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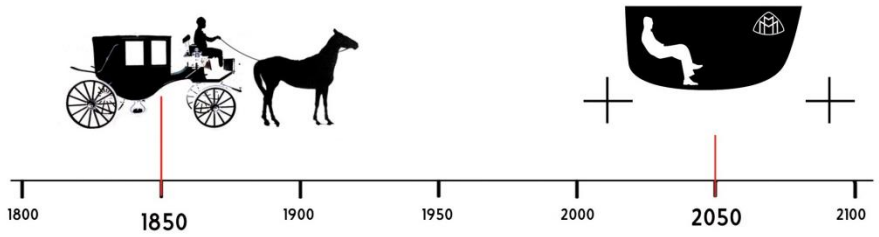
Automated Vehicles

- Vision and Promise
- State-of-the-Art
- Remaining Challenges

Eberhard Zeeb



Vision

Promise

Main Targets for Automation

Cars in private ownership

- drive comfortable and safe
- individual mobility for all
- extended use of driving time

Autonomous cars allow extended individual mobility for all

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Cars for rent and share

- Bring the car to where it is needed
- Bring the car back to its station
- Use the best purpose car

Autonomous cars meet the drivers wherever they are needed

Our Long Term Vision of Car Sharing

Main Targets for Automation

Cars in private ownership

- drive comfortable and safe
- individual mobility for all
- extended use of driving time

Trucks to deliver goods

- extended use of driving time
- automated loading/switching
- drive safe and efficient

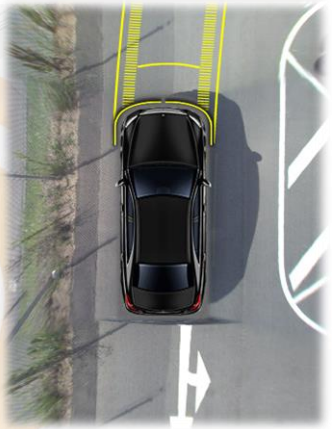
Cars for rent and share

- Bring the car to where it is needed
- Bring the car back to its station
- Use the best purpose car

Autonomous Trucks/Vans adapt the steady flow of goods

State-of-the-Art

Series Cars Today: Mercedes-Benz Intelligent Drive



PRE-SAFE® PLUS

360° camera

Active Blind Spot Assist

Active Parking Assist

DISTRONIC PLUS
with Steering Assist

ATTENTION ASSIST

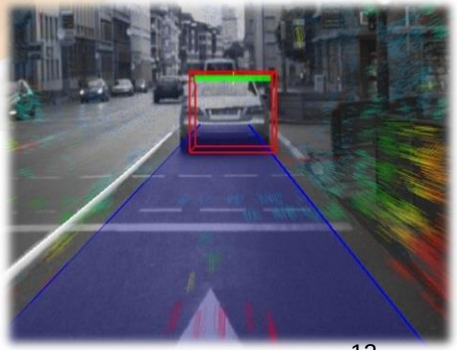
COLLISION PREVENTION ASSIST

PRE-SAFE® Brake
e. g. with pedestrian detection
and urban braking function

Active Lane Keeping Assist

BAS PLUS with Cross-Traffic Assist

Adaptive Highbeam Assist Plus



Mercedes Intelligent Drive: Not only available in luxury vehicles

C-class

E-class

CLS-class

S-class

GLE-class

GLC-class

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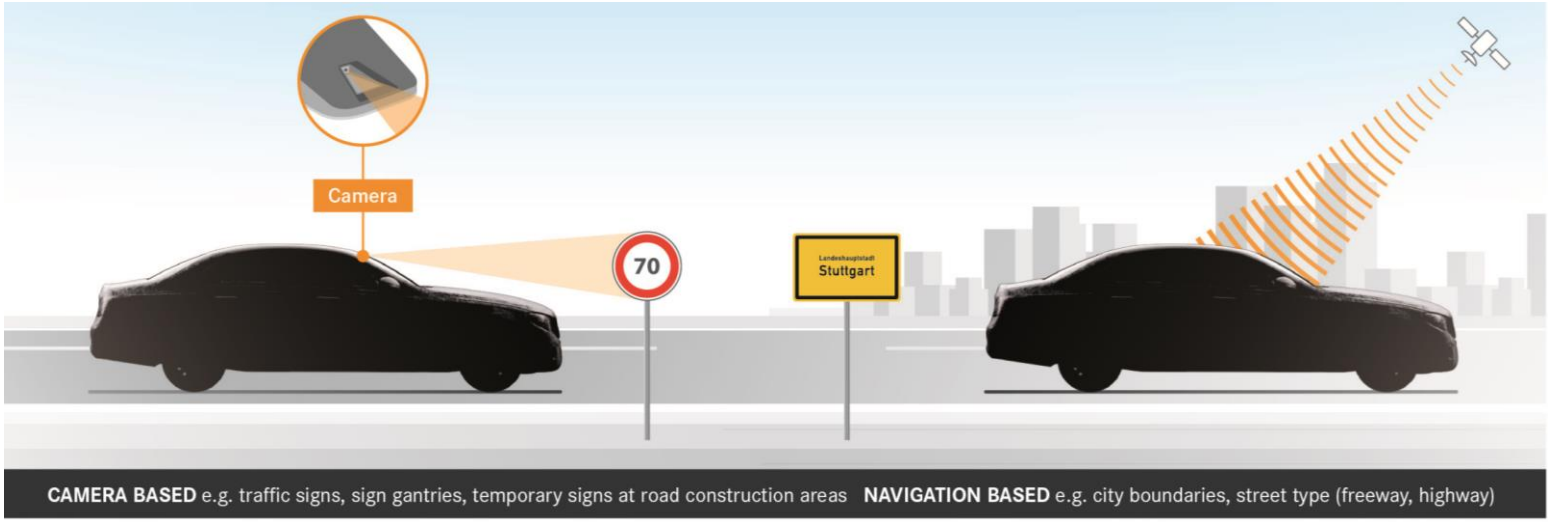
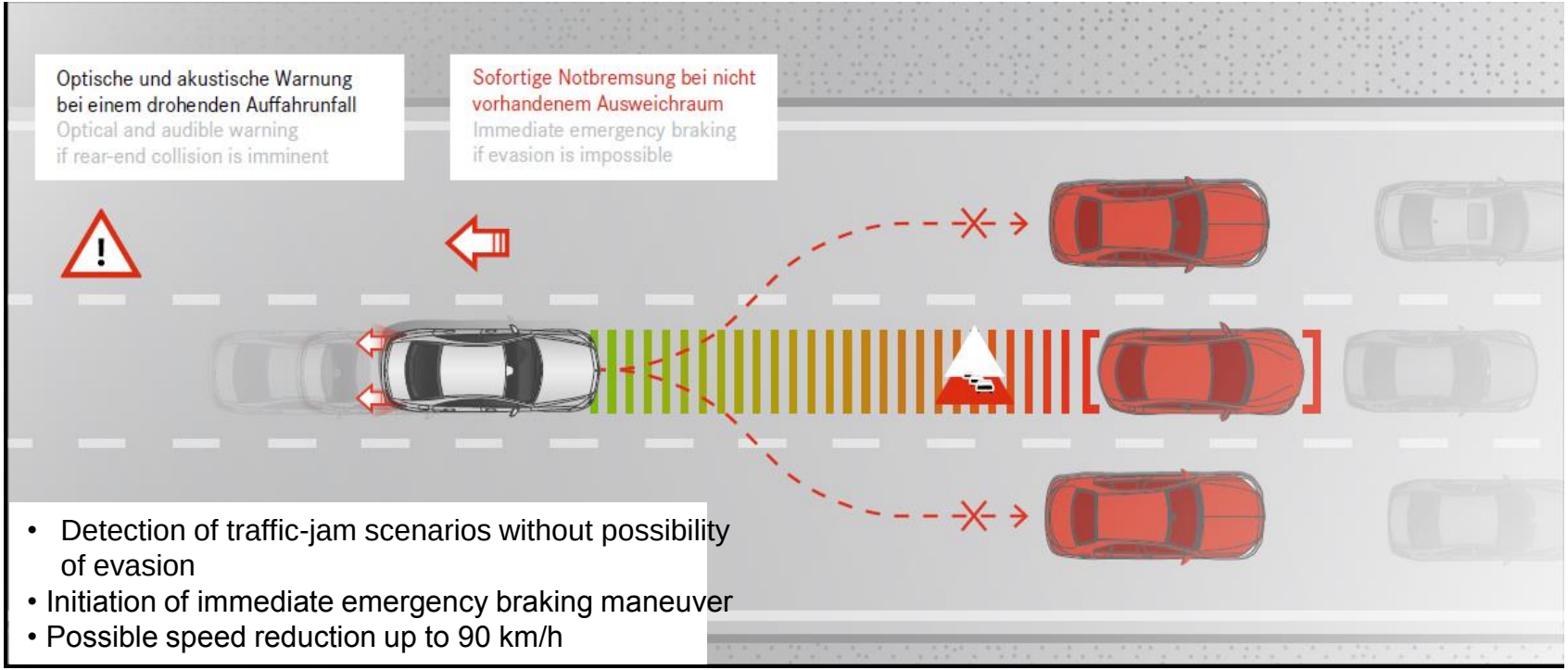
Next Step on the way to autonomous and accident free driving

Next Step on the way to autonomous and accident free driving

Example: Speed Limit Pilot



Example: Active Braking Assist with Congestion Emergency Braking



- Detection of traffic-jam scenarios without possibility of evasion
- Initiation of immediate emergency braking maneuver
- Possible speed reduction up to 90 km/h

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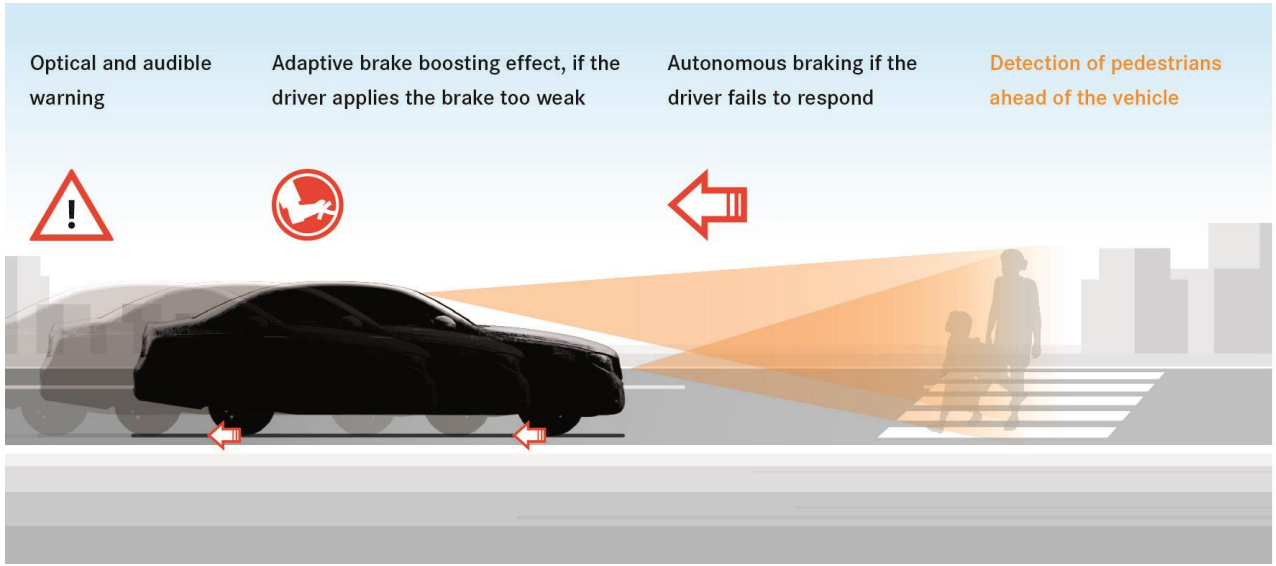
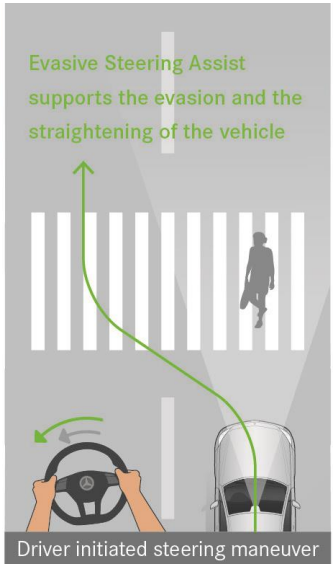
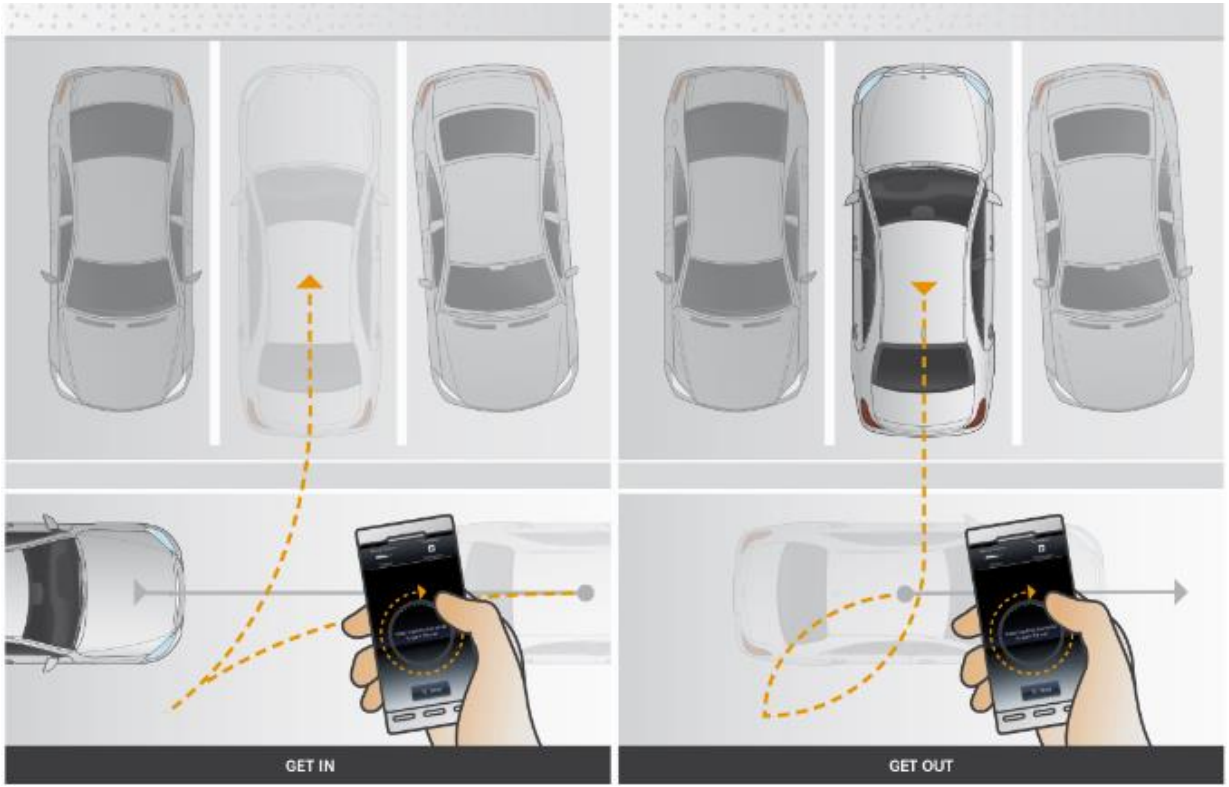
Example: Active Braking Assist and Evasive Steering Assist





Example: Remote Park Pilot



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Further Steps: Change over of Responsibility from Driver to Car

Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
No Automation	Assisted (Assistiert)	Partially Automated (Teilautomatisiert)	Conditionally Automated (Hochautomatisiert)	Highly Automated (Vollauto-matisiert)	Fully Automated (Fahrerlos)
Drivers drives by his own		Driver has to supervise the automated function continuously. **Responsibility stays at the driver** **No** side activities allowed	System **recognizes its limitations** and hands over the responsibility to the driver early enough. **Defined** side activities allowed	System is able to manage all driving sit. autonomously. Side activities are allowed and driverless driving is possible. **Driverless driving allowed**	

Fail safe

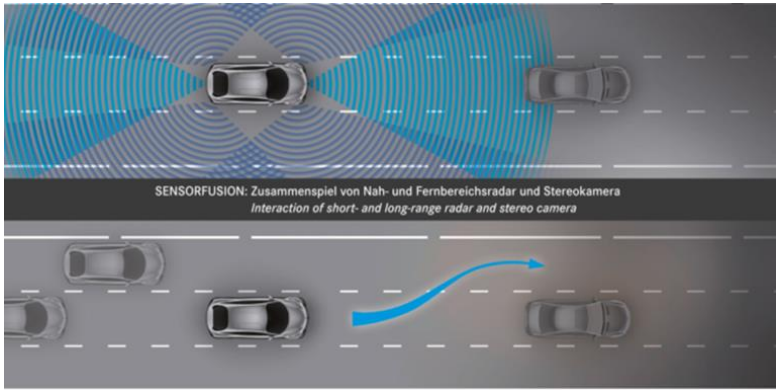
Clearly defined regulations and laws

Fail operational

Regulations and laws under development

Further Steps: Autonomous Highway-Pilot

- On multi-lane roads with parallel traffic the system allows autonomous driving with driver selected cruising speed.
- All speed limits are respected, vehicle speed is adapted to traffic situations and vehicles travelling with lower speed are passed automatically
- **In Highway Pilot Mode collisions are avoided highly reliable on systems own authority**
  (without driver interaction)



Safety and Automation: The Major Challenge

Accidents are almost all due to human error

Humans do much more right when driving than they do wrong

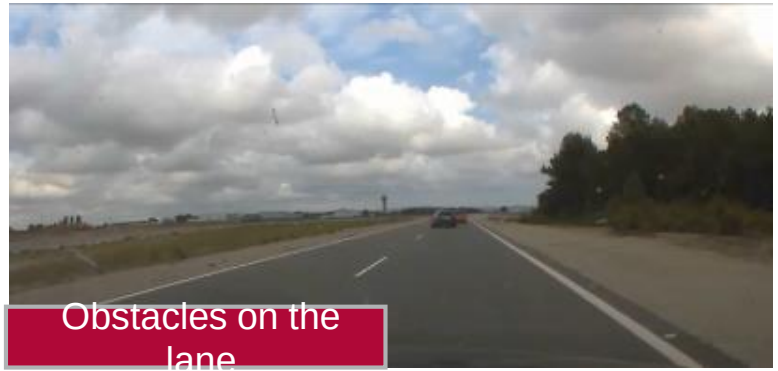
We have with some success automated to intervene when people do something wrong.

We now aim at automating those things that people do right.

On the German Autobahn, every 7.5 million km we <u>may</u> catch an error.

We have to drive those 7.5 million km and <u>must</u> not fail a single time.

Level 3+: Collision Avoidance for Highly Automated Driving is Mandatory



… but it is,
depending on
weather, road, traffic conditions,
extremely challenging!

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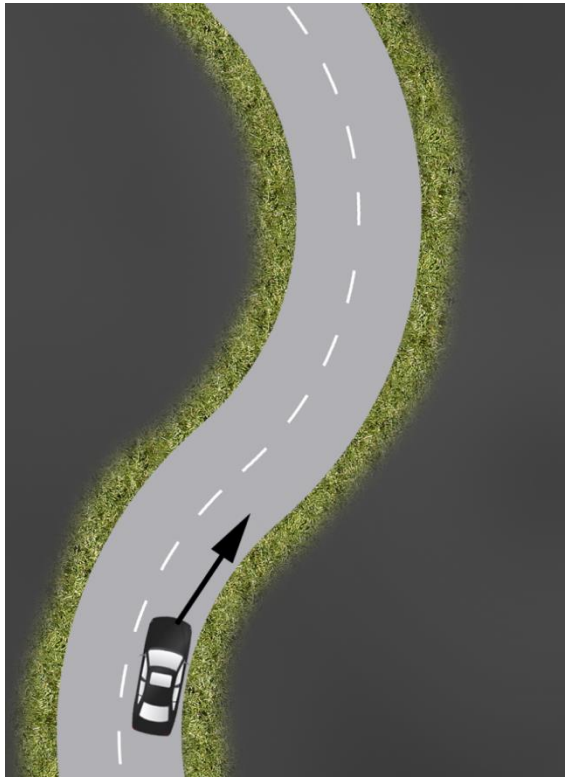
Further Steps: Automated Driving on Urban and Rural Roads

S500 Intelligent Drive:
Driving autonomously on the footsteps of Bertha Benz

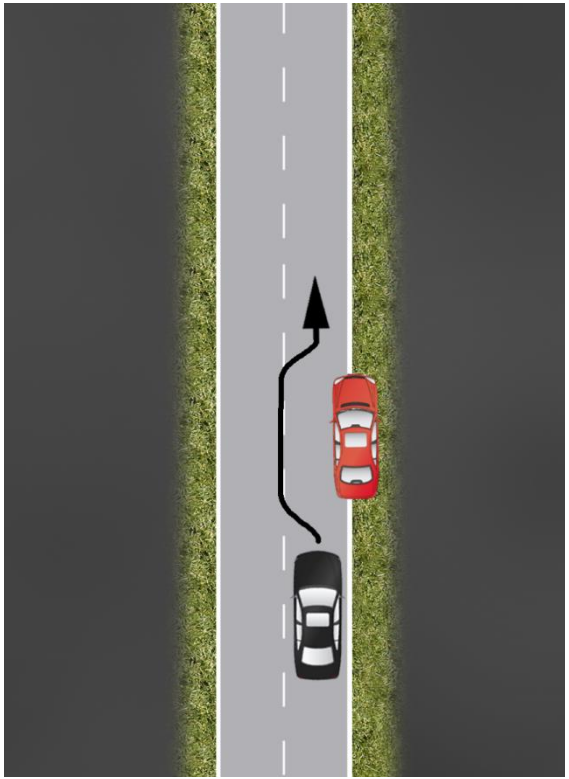
- Regular S 500 with all emergency braking systems enabled as underlying protection
- Accurate map for localization
- Additional automotive grade sensors for object detection, traffic light recognition and positioning

Impression of Bertha Benz Drive: Overland



Few road users, unobstructed view, dedicated lanes

Impression of Bertha Benz Drive: Inner City



Driving around static obstacles with on-coming traffic

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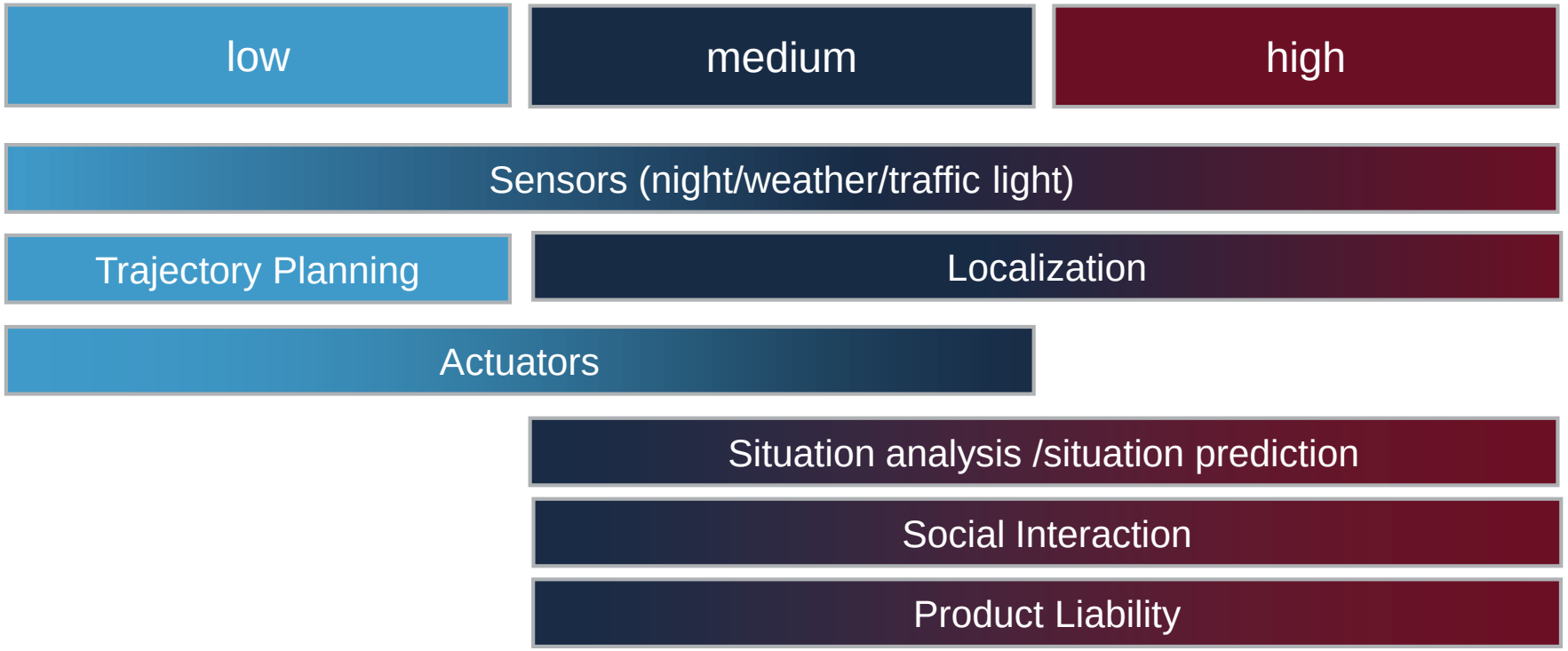
Hurdles on the Way Towards Autonomous Driving



Requirements on Software Creation Process

Today: Intelligent Drive Software is developed in house

- about 2/3 is hand coded in C
  - sensor fusion software
  - situation analysis software

- about 1/3 is model coded using Simulink (using about 20 licenses in series development)
  - control software

Future Challenges for Software Creation

- more software modules with higher ASIL requirements, up to ASIL D
- code generator which generates automatically ASIL code
- get rid of an additional code-analysis process after automatic code generation
- efficient support for software unit test

Future Development Steps Keep „Risk Balancing“ in Mind

One automation scenario at a time ...

- Roads Driven
- Driving Speed
- Automation Level

... with significantly fewer risks ...

- Avoiding old faults
- Creating new faults

... for the individual and society as a whole

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Our Mission

Enhance comfort, safety and grade of automation step by step to reach the vision of autonomous driving soon !