

Magna SmartBridge™ Software - Energy & Motion Control





Off-board Connectivity



Vehicle Energy Control

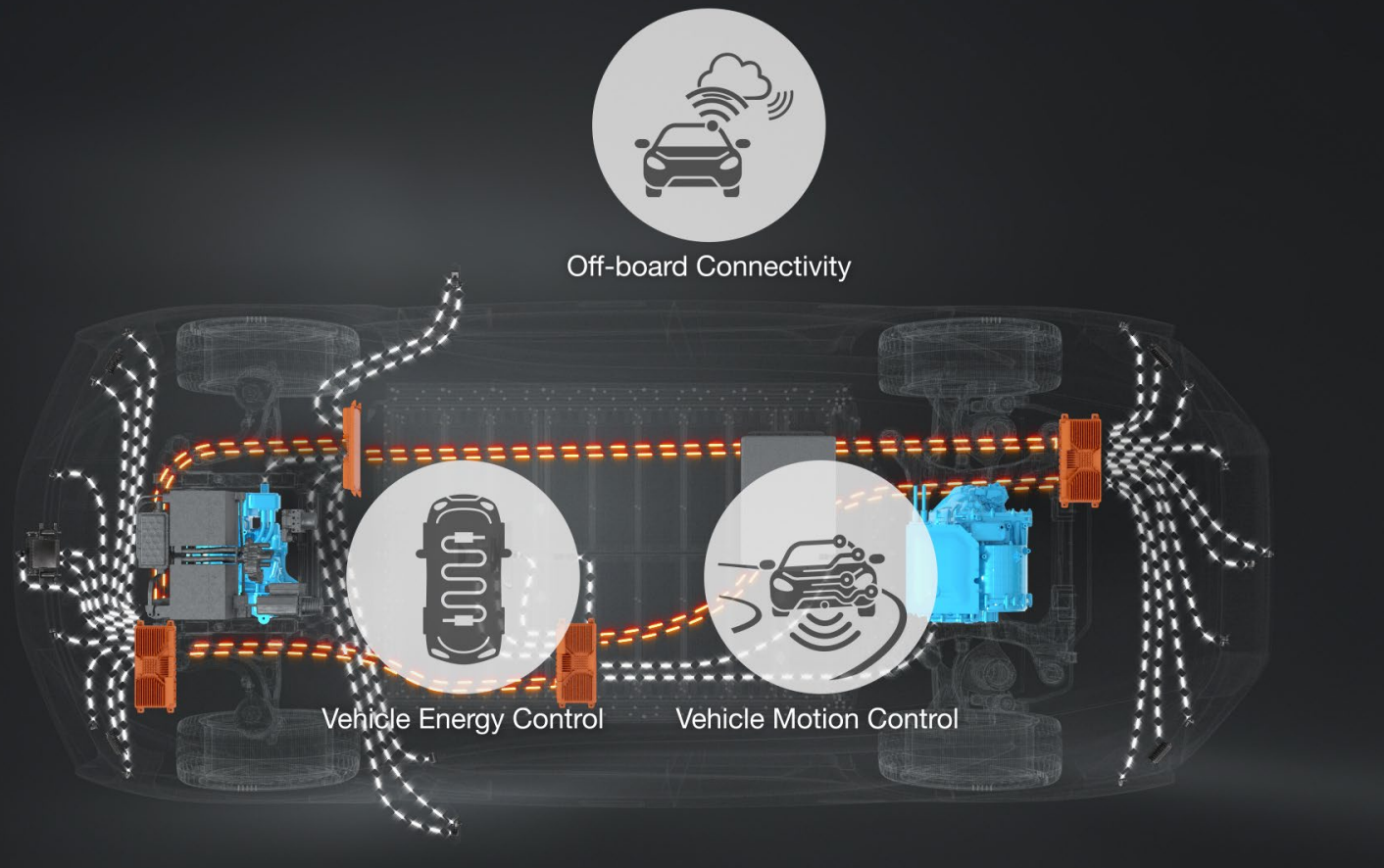


Vehicle Motion Control



Magna SmartBridge™ Software - Energy & Motion Control

Functional modular software platform for BEV and (P)HEV. Magna delivers an operating strategy incl. advanced and predictive vehicle functions for motion and energy control independent of the powertrain layout and E/E architecture. Delivery of software as a product (SaaP).



- Customer specific functionalities allow OEM exclusivity
- Specific calibration of platform functionalities ensures differentiation and supports individual brands image

SmartBridge™ Software – Energy & Motion Control

Vehicle Energy Control

Vehicle Energy Broker

Battery conditioning

Energy management
by using route information

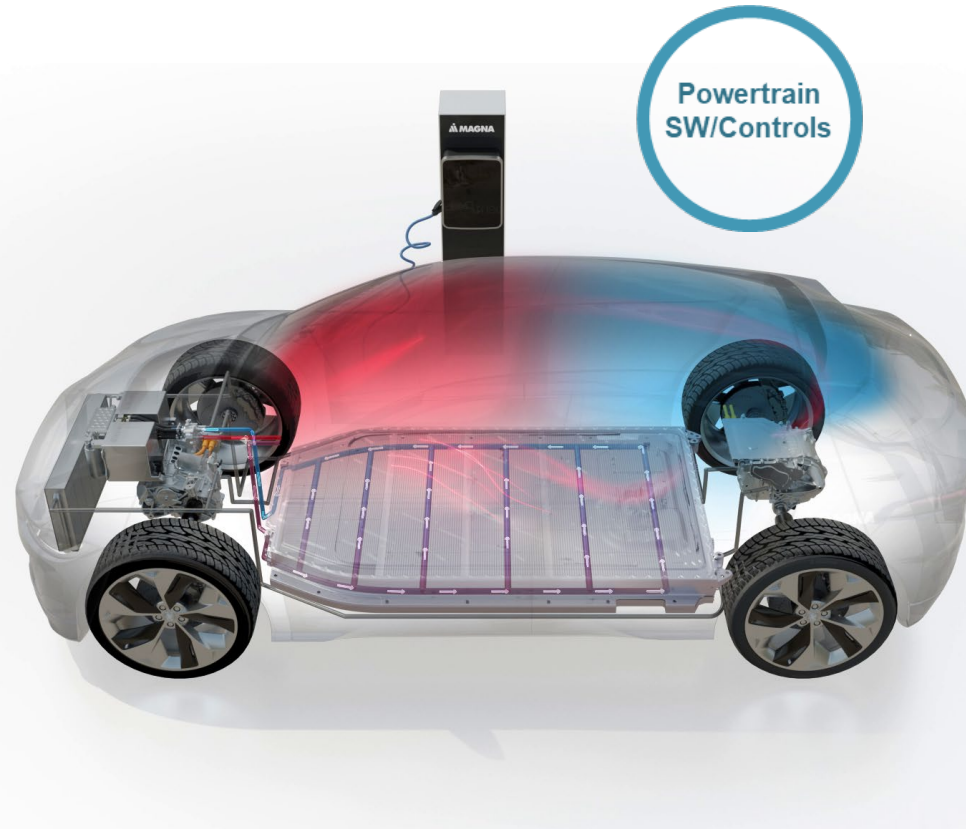
Powertrain conditioning

Predictive cabin cooling / heating

Regeneration function by integrated
control of eDrive and brake

Torque split control for best efficiency

Decoupling strategy of secondary axle



Magna's energy management control ensures highest possible efficiency for future vehicles systems. The waste heat recovery and smart heat distribution between heat sources are linked with the energy demand and generation of the eDrive system to ensure an optimum real-life efficiency.

SmartBridge™ Software – Energy & Motion Control

Vehicle Motion Control



Driver torque request

Brake torque request incl. regeneration and integrated eDrive and brake controls

Longitudinal torque vectoring incl. integrated eDrive and brake controls

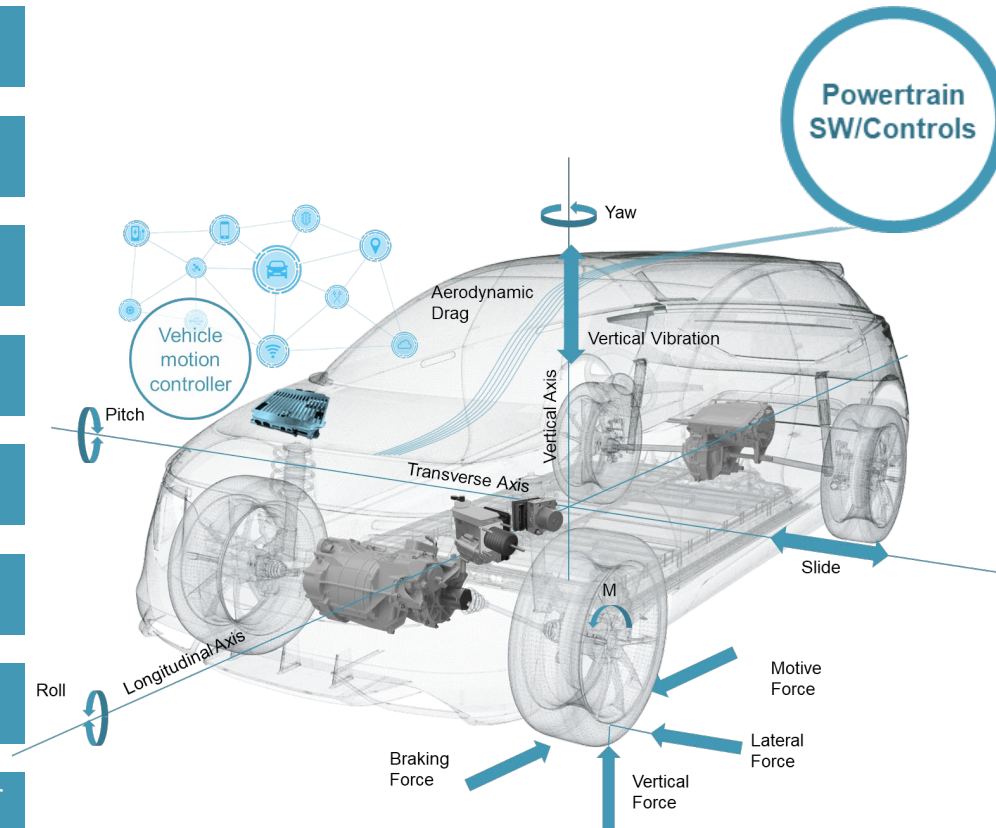
Lateral torque vectoring incl. integrated eDrive and brake controls

Traction control by inverter-based speed controller

Vehicle physics model incl. active sideslip angle control

Traction Predictor incl. Road State Observer

Vehicle State Observer & Predictor (driver requested trajectory)



Magna's vehicle motion control functions allow for superior drivability attributes of future BEVs and Hybrids. The centralized control approach optimizes the end-consumer values safety, dynamics, convenience. This holistic approach reduces system complexity and cost and enables ADAS level >3.

An abstract background featuring a central burst of bright red light rays emanating from the center, surrounded by a complex, glowing blue wireframe grid that resembles a 3D architectural or mechanical structure.

Integrated eDrive and Brake Control

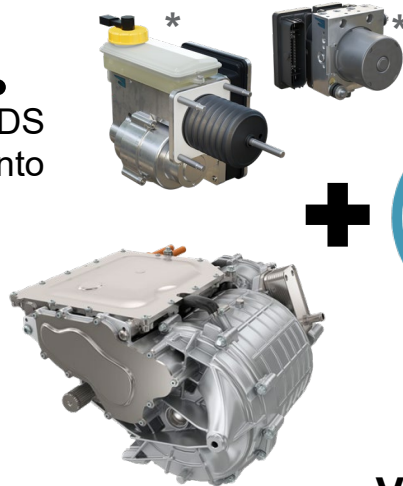
Integrated eDrive and Brake Control



This functionality integrates a brake torque vectoring into the electric Drive Units at the front and rear axle and improves performance, safety and convenience.

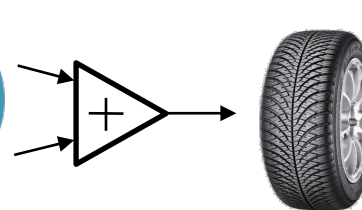
Integrated Controls

- Integrates the function of eDS system and service brake into one high level controller



Advanced Brake Blending

- Reduces friction brake losses



Wheel Torque Interface

- Enables accurate torque and speed control for each wheel individually

Vehicle Dynamics

- Advanced lateral torque vectoring functionality
- Improved traction capability by emulation of LSD functionality

Merits on vehicle level

Safety

Up to 15% safety margin and up to 50% significantly reduced steering wheel demand

Convenience

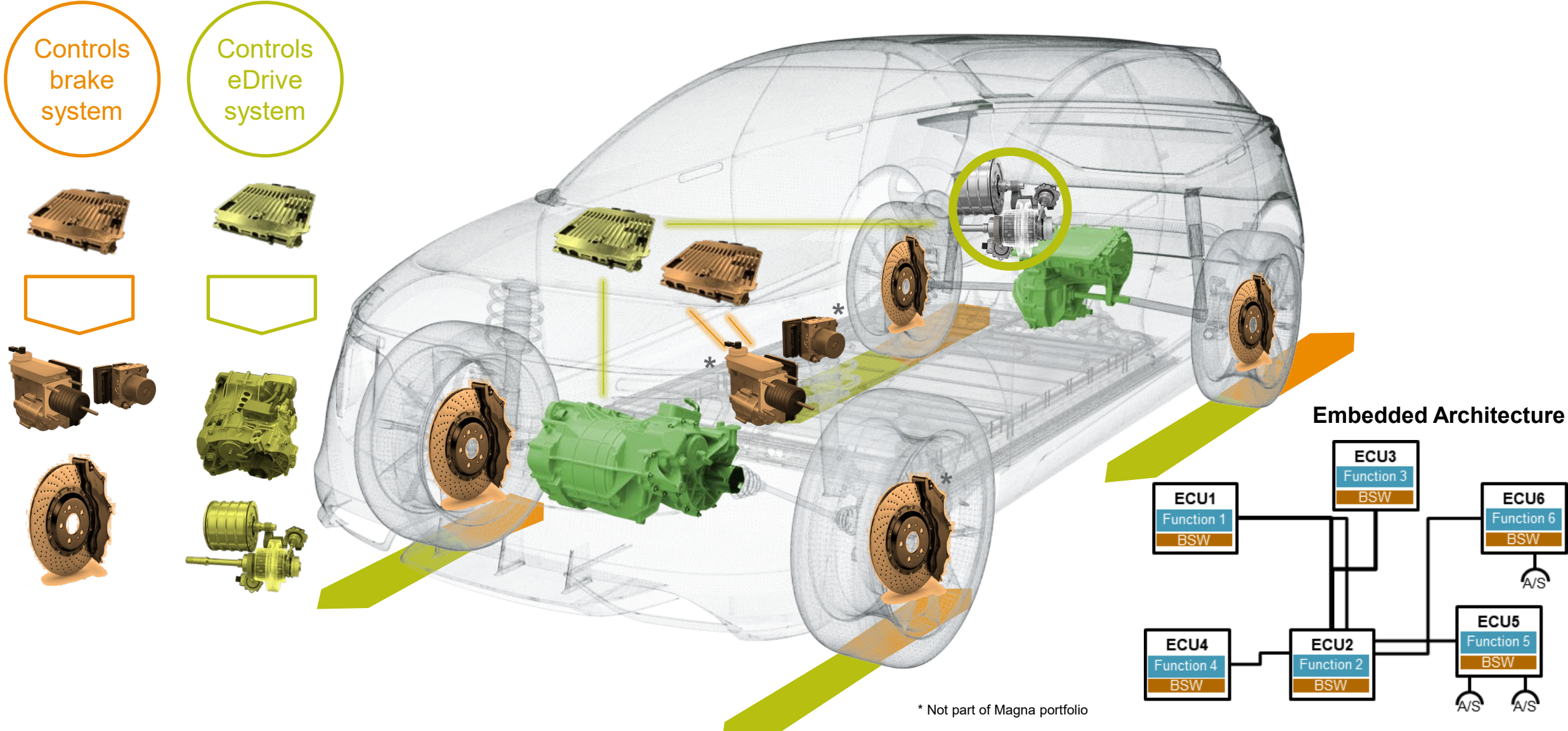
- 50 % steering wheel angle demand

Dynamics

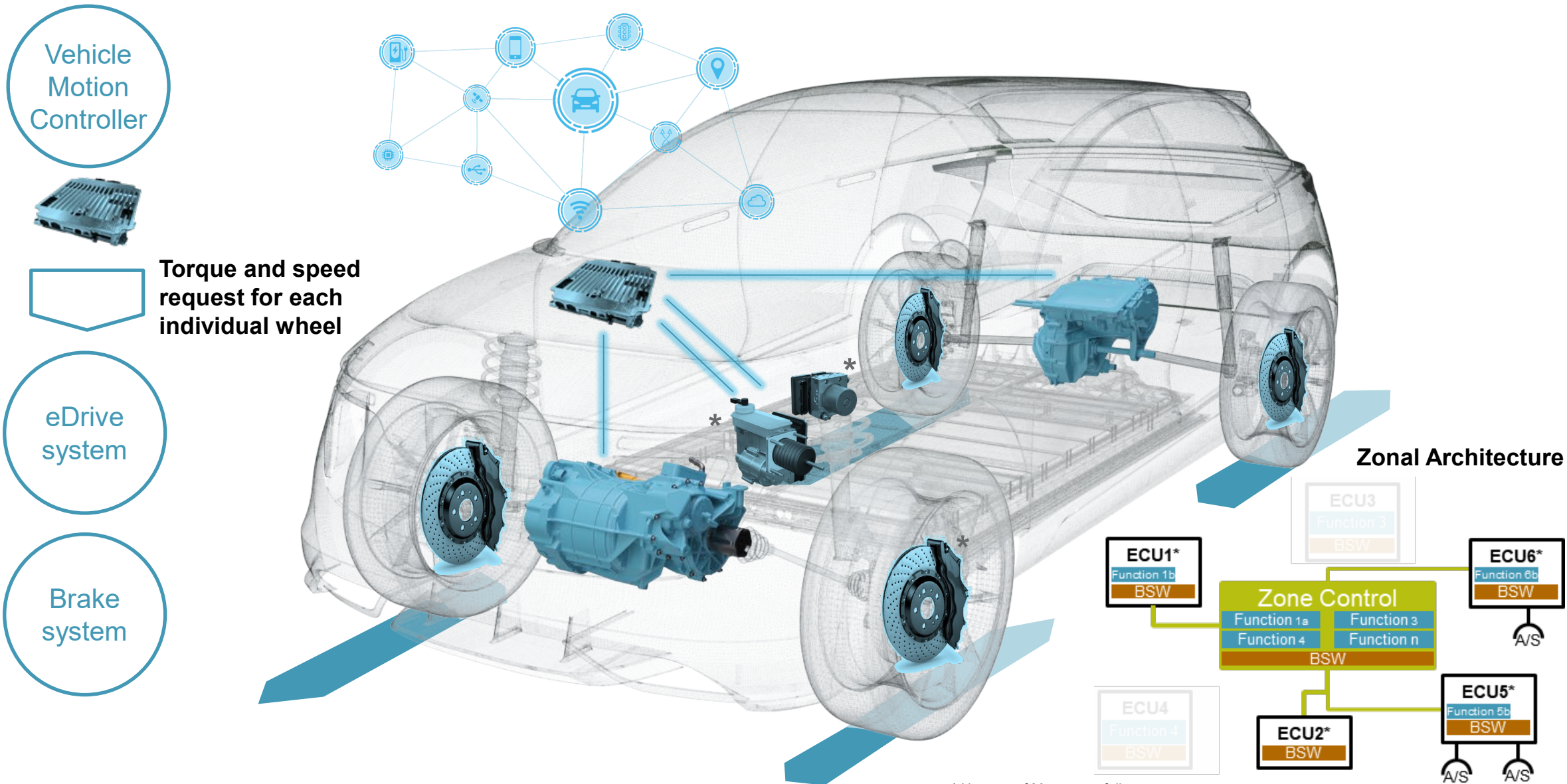
+ 0.1 g lateral acceleration



Propulsion System and Brake System

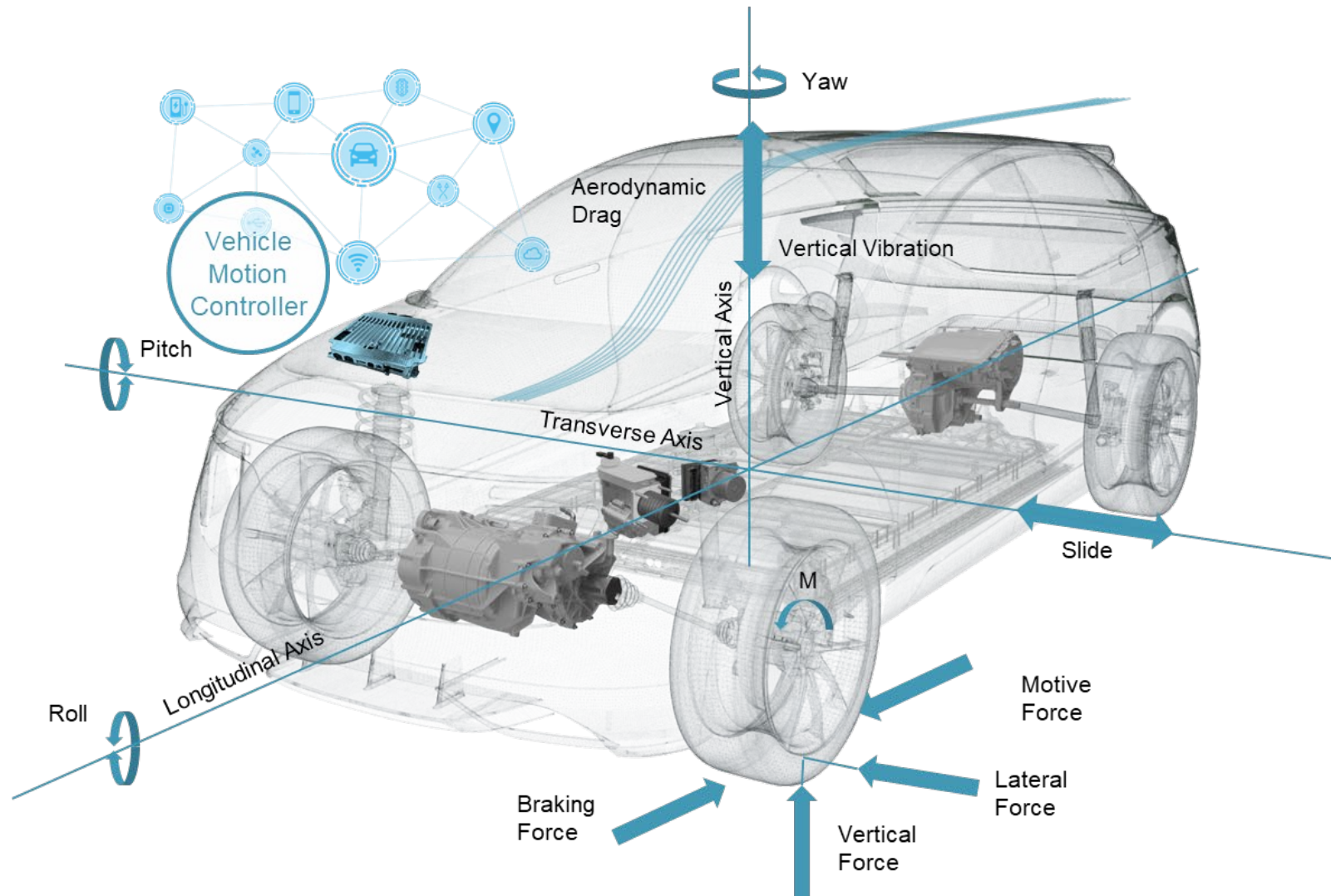


Integrated eDrive and Brake Control



* Not part of Magna portfolio

Integrated eDrive and Brake Control



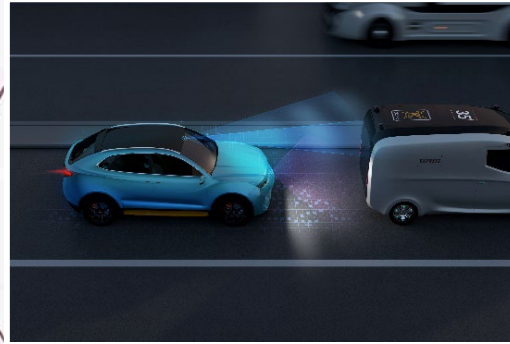
- Superior vehicle motion control resulting in best-in-class drivability
- Optimized interfaces
- Significantly reduced control loop time
- Reduced system complexity and cost
- Synergies in terms of redundancies for brake system for autonomous level ≥ 3

Integrated eDrive and Brake Control Consumer Values



Efficiency

- + Improved brake blending
- + Higher regeneration share in real life cycle
- + Clearly increased regeneration for dynamic driving



Safety

- + Optimum trajectory for every driving situation
- + Clearly improved stability for safety-critical driving maneuvers
- + Best controllability during regen and braking



Dynamics

- + Maximum achievable cornering speed
- + Clearly improved controllability on physical limit
- + Increased range for sporty driving condition



Convenience

- + Imperceptible brake blending functionality
- + Clearly reduced steering effort
- + Smooth yaw control with improved NVH

SmartBridge™ - Active Sideslip Angle Control

Based on advanced physical vehicle model



Advanced and Predictive Powertrain Functions SmartBridge™ - Active Sideslip Angle Control

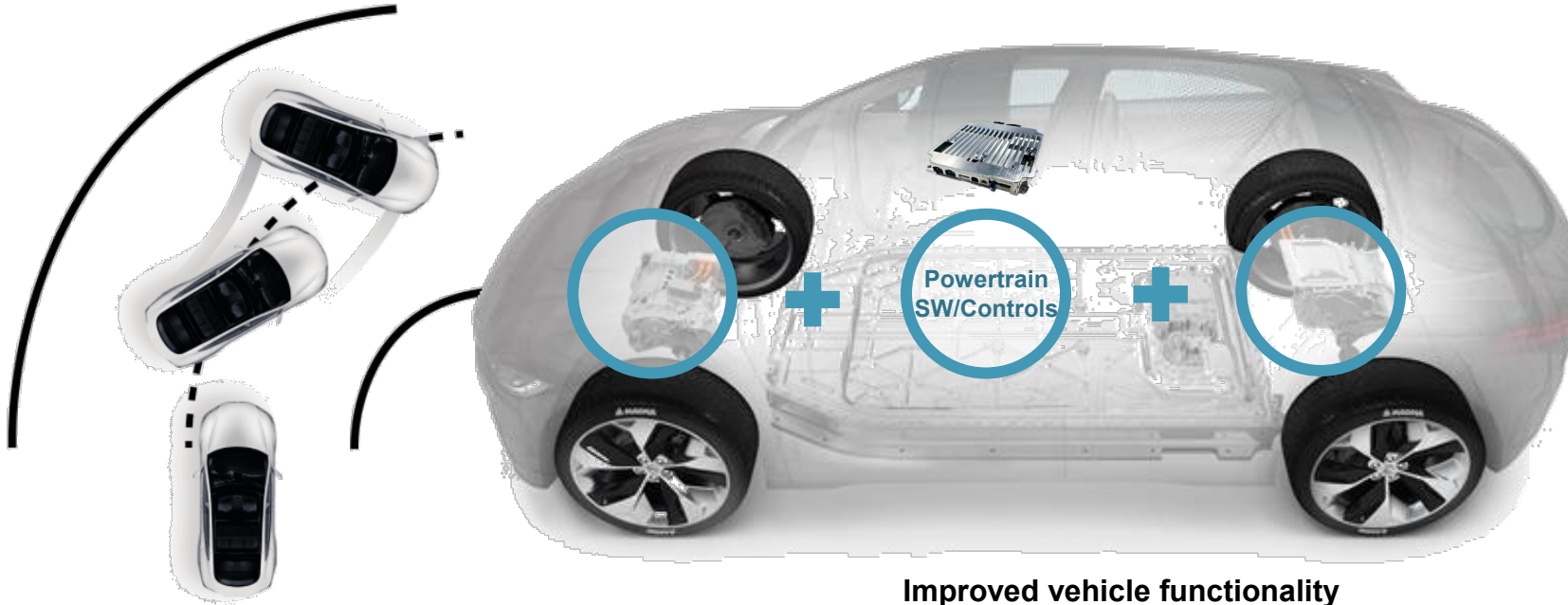


Advanced physical vehicle model

- 5 DOF vehicle model incl. chassis and tire model
- Providing sideslip angle, float angle, wheel loads and torques etc.

Sideslip angle control

- Closed loop control based on sideslip angle and float angle
- Resulting longitudinal and lateral torque distribution including integrated eDrive and brake control



Improved vehicle functionality

- Variable sideslip angle limitation
- Adjustable vehicle self steer behavior

Merits on system level

Safety

Improved controllability and stability in critical driving situations like lane change and avoiding maneuvers.

Performance

Enhanced handling capability and vehicle trajectory for dynamic driving.

Increased cornering speed and lateral acceleration

Convenience

Smooth yaw control and clearly reduced steering effort

Use Cases

Improved yaw control effecting longitudinal and transversal torque split (torque vectoring)
Allowing for enhanced driving functions, driver assistance functions and autonomous functions (>L2+)

- -> **Software function that allows for clearly improved vehicle drivability without additional hardware content**
- -> **This functionality supports unexperienced as well as professional drivers for a variety of driving maneuvers**

Pre-Development

Released for Acquisition

Serial Development

Serial Production

The background of the slide is a dark, abstract image. It features a central burst of bright red light rays emanating from the left. On either side of this central burst are blue wireframe structures that resemble architectural or mechanical frameworks, receding into the distance.

Traction Predictor

Advanced and Predictive Powertrain Functions

Superior Traction Predictor



Optical Road State Observer

- Optical verification of friction value with on-board ADAS sensors (camera, lidar) – near-field

Cloud Data

- Import initial friction value for planned route via cloud data services
- Upload of traction relevant data

Powertrain
SW/Controls

Connectivity

Aggregate based Friction Estimator

- Calculated validation with slip-based friction algorithm model

Pre-Development

Released for Acquisition

Serial Development

Serial Production

Proof of Concept achieved

Merits on system level

Friction Prediction – Input

Use information from cloud data and optical road state observer to generate best known friction forecast

Friction Estimation – Input

Precise friction measurement under controlled vehicle conditions

Continuous and triggered measurements, e.g., road friction by axle torque shift

Traction Prediction – Output

Combination, calculation & learning algorithms

The model-based algorithm delivers the most exact traction horizon in front of the vehicle as input for advanced Vehicle Motion Control

Use Cases

Prepare all driving functions with predictive elements (Decoupling strategy, AWD controls, Torque Vectoring, Integrated eDrive and Brake Controls, Yaw control, Float angle) and to improve driver assistance systems (>L2+) and safety!

→ Predicts the control strategy of the AWD system and ADAS functionalities for best-in-class safety and efficiency by combining advanced vehicle sensor-based and slip-based friction algorithms and cloud data services

An abstract background featuring a blue wireframe grid structure on the left and right sides, with a central area filled with vibrant red light streaks and rays, creating a dynamic and futuristic visual effect.

Details Traction Predictor Friction Estimator

Superior Traction Predictor

Input by Friction Estimator



The road friction by axle torque shift functionality uses distortion of axles against each other (one axle accelerating, second axle braking), and is applicable for vehicles with separately driven axles (currently AWD BEV)

SW-defined vehicle

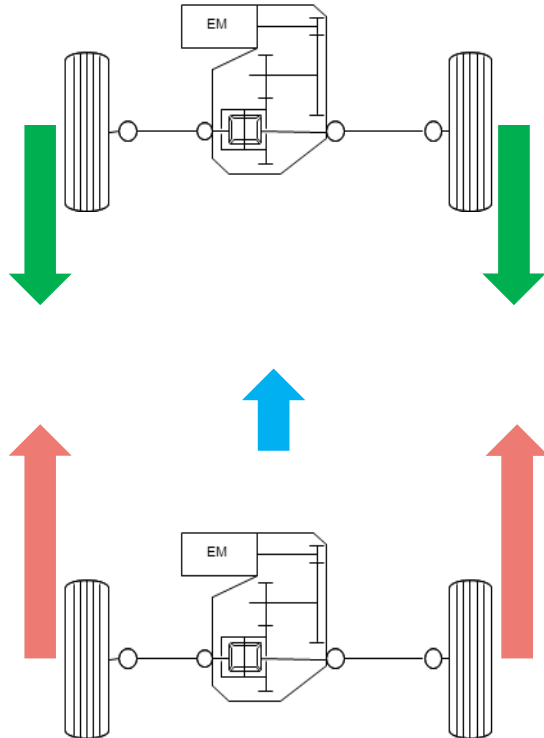
Vehicle Motion Controller



eDrive system

Brake system

Road State Information



Driving Conditions

- AWD, constant speed, straight driving direction

Distortion

- Distortion shall not be noticeable (tbc)

Merits on vehicle level

Safety & Dynamics

Precise measurement of friction value and clear distinction between different road surfaces, e.g., snow and polished ice

Efficiency

Confirmation of high friction coefficient for optimized disconnect strategy



An abstract background featuring a dark blue wireframe grid on the right side and vibrant red light trails or streaks on the left side, creating a sense of motion and technology.

Vehicle State Observer & Predictor

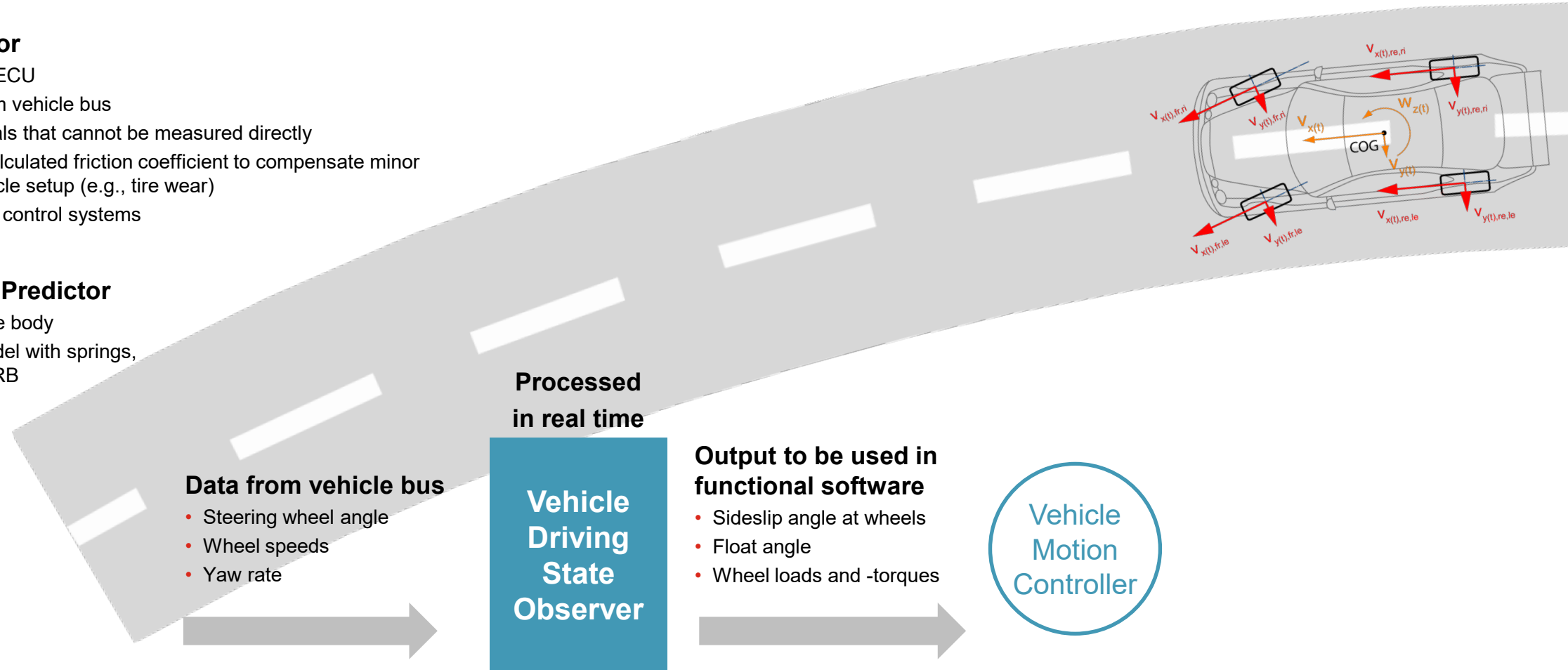
Vehicle Driving State Observer

Facts Predictor

- Located on the ECU
- Uses inputs from vehicle bus
- Calculates signals that cannot be measured directly
- Uses internal calculated friction coefficient to compensate minor changes in vehicle setup (e.g., tire wear)
- Input for vehicle control systems

Specification Predictor

- 5 DOF of vehicle body
- Suspension model with springs, dampers and ARB
- Tire model



DOF: Degree Of Freedom

ECU: Engine Control Unit

ARB: Anti-Roll Bar

→ **Proof of concept done**
→ **Vehicle function active side slip angle control implemented within EtelligentReach**

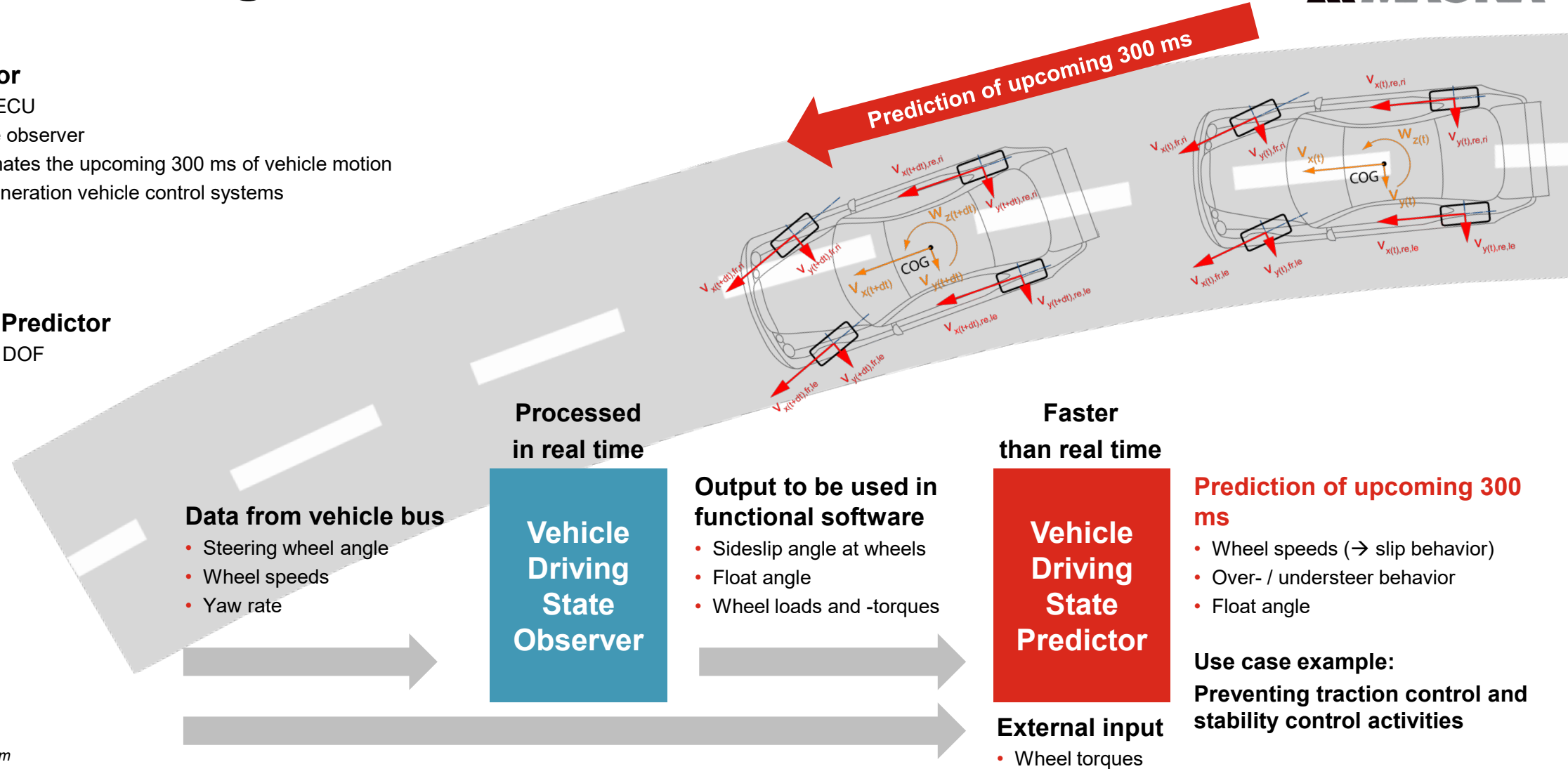
Vehicle Driving State Predictor

Facts Predictor

- Located on the ECU
- Triggered by the observer
- Calculates/estimates the upcoming 300 ms of vehicle motion
- Input for next generation vehicle control systems

Specification Predictor

- Observer plus 5 DOF



DOF: Degree Of Freedom
ECU: Engine Control Unit

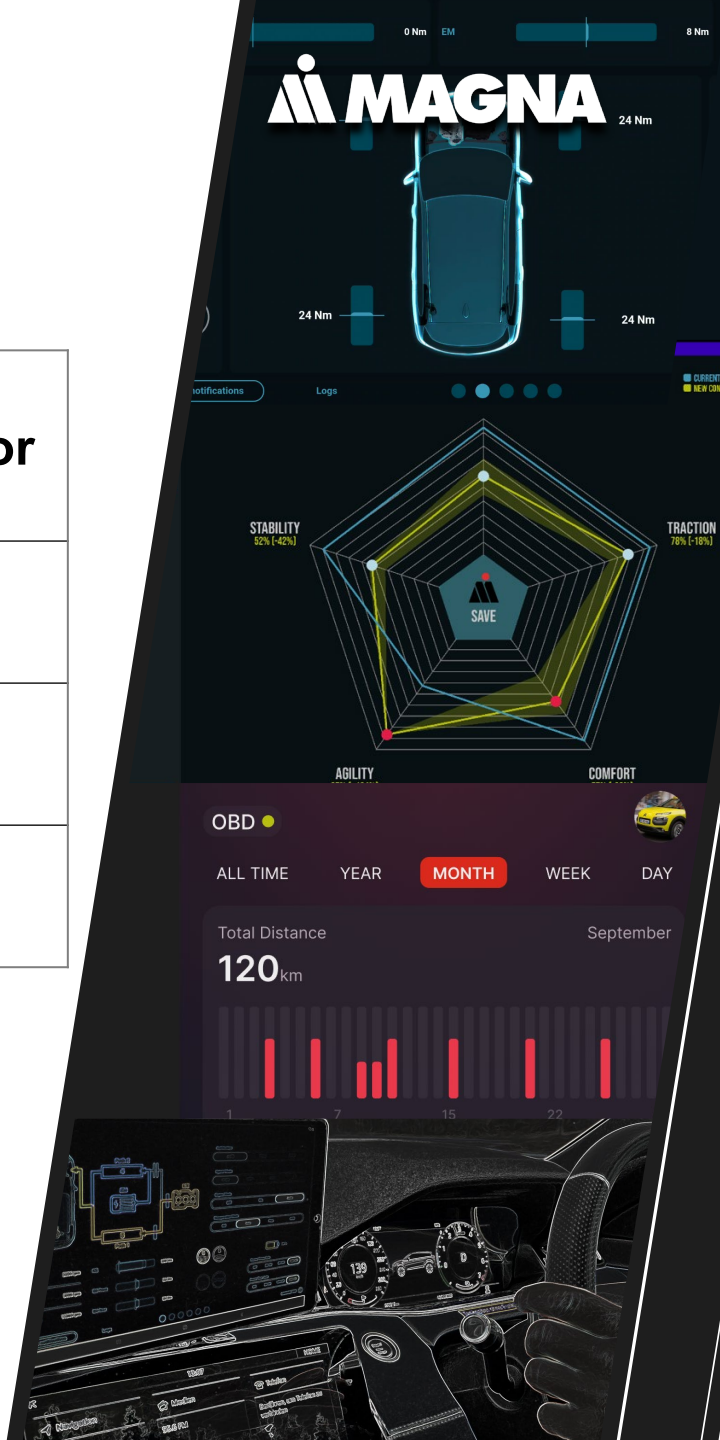
→ *Functionality implemented on rapid prototype system within EtelligentReach*
→ *Next: Commissioning and application of Predictor at Winter Test 2023*

Automotive Applications & Cloud Services

Automotive Applications & Cloud Services

Target Groups				
Focus Area		OEM	Vehicle Driver (End User)	Fleet Operator
 Data collection and analysis		 	 	 
 Visualization			  	 
 Customization				

-  DriveInsights
-  SliderSpider
-  Driva



DriveInsights

Automotive Applications and Cloud Services

Magna DriveInsights



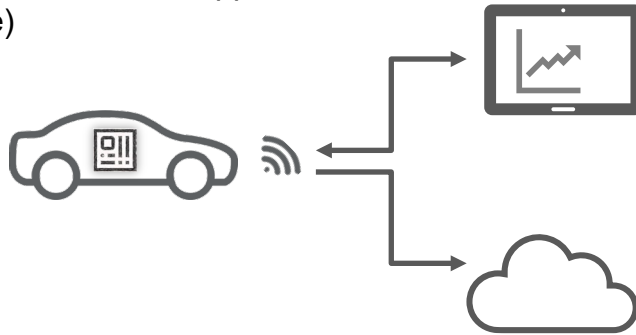
This integrated system provides comprehensive insights in vehicle properties during evolutionary phase and presentation of vehicle features. The versatile app allows an intuitive and modern presentation for emphasizing key features as well as adjustment of component parameters easily and flexible.

All-in-one solution (HW/SW)

- Package includes complete hardware and software (vehicle interface and app for end-to-end service)

Reveal invisible properties

- Present the performance of the vehicle and emphasize unobvious features on any device wirelessly (Tablet, Smartphone, Laptop)



App layout configuration

- User interface is highly customizable from any connected device
- Live view of changes

Cloud configuration and update

- Setup of system is done seamlessly via a cloud configuration interface
- Easy OTA updates for the software modules

- Extract and translate raw data from CAN bus to relevant vehicle KPIs*
- -> real-time, online and suitable for management and media presentation

* joint alignment between customer/MAGNA or preconfigured by MAGNA

Slider Spider

Automotive Applications and Cloud Services

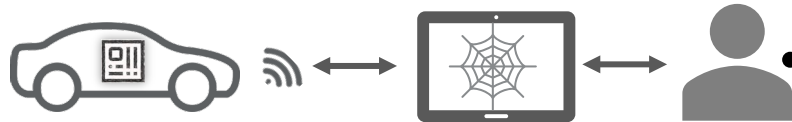
Magna SliderSpider



The interaction concept of SliderSpider offers an intuitive possibility to make all the different vehicle settings transparent to the driver in one single view and it translates an arbitrary number of specific settings into end-consumer values like efficiency, agility or comfort. The very same visualization is used for changing the settings.

Simple presentation

- The current vehicle setup is translated to basic end-consumer values like agility, comfort, traction stability and efficiency.



Understand mutual dependencies

- Interacting and contradicting end-consumer values are made transparent to the driver.

Intuitive user experience

- Driver can change the prioritized end-consumer values and apply the new vehicle setup through the same user interface.

Fully customizable

- An arbitrary amount of vehicle settings is supported and can be added to the app
- The amount and characteristics of end-consumer values can be freely defined
- The SliderSpider approach is independent of vehicle type, powertrain or E/E architecture

Translate an arbitrarily complex amount of vehicle settings into basic end-consumer values through a single, easy-to-read graphical representation

→ Reduced complexity and intuitive user experience

Magna Driva

Automotive Applications and Cloud Services

Magna Driva

under development



Magna Driva allows live data view and tracking of trips incl. visualization of enhanced statistics both within the app and in a web-portal. It makes the driver behavior transparent and enables also improvements regarding efficiency, safety and driving skills.

OEM independent

- The app uses the open OBD port to read data from the vehicle, so that it is usable for all vehicles across the fleet

Advanced data analysis

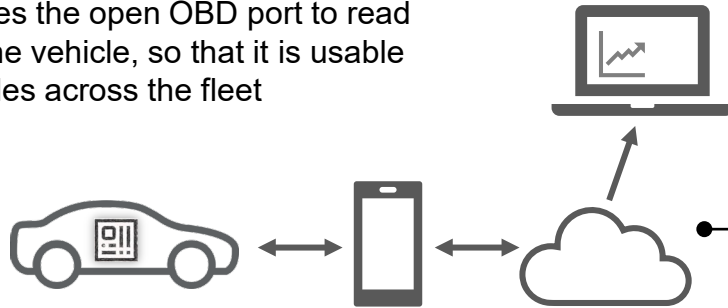
- Historic recordings can be analyzed automatically by cloud-powered algorithms

Comparison and improvement

- Drivers can compare their trips with past recordings or with other users to challenge themselves and each other and improve skills
- Recorded trip data can be compared among each other within the app or by sharing via social media

Consolidated statistics

- Live data and driving statistics are presented on the end user's smartphone and therefore are always available
- Consolidation for multiple vehicles and multiple users



The Driva app enables both live view and consolidation of comprehensive trip data for one vehicle or across a fleet in a single platform, available everywhere and any time