

# Man or Machine – The Path to Zero Accident Driving

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## Automotive Technology

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## **Road accident statistics in the EU:**

**Number of casualties is dropping slower than hoped for.  
25700 persons died at road accidents in 2014.**

Source: Spiegel online

# The Path to Zero Accident Driving

## Development steps in car safety systems



**Passive  
Safety**

**Active  
Safety**

**Driver  
Assistance**

**Automated  
Driving**

Safety Belt  
Combustible Zone  
Airbag

ABS

ASR

ESP

Adaptive Cruise Control

Predictive Emergency Brake

Lane Keeping Assist

Traffic Jam Assist

Autom. Park Assist

Full Autonomic

1960

1978

1995

2000

2008

2014

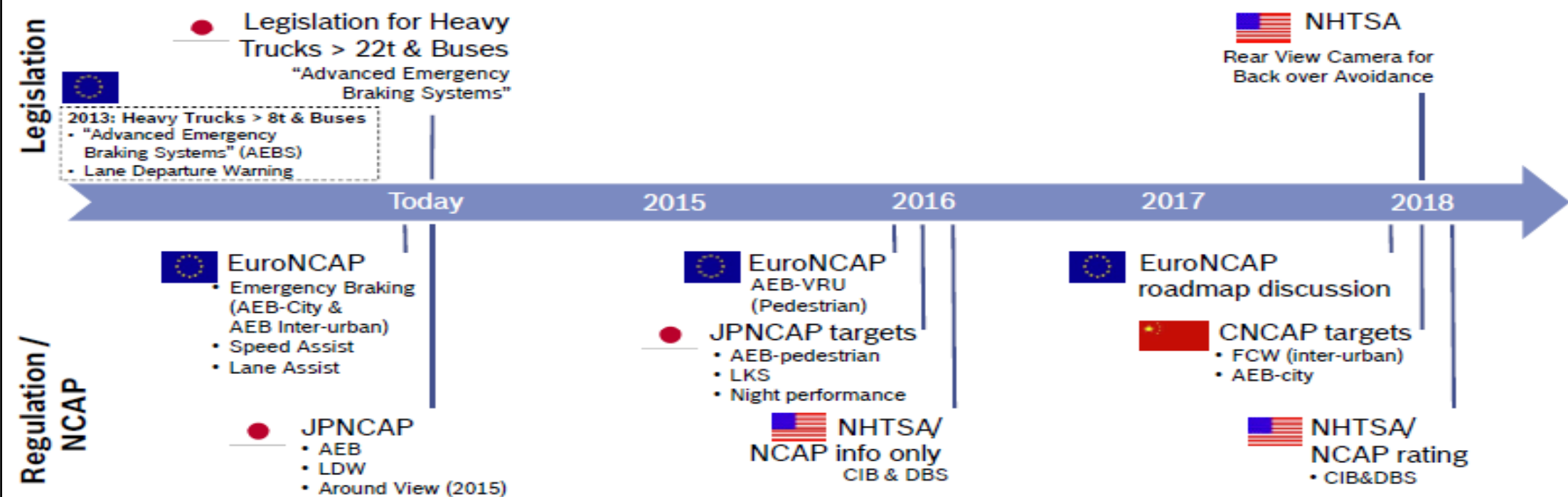
2025

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## Legislation & Regulation EU, JP, NAM, CN



- US Back-Over legislation: mandatory inst. rate ramps up '16: 10% to '18: 100%
- EuroNCAP DA functions rating with mandatory inst. rates since '14
- US, JP, CN NCAP without mandatory inst. rates; optional availability will be awarded

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Threshold for each box requested to get 5 star overall rating



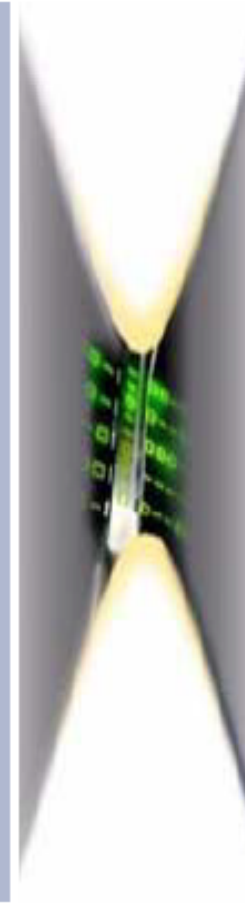
**New!**

- Speed Assist Systems (SAS)
- Lane Departure Warning/  
Lane Keeping Assist (LDW/LKA)
- Automatic Emergency  
Braking (AEB-City, -Urban, -Ped.)

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## Driver assistance functions and products



Long-Range Radar (LRR)	
Mid-Range Radar (MRR)	
Multi Purpose Camera (MPC)	
Stereo Video Camera (SVC)	
Infrared Night Vision Camera Night Vision	
Ultrasonic Sensors (USS)	
Near Range Camera (NRC)	
Head Unit Digital Maps	
Car-to-X Connected Vehicle	
Instrument Cluster   Head-up Display	

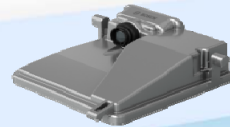
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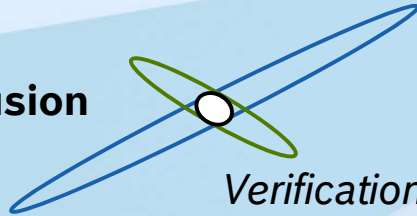
## Sensor Data Fusion for increased Safety

*Widened range  
through video sensor*

**Video  
Range**



**Fusion**



*Verification of object detection  
through Video sensors*

**Radar  
Range**



**Ultra Sonic  
Range**

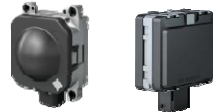


Ultraschallsensor



## Surround sensing – vehicle sensor concept

- Long-range radar
- Mid-range radar



- Lidar
- Stereo-video



- Long-range radar
- Mid-range radar



- Near-range cameras
- Ultrasonic sensors



(not to scale)

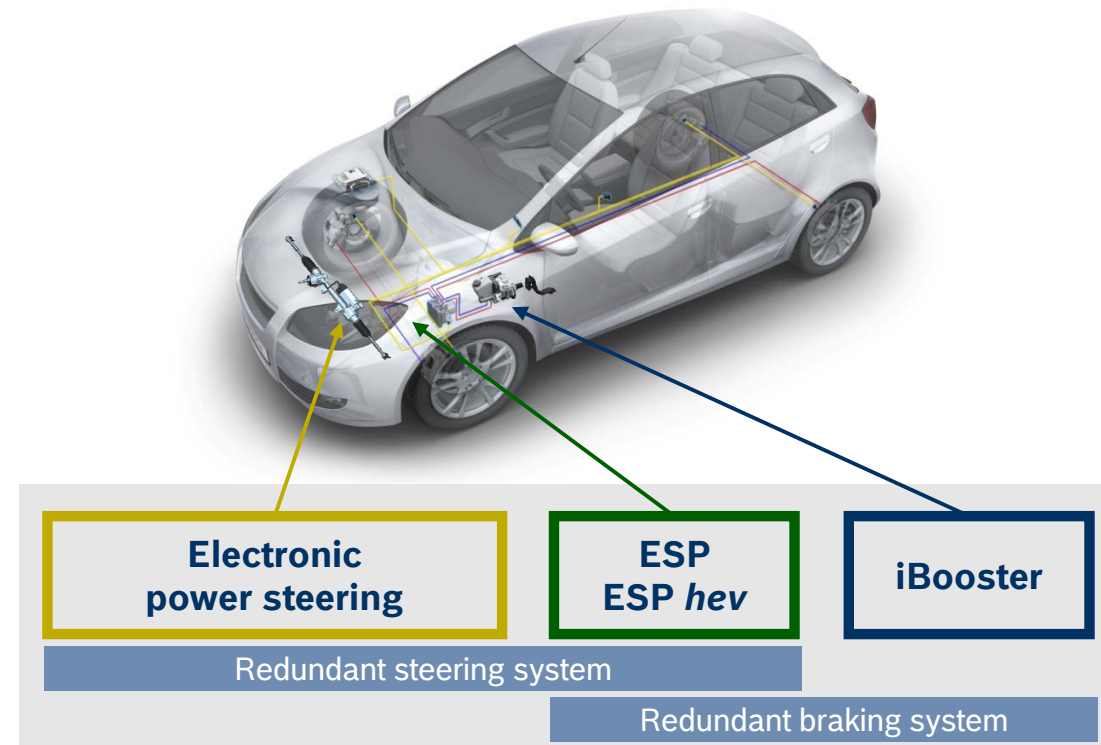
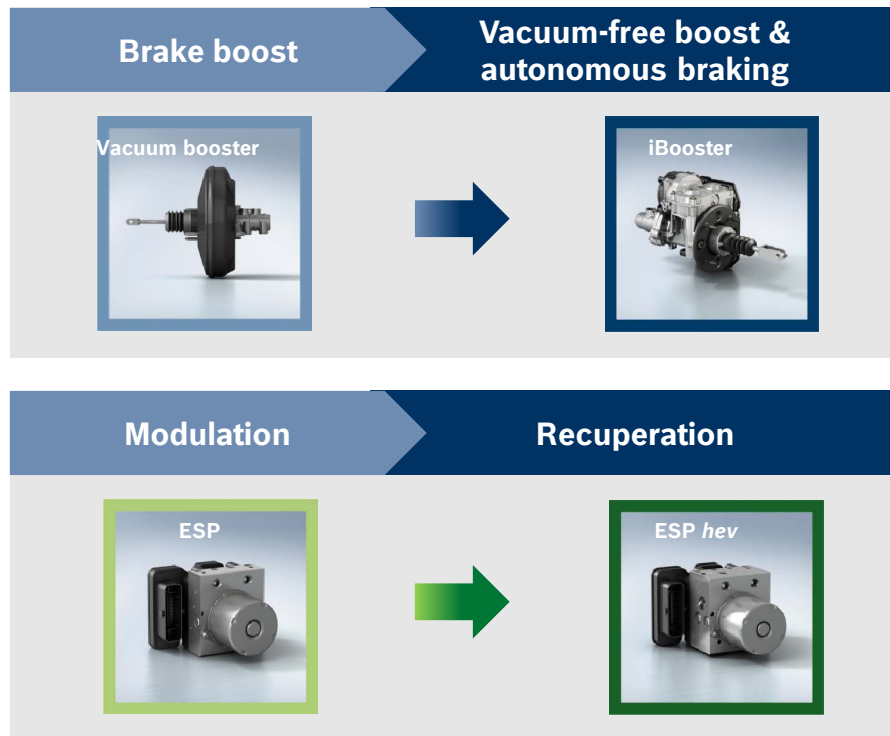
### 360° surround sensing by combination of different sensors

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



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## Safety – reliable actuation elements



### Redundant steering, braking, and stabilization systems required

- Modular actuation concept offers a perfect solution for automated driving

## Use-case: AEB-Pedestrian



### Functional requirements

- Automatic Emergency Brake:  $v \leq 60$  km/h
- Speed reduction:  $\Delta v = 40$  km/h to 60 km/h
- Crossing pedestrians
- Potentially obscured



### Sensor requirements

- Robust pedestrian recognition:
  - Classification of scenarios
  - Robust detection
- Fast reaction time (if obscured)



## Use-case: AEB-City, AEB-Inter Urban



### Functional requirements

- Automatic Emergency Brake:  $v \leq 80 \text{ km/h}$
- Speed reduction:  $\Delta v = 40 \text{ km/h}$  to  $60 \text{ km/h}$
- Moving and stationary objects



### Sensor requirements

- Single sensor
- Robust detection
- No training of scenarios

## Functions with Stereo-Video

### Stereo Video includes all mono video functions

- Functions are identical in Mono and Stereo cameras
- No additional validation and release effort necessary
- Light, Road Signs, Mono Object Classification, Lane



### New object detection functions

- Auto Emergency Brake
- Active Pedestrian Protection
- Adaptive Cruise Control (ACC on Stereo)

### New lane functions

- Traffic Jam Assist
- Construction Zone Assist
- Narrow Passage Assist
- Evasion Assist



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# Human - Machine Interface (HMI)



Foto: Audi

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## Driver Monitoring



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# Automated and connected – social benefits

### Reduced congestion

Fewer traffic jams and less waiting time at intersections and lights  
→ **80% improvement in traffic throughput<sup>1</sup>**

### Higher fuel efficiency

Synchronized traffic flow  
→ **23 to 39% improvement in highway fuel economy<sup>2</sup>**

### Gain in productivity

Time in transit becomes more productive  
→ **56 minutes per day freed up for other uses (US)<sup>3</sup>**

### Democratization of mobility

Over-65 segment growing 50% faster than overall population  
→ **Allow a variety of age ranges to be mobile**

### Improved safety

Reduction in motor vehicle accident rates  
→ **90% of all car accidents involving injury are caused by human error**







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**Automotive News**  
Automotive News Europe  
**CONGRESS**  
June 3-4  
Register

**CNN**  
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Technology » General Motors  
**GM's step-by-step approach toward self-driving cars**  
Strategy counters Google's bold plan

Technology » Ford  
**Ford teams with universities on driverless car research**

**Autocar**  
FIRST FOR CAR NEWS AND REVIEWS

**Renault developing autonomous driving technology**  
Renault says it will have a self-driving car on the road by 2020. We reveal the technology behind it and examine the French firm's other high-tech advances

**REUTERS**  
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**Forbes**  
BUSINESS | 1/07/2013 @ 3:00 PM  
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10 comments, 9 called-out

**Audi Follows Google's Lead, Gets Pass For Driverless Cars**  
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**The Wall Street Journal**  
October 10, 2013, 4:15 p.m. ET  
Thursday, October 10, 2013 As of 4:15 PM EDT  
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**Toyota to Market Automated Driving Technology Around 2015**

**The Telegraph**  
Home News World Sport Finance Comment  
Technology News | Technology Companies | Technology

**REUTERS**  
Daimler aims to launch self-driving car by 2020  
BY IRENE PR...  
MUNICH  
8, 2013 11:02am EDT  
can drift round corners at

**Nissan**  
Nissan road-tests self-driving vehicle

...a Cadillac with Super Cruise. Engineers are refining the technology for day trips, mostly around a circular four-mile track at the company's proving grounds.

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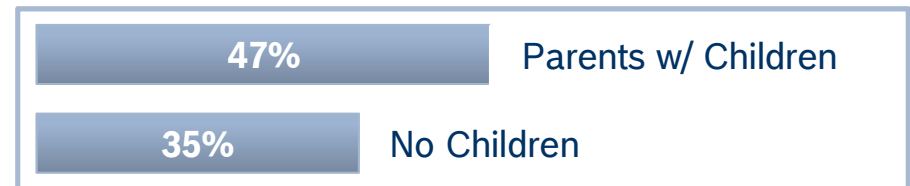
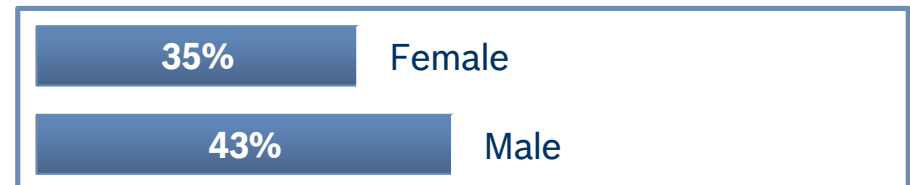
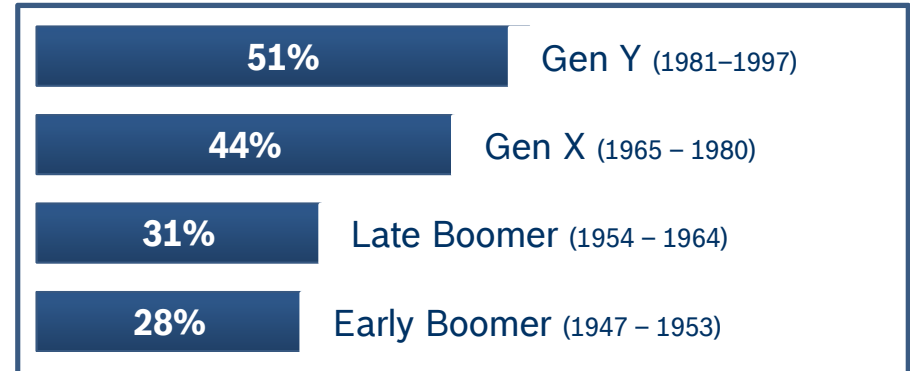
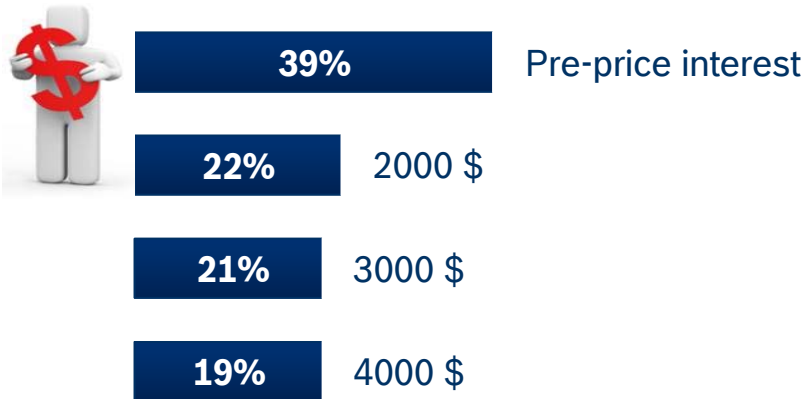
TECH OPINION BREAKING VIEWS

LESLIE, the 21-year-old Nissan Motor Co. employee at the wheel hands off the wheel during the company's test of a self-driving vehicle on the SuperCircuit proving grounds in Nagasaki on Monday. (The Associated Press)

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## Consumer interest level in AD functions



- Acceptance and willingness to pay for Automated Driving functions
- Highest interest showed by Gen Y
- End user wants to have the latest technology combined with the safety benefit

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## Initial Step: Automated Park Assist



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## Partially automated

System takes control of longitudinal and lateral guidance in specific use case  
Permanent driver supervision required

## Highly automated

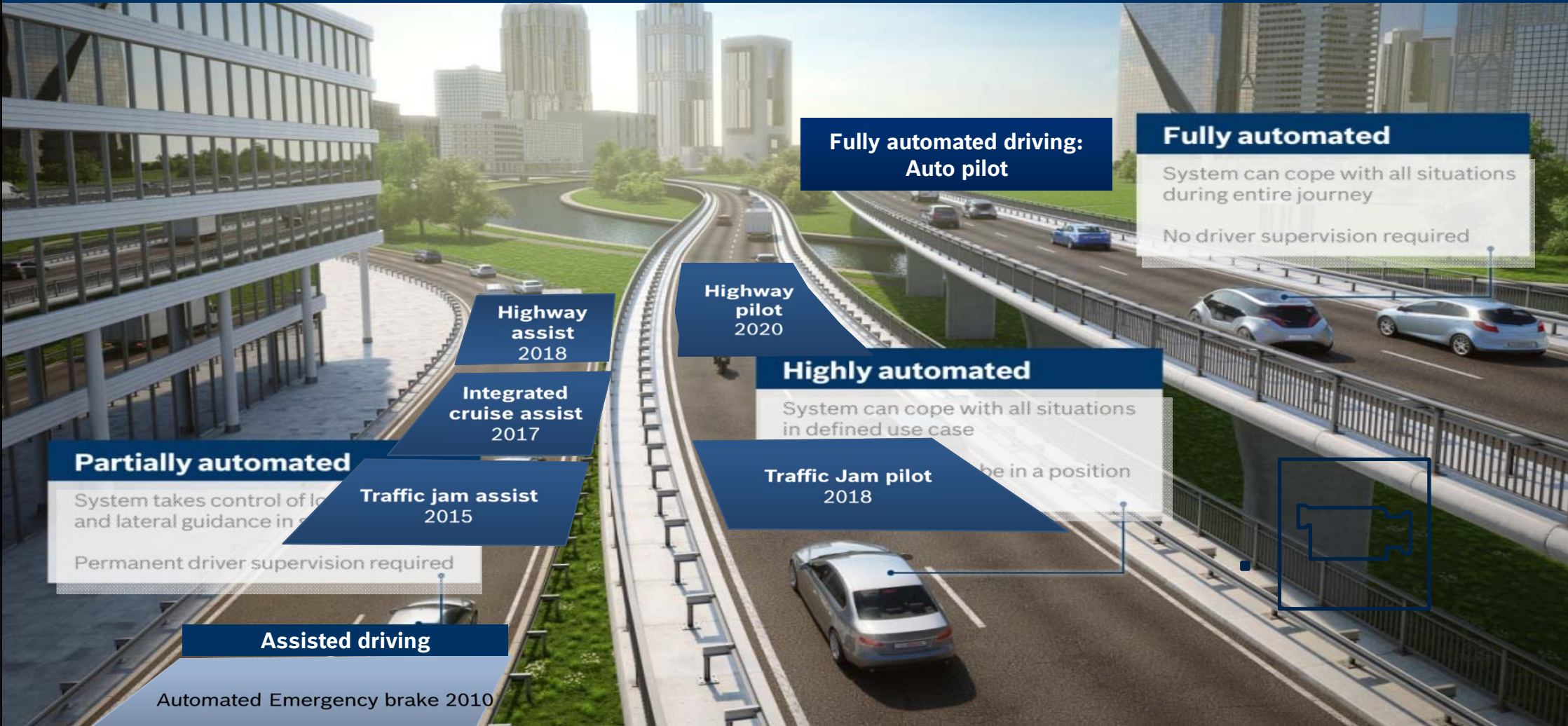
System can cope with all situations in defined use case  
Driver must always be in a position to resume control

## Fully automated

System can cope with all situations during entire journey  
No driver supervision required



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## Difference between partial + high automation

	Partial Automation	High Automation 
Decision Making	System	System
Responsibility	Driver	System
Insufficient Actuation	Driver take over	Not permissible
Situations addressed	Selected use cases	All situations
System failure	Fail safe / fail silent	Fail operation

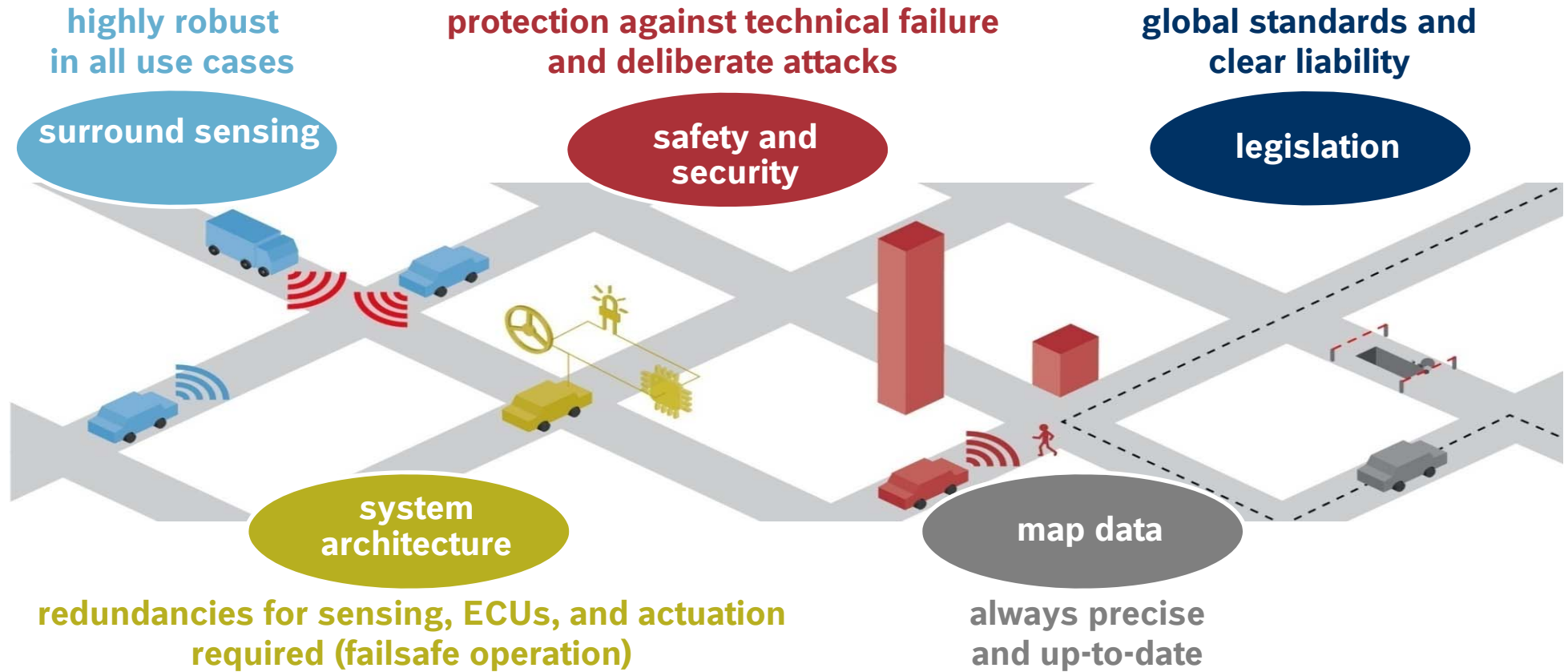
### High automation requires...

Redundancy for sensors, ECUs, communication and actuation

New methods for data fusion and decision making



# Prerequisites for automated driving – overview



## Safety and security - distinction

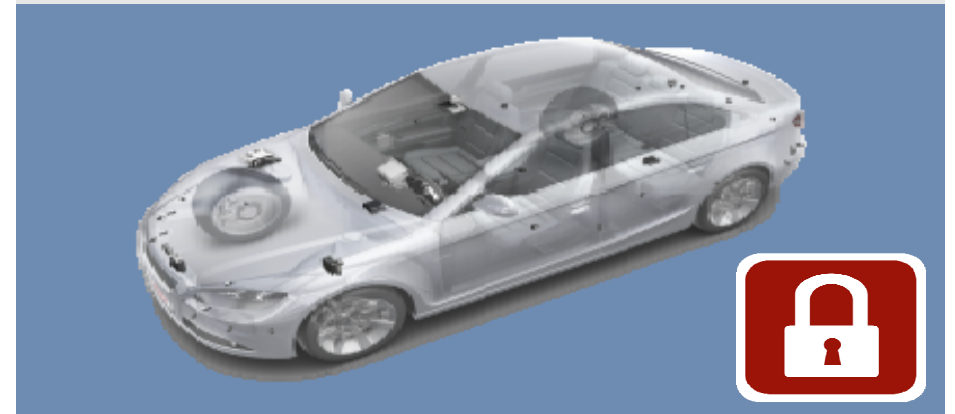
### Safety

- 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



## Legislation frameworks – need for adaptation

### Current legal framework

- National laws
- UNECE-Regulations (e.g. R 79)
- Vienna convention on road traffic (1968):

Article 8 (5):

„Every driver shall at all times be able to control his vehicle or to guide his animals“



### Adaptation of legislation framework started

Amendment to Vienna convention has been adopted by UNECE-WP.1 (not yet in force), further steps must follow (UNECE, NHTSA)

### Ongoing activities

- Legislation and regulation of automated driving decided in individual U.S. states
- Initiative in Europe by VDA
- Japan (MLIT) is exploring different possibilities (e. g. special lanes)



## Automated driving – performance public roads

### Performance

- **Highly automated** driving on public highways
- **Automated lane changes**, no driver confirmation required

### Public Road Testing

- First automated drive in **California** on I280 on **Mar, 2013**
- First automated drive in **Germany** on A81 on **Apr, 2013**



### 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

