2020 MathWorks
中国汽车年会

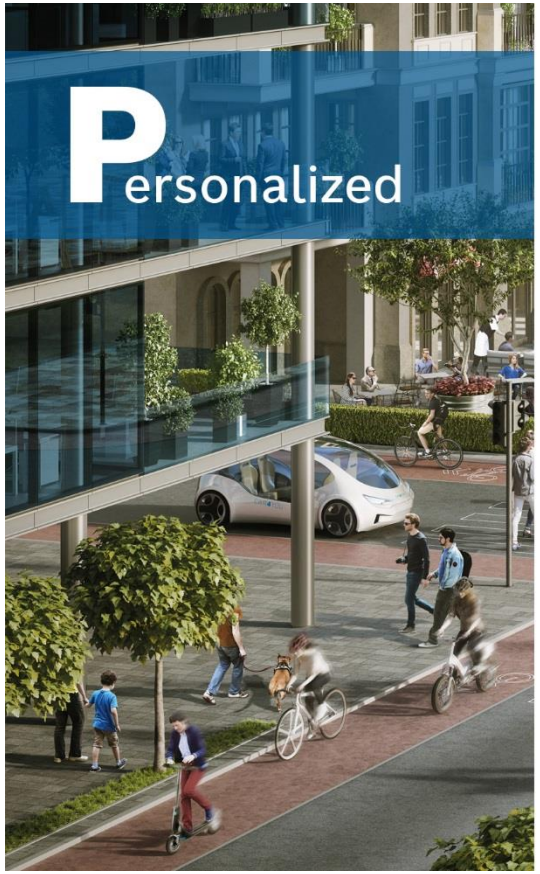
自动驾驶系统的演进

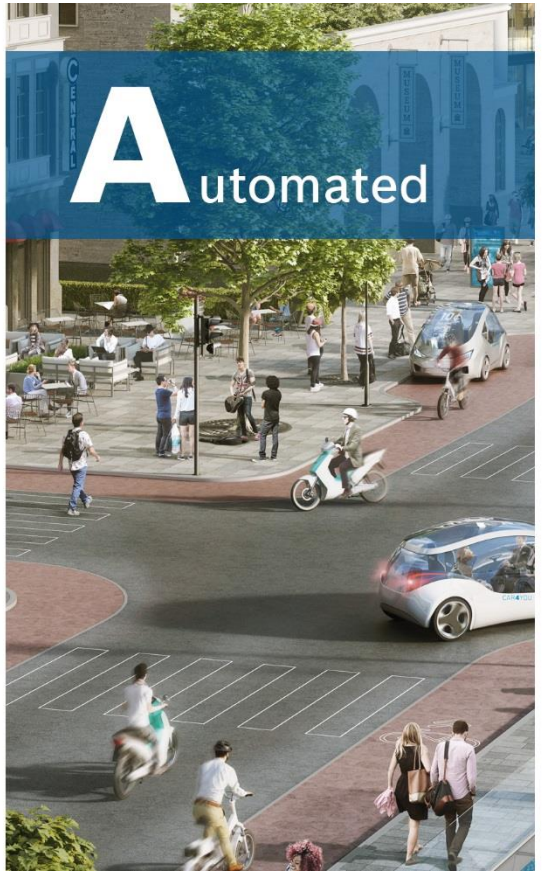
卢红兵
博世底盘系统控制中国区
自动化驾驶高级项目经理

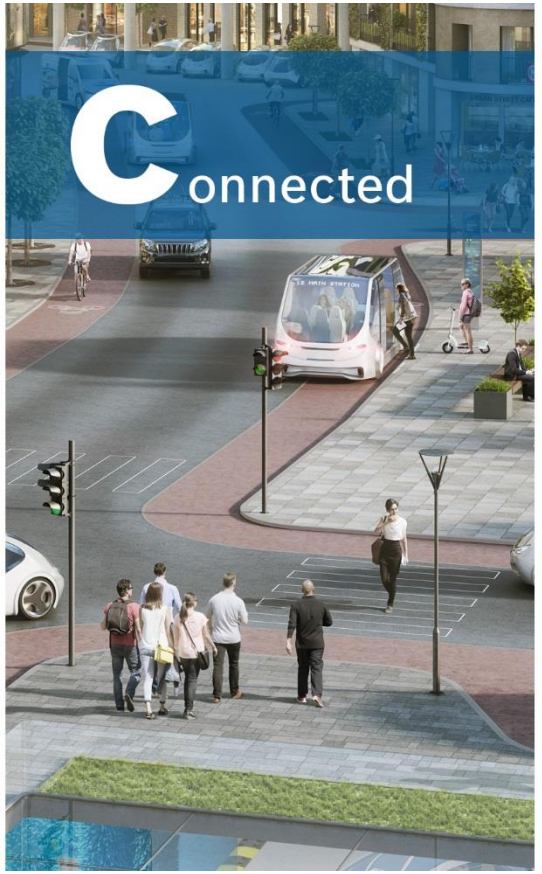
MathWorks®

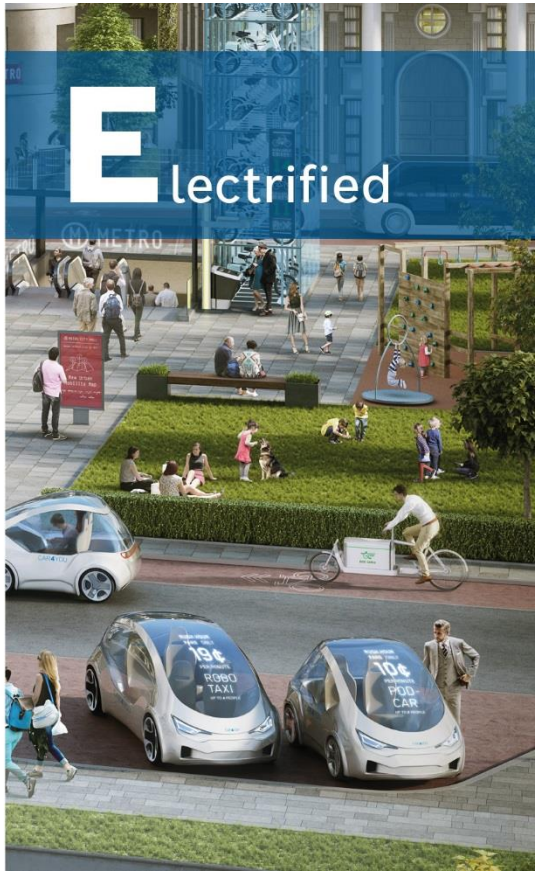
Toward Future Automated Driving System

Trends of Future Mobility









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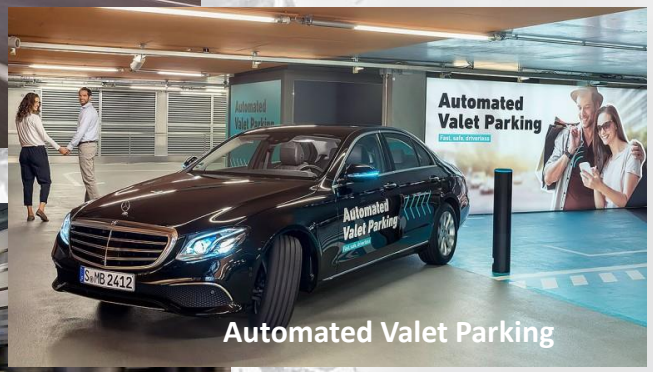
Toward Future Automated Driving System

Dispute About Safety – How Far from Demo to Mass Production

Bosch automated driving study since 1993,
working intensively since 2011.



From DEMO to Mass Production: 80/20 effort distribution

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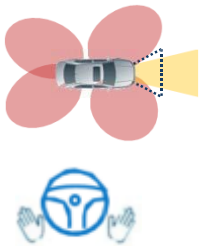
Steps Autonomous Drive – Vehicle Centric

Level 3
Conditional Automation



Traffic Jam Pilot (TJP)
0~60kph,
ego lane
hands-off,
eye-off, no sleep

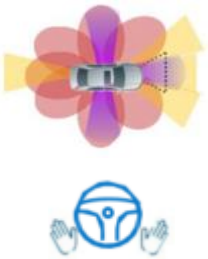
Add-ons

Sense: Stereo camera, USS, NRC, MC

Think: DASy (DASy enhanced)

Act: ESP + iBooster (Redundant)
EPS

Level 3/4
Conditional/High Automation



Highway Pilot (HWP)
0~130kph, lane change
hands-off, eye-off, sleep

Add-ons

Sense: high definition & performance radar/ camera, Lidar

Think: redundancy DASy

Local.: HD Map, VMPS, Road signature

Arch.: redundancy E/ E

Level 4/5
High/Full Automation

Urban Automated Driving Taxi (UAT)
0~55kph,
complex urban driving Driverless

Add-ons

Sense: high definition & performance Radar, Video (e.g. traffic light camera, surround vision camera), far range Lidar

Think: AI computer, etc..

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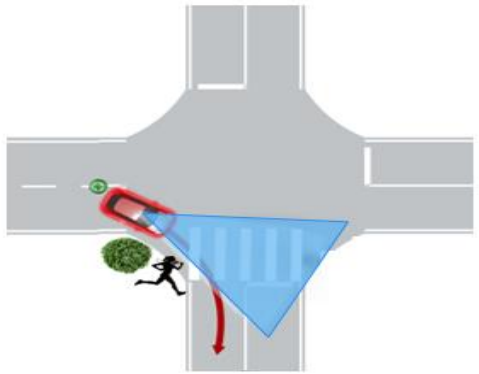
Toward Future Automated Driving System

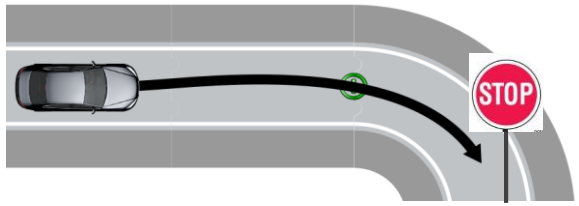
Challenges

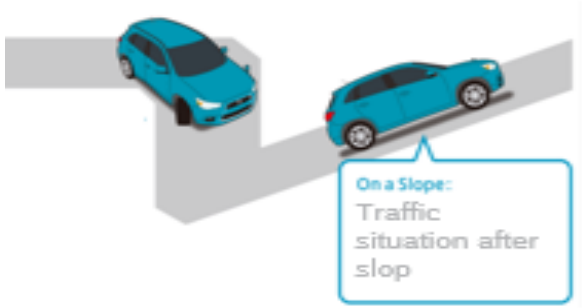
Source: 新浪网，北方网

Traffic sign



Blind spots





Non-line of sight

Toward Future Automated Driving System

Challenges

Which level of elevated road

Tunnel

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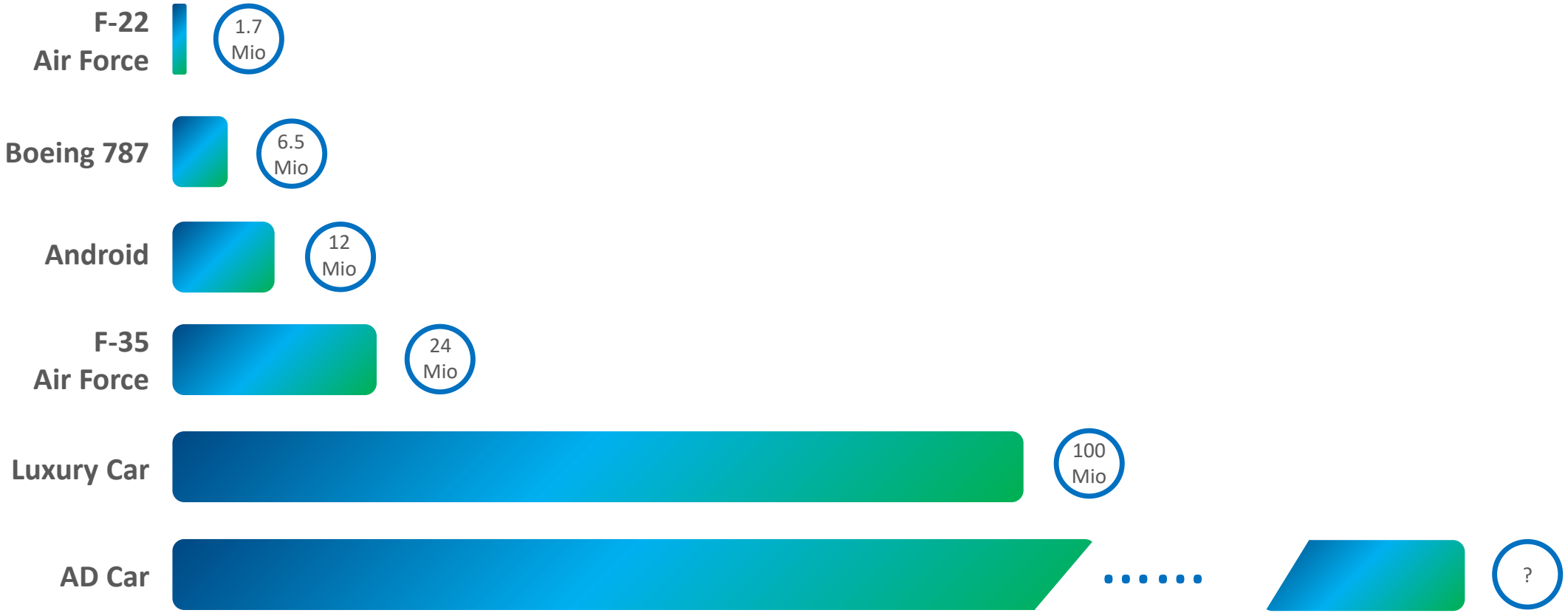
Challenges



Source: INFORMATION IS BEAUTIFUL

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Robo-drive vs. Human Drive

Mature human driving

4.8 tera kilometers

accumulated driving mileage whole year

147 million kilometers

one death on average

2 million kilometers

one injury on average

Data source: driving accident statistics in US in 2015

=

How to prove automated driving is safer than human driving?

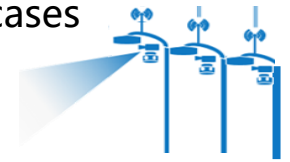
Toward Future Automated Driving System

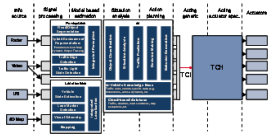
Challenges

Legislation
Global standards and clear liability

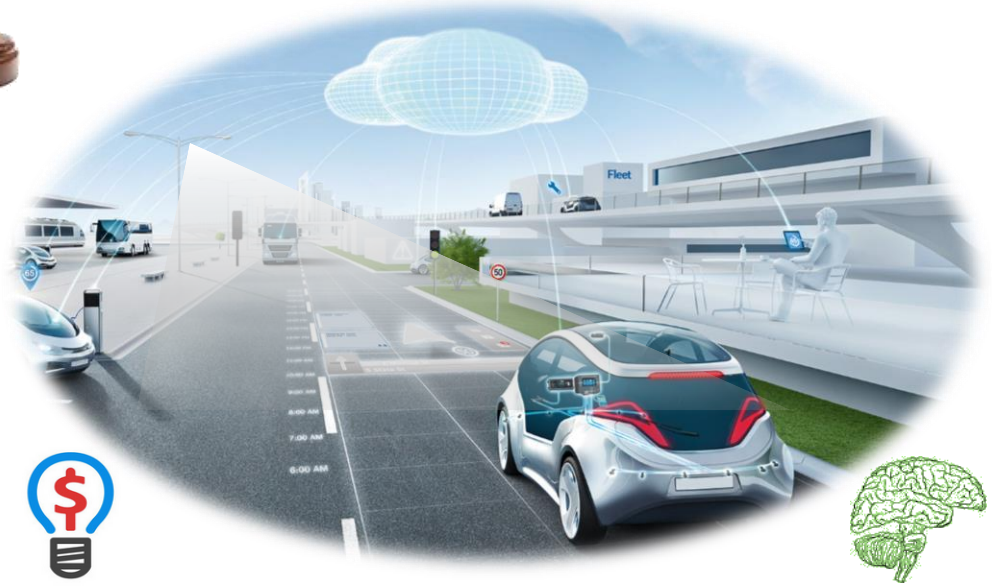
Safety and Security
Protect against technical failure and deliberate cyber attacks

Infrastructure sensing
High robustness in all use cases





Entire System Architecture
Vehicle, infrastructure, MEC, network, cloud.
Redundancies for sensing, ECU and actuation (Fail operational)



Network
Ensure low latency, high bandwidth and high reliability

Business Model
Potential business model for industrialization

System Intelligence
Vehicle-road intelligence fusion, Interpret the situation, plan, decide and execute

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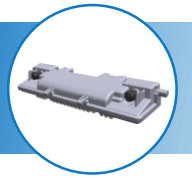
Driver Assistance Products Overview

Rear/ Surround View

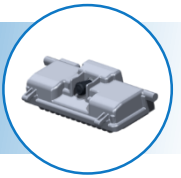
Near Range Camera System

Rear / Surround View Camera

Front Video



Stereo Video Camera

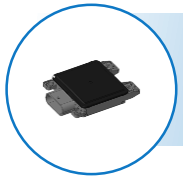


Multi Purpose Camera

Dasy

DASy

Radar

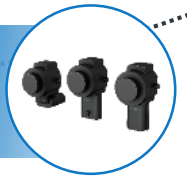


Corner Radar Base

Front & Rear/Corner & Near-range Radar Plus

Front Radar Premium

Ultrasonic



Ultrasonic Systems

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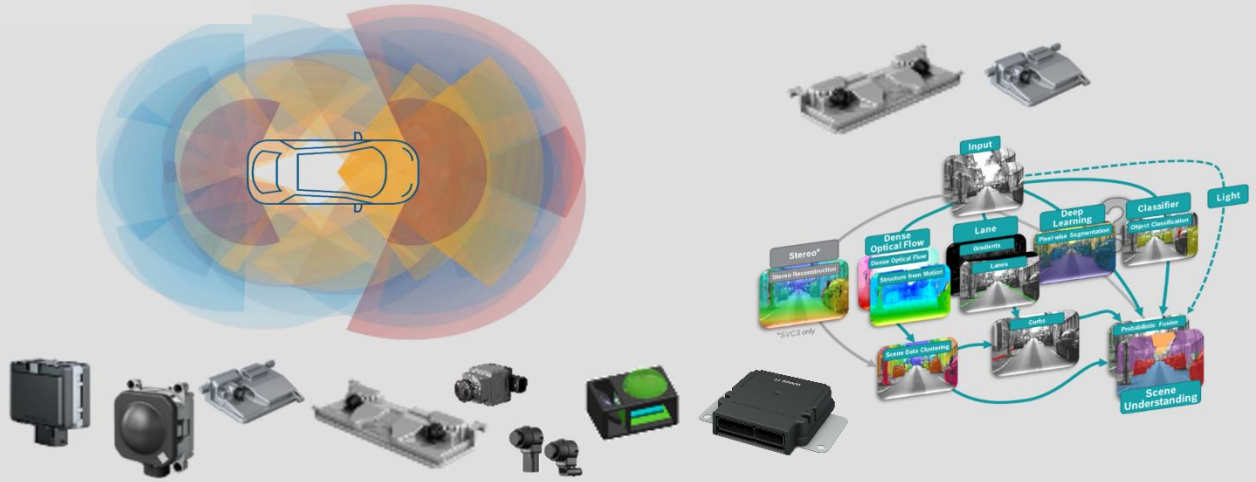
Redundant Solution from Bosch

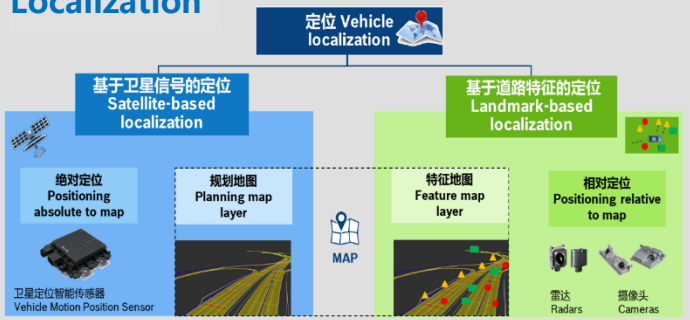
Redundant High-Performance Sensor, Computing Unit and Algorithm

See & Think



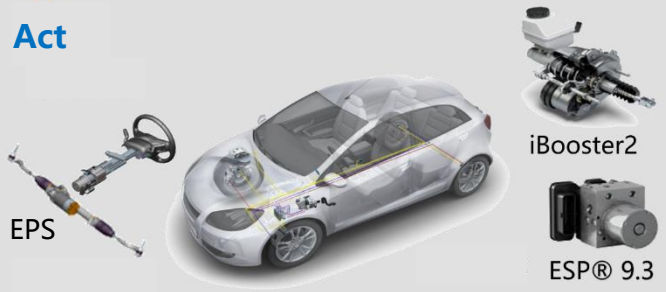
Redundant Localization Solution

Localization



Redundant Braking and Steering

Act

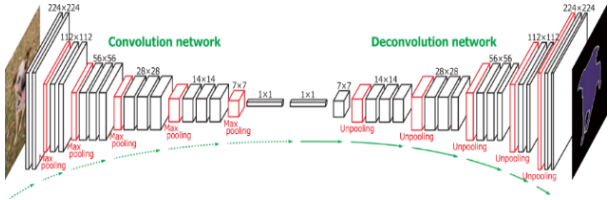


Toward Future Automated Driving System

Deep Learning for Semantic Segmentation

High Performance DNN

Dedicated compressed deep networks for semantic segmentation, implemented via energy-efficient embedded HW IP



Bosch Suzhou and Mathworks are exploring a co-study regarding lane segmentation with deep-learning approach

Intensity channel

Intensity channel After Preprocessing
(Ignoring values below 500)

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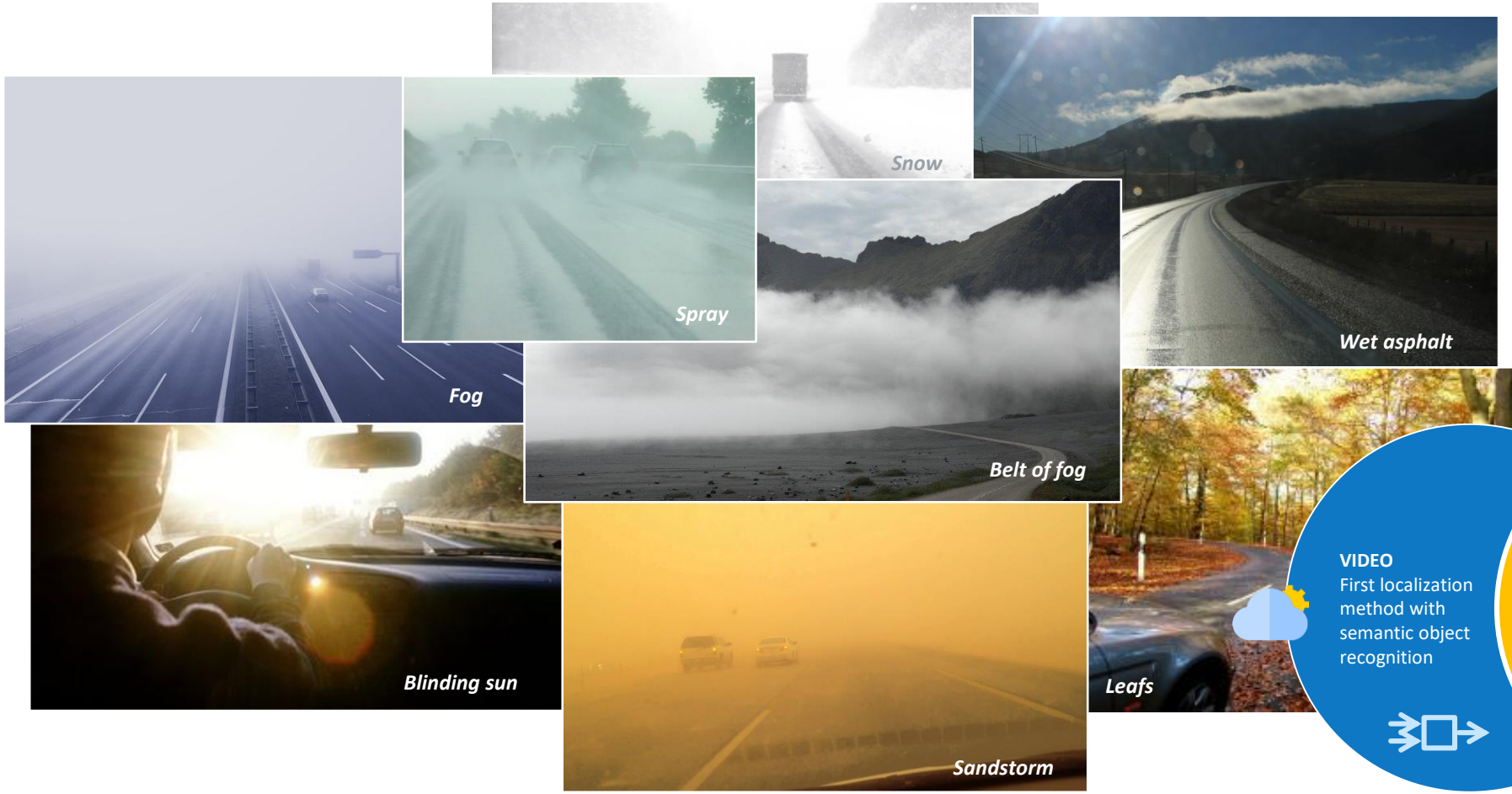
Redundant Localization



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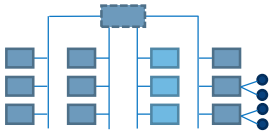
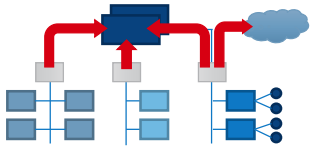
Middleware for Computation Platform



分布式架构
微控制器

μC

AUTOSAR
Classic Platform

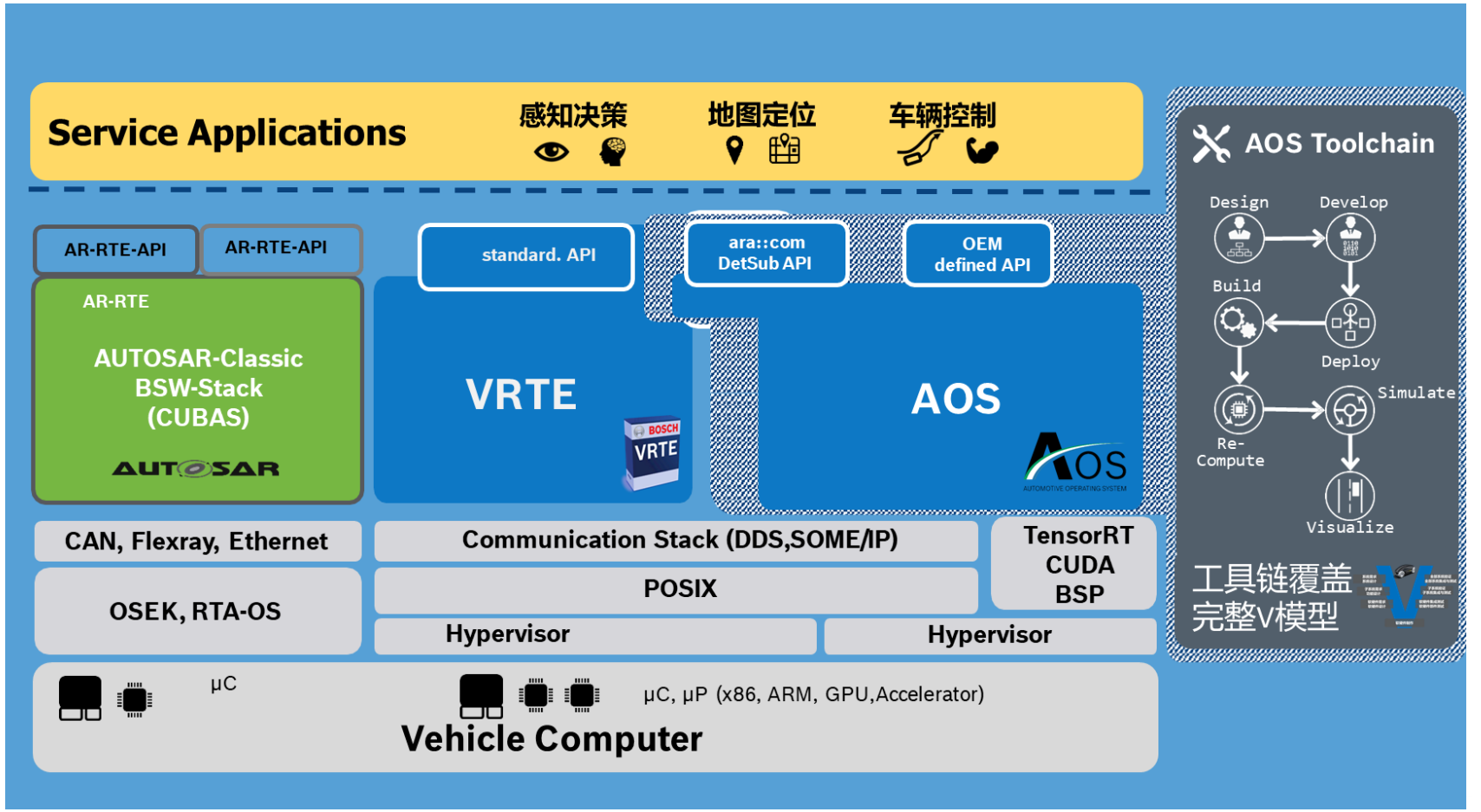


集中式架构
域控制器

AI

μP

AUTOSAR
Adaptive Platform



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V2X build up a vehicle-road collaborative network

Vehicle-to-infrastructure (V2I)

traffic signal synchronize

Vehicle-to-network (V2N)

Real-time traffic, Cloud service

Vehicle-to-vehicle (V2V)

Collision avoid guidance

Vehicle-to-pedestrian (V2P)

Safety alert to vulnerable groups

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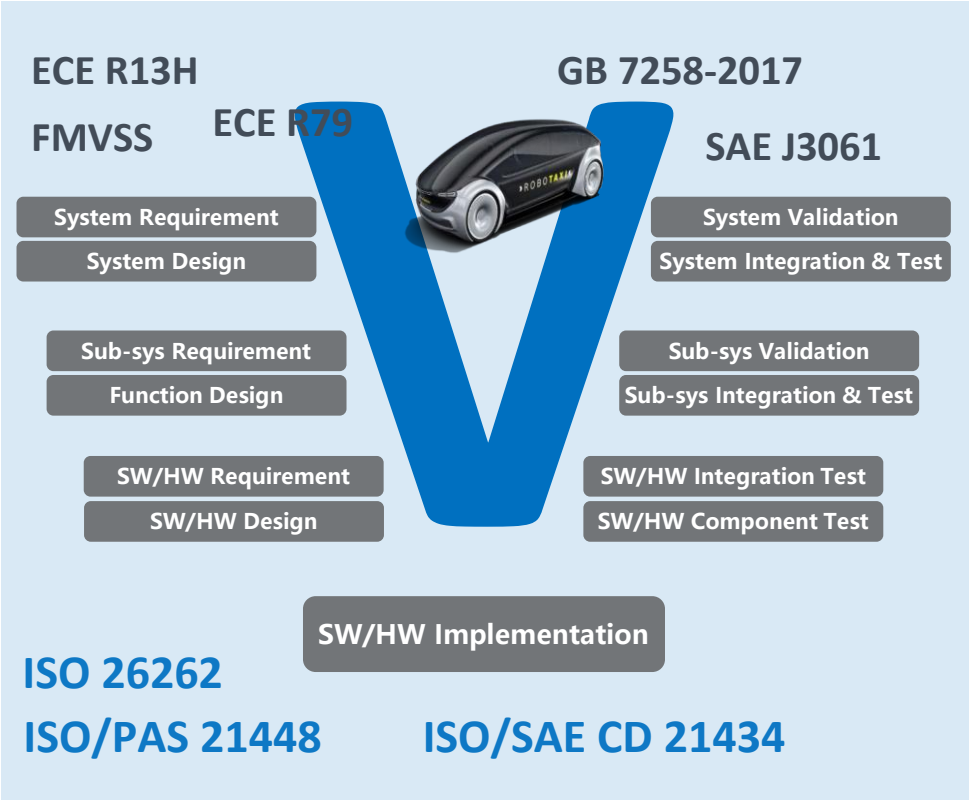
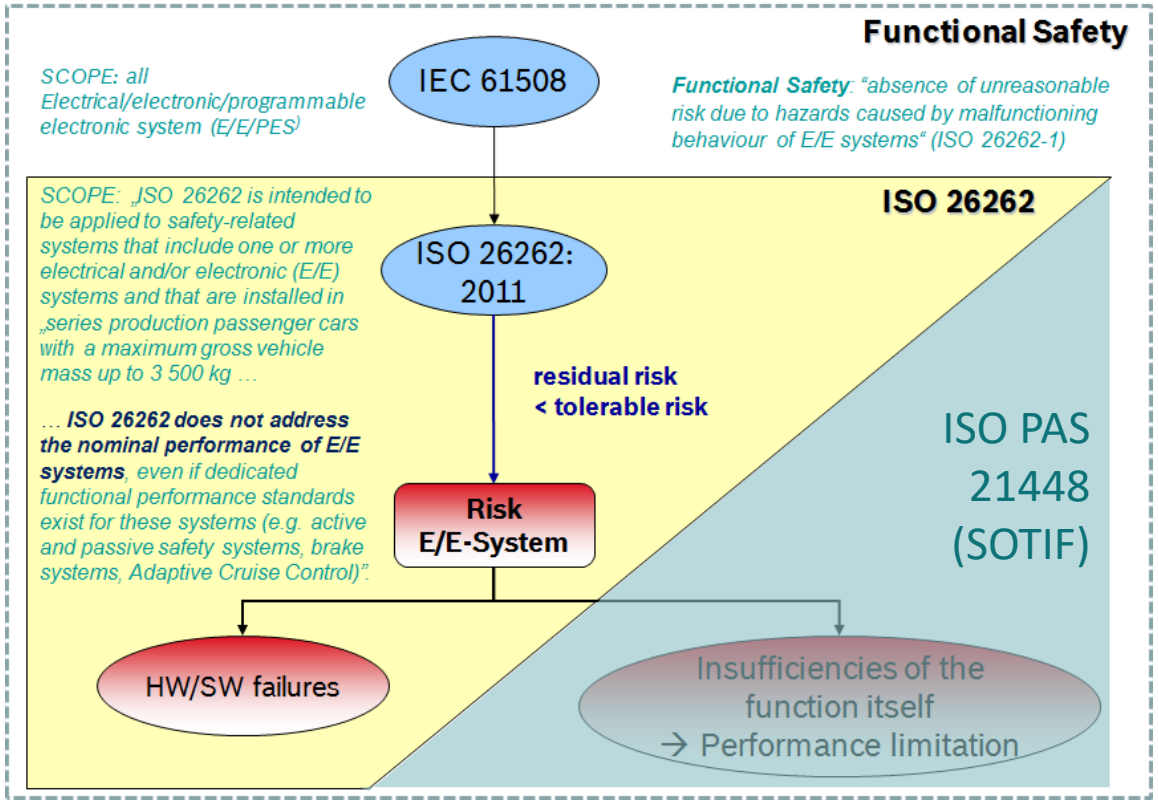
Safety Standards – Way to be safe





Safety Standards work with system know-how !

FMVSS = Federal Motor Vehicle Safety Standards
SOTIF = Safety of the Intended Functionality

Toward Future Automated Driving System

Overview of Validation Strategy

Overall target: Automated driving with safety and high efficiency*

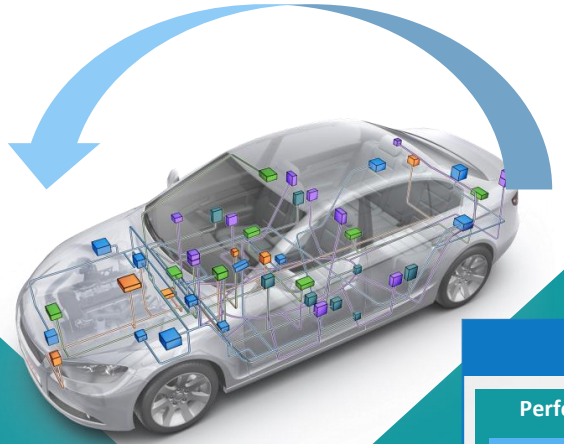
Use cases：Specification is consistent and complete; Behavior is safe

Design for validation：building a well-understood and safe product

- SOTIF H&R
- SOTIF Analysis
- Triggering event
- SOTIF Measures

Set of needed evidence

- KPIs
- Assumptions
- System boundaries
- Corner cases



Release pilot system

Connectivity based validation

- Release pilot as L2 function
- Huge data recording online

Release assistance system

System level validation

Performance	HMI/UX	Degradation	Activation
Endurance run	User studies	Simulation	Reference route
Test track	Endurance run	Test track	KPI simulation

Sub-system level validation

Environment model		Decision making		Motion control	
Data replay	Ground Truth	Systematic use case	Simulation in loop	SiL	ViL

*Target depends on function, public opinion and state of the art

*Take Bosch L2/L3 system as an example

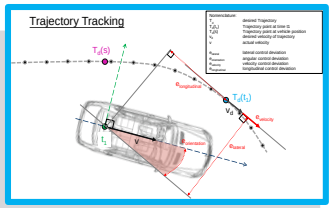
* Trial-run of cloud-based toolbox by MathWorks

Toward Future Automated Driving System

Connectivity based validation

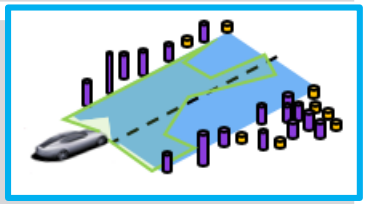
System KPI

Controlling



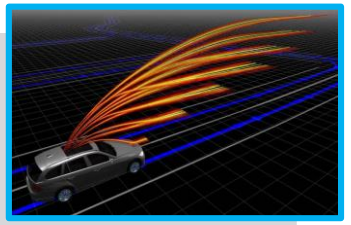
- Deviation
- Possibility decrease of input
- Over saturated
- Oscillation

Sensing



- Overlap
- Stability and target loss
- Detection rate

Planning



- Trajectory set
- Prediction quality

Sensor

- Cross check
- Sensing reliability

Others

- Minimum distance reached
- Overtake
- Activation of other functions

- Prioritize of events
- Categorize events
- Event update in end user vehicle via OTA

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Safety for automated driving still a long way to go, we are on the way together

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