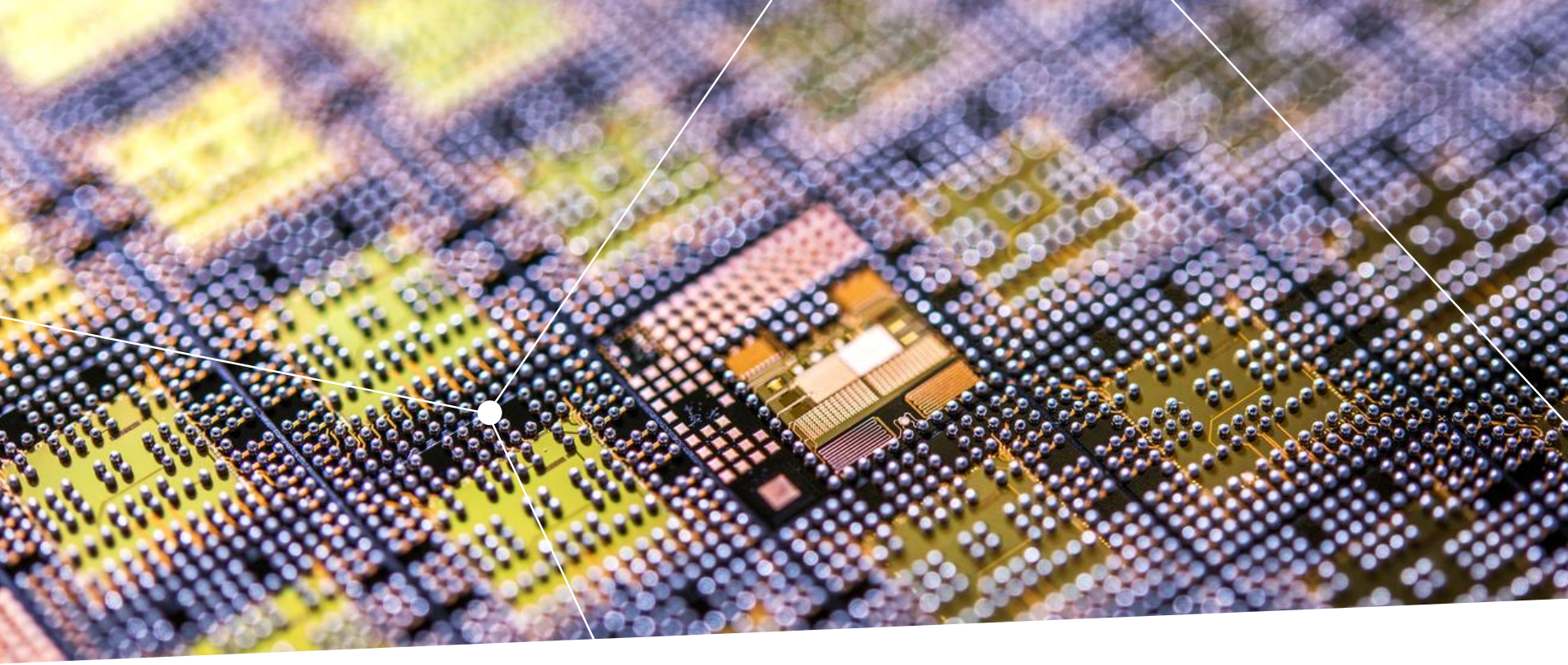


Liberum Future of E-Mobility Conference

Semiconductors enabling Automated Driving

Hans Adlkofer, VP Automotive System Group
London, 11 December 2019

Agenda

1. Automated Driving
2. Sensor technologies
3. Computing Requirements
4. Dependability Requirements

Long-term semi content drivers intact; improved market position in all addressed product categories

Strong drivers for semi content per car

electro-mobility

- driven by legislation
- all kinds of xEV, including 48 V
- today China; tomorrow Europe

automated driving

- near-term L1/L2/L2+
- long-term L3/L4/L5
- need for dependable functionalities* (e.g. sensors, power supplies, computing power)

comfort, premium

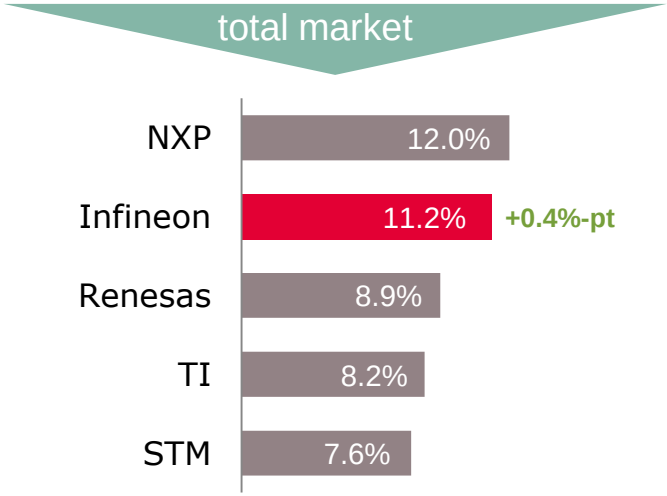
- comfort features trickling down from high- to mid-range
- user experience
- lighting
- replacement of hydraulic and electro-mechanical units

* For more information on “dependable functionalities” please see slide 12.

Automotive semiconductor market

2018 total market size: $37.7bn

- **#1 in power:** market share of 26.2% (+0.2 %-pt)
- **#2 in sensors:** market share of 13.4% (+0.5 %-pt)
- **#4 in µC:** market share of 9.1% (+0.6 %-pt)



Source: Strategy Analytics, "Automotive Semiconductor Vendor Market Shares", April 2019

L2+ becomes the new L3 as legislation is delayed; but features will be implemented

Legal regulation

- it requires that the vehicle is under continuous control of the driver (Art. 8 UN regulation)
- it doesn‘t allow the approval of „Autonomous Steering Systems“ (ECE) in normal operation without human activation (e.g. flashing indicator)

L2+ = L3 function + L2 driver obligation (e.g.)

L3

„eyes off“

- Driver need to intervene and **rapidly take over** control of the vehicle when automation fails

L2

„hands off“

- Driver assistance system is capable of controlling speed and direction but requires an **attentive driver**

L2+

Daimler‘s „Drive Pilot“ solves the issue of unclear / un-defined L3 regulation:

- the fallback-ready user must resume manual driving at any time
- the „driver readiness“ is continuously monitored
- the driver is not permitted to sleep or to leave the driver seat
- autom. lane changes are not allowed

https://www.daimler.com/innovation/case/autonomous/drive-pilot-2.html

The architecture must change to support xEV, AD, SOTA and enabling MaaS while balancing system cost

- ADAS and AD requires **hierarchical** architecture
- Manage **complexity** introduced by new/advanced functionalities
- Address increased **safety** and **security** requirements
- Increase **flexibility** and enable “upgradability” (SOTA)
- Optimize **system cost** at low power consumption

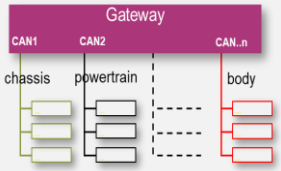
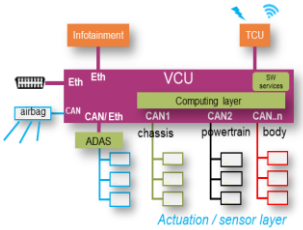
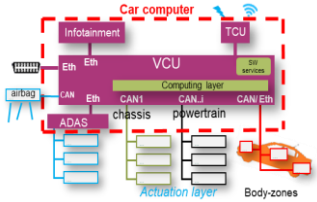
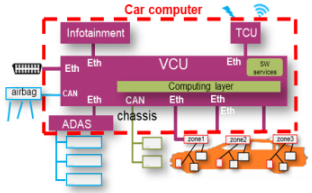
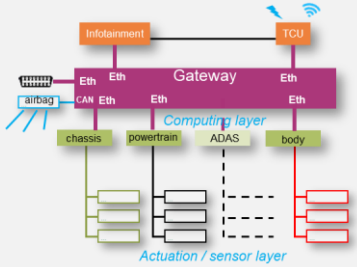
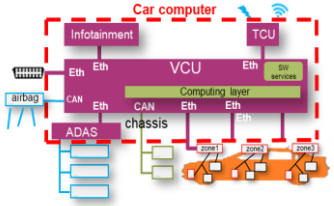
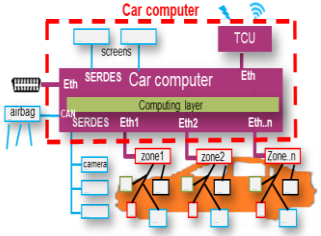
Different OEMs approaches
(evolutionary or disruptive)

These approaches can be clustered with good approximation into the following **categories**:

Domain Control
Domain Integration
Zone Architecture
Car Computer

AD = automated driving; SOTA = software over the air; MaaS = mobility as a service

OEM road-maps in E/E architectures; architecture will converage towards zone-based architecture

	today	start of production: 2023/24	start of production: 2025/26	start of production: 2028/29
Volume OEMs *(up to L2)*	**Distributed** 	**Domain integration** 	**Hybrid zone-low** 	**Hybrid zone-mid + car computer** 
Premium OEMs *(up to L2+)*	**Domain controllers** 	**Various directions** - System in transition - Higher domain integration - Zone-low & mid	**Hybrid zone-mid** 	**Car computer** 

Note: most probable scenario seen by Infineon

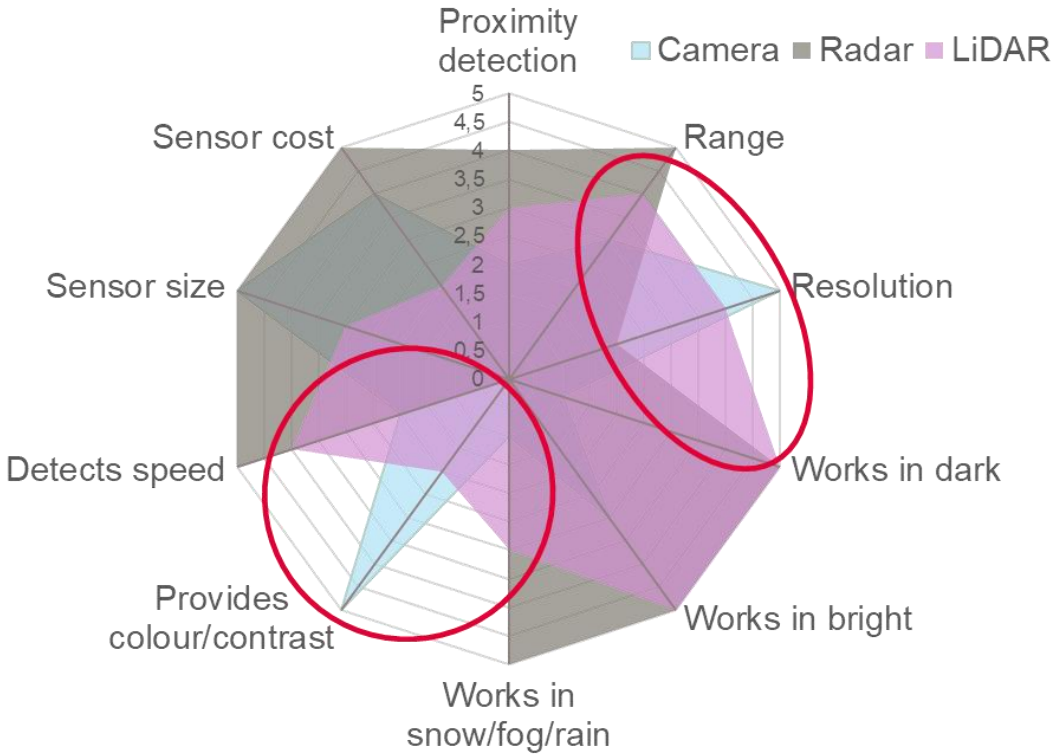
Increased sensor requirements drive the content in the next five years and beyond

More sensors required for any next level of automation

	NCAP 5 Star, AD L2	AD L2+/L3	AD L4/L5
Application*	Automatic emergency brake/ forward collision warning Parking assist Lane keep assist	Highway assist	Valet parking Highway and urban chauffeur
Radar # of modules**	Corner MRR/LRR ≥ 3 New: Corner; starting 2020	MRR/LRR ≥ 6 Corner	Imaging ≥ 10 Surround
Camera # of modules**	≥ 1	≥ 4	≥ 8
Lidar # of modules**	0	≤ 1	≥ 1
Others	› Ultrasonic	› Ultrasonic › Interior camera	› Ultrasonic › Interior camera › V2X

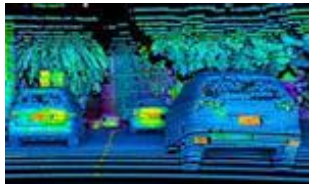
* Source: VDA (German Association of the Automotive Industry); Society of Automotive Engineers
** market assumption

We need 3 sensor technologies to have always data from two sensors available → 2 out of 3

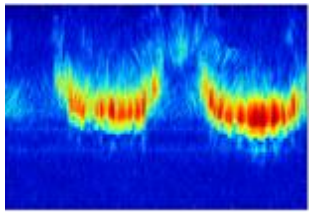


Camera

Lidar



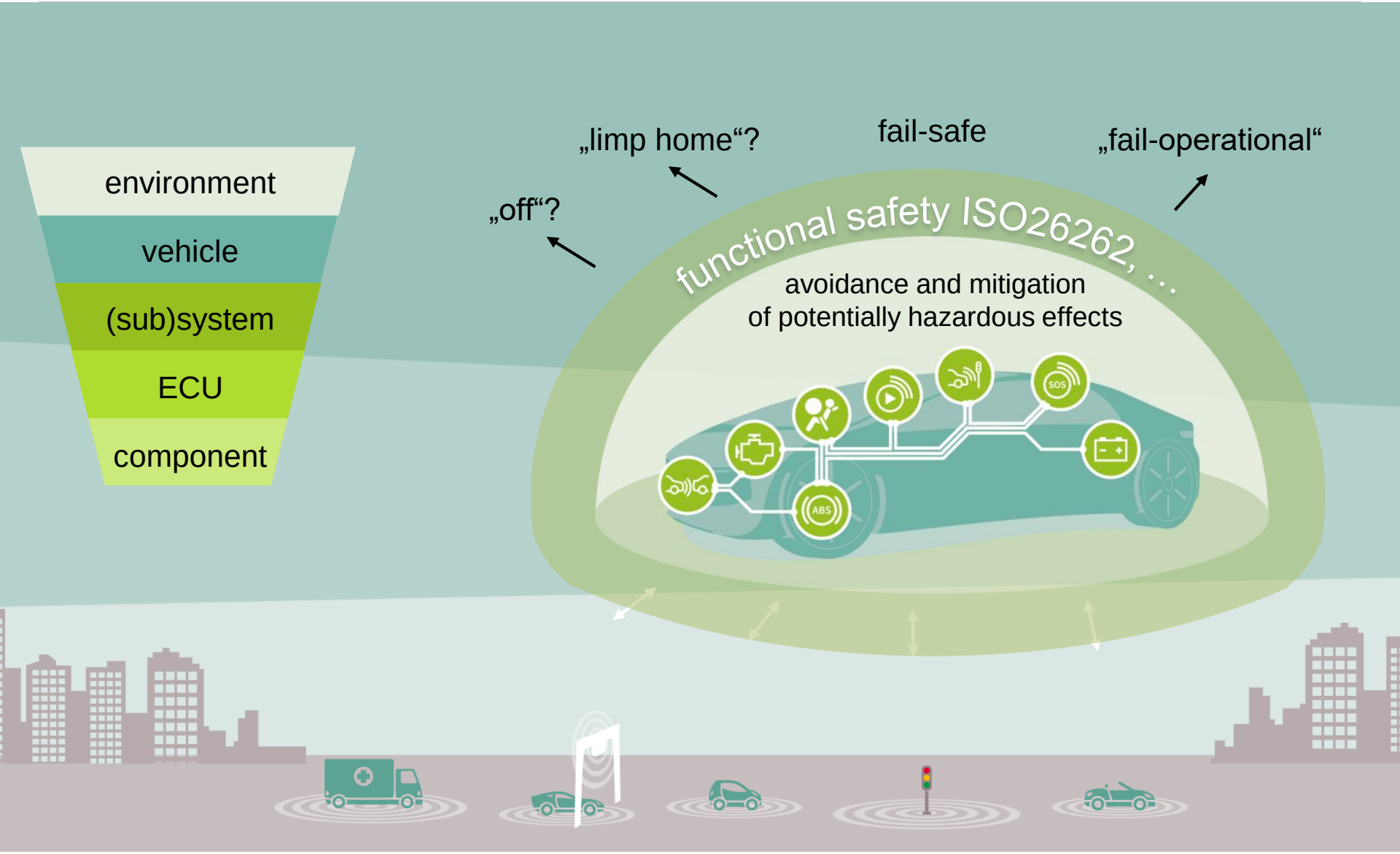
Radar



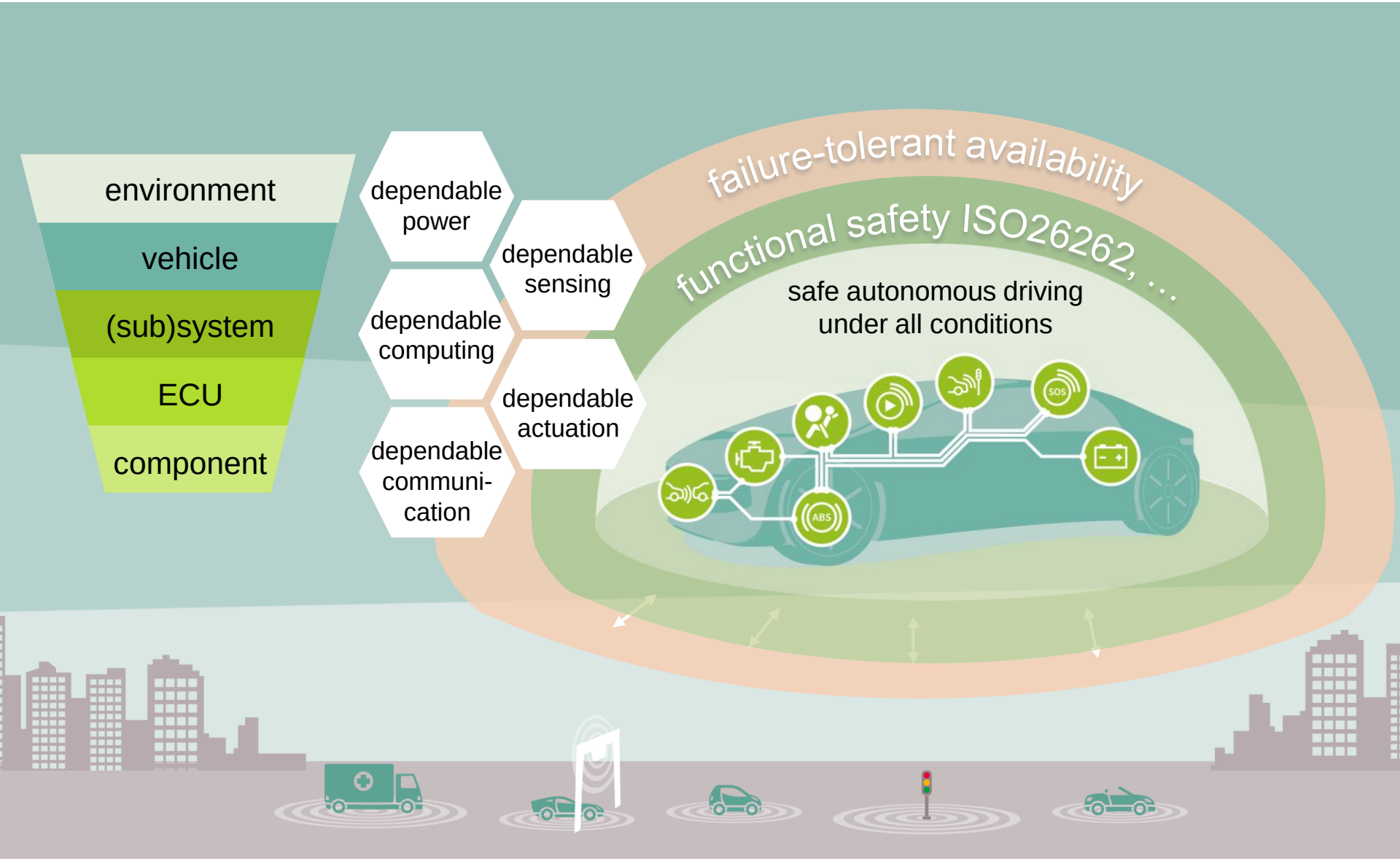
criteria	Good weather	Bad weather
range	Radar / Lidar	Radar / Lidar
resolution	Camera / Lidar	Lidar / Radar
speed detection	Radar / Lidar	Radar / Lidar
contrast	Camera / Lidar	Lidar / Camera

Note: first technology shows best performance

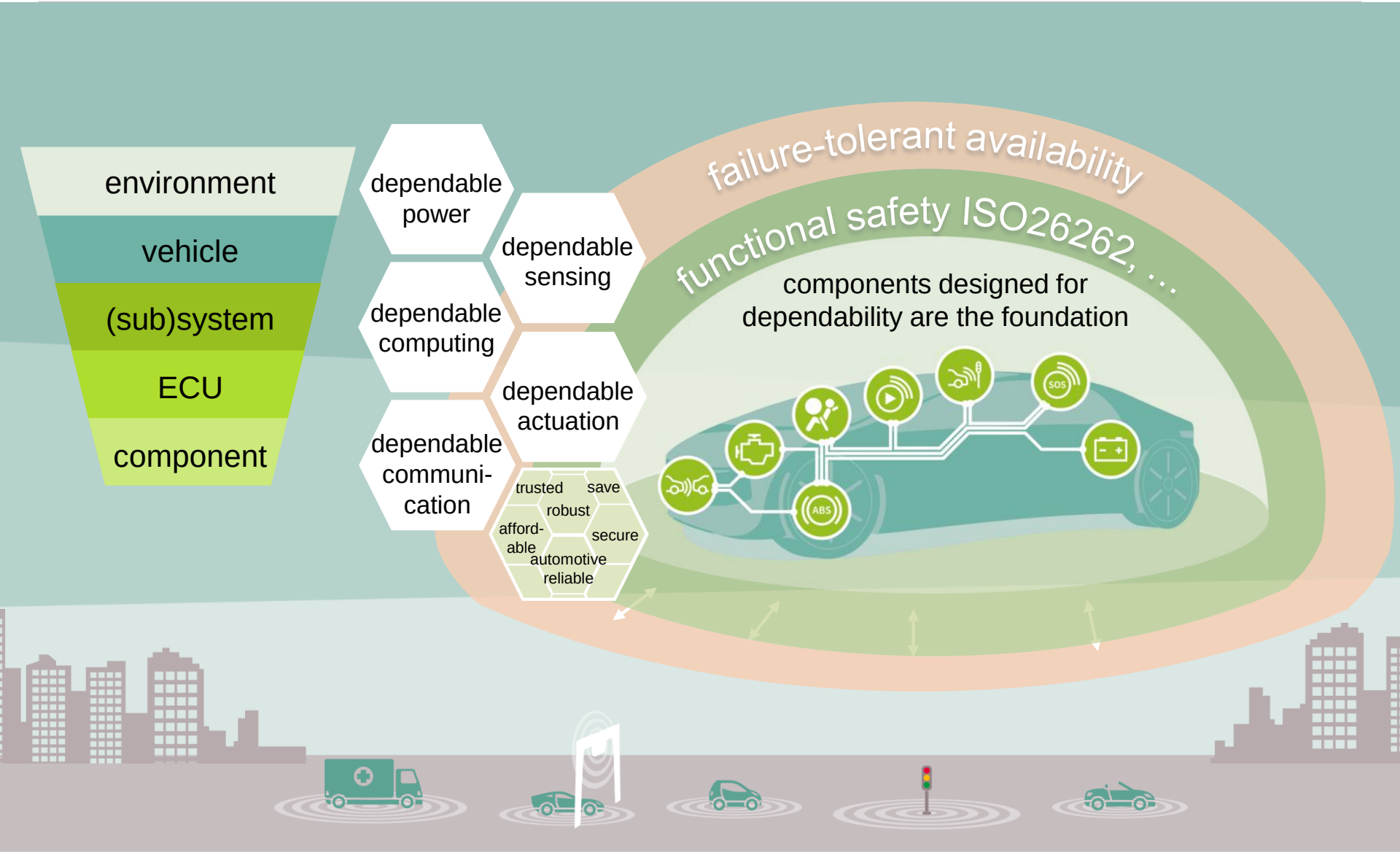
Vision Zero – AD requires failure-tolerant availability of the system, “better than a human”



Vision Zero – AD requires failure-tolerant availability of the system, “better than a human”

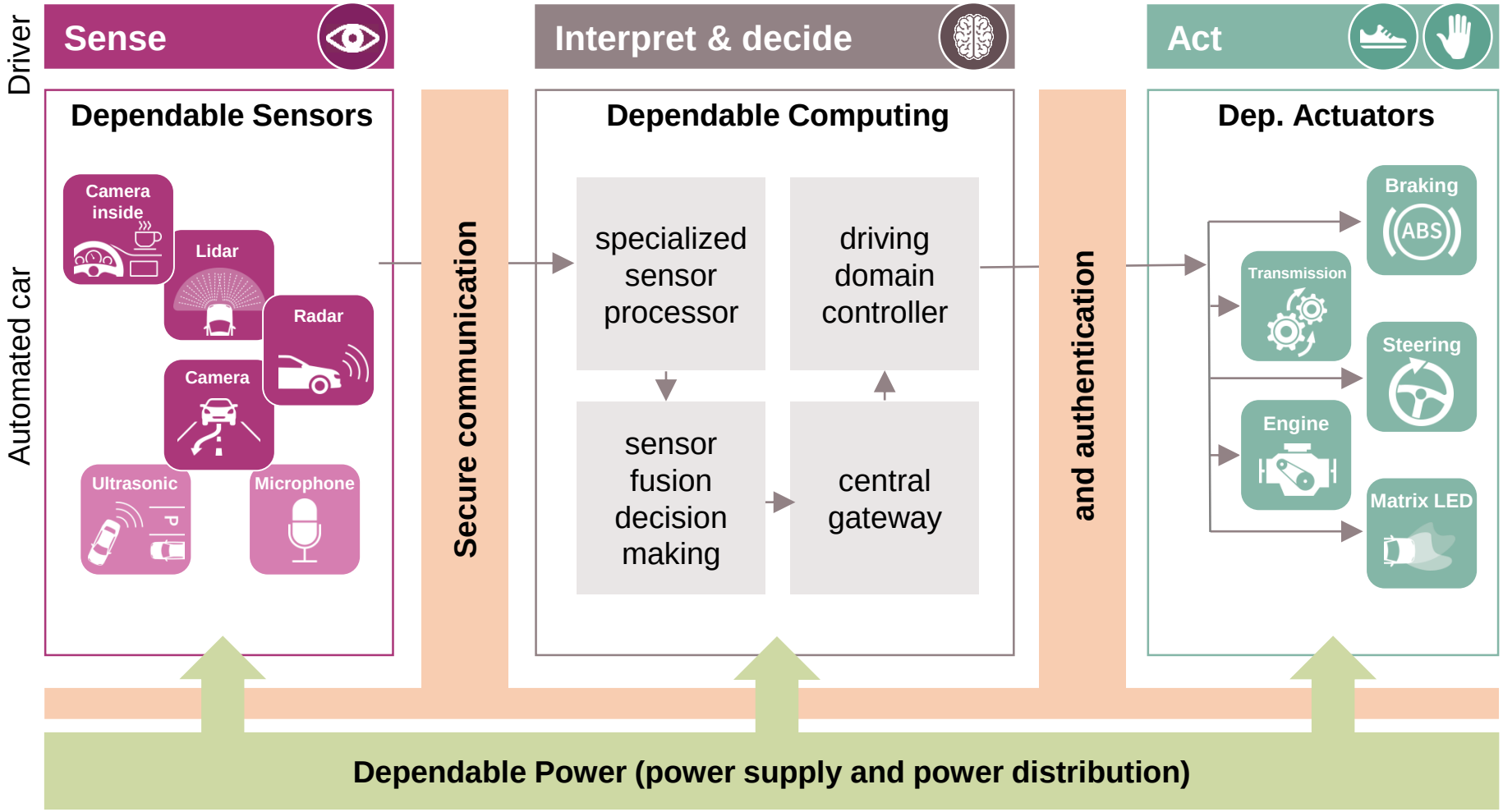


Vision Zero – taking the next step from functional safety to failure-tolerant availability



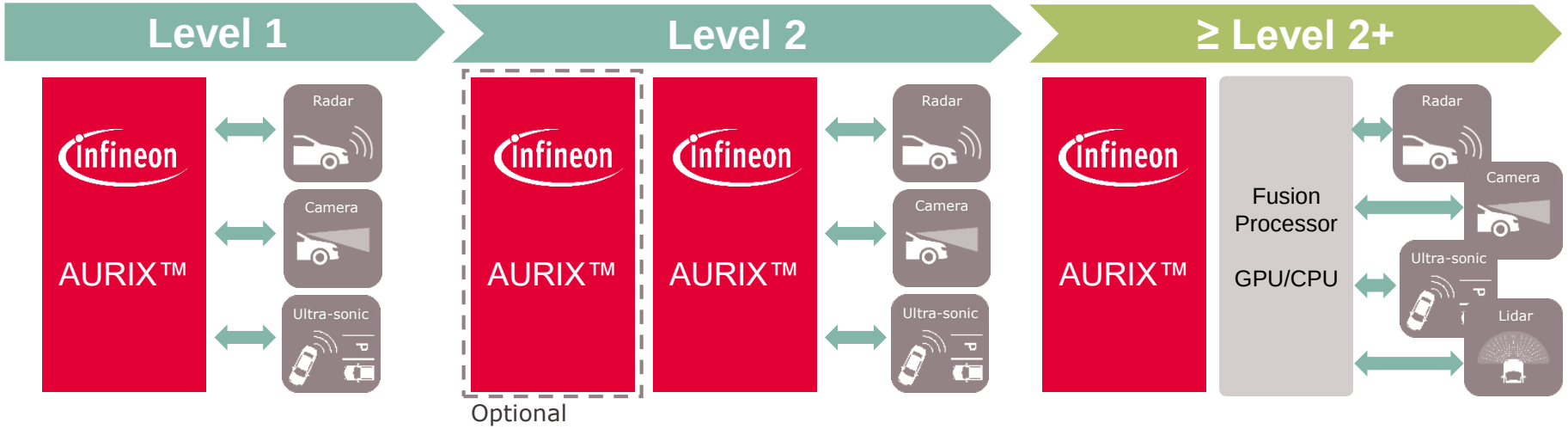
Vision Zero – AD requires failure-tolerant availability of the system in the environment, “better than a human”

A failure-tolerant system with high availability relies on dependable key functionalities



AURIX™ first-choice microcontroller dependable systems enabling ADAS/AD platforms

- AURIX™ family provides leading technology for sensor fusion either as main fusion computer for L1/L2 or as host controller for higher autonomy levels.
- Major OEMs from Europe, Japan, Korea, China, and North America will ramp production in 2021.



AURIX™ functionalities

- fusion and decision-making
- safety management
- security management
- vehicle gateway

AURIX™ functionalities

- parallel usage to enable scalability with compatibility
- safety management
- security management

AURIX™ functionalities

- host controller for the data fusion processor
- enables ISO 26262 ASIL-D
- emergency response in case of a GPU/CPU fail

ADAS/AD semi growth driven by radar and camera sensor modules over the next 5 years

Average semiconductor content per car by level of automation at the given years

NCAP 5 Star/AD L2

L2 vehicles in 2020: ~6m

AD L2+

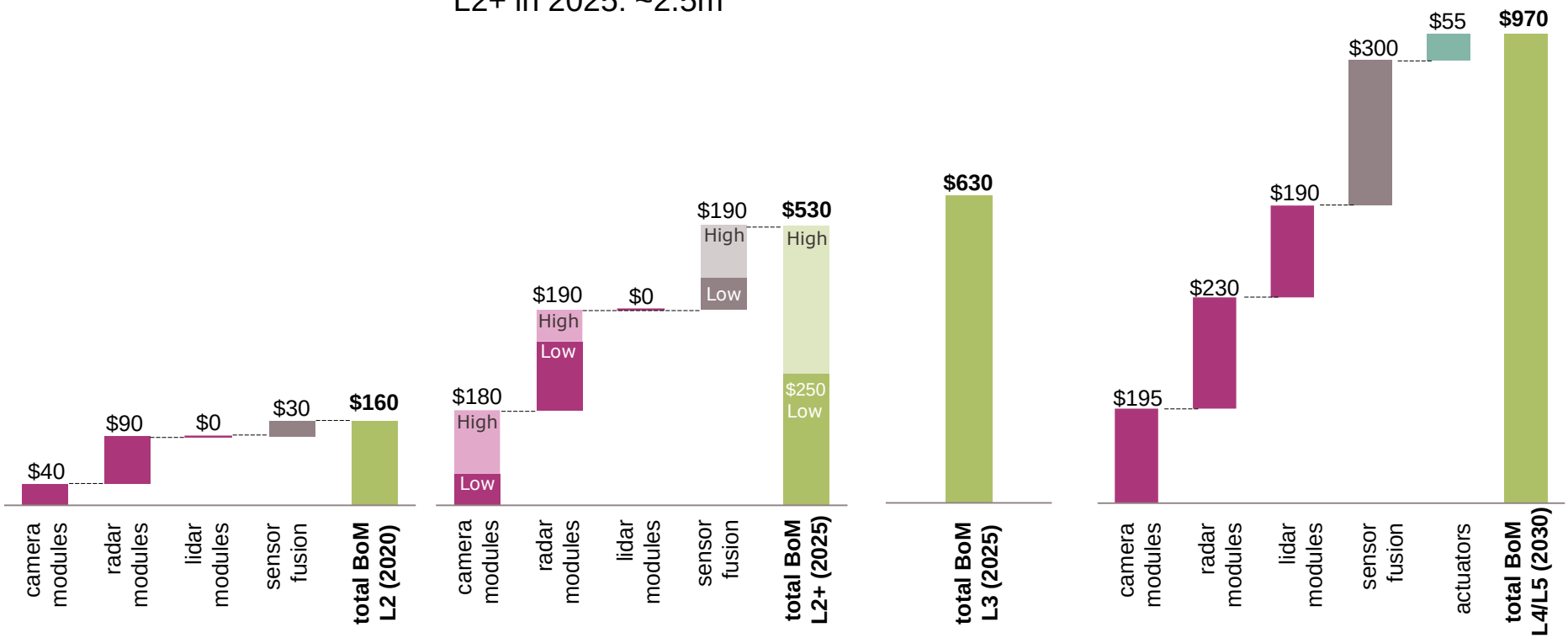
L2+ in 2022: ~1m
L2+ in 2025: ~2.5m

AD L3

L3 in 2025: ~1.5m

AD L4/L5

L4/L5 vehicles in 2030: ~4m



Source: Strategy Analytics; Infineon.
BoM contains all type of semiconductors (e.g. radar modules include µC); sensor fusion does not include memory.
BoM are projected figures for the respective time frame.

Semiconductors enable the future of driving: More safety, more comfort, less pollution

- semiconductors enable ~80% of innovation in automotive
- automated vehicle will increase safety and comfort, but also support CO_2 reduction
- dependable electronic systems are needed in order to enable safe and secure automated driving
- a connected car requires a secure system architecture combined with hardware-based security which will provide the appropriate level of protection

Part of your life. Part of tomorrow.