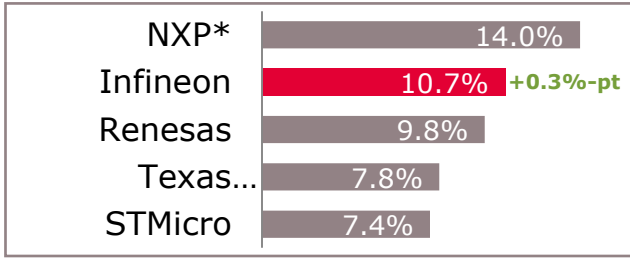
Infineon AURIX™ 32-bit microcontrollers as the basis for ADAS / Automated Driving

Deutsche Bank AutoTech Conference
San Francisco, 11 May 2017

Dr. Jürgen Rebel
Corporate Vice President, Investor Relations

Infineon's position in the automotive semiconductor universe

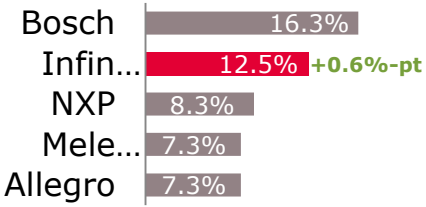
Automotive semiconductors
2016 total market size: $30.2bn



Market share trend

- Infineon benefits disproportionately from the two mega trends
  - clean cars
  - ADAS/AD

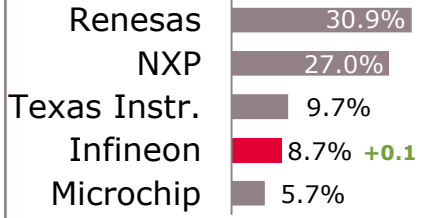
Sensors



m.s. trend

- 24 / 77 GHz radar
- REAL3™ sensor

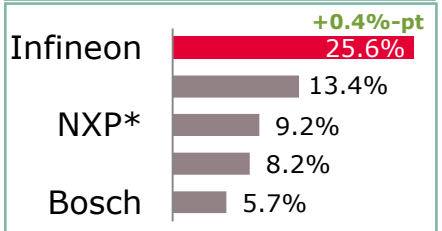
Microcontrollers



m.s. trend

- ADAS/AD
- Powertrain

Power



m.s. trend

- xEV penetration
- EPS
- Lighting

* Divestiture of NXP's Standard Product business ("Nexperia") closed on 16 Feb 2017; hence included in the 2016 ranking.
Source: Strategy Analytics, "Automotive Semiconductor Vendor Market Shares", April 2017

Copyright © Infineon Technologies AG 2017. All rights reserved.

Key market trends significantly drive increasing semiconductor content per car

ADAS/AD

› ADAS and AD are critical enabler to reduce the number of fatalities and serious injuries (“Vision Zero”)

Clean cars

› To reach CO_2 emission goals, the automotive industry has to focus on
  – a higher efficiency of the classic ICE, and
  – the electrification of the drivetrain (xEV)

Connectivity/security

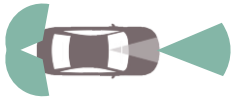
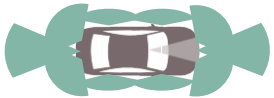
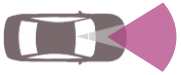
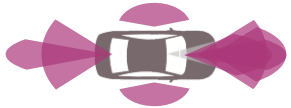
› Advanced connectivity is driven by making the car part of the internet

› Connectivity must be secure

ADAS/AD and clean cars will generate half of the 8% trendline growth of ATV

Copyright © Infineon Technologies AG 2017. All rights reserved.

Any next automation level requires more assistance systems and thus ECUs

	Level of automation		
	Level 2	Level 3	Level 4/5
Application*	Parking assist		Valet Parking
	Highway & Traffic Jam Assist	Highway pilot	Urban pilot / Robot Taxi
Radar # of modules**	 ≥ 3	 ≥ 6	 ≥ 10
Camera # of modules**	 ≥ 1	 ≥ 2	 ≥ 8
Lidar # of modules**	 0	 ≤ 1	 ≥ 1
Others	Ultrasonic	Ultrasonic Interior camera	Ultrasonic Interior camera V2X***

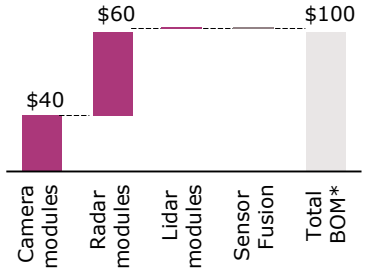
* Source: VDA (German Association of the Automotive Industry), Society of Automotive Engineers
** Market assumption; *** See glossary

Copyright © Infineon Technologies AG 2017. All rights reserved.

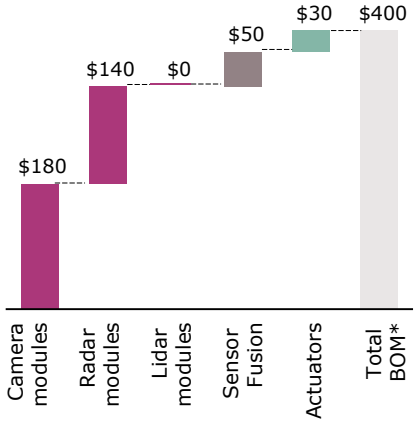
ADAS/AD semi growth driven by radar and camera sensor modules over the next 5 years

Average semiconductor content per car by level of automation*

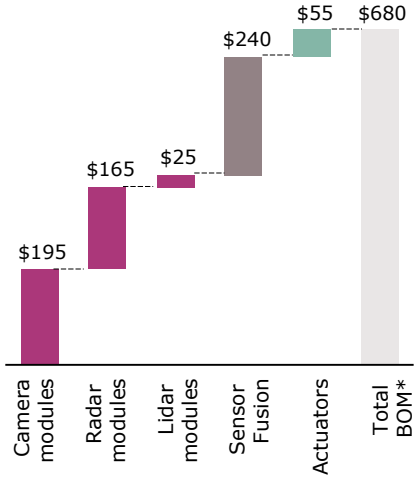
Level 2 (2020)



Level 3 (~2025)



Level 4/5 (2030+)



Bill of material estimates include <u>all</u> type of semiconductors**

Sense | Compute | Actuate

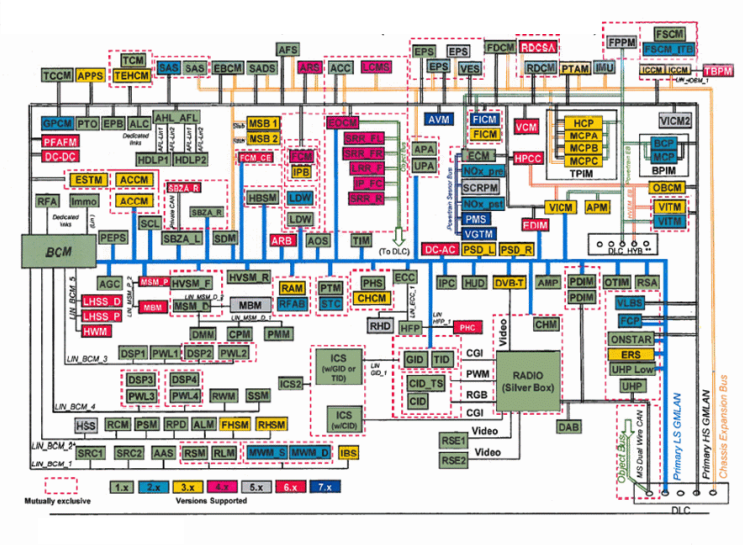
* Source: Strategy Analytics, IHS Markit, Infineon; ** e.g. radar includes µC
BOM roughly estimated for around 10m vehicles in each level – Next Update planned in H2 2017

Copyright © Infineon Technologies AG 2017. All rights reserved.

Tomorrow’s car system architecture will be much different from today

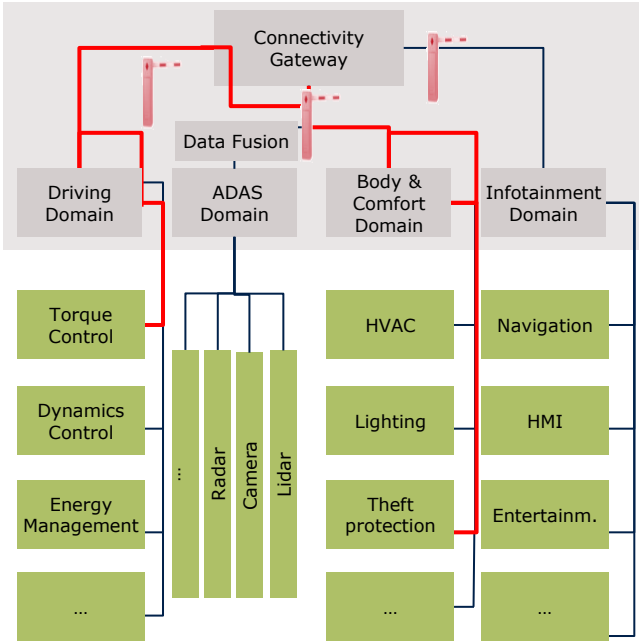
Today

› “Democratic” structure: Systems are connected to one another



Tomorrow

› In the future, systems will be clustered in domains and organized hierarchically



Copyright © Infineon Technologies AG 2017. All rights reserved.

Introduction of central computers triggers demand for high-performance, fail operational microcontrollers (MCUs)

decision making

L0 / L1 / L2 vehicles

human acts

L3 / L4 / L5 vehicles

camera
radar
lidar
GPS

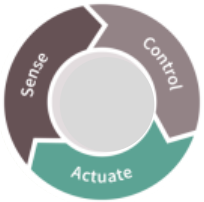
central computer
CPU / GPU
+
MCU (AURIX™)

central computer triggers car operations

basic car functions

classic ECU

- temperature
- pressure
- position
- speed



- MOSFETs
- IGBTs
- power ICs

- MCUs, e.g. AURIX™

future ECU = classic ECU

+ higher performance
+ fail operational
+ secure

fail operational systems require redundancy in
- power switches, power supply
- sensors
- MCUs

car security is achieved through
- discrete security controller (OPTIGA™)
- integrated security modules in MCUs (AURIX™)

Copyright © Infineon Technologies AG 2017. All rights reserved.

Demand for MCUs is driven by a rising average number of ECUs in the mid-range and central computing platforms

vehicle segments	Light vehicle production	ECU	Central Computing
luxury/premium 	[units m] 2016: 10 total, 0 thereof L3+ cars; 2020: 12 total, 5 thereof L3+ cars; 2025: 14 total, 9 thereof L3+ cars	[MCUs per car, today / trend] up to **110 MCUs** „slightly down“	[CPU/MCUs per L3+ car] **2 CPUs + 1 MCU**
mid-range 	2016: 65 total, 0 thereof L3+ cars; 2020: 71 total, 0 thereof L3+ cars; 2025: 77 total, 6 thereof L3+ cars	up to **60 MCUs** „up“	**1-2 CPUs + 1 MCU**
economy/low-end 	2016: 17 total, 0 thereof L3+ cars; 2020: 19 total, 0 thereof L3+ cars; 2025: 21 total, 0 thereof L3+ cars	up to **20 MCUs** „same“	**0 CPU 0 MCU**

Source: Strategy Analytics, Infineon estimates

Copyright © Infineon Technologies AG 2017. All rights reserved.

AURIX™ microcontroller complements CPU/GPU to make the central computer robust and fail operational

Examples of central computing platforms

Functionality

- Data processing for applications (e.g. parking)
- Fusion of object data, deep learning algorithms
- Environmental model calculation (road, objects)
- Trajectory planning
- Modelling of driver behaviour

1

DRIVE™ PX 2

NVIDIA

2

INTEL® GO™
DEVELOPMENT PLATFORM FOR AUTOMATED DRIVING

AURIX™ as real-time main controller or host controller

- ISO 26262 ASIL-D safety host monitoring operation of the data fusion ECU
- Safe and secure gateway to the vehicle network
- Fallback operation in case of a GPU/CPU fail
- Safe communication to actuator control units

› AURIX™ is <u>the</u> market reference as host controller in central computing platforms

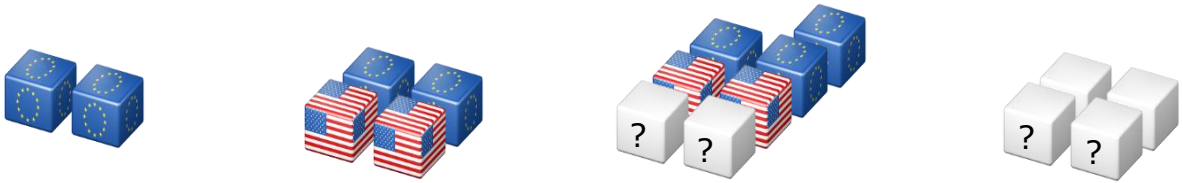
Pictures: Courtesy of Nvidia, Intel

Copyright © Infineon Technologies AG 2017. All rights reserved.

AURIX™ microcontroller is the safety controller of choice for current and upcoming data fusion platforms

Featured in leading OEM platforms

SOP 2015 - 2016	SOP 2017 - 2018	SOP 2019 - 2020	SOP 2021 - 2022
› 2x Europe	› 2x Europe › 2x US	› 3x Europe › 2x US › 2 in discussion	› 4 in discussion

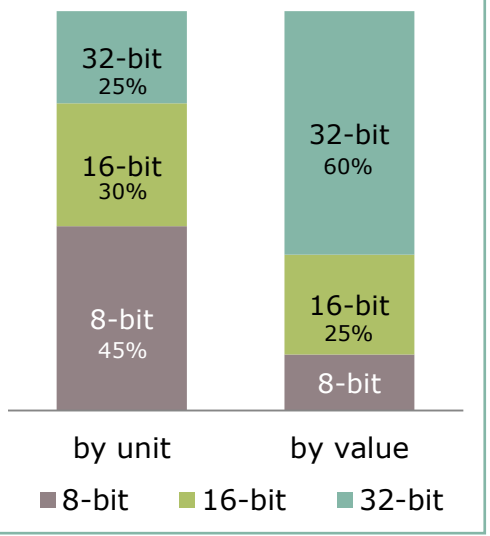


High-profile Tier 1 customer base

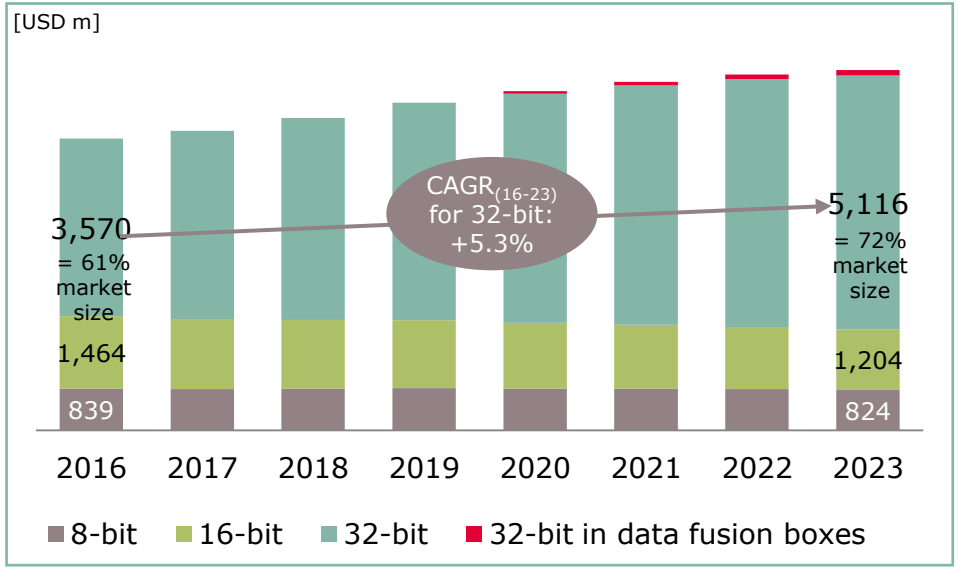
Copyright © Infineon Technologies AG 2017. All rights reserved.

32-bit microcontrollers capture the lion share of $-opportunity in automotive applications

Example:
A premium car with ~110 MCUs



32-bit MCU market is the place to be



› AURIX™ microcontrollers fit basically to all 32-bit use cases (except infotainment) and is clearly gaining market share in 32-bit automotive market.

Source: Strategy Analytics, „Automotive Semiconductor Demand Forecast 2014 – 2023", January 2017; Infineon estimates

Copyright © Infineon Technologies AG 2017. All rights reserved.

Infineon AURIX™ microcontroller family covers the majority of 32-bit use cases

AURIX™ use cases	Powertrain	Chassis / Safety / ADAS / AD	Body / advanced connectivity
		 	
ICE	engine management	domain control	chassis suspension	vehicle stability control	advanced body control module	over-the-air update
ICE	transmission	power steering	electric parking brake	airbag and safety	connected gateway	online control module
ICE	starter generator	77 GHz radar	24 GHz radar	advanced lighting	infrastructure controller for V2V/V2X	
xEVs	BEVs HEVs, PHEVs	DC-DC converter	driver monitoring	sensor fusion	vision safe host controller	
xEVs	onboard charger	battery management				
growth driver	› unit production › xEV penetration	› ADAS/AD penetration › evolution from L0 towards L5	› comfort penetration › connectivity

Copyright © Infineon Technologies AG 2017. All rights reserved.

Key takeaways

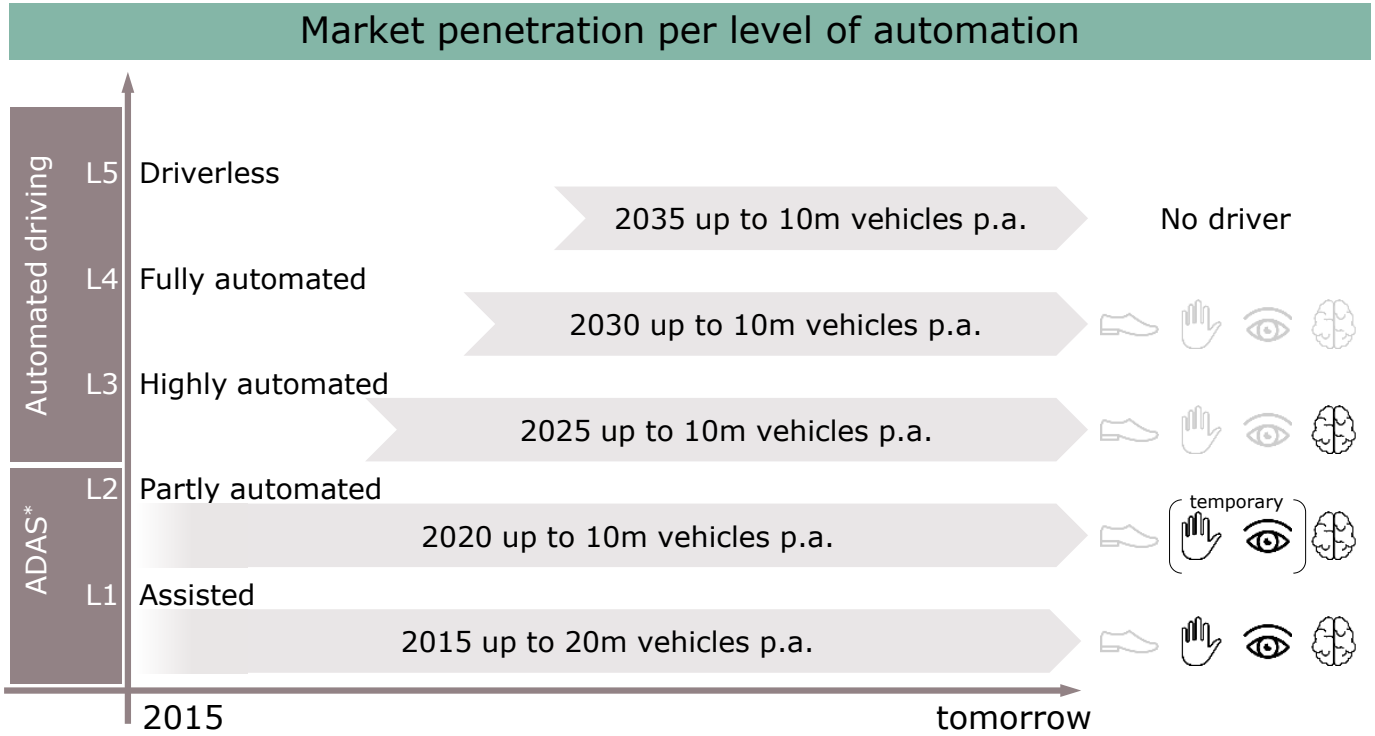
- The hierarchical system architecture of the car of the future will require an increasing number of high-performing and fail operational 32-bit microcontrollers
- The demand for microcontrollers will be driven mainly by a higher average number of ECUs in mid-range cars and on top central computing platforms for level 3+ beyond 2020
- Infineon AURIX™ family is the microcontroller of choice in more than 80% of current and upcoming data fusion platforms
- By 2023, about 72% of automotive MCU $-value will stem from 32-bit
- AURIX™ microcontrollers fit basically to all 32-bit use cases (except infotainment) and represent the most comprehensive portfolio in the industry
- Strong multi-billion-$ design-win pipeline drives revenue growth and continuous market share gains in automotive microcontrollers

Copyright © Infineon Technologies AG 2017. All rights reserved.

Part of your life. Part of tomorrow.

Infineon

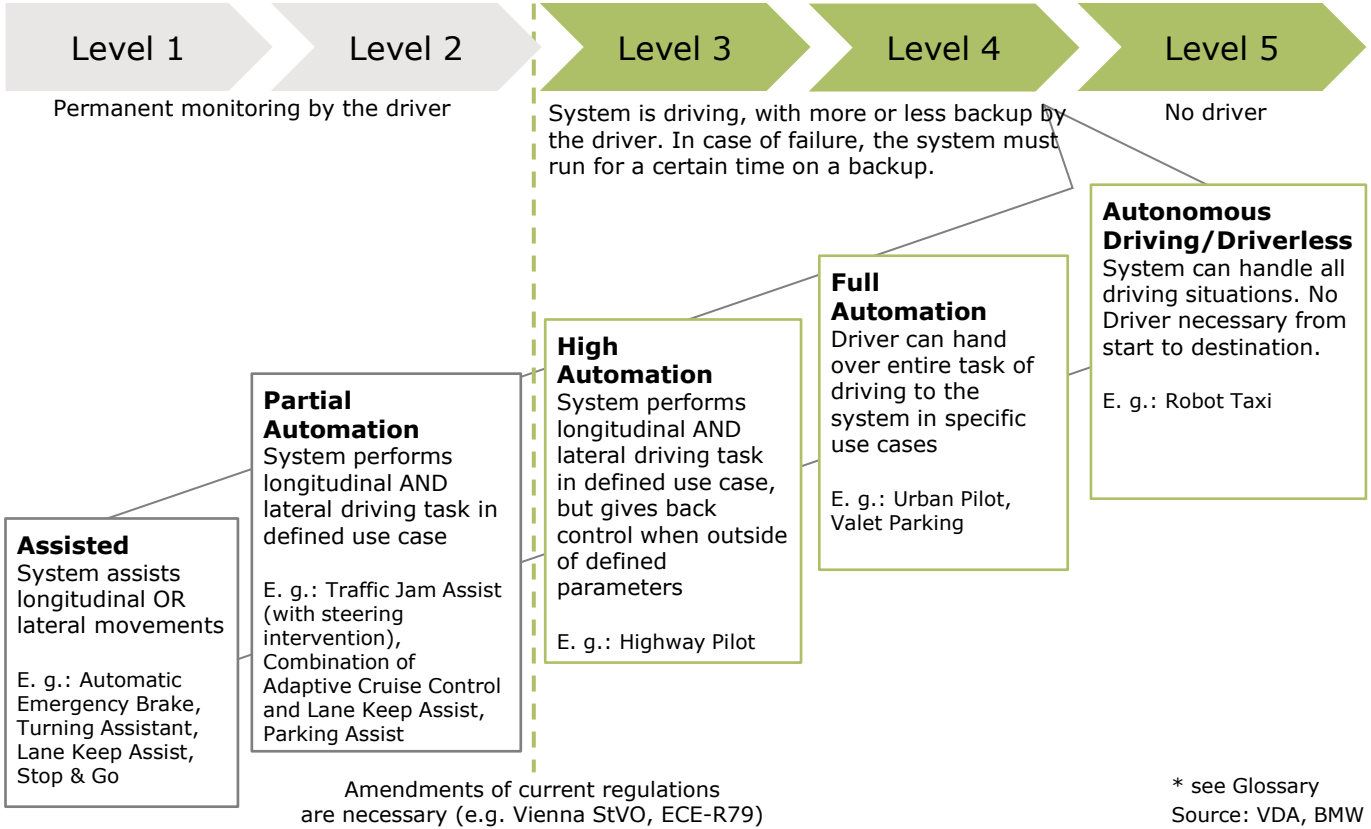
ADAS*/AD* semi BoM* growth is driven by radar and camera sensor modules



* See glossary
Source: IHS Markit, McKinsey, UBS, Infineon

Copyright © Infineon Technologies AG 2017. All rights reserved.

The 5 levels of increased automation (VDA* definition)

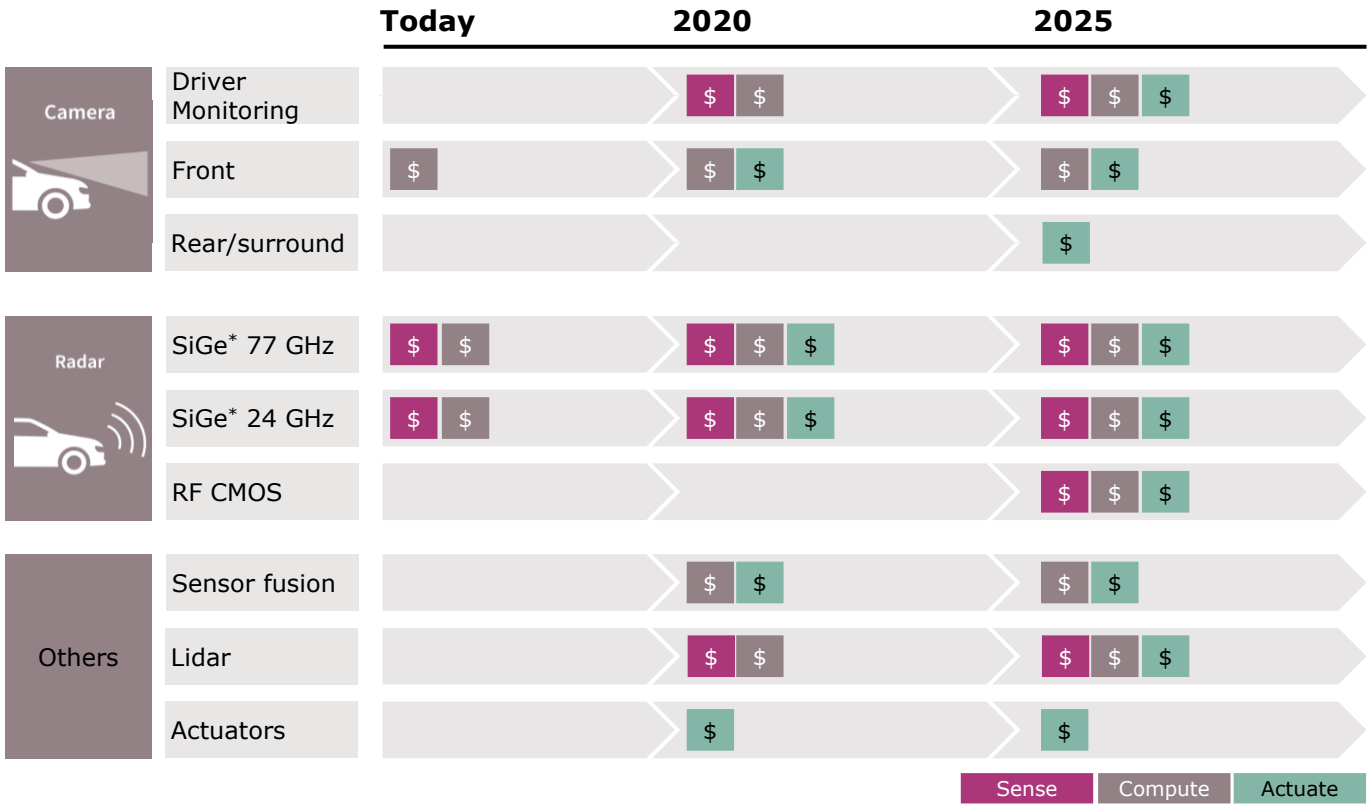


* see Glossary

Source: VDA, BMW

Copyright © Infineon Technologies AG 2017. All rights reserved.

Infineon's product portfolio fosters revenue growth in ADAS/AD for the next decade



Copyright © Infineon Technologies AG 2017. All rights reserved.

Glossary

- ADAS: Advanced Driver Assistance Systems
- AD: Automated Driving
- AI: Artificial Intelligence
- BCM: Body Control Module
- CC: Central Computer
- CPU: Central Processing Unit
- ECU: Electronic Control Unit
- FOTA: Firmware Over-The-Air
- GPU: Graphics Processing Unit
- MCU: Microcontroller Unit
- SoC: System-on-Chip
- VDA: German Association of Automobile Manufacturers
- V2V: Vehicle-To-Vehicle
- V2X: Vehicle-To-Everything

Copyright © Infineon Technologies AG 2017. All rights reserved.