HAD – open reference architecture for highly automated driving as base for efficient testing

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electronica 2016
inside tomorrow

1. Motivation

An ACC Developer‘s World in 2002

Radar

target vehicle candidates,
their velocity / acceleration

Steering Wheel Angle

target vehicle selection

Motor Speed Control

ego vehicle speed control

Head Unit

system activation,
status communication

Items to specify: 4

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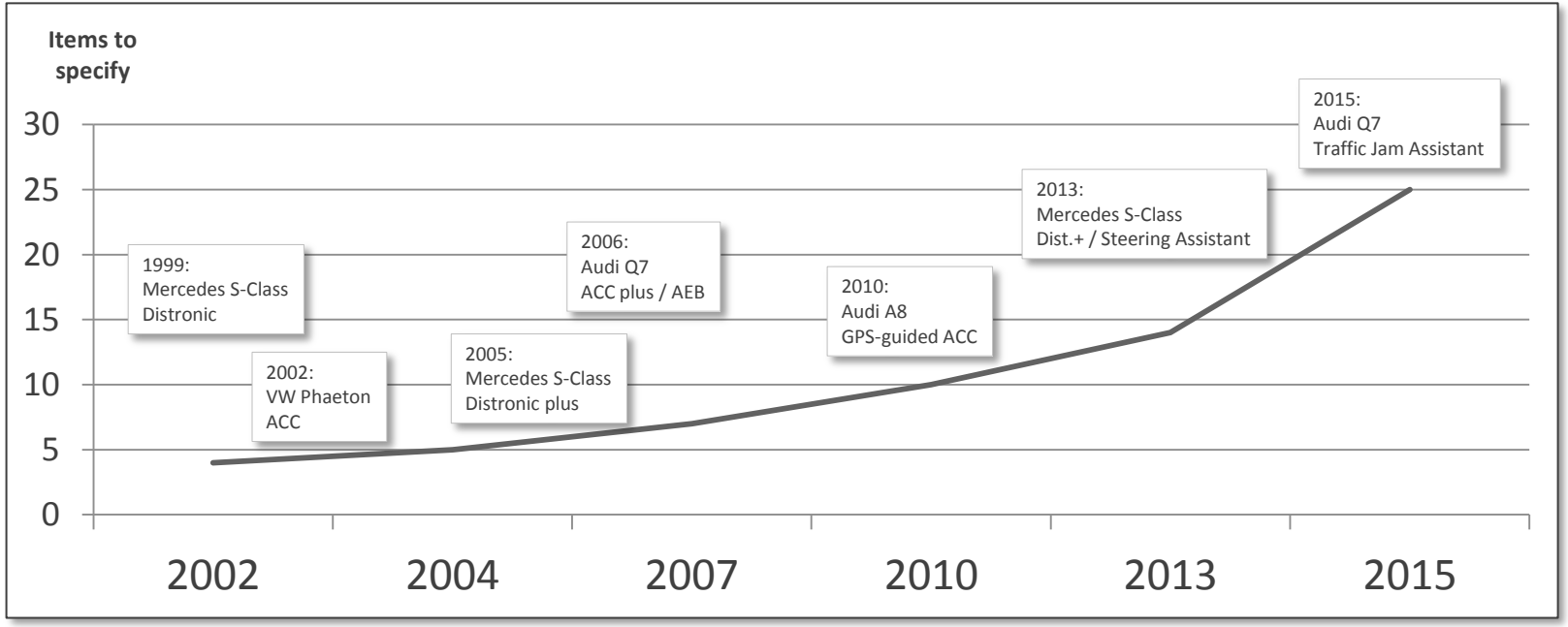
Driving Function Growth



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A Driverless Car Developer‘s World in 2016

Radar

Camera

LIDAR

Sonar

Steering Wheel Sensors

Wheel Speeds

IMU / Gyro

Global Position

Maps

Moving objects

Static obstacles

Lanes

Signs

Vehicle ego motion

Trajectory planning & control

FAIL-SAFE

Fail-safe / -degraded mechanisms

Motor Speed Control

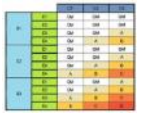
Regenerative Braking

Brake Pressure

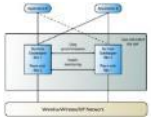
Steering Angle Control

Head Unit

Side Tasks



Functional safety



Redundancies

Items to specify: 24

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And all needs to be tested!


TESTED
Radar


TESTED
Camera


TESTED
LIDAR


TESTED
Sonar


TESTED
Steering Wheel Sensors


TESTED
Wheel Speeds


TESTED
IMU / Gyro

TESTED
Global Position


TESTED
Maps


TESTED
Moving objects


TESTED
Static obstacles


TESTED
Lanes

TESTED
Signs


TESTED
Vehicle ego motion


TESTED
Trajectory planning & control

TESTED
FAIL-SAFE
Fail-safe / -degraded mechanisms


TESTED
Motor Speed Control

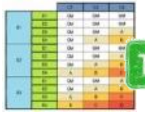

TESTED
Regenerative Braking

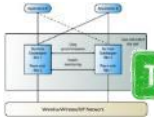

TESTED
Brake Pressure


TESTED
Steering Angle Control


TESTED
Head Unit


TESTED
Side Tasks


TESTED
Functional safety


TESTED
Redundancies

Items to specify: 24

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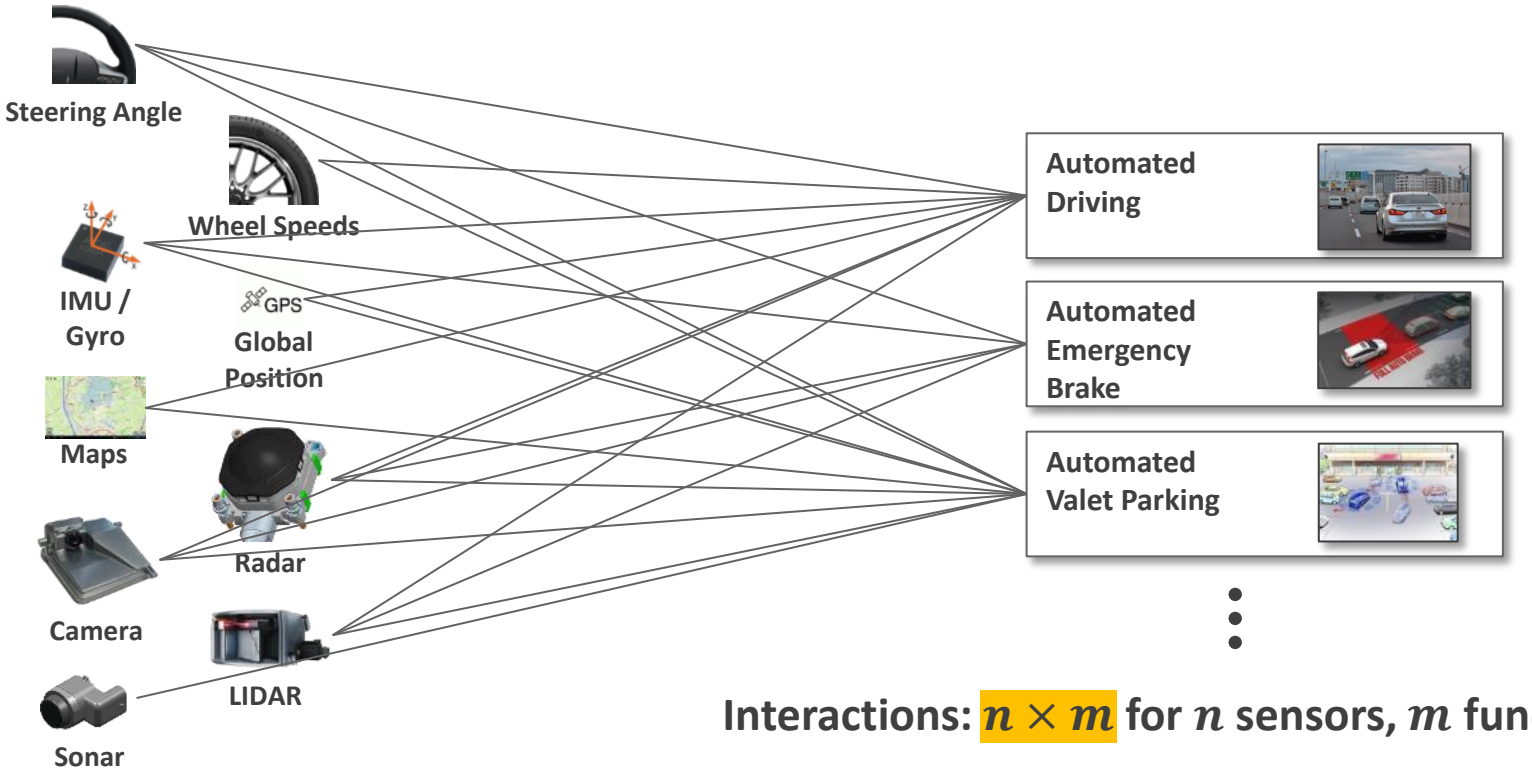
What Does Help Reducing Complexity?



Interactions: $n \times m$ for n sensors, m functions

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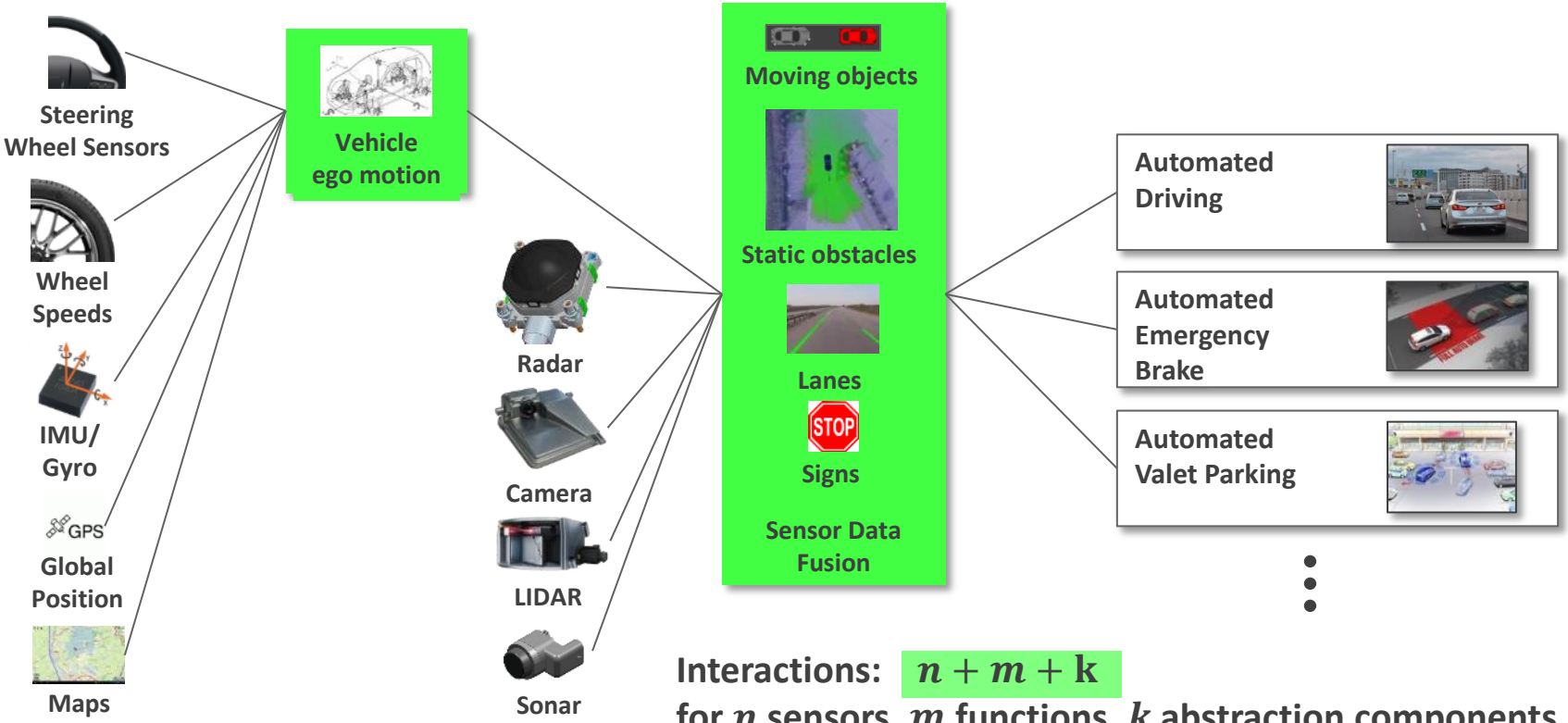
So What Does Help?



Interactions: $n + m + k$

for n sensors, m functions, k abstraction components

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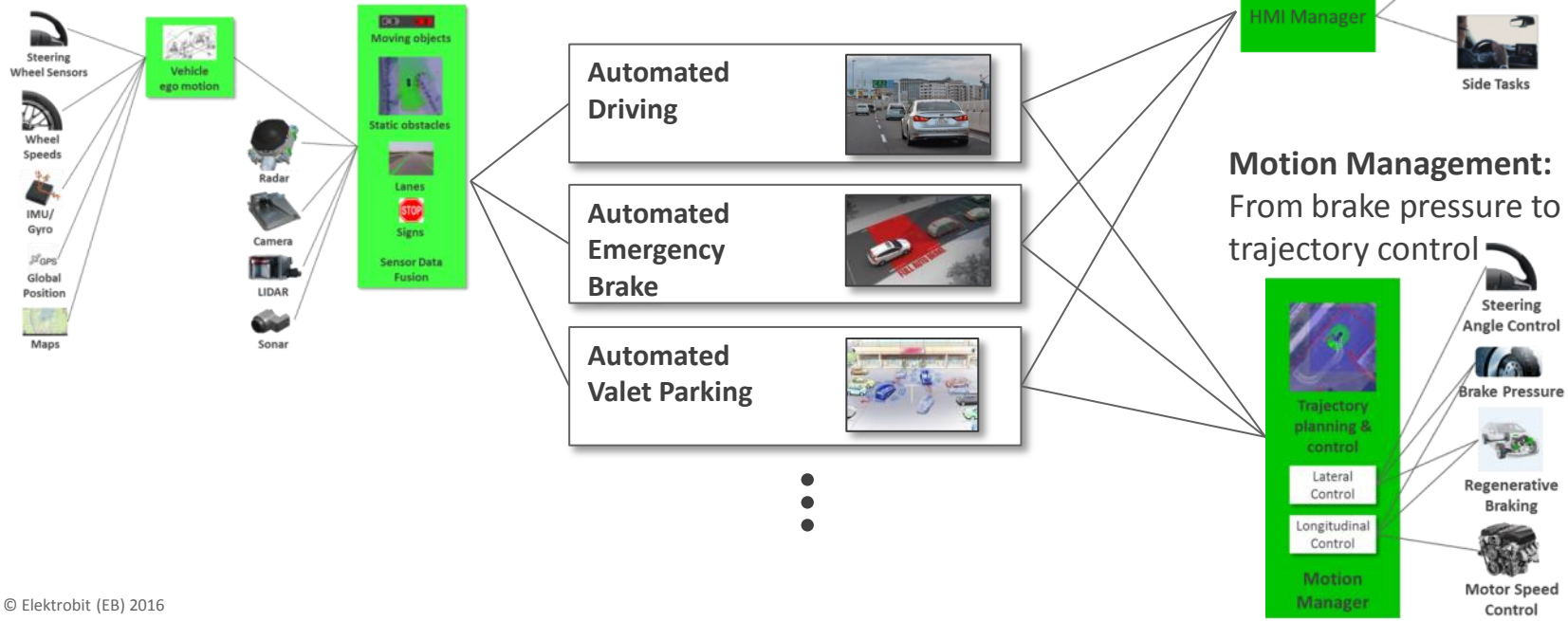
From Exponentiality to Linearity

Sensor Data Fusion:
From echos to objects and free space

HMI Management:
From buttons and LEDs
to user interactions



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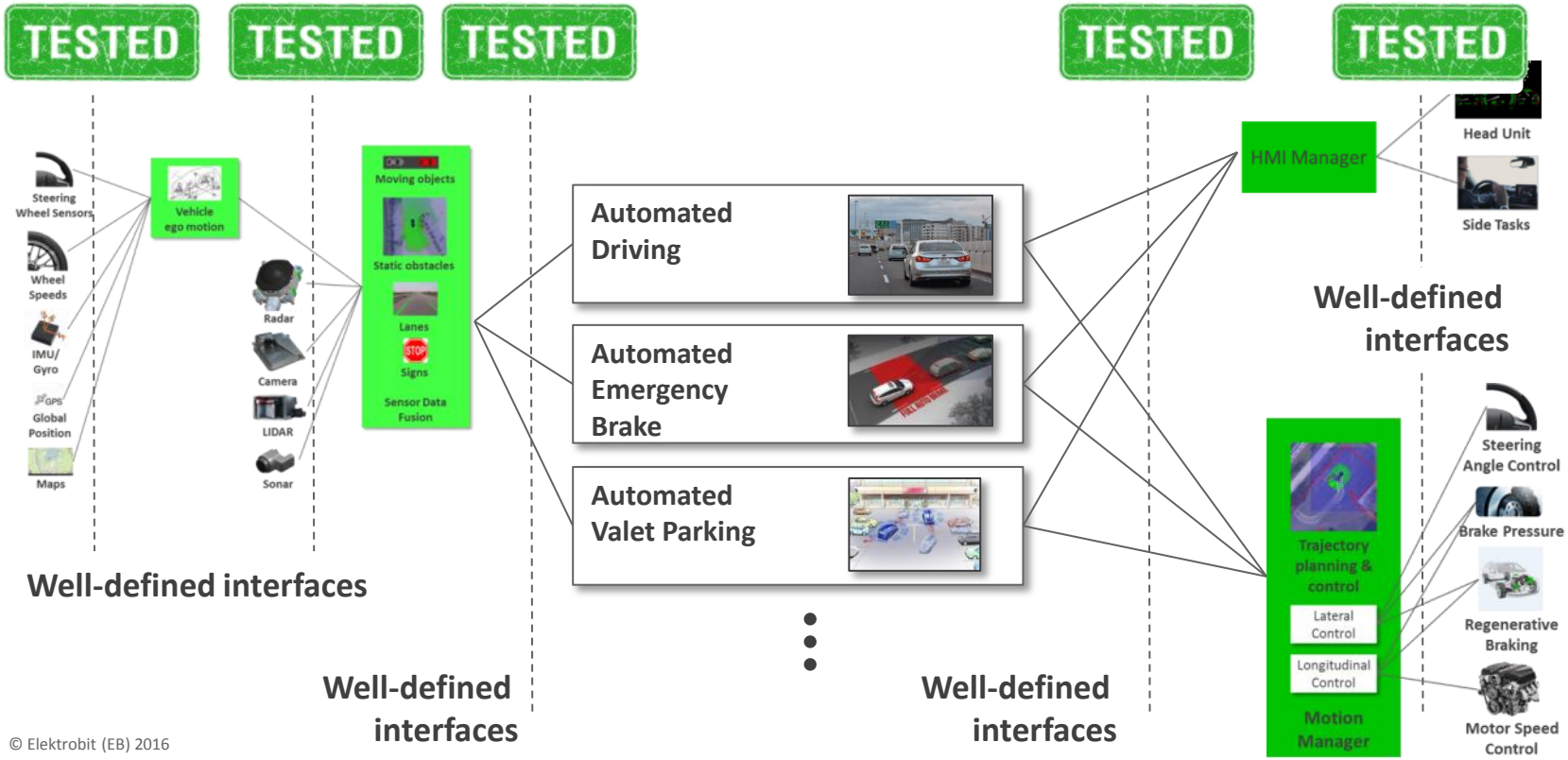
From Exponentiality to Linearity



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Best Practice Leverage: Project, Product Family, Industry

Project-Level Architecture Best Practices:
Reduce complexity

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Product Family Architecture Best Practices:
Re-use specified, developed,
industrialized and tested components

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Industry-Wide Architecture Best Practices
Peer review of functionalities, safety and security mechanisms
Lower entry into HAD development
No vendor lock-in

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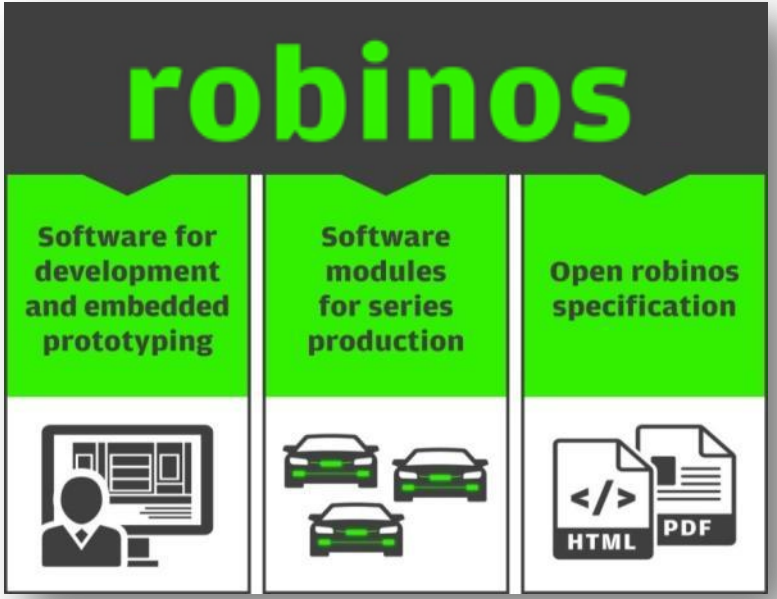
2. Implementation

Open Architecture for Automated Driving

Working Group Members are Welcome

EB robinos

- Software modules
  - **for prototyping** in EB Assist ADTF
  - **for rapid embedding** on AUTOSAR
  - **for production** on vehicle ECU
- Developed, tested, verified according to **functional safety standards**



Open robinos

- Specifies a **reference platform** for automated driving up to Level 5 (SAE)
- **Freely available** and licensed as Creative Commons

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PC Based Quick Start

EB robinos

EB Assist ADTF

Rapid prototyping

C, C++, Model based

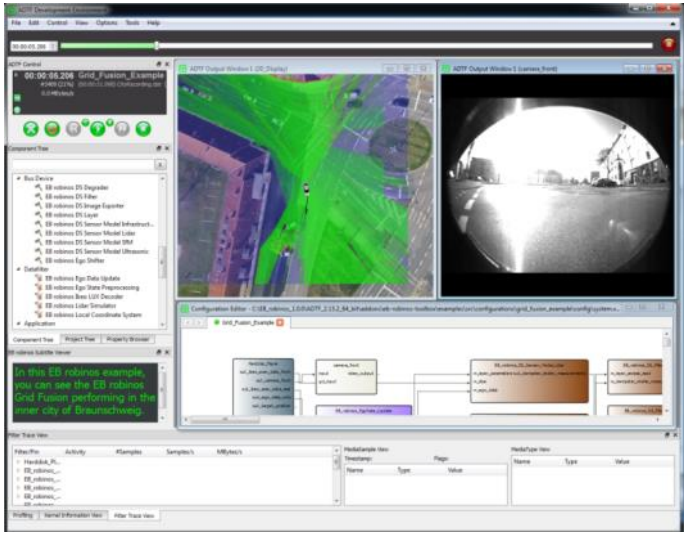
Desktop PC / Car PC

PC based development environment for

- rapid prototyping
- simulation
- test drive recording
- analysis and visualization

Implement complete automated driving functions
in test cars

- Valet parking
- Highway driving
- Others



www.try-eb-robinos.com

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Transfer onto Embedded Hardware / AUTOSAR

EB robinos

EB Assist ADTF | **EB tresos solution for AD**

Rapid prototyping

C, C++, Model based

Desktop PC / Car PC

Embedded prototyping

C, C++

Evaluation Hardware

Step by step transfer

- same source
- optimize module by module
- re-use of
  - visualization
  - simulation
  - recorded test data

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Integration into Domain Control ECU

EB robinos

EB Assist ADTF | **EB tresos solution for AD**

Rapid prototyping

C, C++, Model based

Desktop PC / Car PC

Embedded prototyping

C, C++

Evaluation Hardware

Automotive grade software

Domain Control ECU

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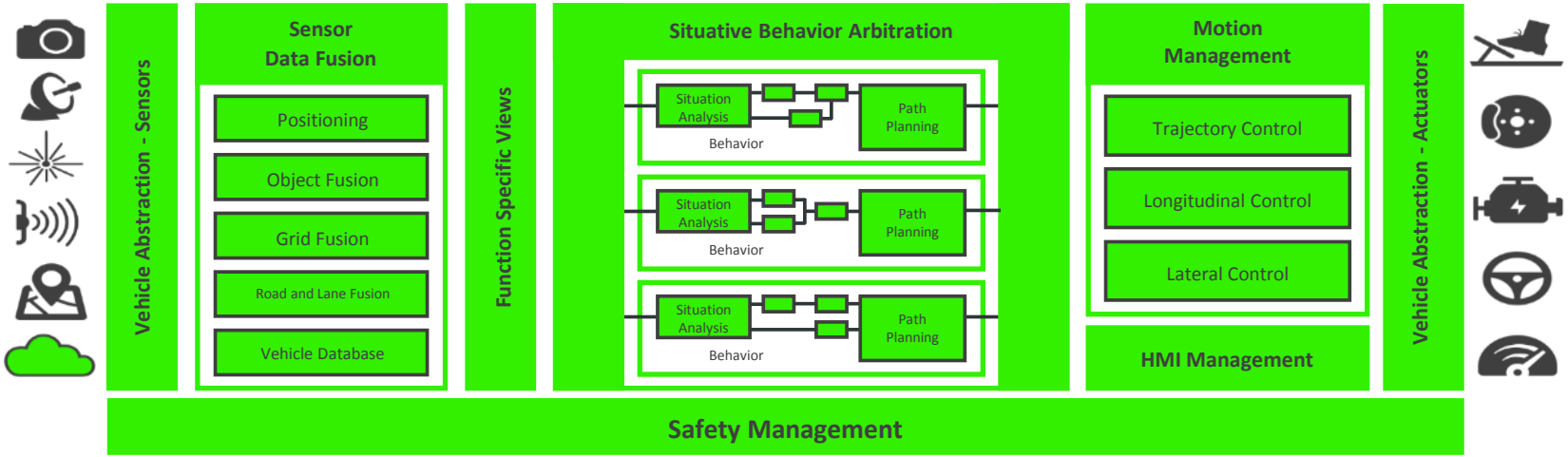
EB robinos – Modular Framework for Automated Driving



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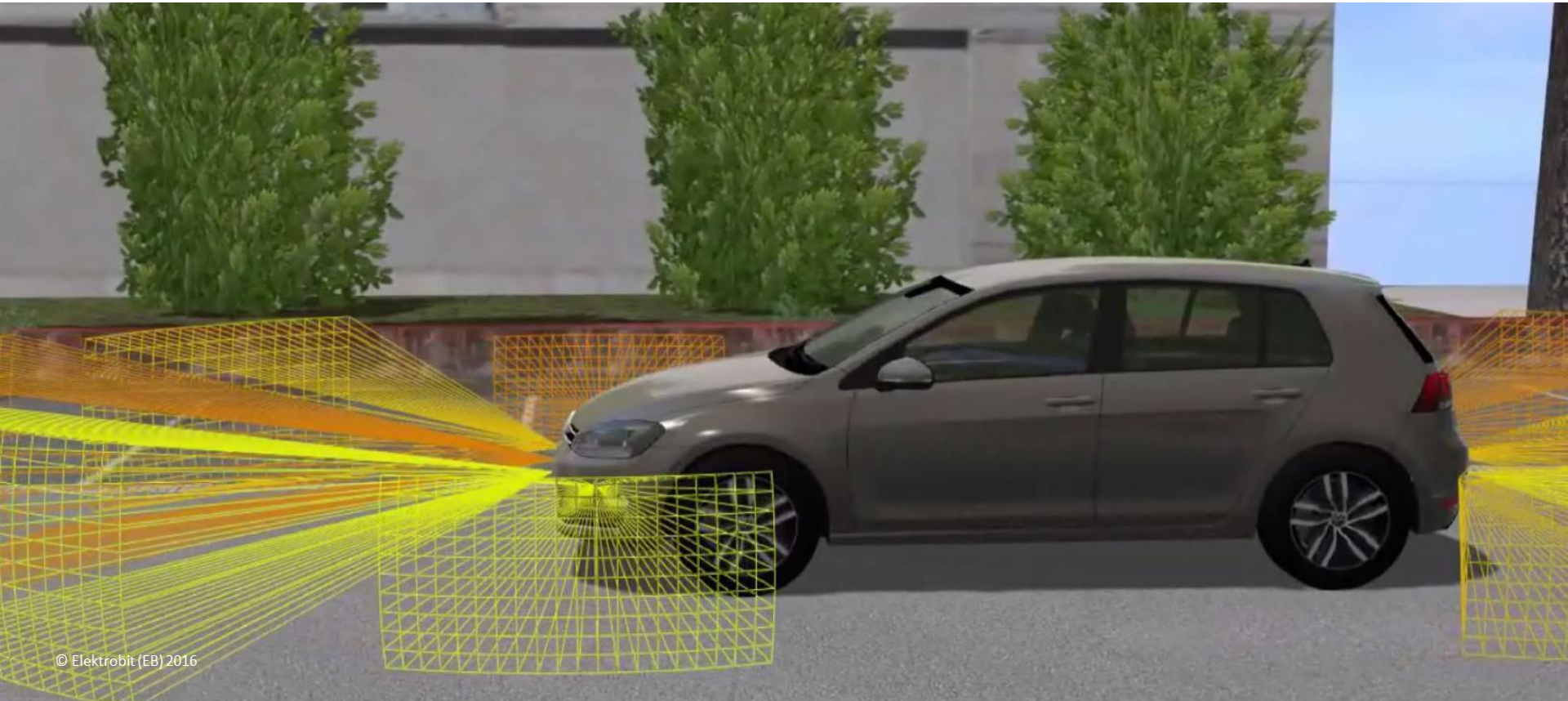
Example Application: Automated Valet Parking



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Example Application: Automated Valet Parking

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Example Application: Automated Valet Parking

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Example Application: Automated Valet Parking

Industry wide Best Practice – Growing testing eco system

Industry-Wide Architecture Best Practices

Peer review of functionalities, safety and security mechanisms

Lower entry into HAD development

No vendor lock-in

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Summary

Automated driving systems are complex

Efficient collaboration requires a standard architecture

Open robinos ist the first step
open-robinos.com

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Thank you.

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