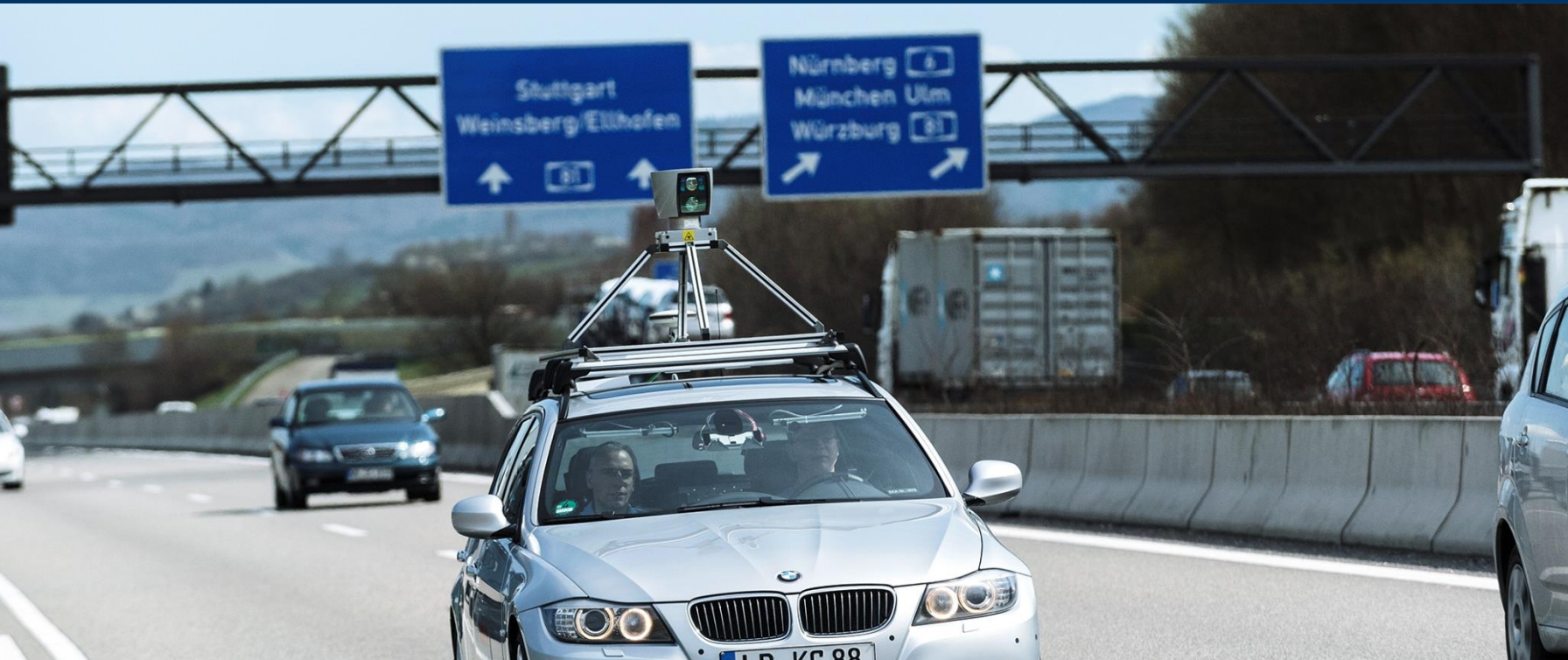


Driverless Vehicles



Carl Liersch
General Manager, Chassis Systems Engineering
Robert Bosch (Australia) Pty. Ltd.

All abbreviations within this presentation
used for simplification purpose

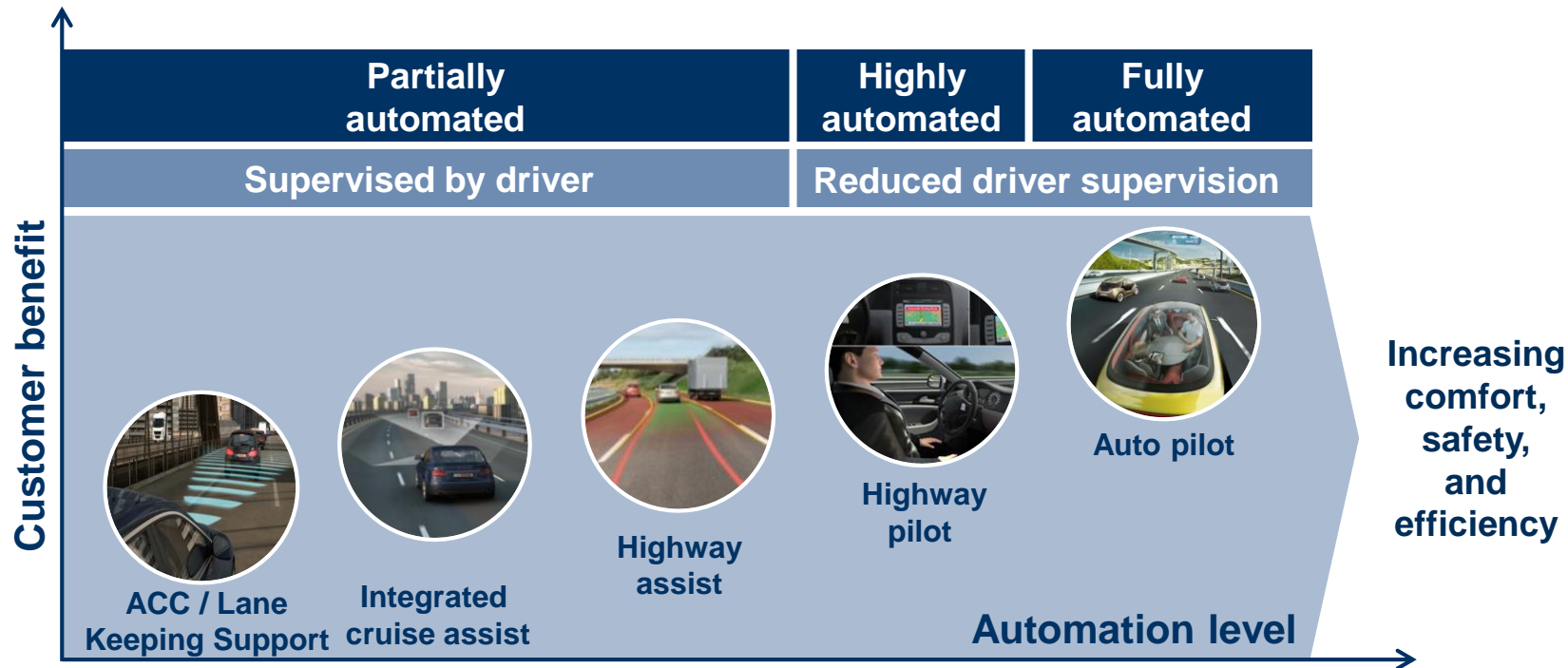
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Driver assistance – degree of automation



Automated driving starts with highway driving and parking functions

- Step-by-step approach – for technological and psychological reasons
- Survey: 52% in favor of automated driving as long as it can be switched off¹

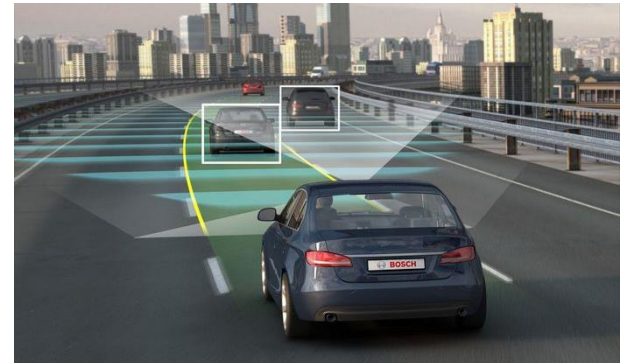
¹ Source: Bosch survey 2012 (CC)

Integrated Cruise Assist

- ➔ Automatic longitudinal and lateral guidance
- ➔ 0...130 km/h (on highways and major roads)
- ➔ In case of missing lane markings, lateral guidance provided via dynamic radar objects

Extensions (with driver confirmation):

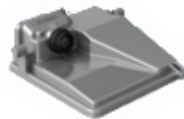
- ➔ Automatic lane change
- ➔ Automatic speed adaptation based on road sign recognition



Long range radar



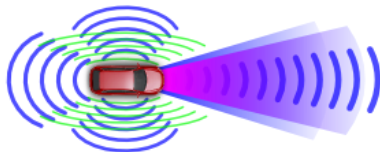
Mid range radars for lane change function



Mono video camera

Highway Pilot

- Fully automated driving without driver in the loop
- Function starts upon driver request and system release
- Tracking the vehicle position within driving lane
- Lateral vehicle motion via steering wheel intervention or brake intervention
- Overtaking manoeuvre if convenient
- Reaction to construction zones and intersections



360 degree 3D
surround sensing



Key technologies

Surround sensors



highly robust
in all use cases

Driver monitoring



for partly automatic
functions

Online map data



precise and up-to-date
every moment

Perception and localization

leads to unambiguous and comprehensive
360° environment model



Reasoning and decision making

enables correct decisions, even in highly
dynamic situations and with incomplete information

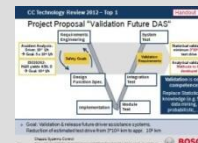


Motion control

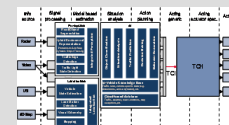
works safe, fast and precise in all dimensions



Functional safety
guarantees high
standard at
reasonable effort

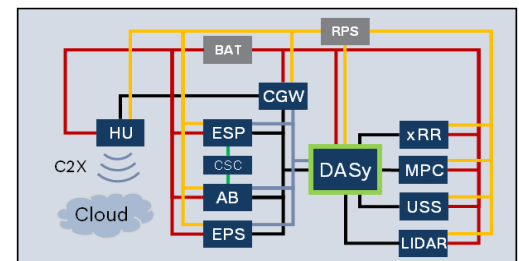
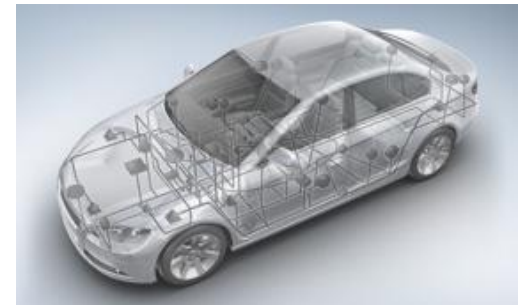


Architecture
supports safety,
performance and
cost targets



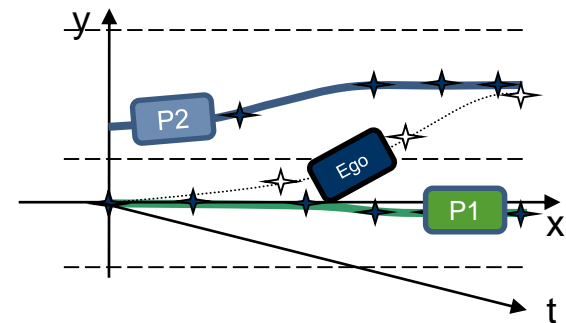
Reasoning and decision making

- Reliable decisions based on dynamic and uncertain information
 - Interpretation of sensor information
 - Decision making
 - Trajectory planning
- Increased requirements on hard- and software
 - Connectivity, data flow
 - ECUs (power, connectivity, reliability)
 - Communication (bandwidth, protocols, redundancy)
 - Energy supply (reliability, backup)

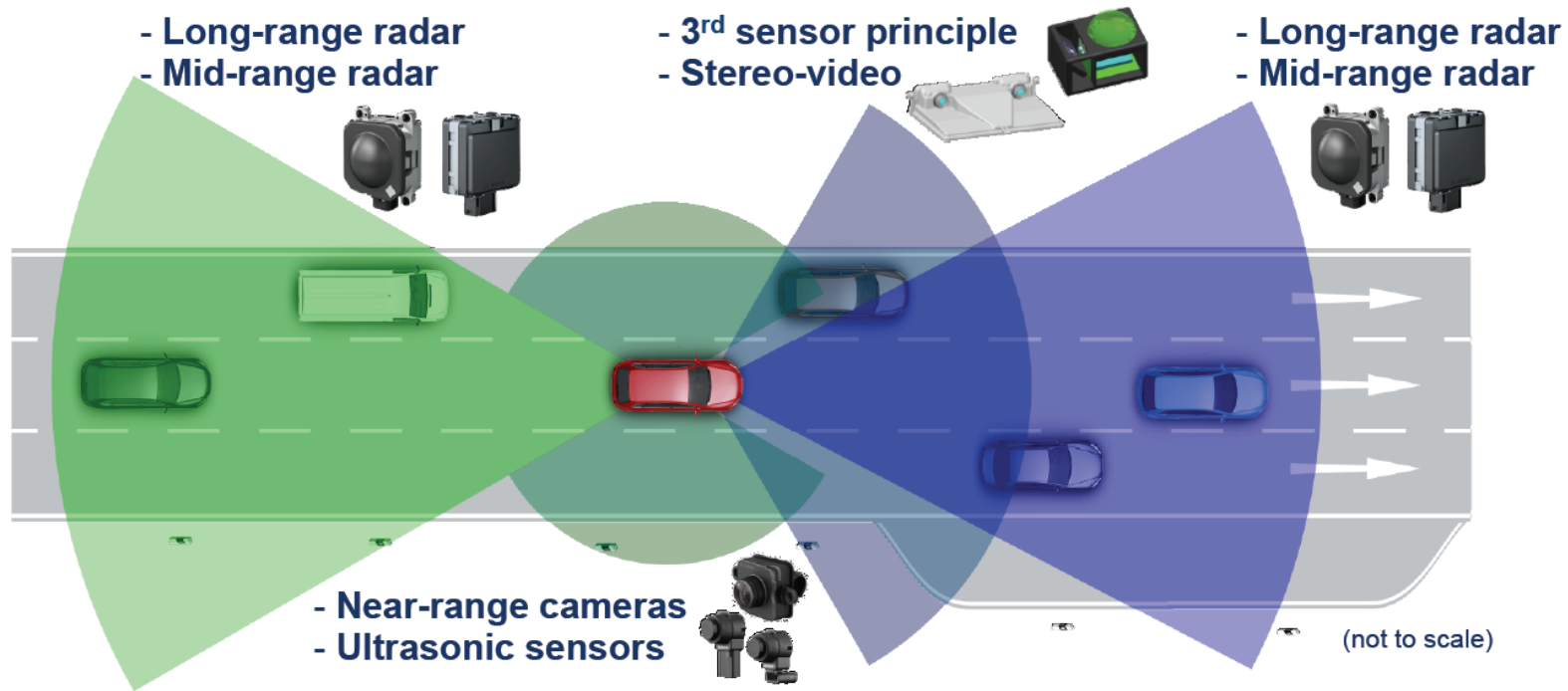


Motion control

- Precise motion control
 - It must be ensured that the vehicle follows the generated trajectory at all times
- Safe state
 - Vehicle must be brought into safe state even without driver intervention at the unlikely event of system failure
 - Redundant actuation
 - Emergency operation mode
 - Energy backup for vehicle detention



Surround Sensing – Vehicle Sensor Concept

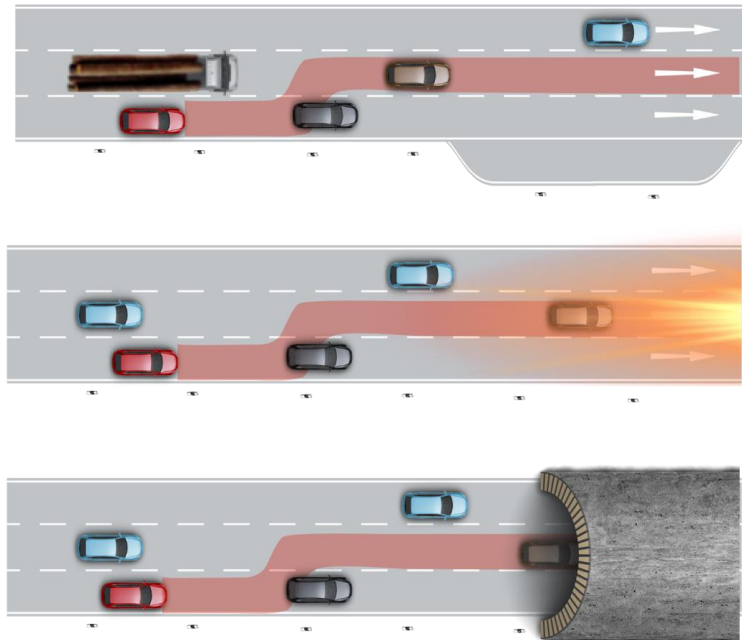
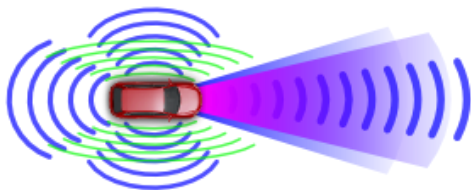


360° surround sensing by combination of different sensors

- Long- and mid-range radar prerequisite for driving at higher speed
- Satisfy reliability requirements by using multiple sensors for each area

Surround sensors

- New use cases require
- 360°surround view with
 - 3D information
 - Shape and surface measurement
 - Highreliability
 - Low sensitivity to weather and light
 - Physical redundancy
 - Preferably active measurement
 - Preferably object classification



Driver monitoring



Distraction detection

... because 80% of accidents caused by inattentive drivers¹



Drowsiness detection

... because 30% of drivers have experienced microsleep events²



Health monitoring

... because 10% of fatal accidents caused by medical conditions³



Identification

... because it enables the vehicle to adapt to the person driving



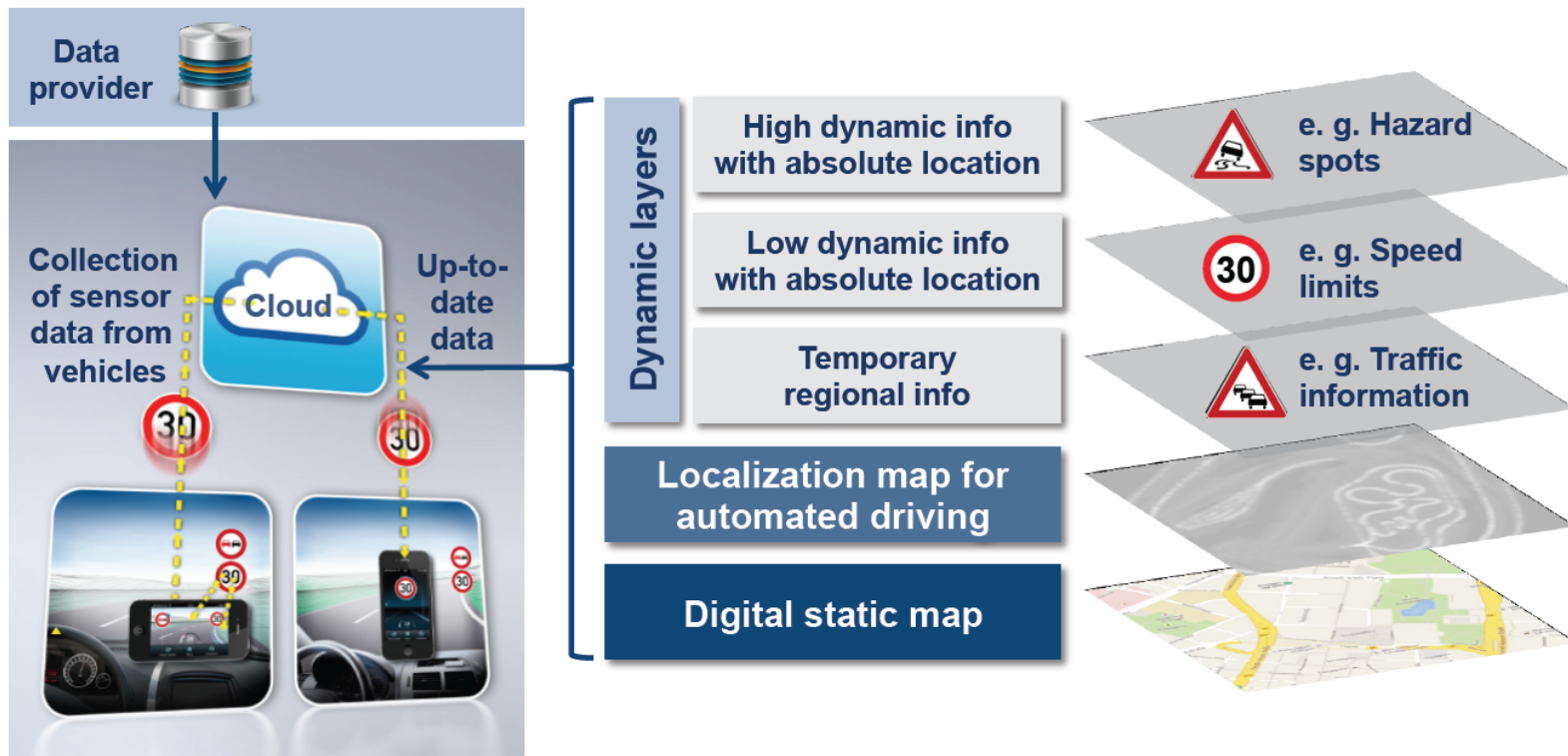
Adaptive assistance

... because it enables the vehicle to react according to the driver's state

Driver monitoring will be a key element for automated driving functions

- System has to be able to return control to the driver at any time

Dynamic Map Data – Layered Approach



Highly automated driving requires latest high-precision map data

· Aggregated information processing and delivery via the cloud

Safety and Security - Distinction

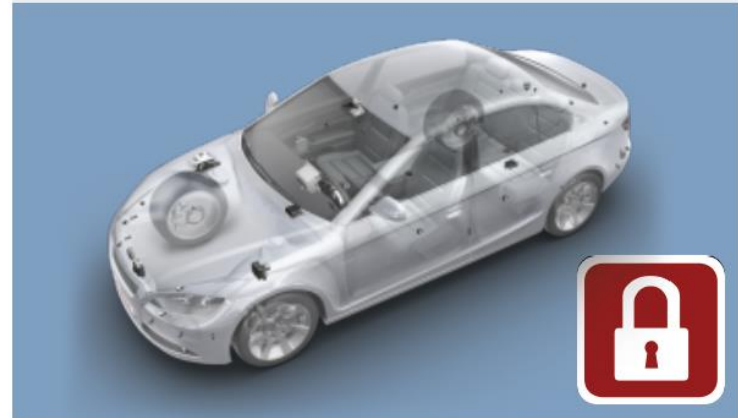
Safety

- Protection against technical failures
- Covers malfunction aspects



Security

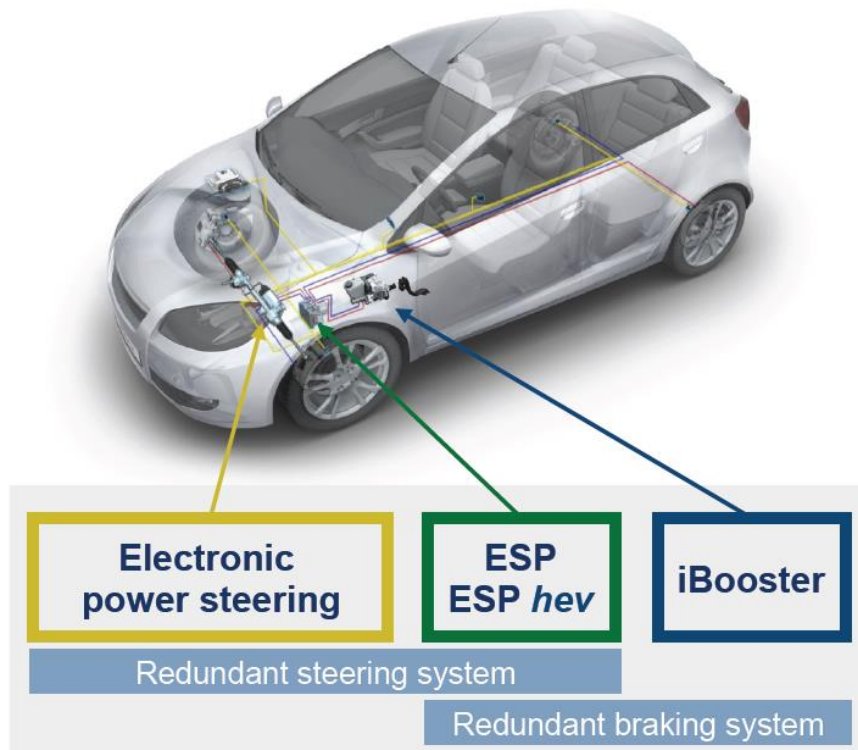
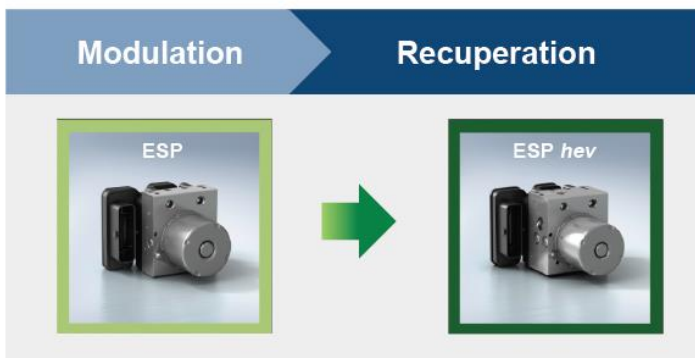
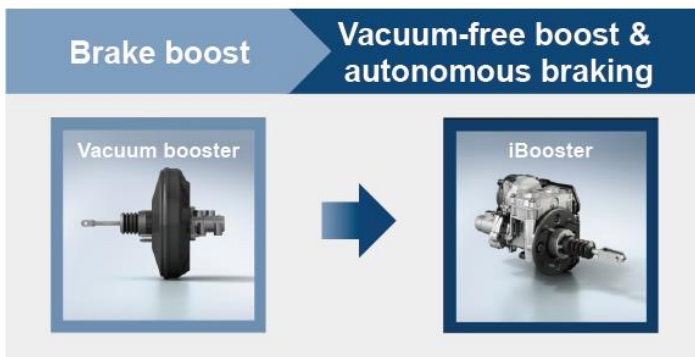
- Blocking of deliberate attacks
- Confidentiality, integrity, availability



Safety (malfunction) differs in scope from security (deliberate attack)

· Leaks in security can put safety at risk

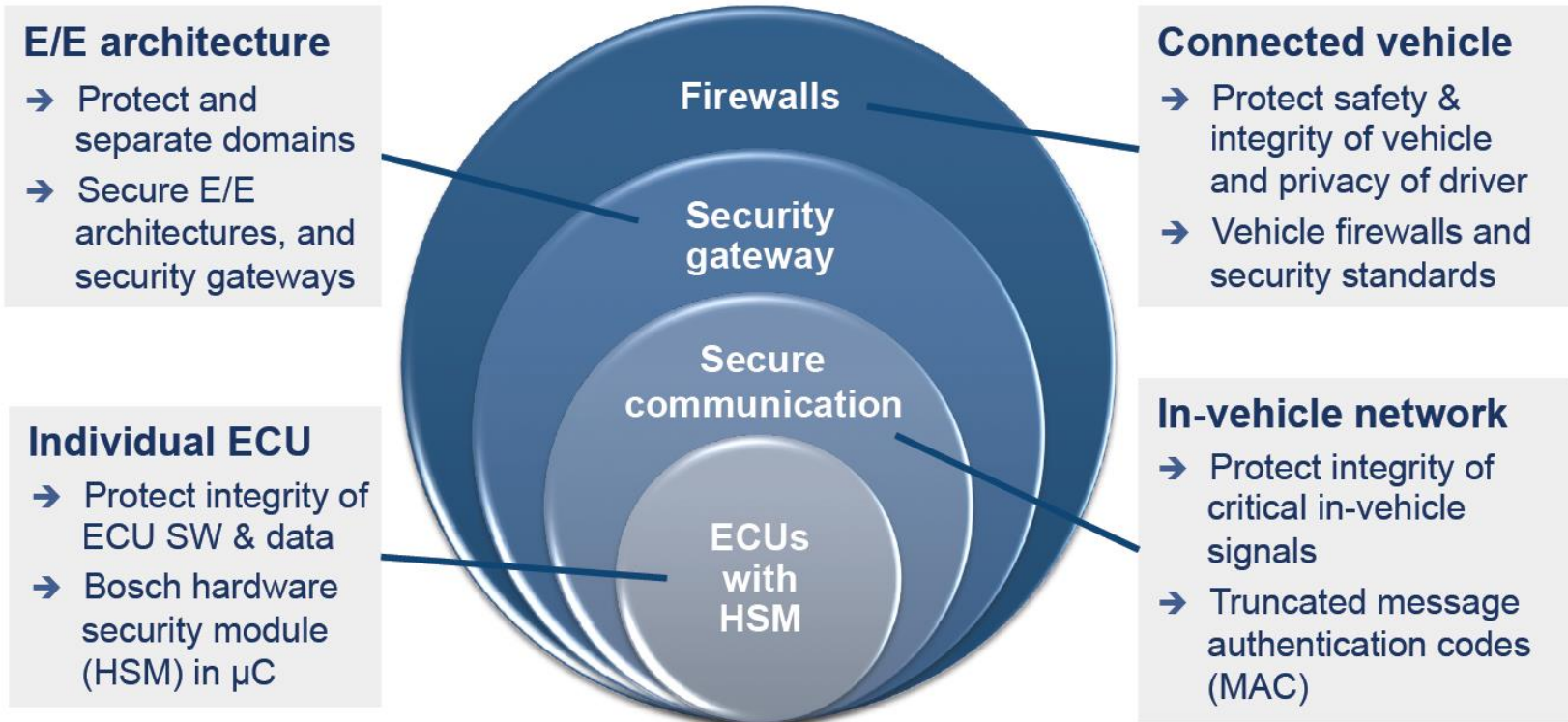
Safety – Reliable Actuation Elements



Redundant steering, braking, and stabilization systems required

· Modular actuation concept offers a perfect solution for automated driving

Security – Layered Automotive Approach



No automotive security standardization or agreement available yet

· Bosch offers a broad spectrum of solutions for automotive security

Test and application on highways

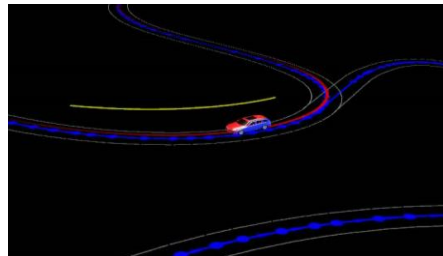
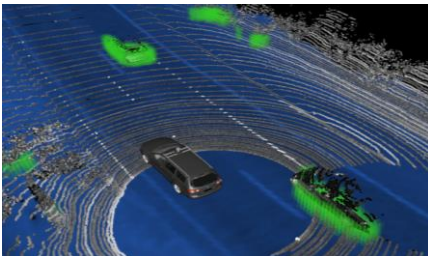


Prototypes driving on public freeways in Germany and USA

- Bosch: first vehicles on German freeways since early 2013
- Tests in real traffic conditions accelerate the development of new functions

Summary

- Future mobility will be connected and automated, offering benefits for **safe and relaxed driving**
- Stepwise implementation **starting** with **highway driving** functions
- Legal challenges still need to be solved, but are being addressed.
- The trend towards automated driving is generating **new technical challenges for sensors, actuators and E/E architecture**



The Future Is Coming



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