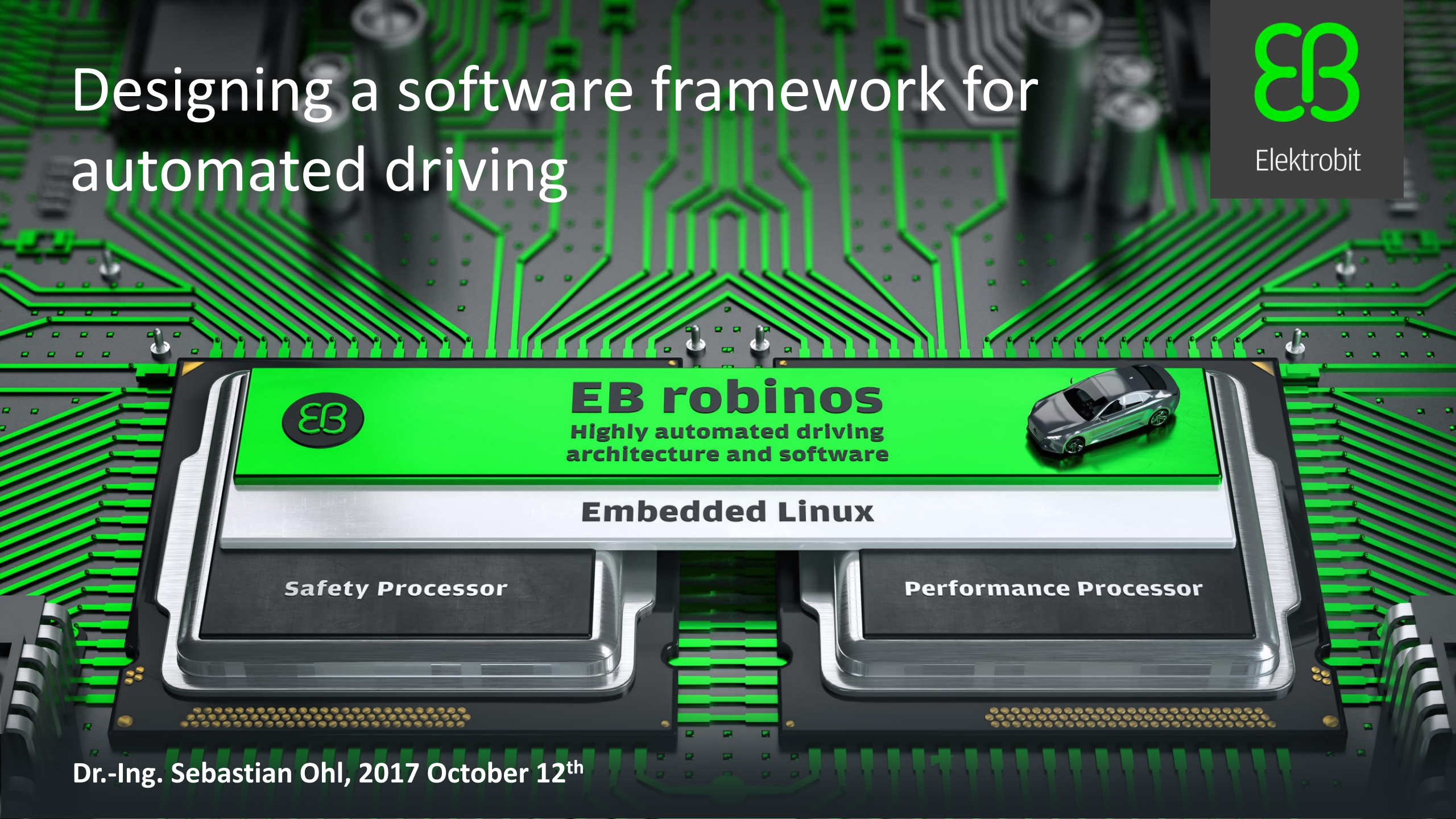
Designing a software framework for automated driving

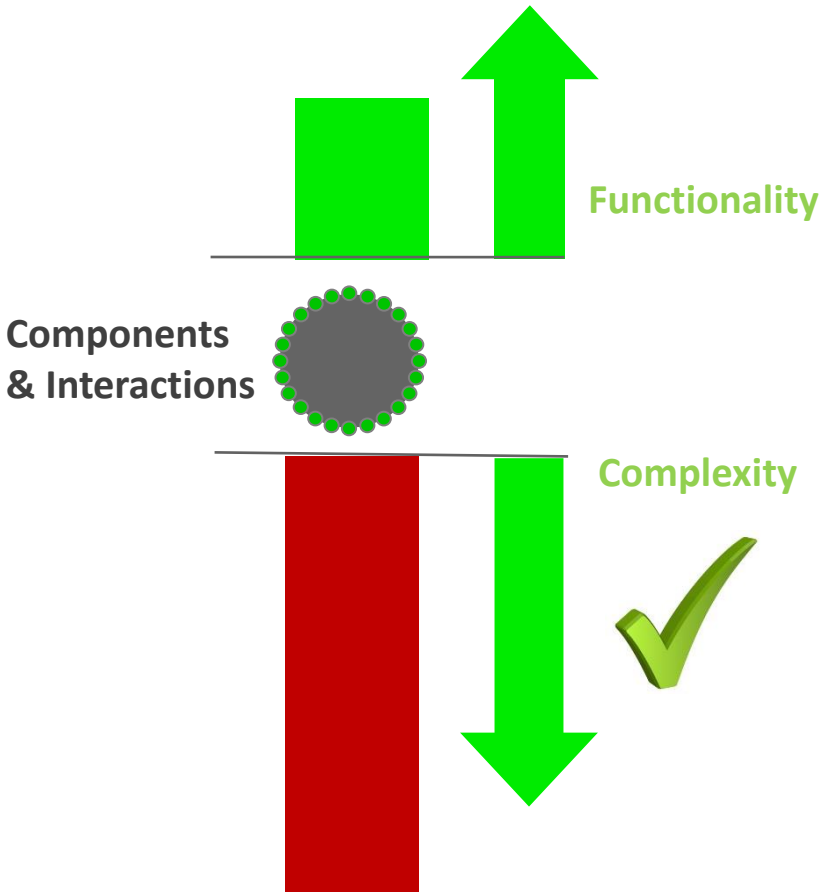
Elektrobit



Dr.-Ing. Sebastian Ohl, 2017 October 12th

Challenges

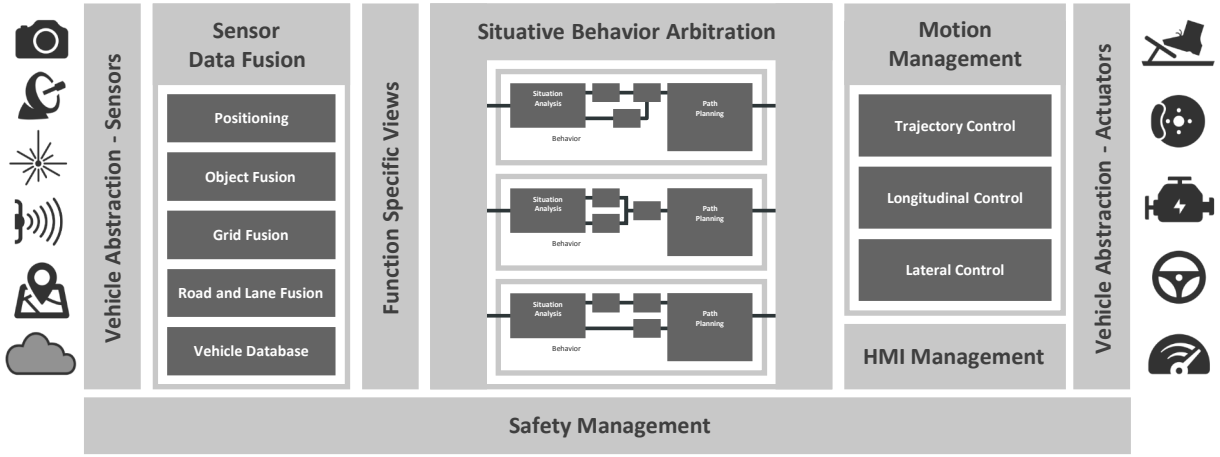
- Functional software architecture with open interfaces and a set of well-defined software components for automated driving systems up to SAE level 5
- Seamless cooperation and combination of automotive soft- and hardware
- Highly automated driving software from prototyping to embedded/serial use

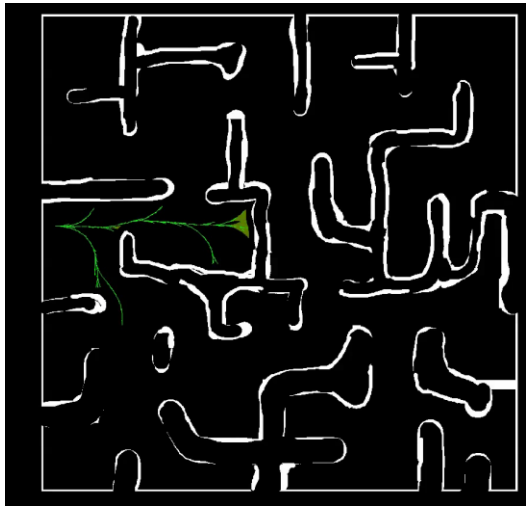


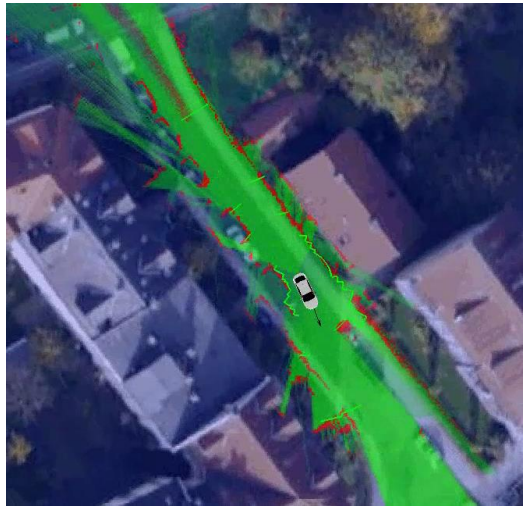
EB robinos: EB‘s Autonomous Driving Software

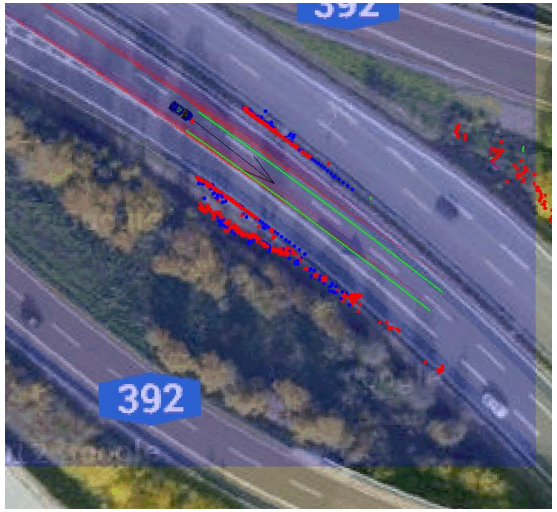
Key features:

- Architecture for ADAS up to SAE level 5
- Runs on AUTOSAR
- Central ECU as well as distributed systems
- Incorporates existing or new, customer or third party subsystems



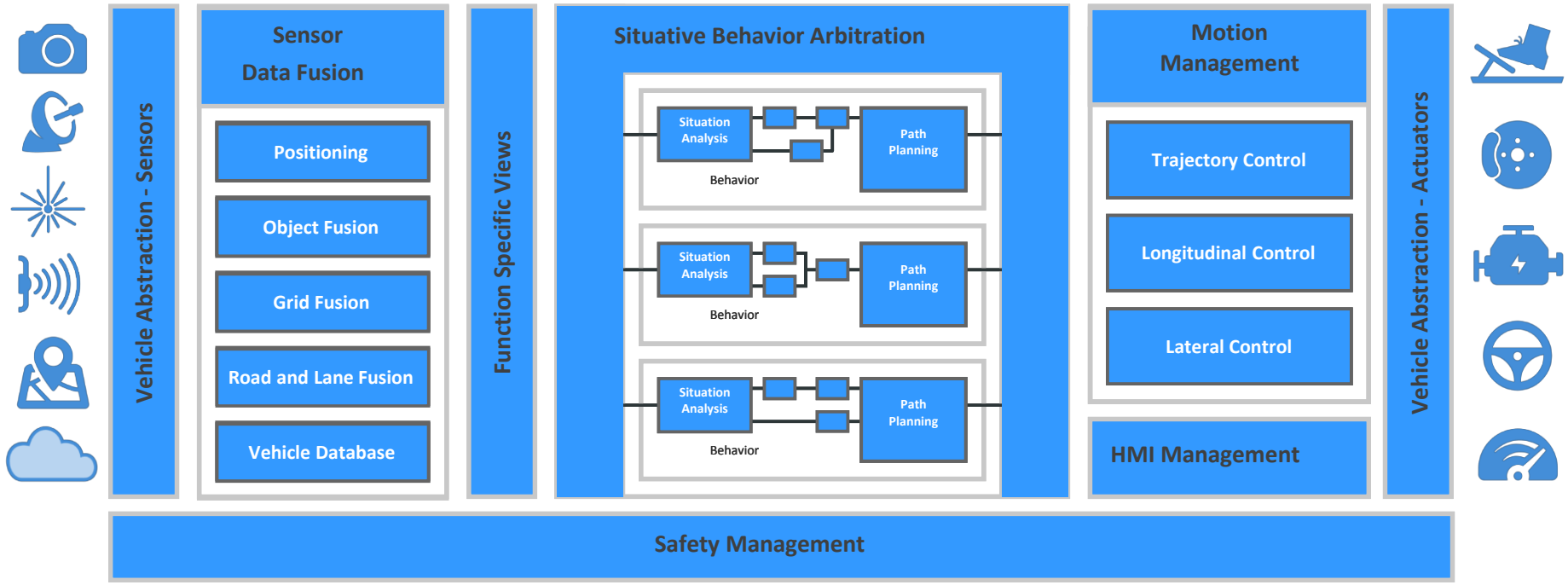






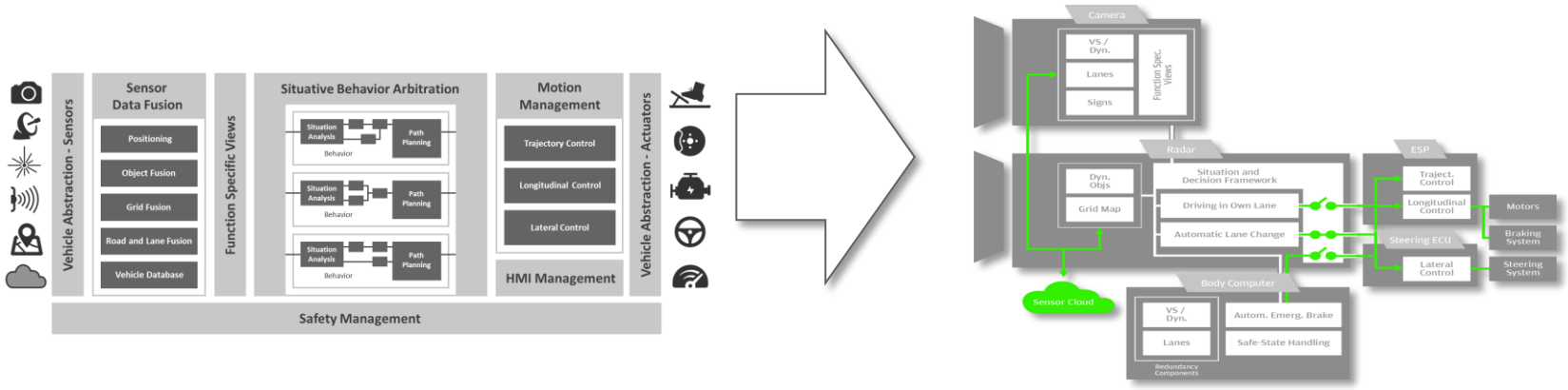
Elektrobit

A modular, extensive framework for automated driving

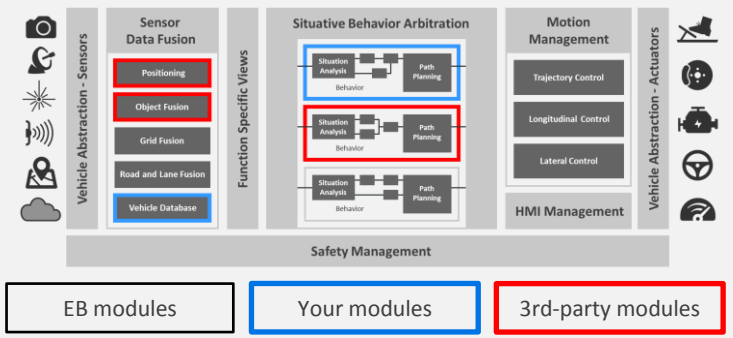


Interfaces for • **interoceptive sensors:** wheel ticks, s • „smart“ **environment sensors** – poir • ADASIS for map, SENSORIS for cloud	**Extensible function frame** • rule-based **coordinatio** • clear **upgrade path** fro • complex behavior eme • guaranteed **testability**	Coordination of **v** • braking, steeri • safe communi • **safe hand-ove**	Interfaces for • kinematic vehicle components • instrument cluster • infotainment display

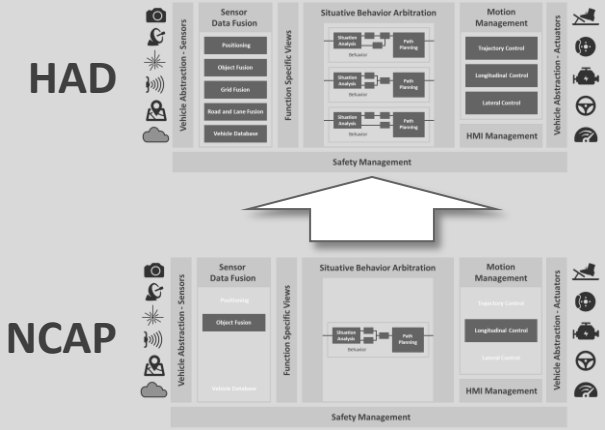
A modular framework



Map onto concrete ECU architecture



Ensure differentiation, shorten time to market



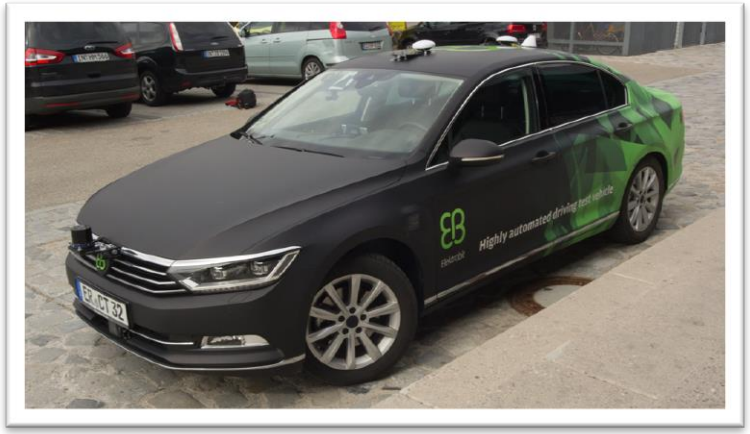
Upgrade across models / Upgrade over time

Different Test Vehicles Running the Same Software

Automated Valet Parking & inner-city Driving

- Lidar, ultra sonic, and 360° camera sensors
- High performance computer
- Additional actuators for steering & pedals
- High precision IMU

Highway Driving



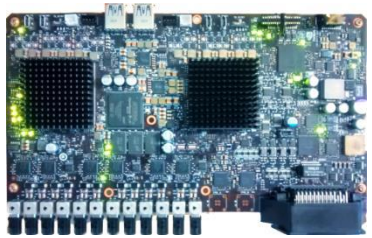
- Lidar, camera, and radar sensors
- High performance computer
- Additional actuators for steering & pedals
- High precision GPS

Embedded Valet Parking

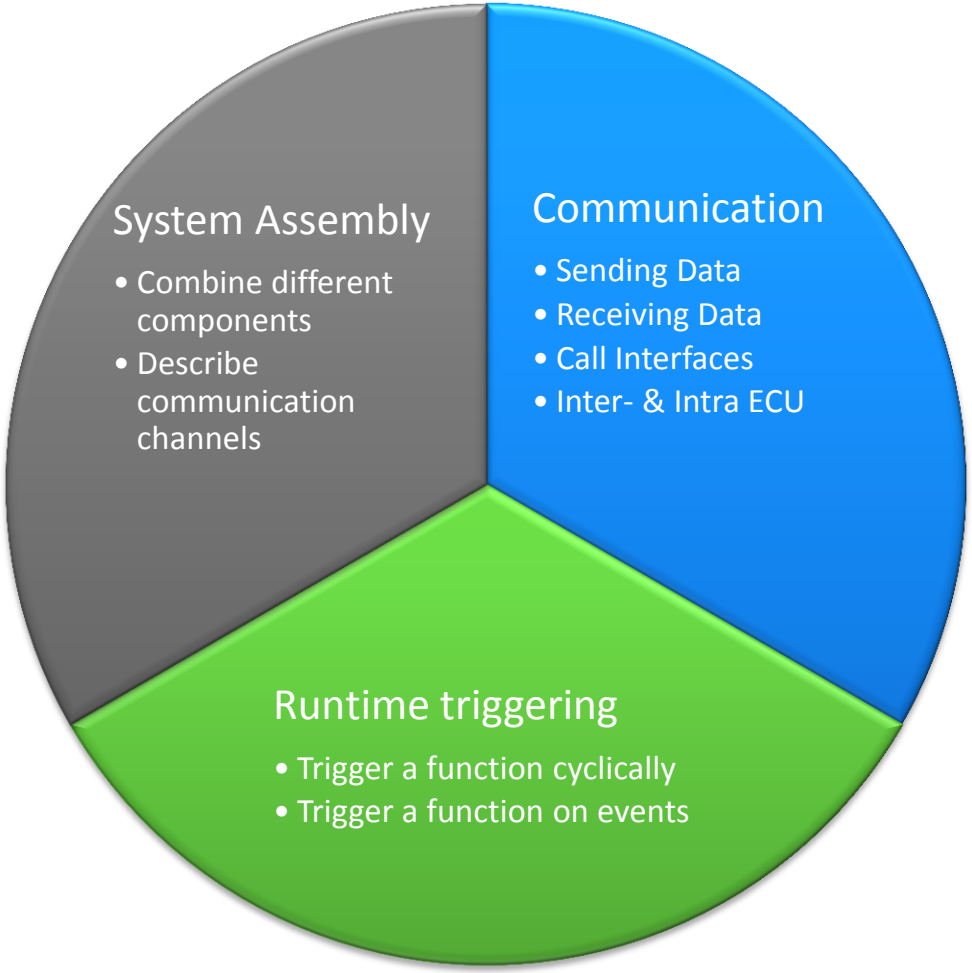
- Lidar and radar sensors
- Embedded computing platform
- Using OEM interfaces to actuators
- Low precision IMU

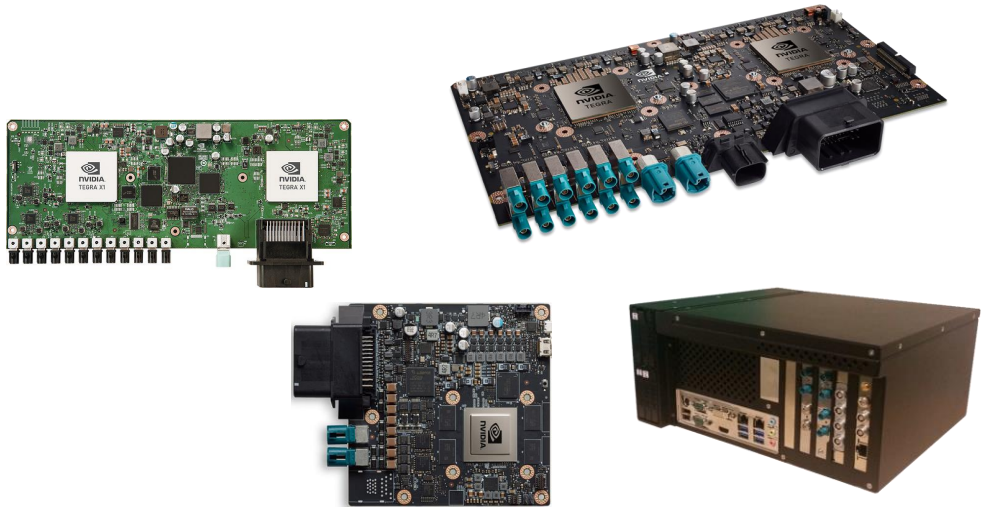
Different Development Stages

EB robinos

EB Assist ADTF Middleware	Embedded Linux Middleware	EB Adaptive AUTOSAR
Rapid prototyping **C, C++, Model based** 	**Rapid embedding** C, C++ 	**Automotive grade software** 
PC	**Evaluation hardware**	**ECU**

A Runtime Environment for EB robinos





High Performance ECU Characteristics

- High computation power with heterogeneous computing
- Hardware virtualization
- Widespread, POSIX-like Operating System (e.g. Linux)
- Extensive update capabilities
- Interfacing with common in-vehicle bus systems

Different Run-time Platforms

EB Assist ADTF

- Rapid Prototyping Framework
- Supports Sender/Receiver communication via Pins
- Call interfaces are supported by ADTF services
- Provides MessageBus for Inter-ECU communication
- Configuration Editor for system assembly

Classic AUTOSAR

Discontinued

- Mass production grade ECU basic software
- Widely used for 32-Bit controllers
- Provides Sender/Receiver as well as client/server communication
- Various bus systems supported
- System assembly by AUTOSR system architecture tool

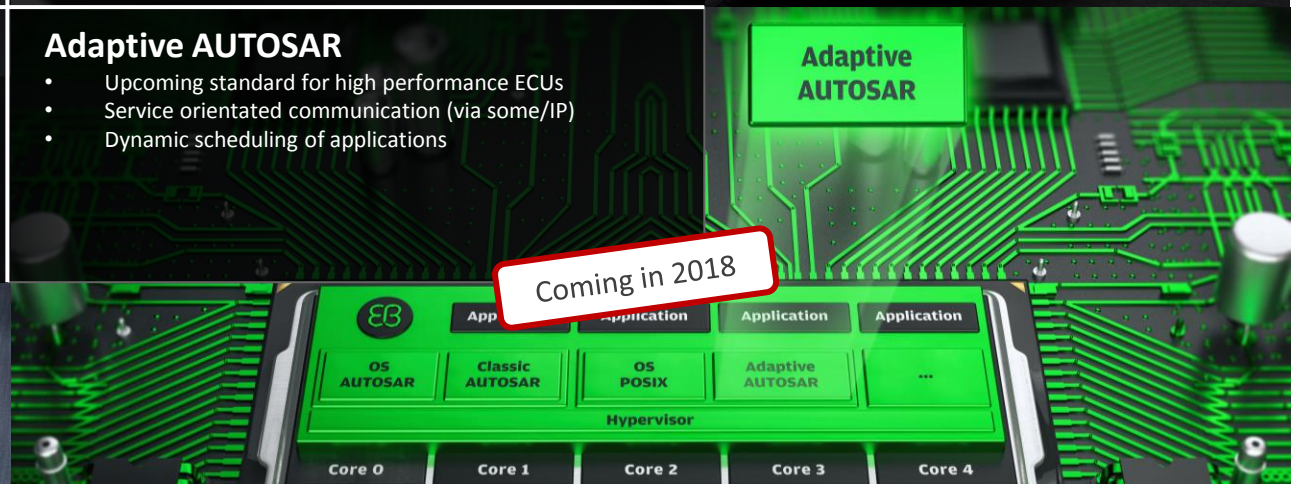
Embedded Linux

- Much more suitable for high performance computing systems
- Inter-Application communication via some/IP and MessageBus protocol
- Intra-application communication via C++ calls
- System assembly directly in C++ code

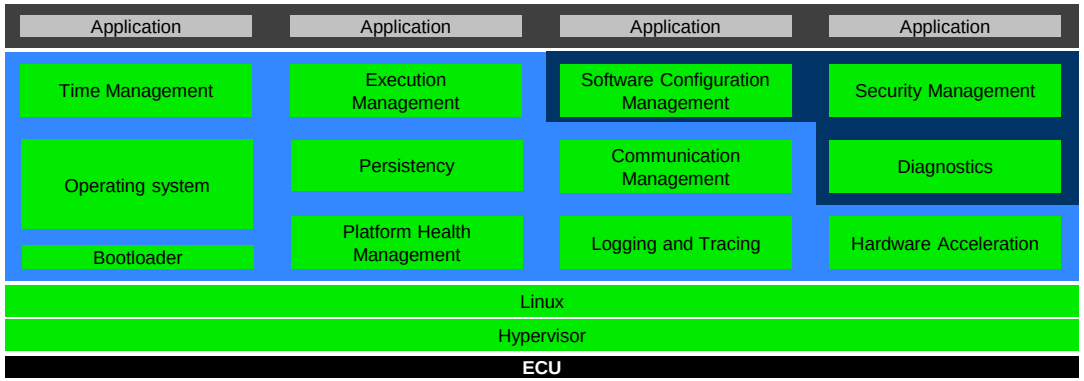
Adaptive AUTOSAR

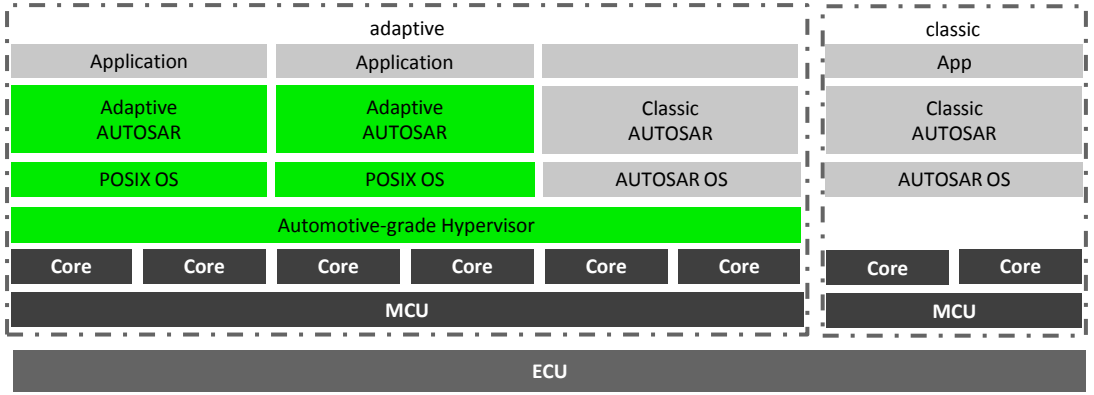
- Upcoming standard for high performance ECUs
- Service orientated communication (via some/IP)
- Dynamic scheduling of applications

Coming in 2018



EB Adaptive AUTOSAR





Adaptive AUTOSAR Characteristics

- Designed for major market trends like E-Mobility, Automated Driving and Mobility Services
- Complementing standard, neither replacing classic AUTOSAR nor replaces proven implementations
- Standardized methodology
- Specifying API's and functional requirements only

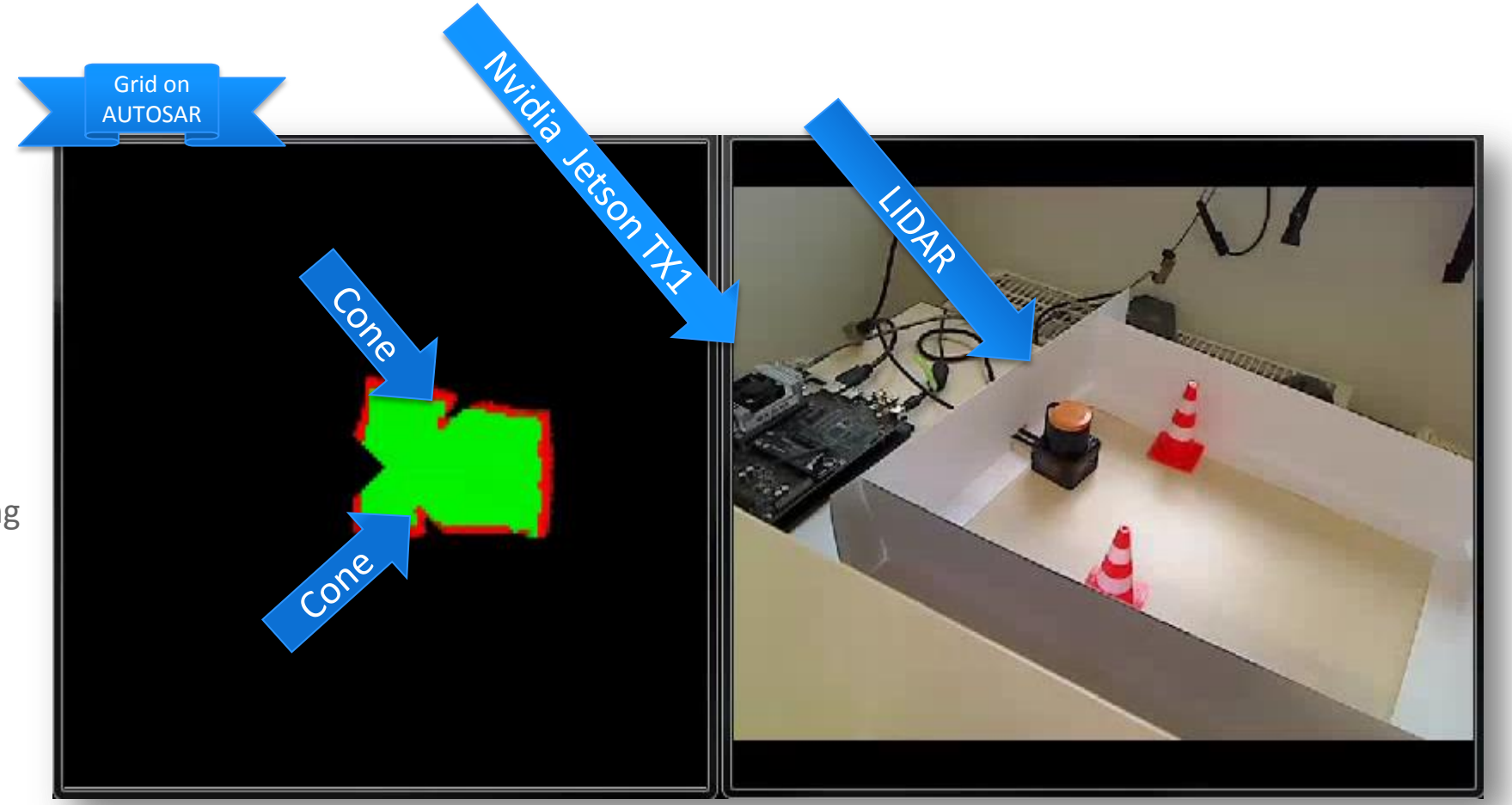
Key Features & Benefits

- Software Development Kit for construction, qualification and deployment of adaptive applications for high performance controllers
- Offers service-oriented architecture and communication
- Support integration with multiple variants of POSIX-Like Operating Systems (e.g. Linux, QNX, …)
- Enables OEMs and TIER1s to reload software functionality at runtime

EB robinos Grid Fusion Processing Online Data

- Grid: 160x160 cells covering 1x1cm
- Sensor: Hokuyo UST-10LX LIDAR at 40 Hz
- Board: NVIDIA Jetson TX1 (same processor as the Nvidia DrivePX 1)
- Runtime Environment:
  EB tresos Solution for AD

- The demo shows the grid processing online data from the LIDAR sensor. During the demo obstacles are introduced and moved.
  This results in changes in the grid fusion's visualization.

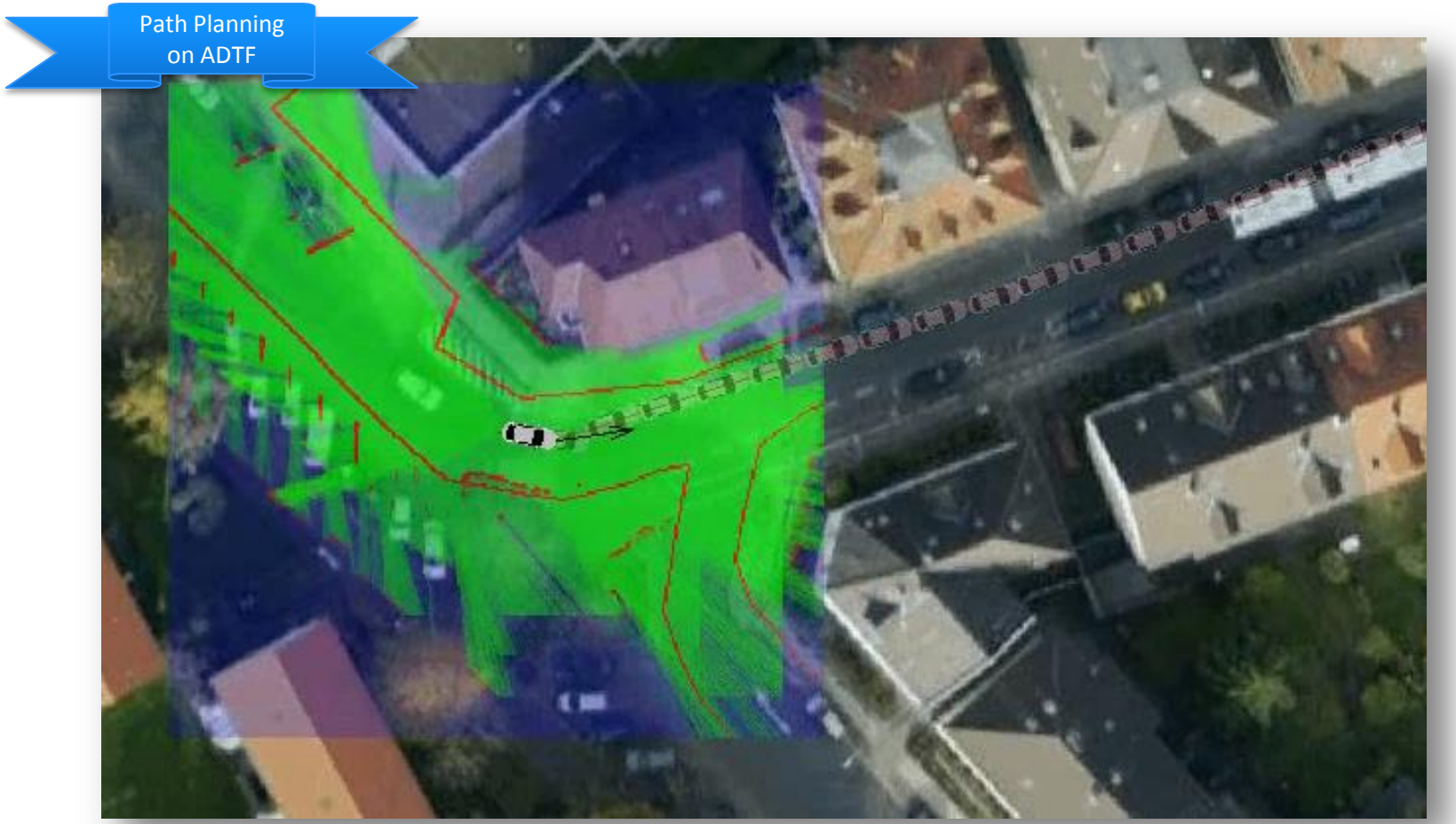


Black: unkown cells
Green: free cells
Red: occupied cells

EB robinos Path Planning Processing Recorded Data

- Sensor: IBEO Lux Gen4 at 12.5Hz
- Board: Intel based PC
- Runtime Environment:
  EB Assist ADTF

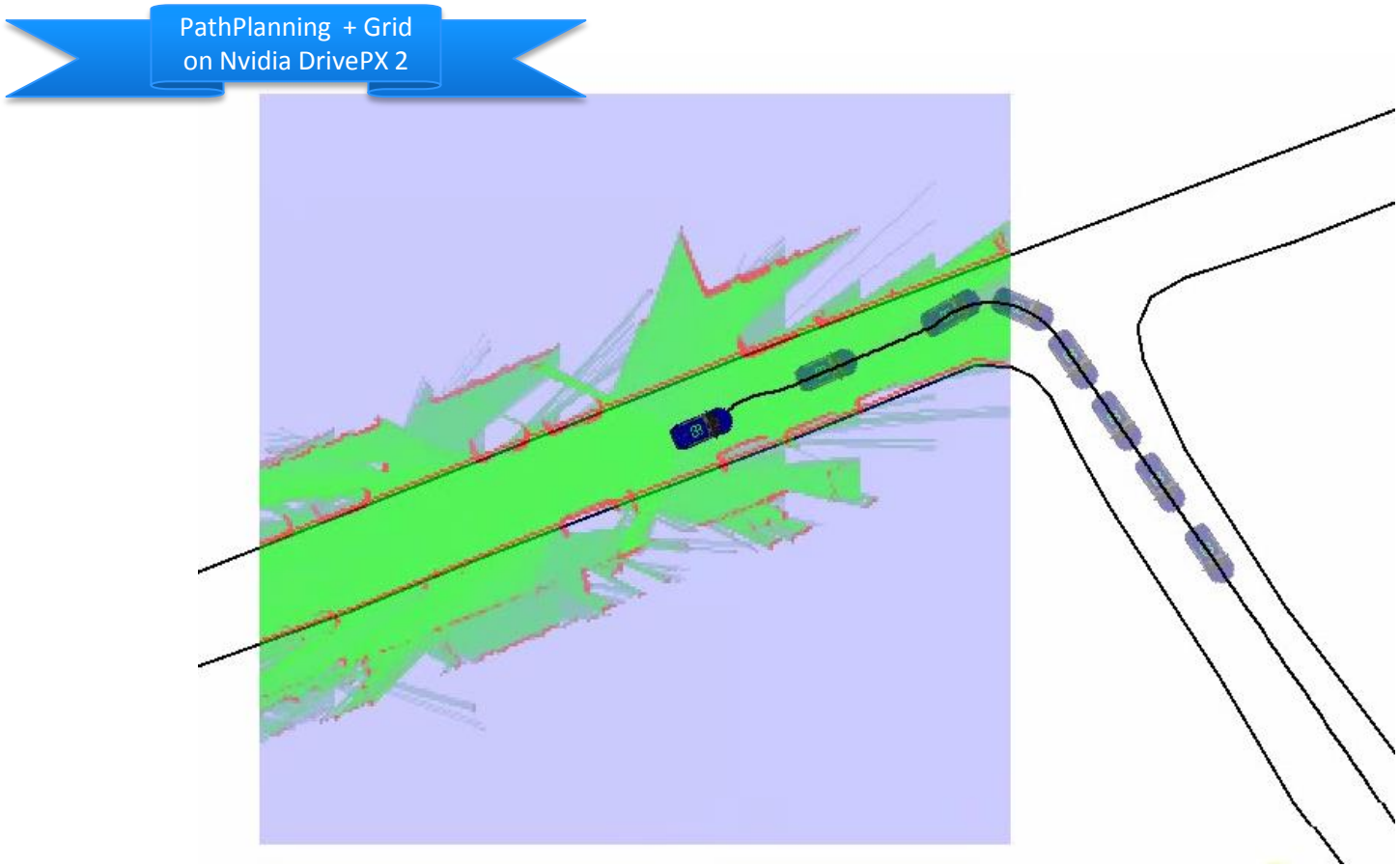
- The demo shows EB robinos Path Planning running on EB Assist ADTF. It is taking local sensors as well as map data into account. Moreover, the path is adapted according to local traffic participants. The motion model is restricted according to traffic rules and vehicle speed.



EB robinos Processing Recorded Data

- Sensor: IBEO Lux Gen4 at 12.5Hz
- Board: NVIDIA Drive PX2
- Runtime Environment:
  EB robinos Linux Environment

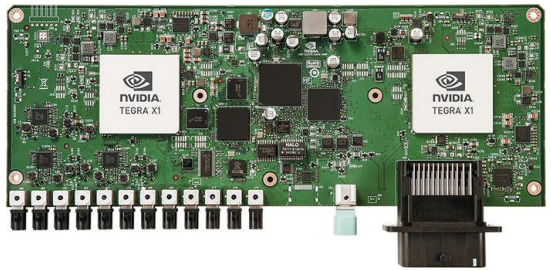
- The demo shows grid processing and inner-city path planning running on a NVIDIA DrivePX 2 hardware. All processing and visualization is running on the embedded platform.

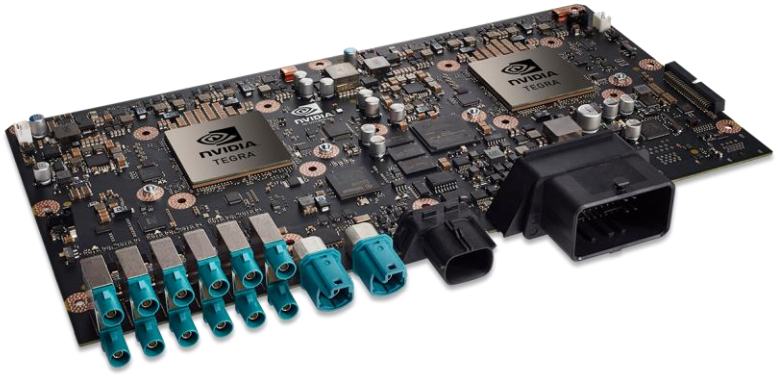


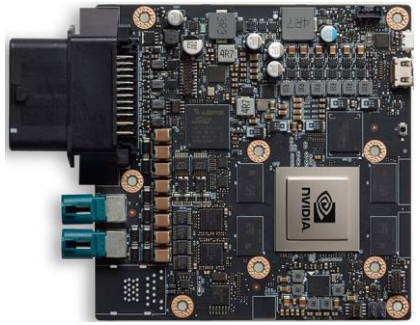
EB robinos for Embedded Linux on NVIDIA DrivePX

Available End of October 2017

- Ready to use HAD software modules
- Different show cases possible
  (e.g. Valet Parking or people mover)
- Running as pure Linux applications
- Packaged modules (Oct 2017)
  - EB robinos Grid Fusion
  - EB robinos Path Planning
  - EB robinos Cross Product components







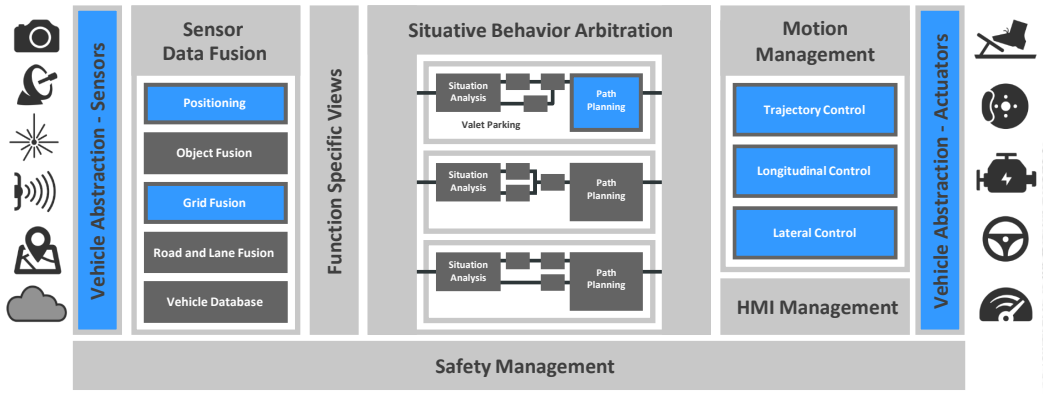
Automated Valet Parking with EB robinos

Solution

EB robinos software components can be used to automatize parking applications from simple maneuvers up to **complete autonomous systems** navigating on big parking lots.

Key Message

- Valet Parking as SAE Level 5 function
- Usable on private property
  (depending on local laws)
- Assisted parking for complex situations
- Garage parking



EB's added value

EB robinos - Software modules

- **for prototyping:** EB Assist ADTF
- **for rapid embedding:** (adaptive) AUTOSAR or embedded Linux
- **for production:** on vehicle ECU

Highway Pilot with EB robinos

Solution

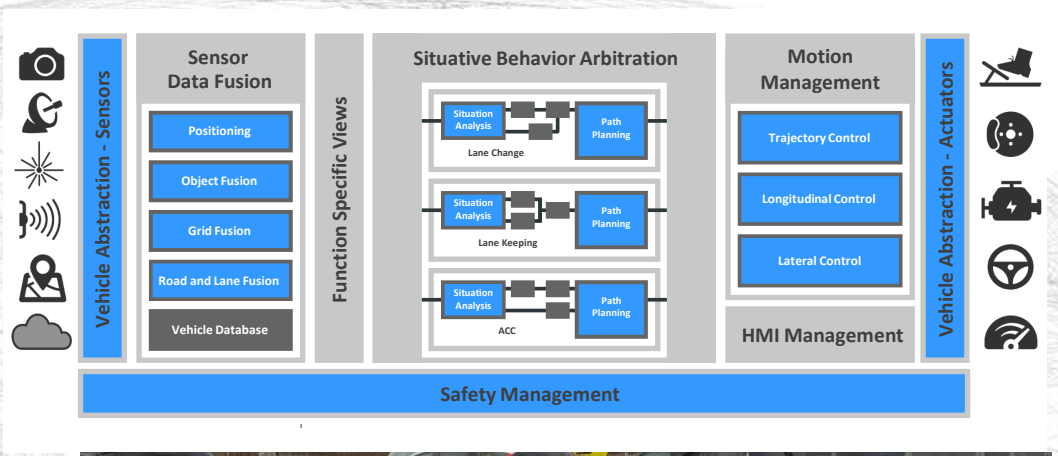
Highway Pilot with EB robinos is providing software modules to bring **EB robinos** to the highway.

Key Message

- Highly Automated Driving on highways, 0-120 km/h
  - free driving and vehicle following
  - lane keeping
  - automated lane change
- Automatically detect of system failures and limits
- React to failures / limits with appropriate safety maneuvers.

EB's added value

- Use **EB robinos** software framework and standard interfaces
- Support a wide variety of sensors, actuators, and ECUs
- Easy integration into customer E/E architecture



Get in touch!

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