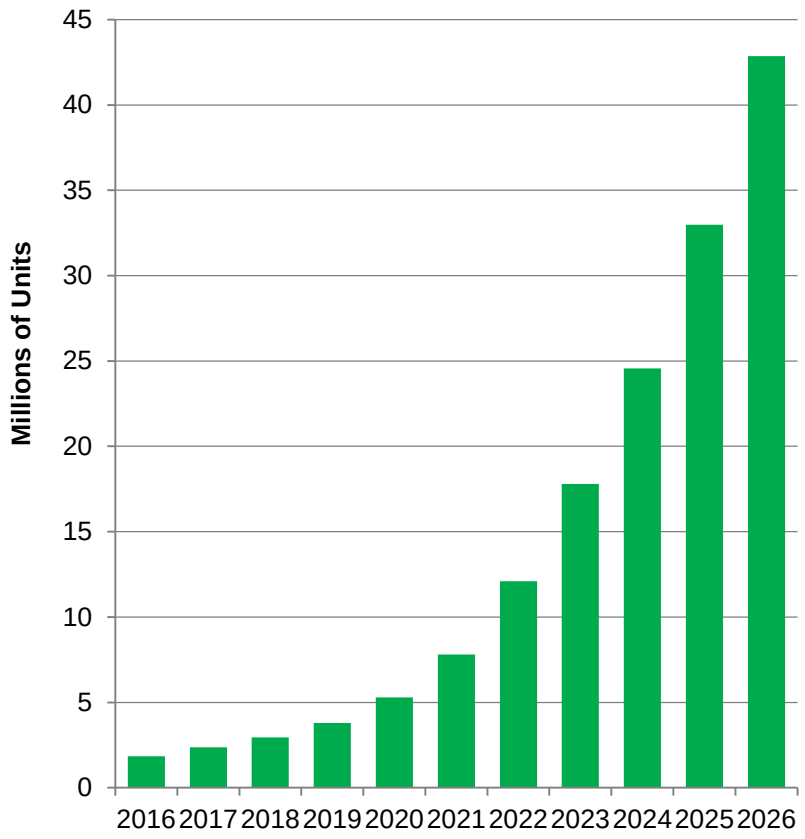
Required Performance



Source: IHS Markit

Pure solid-state technology to dominate LIDAR space by 2025

LIDAR shipment forecast in million units



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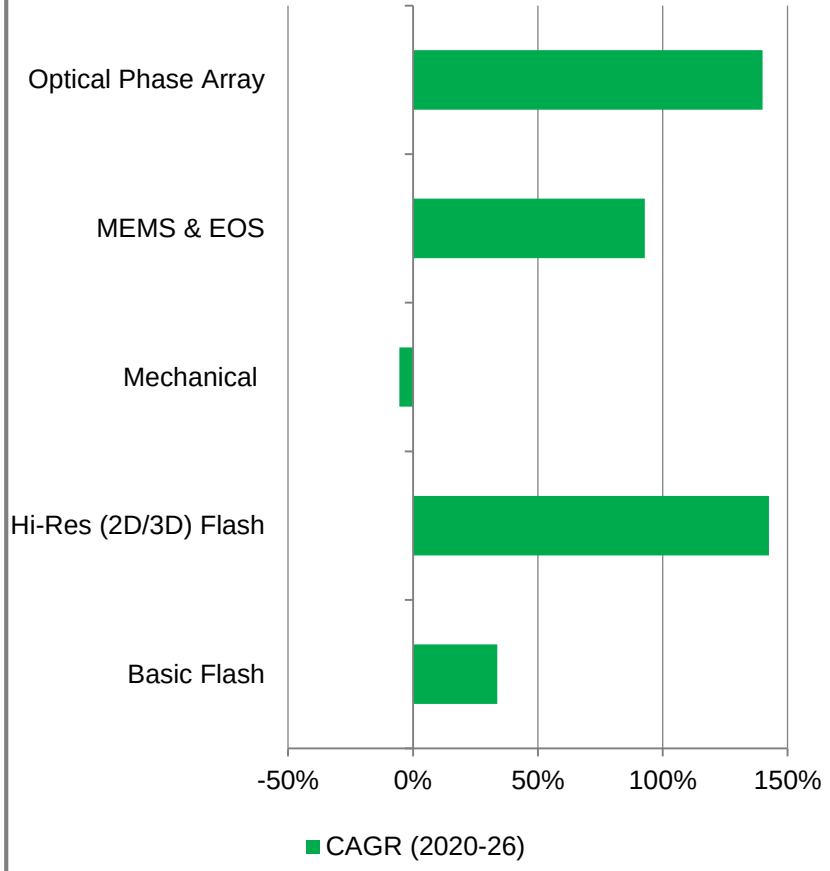
LIDAR shipments CAGR (2020-26)



Source: IHS Markit

Machine vision – a software driven market

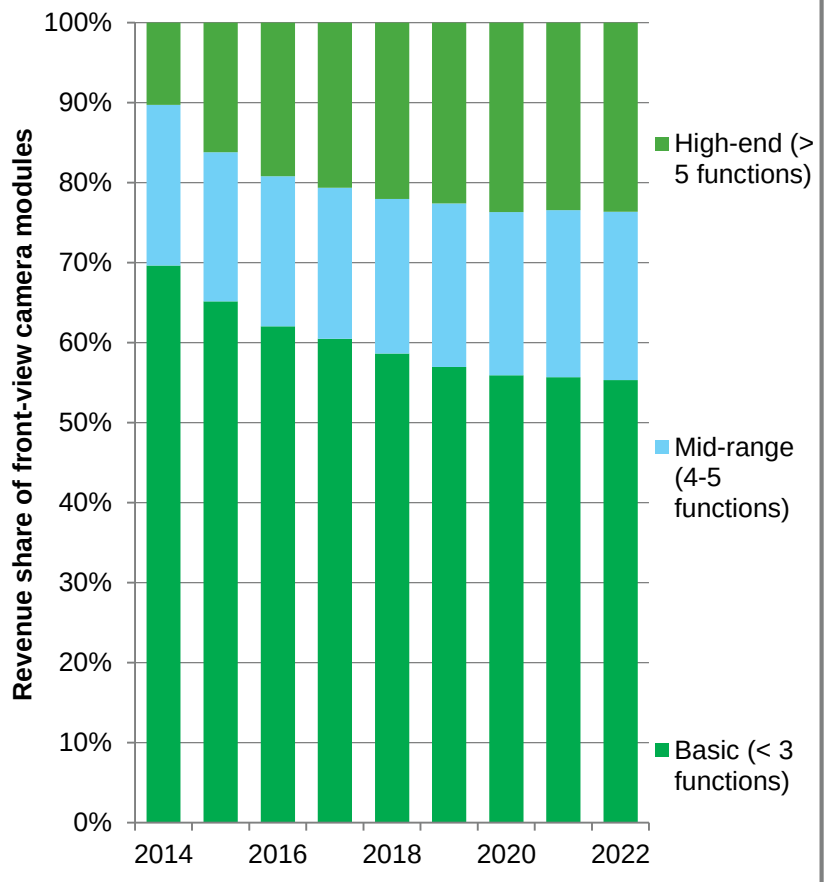
System revenue for front-view camera modules to grow fourfold by 2022

- Basic cameras: Mass adoption in economy segments to meet regional guidelines with declining semiconductor BOM and software costs
- Mid-range and high-end cameras: adoption on premium segments with increasing semiconductor BOM and software costs

Semiconductor revenue for front-view camera modules will reach up to $1.5 billion by 2022

- SoCs based on MPUs or FPGAs?
  - Intel (Mobileye) and the rest (S32V, TDAx, R-car, Visconti, Zynq,)
  - Key benchmarks: power consumption, performance and safety compliance

Revenue for front-view camera modules



Source: IHS Markit

Sensor fusion modules – Growth in semiconductor value for safety-critical functions

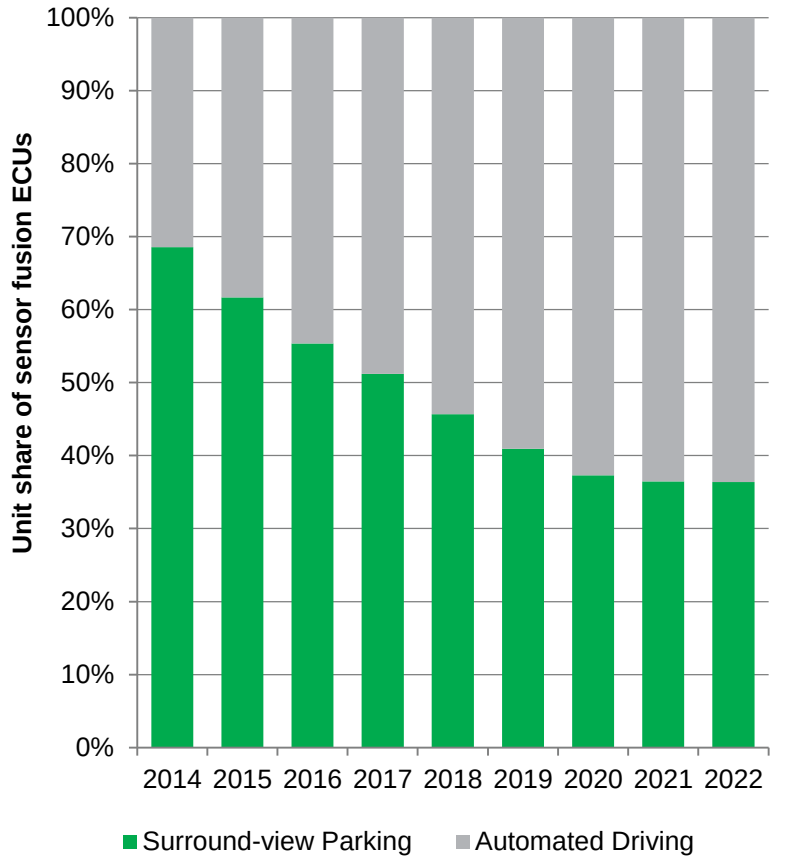
System level:

- **Challenge**: Software for enabling AD via machine vision, deep learning, sensor fusion and etc.
- **Opportunity**: Universities, technology labs and start-ups working on unconventional technologies (deep learning, machine vision, etc.)

Chip level:

- **Challenge:** High performance processors meeting traditional automotive requirements (power consumption, functional safety temperature, life-time, etc.)
- **Opportunity:** Suppliers with high-performance computing platforms at lower power consumption and small die size

ADAS sensor fusion module forecast

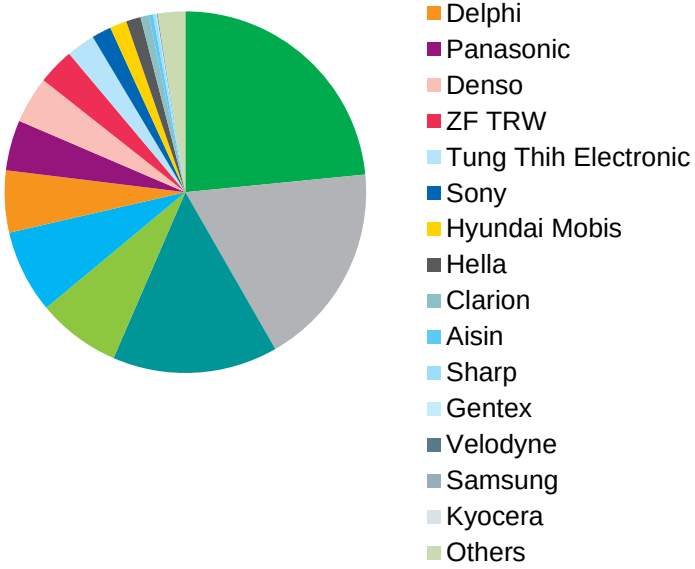


Source: IHS Markit

Market Outlook & Key takeaway

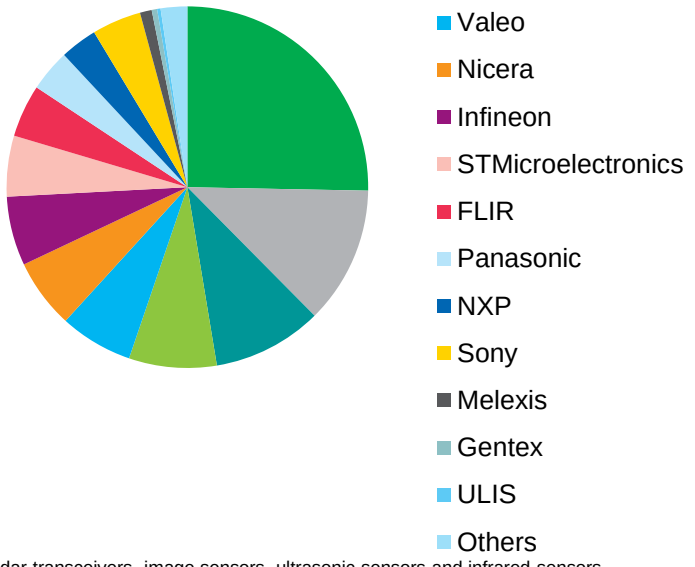
Market share for ADAS sensor suppliers (in revenue)

2016 ADAS electronics system supplier



Source: IHS Markit

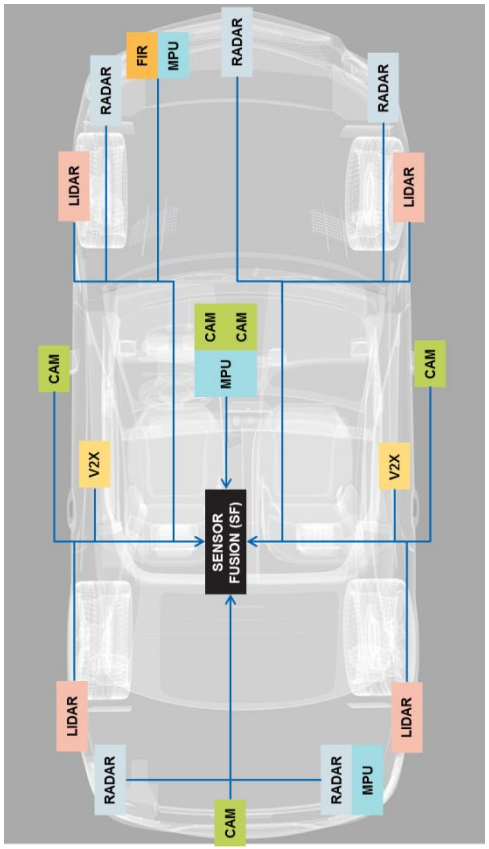
2016 ADAS semiconductor* supplier share



*Only for radar transceivers, image sensors, ultrasonic sensors and infrared sensors

Source: IHS Markit

Key Takeaways



- Economy vehicle segments – proliferation of sensors and ECUs for compliance (NCAPs, NHTSA,..).
- Premium vehicle segments – Addition of LIDARS and high-end sensor fusion modules for automated driving.
- No compromise on sensor technology for automated driving – redundancy is a must.
- Functional safety and performance for autonomy will drive the semiconductor growth through artificial intelligence and sensor fusion.
- Consolidation of ECUs to drive high-performance computing platforms.

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