



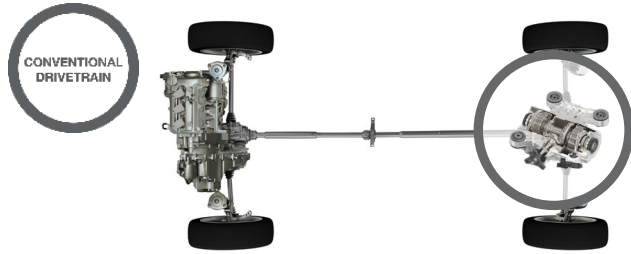
Wintertest 2023

Magna PerformMax™ Rear Drive System in Cupra Formentor VZ5



Magna PerformMax™ Rear Drive System for Cupra Formmentor VZ5

Rear Axle



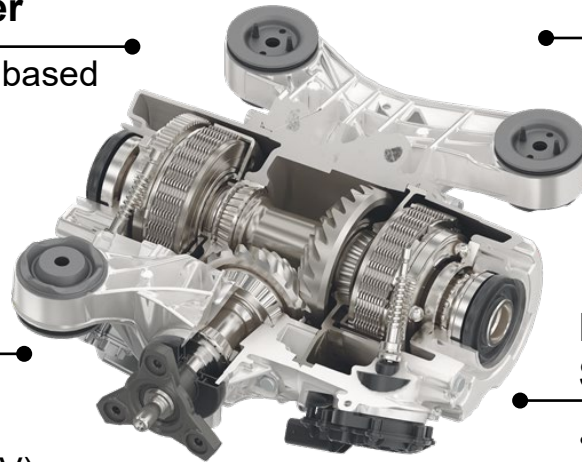
The dual-clutch torque vectoring rear drive system allows for independent torque to be provided to the rear left and right wheels. With this, a superior driving performance can be achieved.

Magna Vehicle Controller

- Advanced control strategy based on physical vehicle model
- Closed loop yaw control

Variability

- SW calibration supports different vehicle segments (from B/C-Sedan to C/D-SUV)
- Different driving modes for each vehicle (Comfort; Sport; Cupra (Race); Torque Rear (Drift); Offroad)



Torque Vectoring

- Stable performance across the complete temperature range
- Lowest hysteresis by advanced position controls

Electromechanical Actuation System

- Two brushless motor integrated actuators
- Ball-ramp type actuation system



PerformMax™ Dual-Clutch Rear Drive System

Safety

Throttle-off closed loop yaw damping

Convenience

5 driving modes with noticeable changing vehicle behavior

Dynamics

3,500 Nm axle torque capacity
(1,750 Nm per side)

Technical details:

Axle ratio: 27:17

Feature: MSE-ISP
(latest gen. integrated ACTR)



Pre-Development

Released for Acquisition

Serial Development

Serial Production

Magna PerformMax™ Rear Drive System for Cupra Formentor VZ5

Rear Axle



The dual-clutch torque vectoring rear drive system allows for independent torque to be provided to the rear left and right wheels. With this, a superior driving performance can be achieved.



Features/Specifications

Cupra Formentor VZ5

Engine type:	2.5 l gasoline I5
Engine power:	287 kW
Engine torque:	480 Nm
Ratio PTU:	1.59
Ratio RA:	1.59

Magna Technology
PerformMax™
Dual-Clutch Rear Drive System

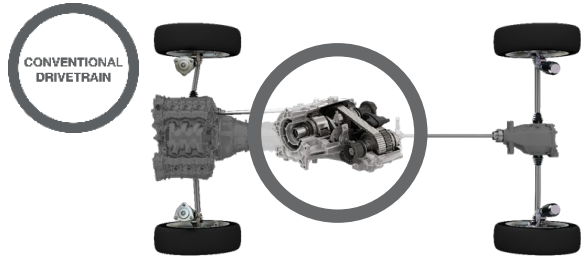


Pre-Development Released for Acquisition Serial Development **Serial Production**

Magna UltiMax™ Transfer Case in Jeep Gladiator Overland



Magna UltiMax™ Transfer Case in Jeep Gladiator Overland



Magna Powertrain's ULTIMAX™ Active Transfer Case is a 2-speed transfer case with a multi-plate wet clutch and electromechanical ball ramp type actuation.

Design

- Unique Layout to support highly capable off-road vehicles; while maintaining Magna's Building Block Strategy to leverage common Core Technologies



Controls

- Direct Actuation System and MPT's controls strategy for optimal torque accuracy and dynamic torque distribution (front to rear)

Electromech. Clutch Actuation System

- Ball-ramp type actuation system w/ calculated self-locking effect for min. power consumption



Magna UltiMax™ Two-Speed Active Transfer Case

Technical details:

Max. clutch torque: 1,600 Nm
Center distance: 242.9 mm

Pre-Development Released for Acquisition Serial Development **Serial Production**



Magna UltiMax™ Transfer Case in Jeep Gladiator Overland



Magna Powertrain's ULTIMAX™ Active Transfer Case is a 2-speed transfer case with a multi-plate wet clutch and electromechanical ball ramp type actuation.



Features/Specifications

Jeep Gladiator Overland

Engine type: 3.6 l

Engine power: 212 kW

Engine torque: 352 Nm

Magna Technology

UltiMax™ two-speed active transfer case



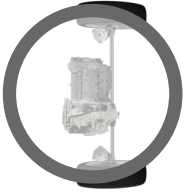
Pre-Development Released for Acquisition Serial Development **Serial Production**

Magna 7HDT300 48V for Alfa Romeo Tonale



Magna 7HDT300 48V for Alfa Romeo Tonale

Front Axle



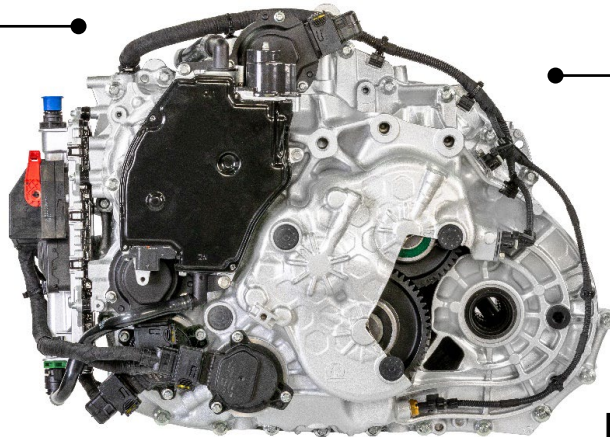
7-speed hybrid dual-clutch transmission for mild hybrids; torque-split design to enable ideal use of the efficiencies of the combustion engine and the e-motor. Ideal for B- up to D-class.

Family concept

- Part of 300/400 family with DCT, HDT and DHD application

eMotor

- Mild hybrid (48 V)
- Independent on demand cooling for clutch and e-motor
- Single oil circuit for cooling and lubrication
- Integrated, high-speed e-motor



Best in Class Efficiency

- Low-drag torque due to low-viscosity fluid
- High gear mesh efficiency

BIC Torque-to-Weight ratio

DCT-based P2.5 architecture
High speed eMachine concept

Magna 7HDT300

Efficiency:

Up to 18 % CO2 savings according WLTP versus DCT

Safety & Reliability:

Reuse of matured technologies and building blocks incl. ASIL C

Convenience:

Adjustable Drivability by Clutch Modulation and eRock-Cycling

Dynamics:

320 Nm ICE Torque plus
15kW eBoost capability

Integration:

BIC torque-to-weight ratio (= 3,8 Nm/kg) and interchangeable flexibility

Pre-Development

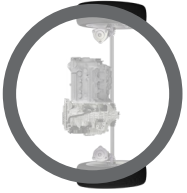
Released for Acquisition

Serial Development

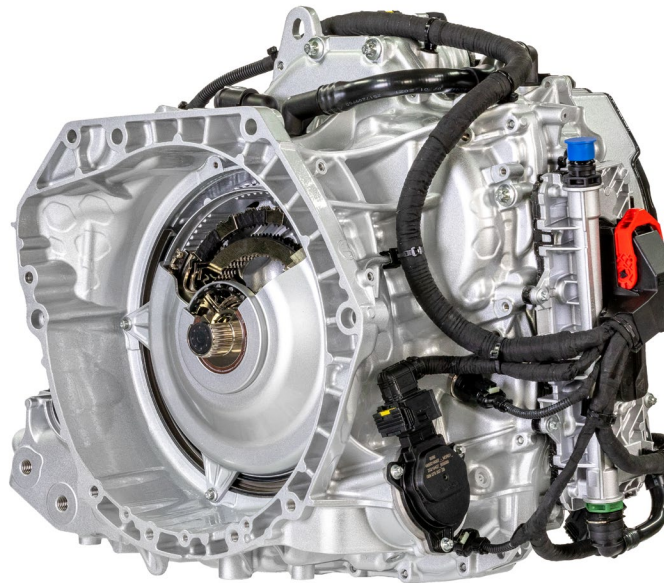
Serial Production

Magna 7HDT300 48V for Alfa Romeo Tonale

Front Axle



7-speed hybrid dual-clutch transmission for mild hybrids; torque-split design to enable ideal use of the efficiencies of the combustion engine and the e-motor. Ideal for B- up to D-class.



- Max. torque: 320 Nm
- Installation length: 364 mm
- Center distance: 197 mm
- Ratio 1st gear: 13.7 - 18.6
- Gear ratio spread: up to 8.5

Magna 7HDT300

Efficiency:

Up to 18 % CO₂ savings according WLTP versus DCT

Safety & Reliability:

Reuse of matured technologies and building blocks incl. ASIL C

Convenience:

Adjustable Drivability by Clutch Modulation and eRock-Cycling

Dynamics:

320 Nm ICE Torque plus 15 kW eBoost capability

Integration:

BIC torque-to-weight ratio (= 3,8 Nm/kg) and interchangeable flexibility



Magna 7HDT300 48V for Alfa Romeo Tonale

Front Axle



7-speed hybrid dual-clutch transmission for mild hybrids; torque-split design to enable ideal use of the efficiencies of the combustion engine and the e-motor. Ideal for B- up to D-class



Features/Specifications

Alfa Romeo Tonale

Engine Type: 1.5 l.

4 cylinder turbo charged direct injection engine

Engine Power: 118 kW

Engine Torque: 240 Nm

Battery: 48V 0.8 kWh (nominal)

Magna Powertrain Technology
7HDT300 with 15kW EM

Pre-Development

Released for Acquisition

Serial Development

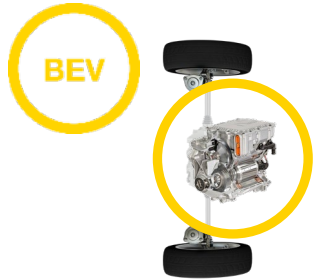
Serial Production



Magna eDS Low CE for VW iD.5 GTX



Magna eDS Low CE for VW MEB Platform



Compact secondary boost drive for midsize EVs with best-in-class drag torque and compact design. Dedicated design for EV platforms.

Package & Weight

- Compact coaxial design, especially in critical x-direction enabling maximum interior space

E-motor

- ASM w/ OD 200 mm



Vehicle Integration

- NVH jacket prevented

System Efficiency

- Best-in-class drag torque

Magna eDS Low CE

Efficiency

150 W @ 600 rpm best-in-class drag loss

Safety

1,570 Nm front axle torque

Convenience

Preventing secondary NVH measures

Dynamics

80 kW peak power on front axle up to maximum speed

Sustainability

Dedicated secondary ASM rare earth free

Technical details:

Peak axle power:	80 kW for 30 s
Peak axle torque:	1,570 Nm
Cont. axle torque:	400 Nm
Output speed:	1,350 rpm
x-direction w/o mountings	250 mm

Pre-Development

Released for Acquisition

Serial Development

Serial Production



Magna eDS Low CE for VW MEB Platform



Compact secondary boost drive for midsize EVs with best-in-class drag torque and compact design. Dedicated design for EV platforms.



Features/Specifications VW ID.5 GTX

System power: 220 kWp

Primary drive: 150 kWp

Secondary drive: 80 kWp

Magna Technology
eDS Low CE Front Axle Drive:
Compact secondary boost
drive

Pre-Development Released for Acquisition Serial Development **Serial Production**

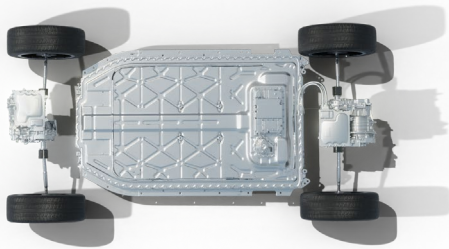


Magna eDS Mid+ for EtelligentReach Demonstrator



Magna eDS Mid+ Demonstrator

Primary Axle

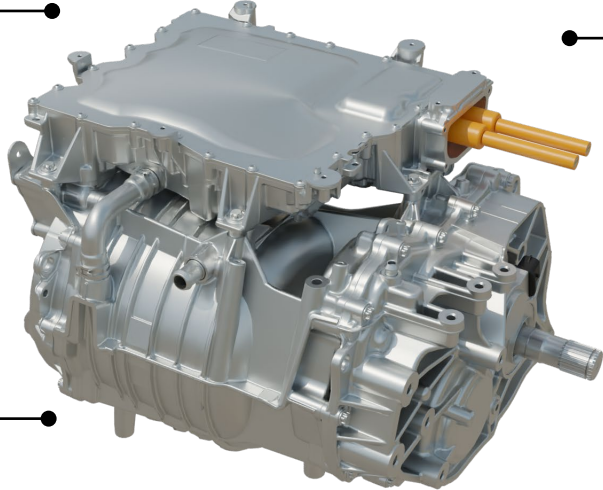


Magna's eDrive system on the front provides up to 207 kW. It can be applied to both hybrid and battery electric vehicles. Next-gen technologies support best-in-class efficiency, safety, convenience and dynamics.

for C, D, E, VAN Segment

Inverter

- SiC power electronics
- Boost option for higher torque & power
- Native speed interface for fast interaction w/ vehicle controls



E-motor

- PSM e-motor with highly efficient insertion winding technology

Parklock

- Electric BLDC actuation
- ASIL B, stay silent

Gearset

- Rotor shaft with 2 bearings
- Low loss gears applied for 2nd gearset

Magna eDS Mid+

Efficiency

35 W drag loss at 50 kph or
94 % max. efficiency
91.6 % avg. efficiency WLTC

Safety

< 200 ms fast reconnect time

Convenience

1 ms control loop of native speed interface

Dynamics

+ 8 % torque boost (7 sec.)
+ 22 % power boost (7 sec.)

Sustainability

Greenhouse gas neutral
manufacturing from 2025



Pre-Development

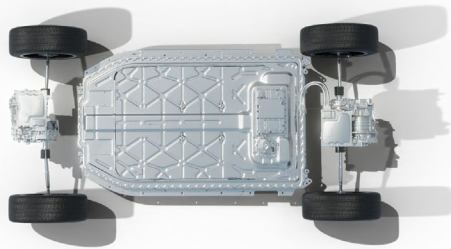
Released for Acquisition

Serial Development

Serial Production

Magna eDS Mid+ Demonstrator

Complimentary Axle (Rear)



Magna's eDrive system on the front provides up to 207 kW. It can be applied to both hybrid and battery electric vehicles. Next-gen technologies support best-in-class efficiency, safety, convenience and dynamics.

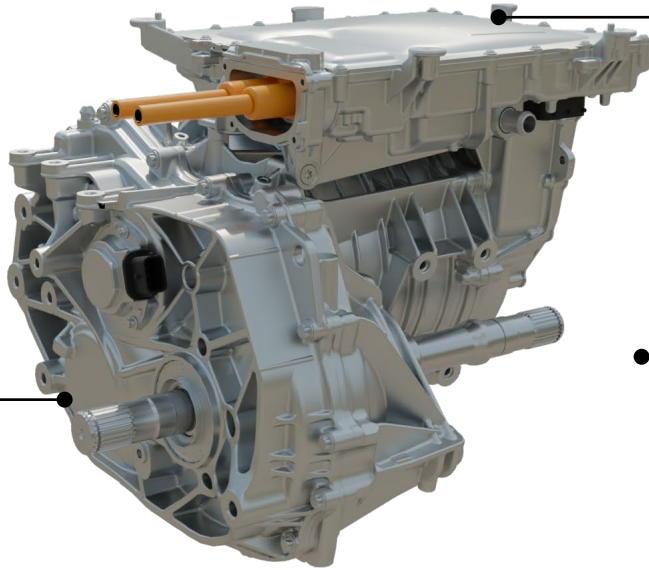
for C, D, E, VAN Segment

Inverter

- Si power electronics
- Boost option for higher torque & power
- Native speed interface for fast interaction w/ vehicle controls

E-motor

- PSM e-motor with highly efficient insertion winding technology



Decoupling

- Proven AWD technology combined with new controls strategy leading to improved efficiency (2WD) while maintaining performance and safety

Gearset

- Rotor shaft with 2 bearings
- Low loss gears applied for 2nd gearset

Magna eDS Mid+

Efficiency

35 W drag loss at 50 kph or
94 % max. efficiency
91.6 % avg. efficiency WLTC

Safety

< 200 ms fast reconnect time

Convenience

1 ms control loop of native speed interface

Dynamics

+ 8 % torque boost (7 sec.)
+ 22 % power boost (7 sec.)

Sustainability

Greenhouse gas neutral
manufacturing from 2025



Pre-Development

Released for Acquisition

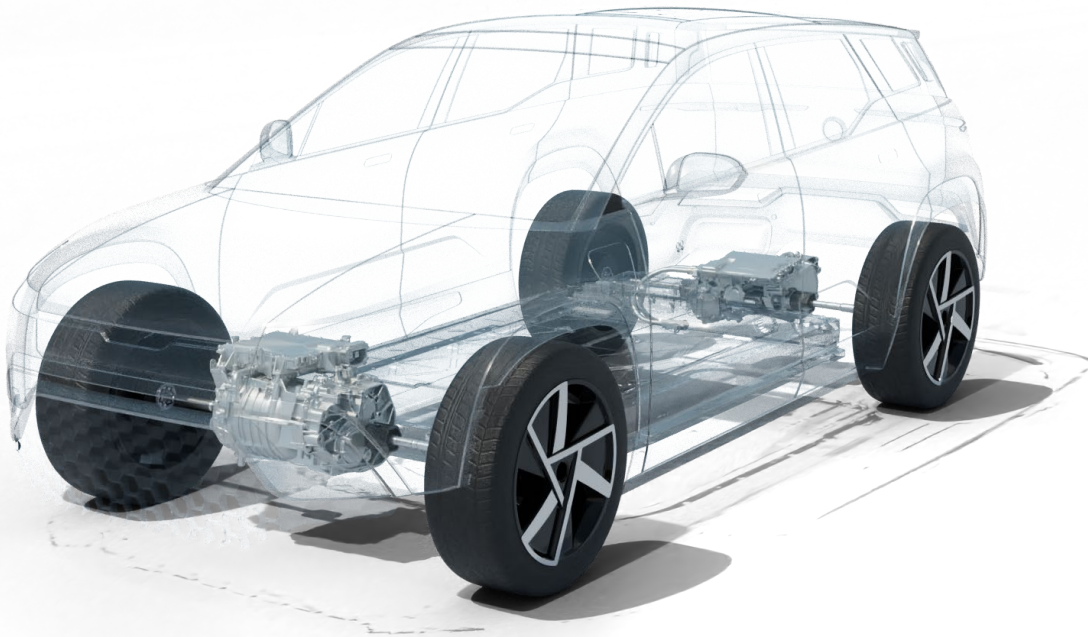
Serial Development

Serial Production

Magna eDS Mid+ Demonstrator

BEV

Magna's electric powertrain solution with highly integrated eDrive systems on the front and rear axles, as well as an intelligent operating strategy that allows for outstanding drivability in any situation with the most efficient energy use and an extended range.



Features/Specifications

Rear Electric Drive System Magna eDS Mid+ with Decoupling

Max. axle power	207 kW for 7s
Max. axle torque	4,290 Nm
Cont. axle power	83 kW
Ratio rear axle	11,349

Front Electric Drive System Magna eDS Mid+ with Parklock

Max. axle power	207 kW for 7s
Max. axle torque	4,290 Nm
Cont. axle power	83 kW
Ratio rear axle	11,349

& Magna Operating Strategy

Pre-Development Released for Acquisition Serial Development Serial Production



Magna Hybrid Demonstrator Vehicles





- Electric Range
- EV-Feel Driving
- Intelligent Assistance
- Affordability
- Efficiency

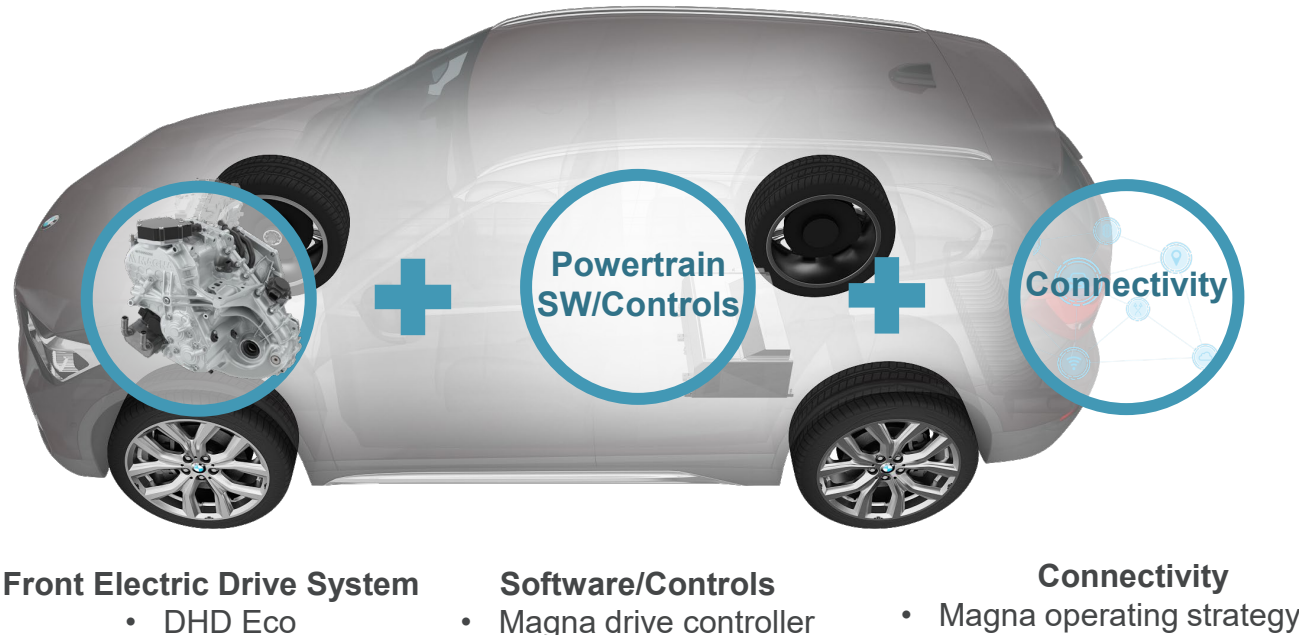


Magna EtelligentEco

EtelligentEco Benchmark for Efficient PHEVs



Magna EtelligentEco is an advanced PHEV solution that improves range and efficiency for high-volume applications with front-wheel drive without compromising drivability, even in electric mode. The software and DHD Eco dedicated hybrid drive reduce greenhouse gas emissions.



Pre-Development Released for Acquisition Serial Development Serial Production

Magna EtelligentEco

Efficiency

CO2 saving for vehicles in real world driving conditions and 100 km pure electric range (WLTP)

Convenience

Up to 135 kph top speed in eDrive
Intelligent launch by 1 msec control loop

Dynamics

Smooth BEV-like response behavior
Up to 3,000 Nm axle torque

Benefits

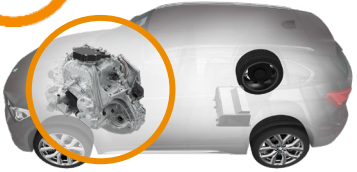
Best-in-class value-for-money
Best-in-class torque-to-weight ratio (= 3,8 Nm/kg)



Dedicated Hybrid Transmission DHD Eco

Front Axle

PHEV



The DHD Eco is part of the Eco family and uses a smart modular, scalable approach for low torque HV applications. The DHD Eco is reduced to four gears (acting as a dedicated hybrid drive) with eLaunch, eReverse and two gears in electric driving.

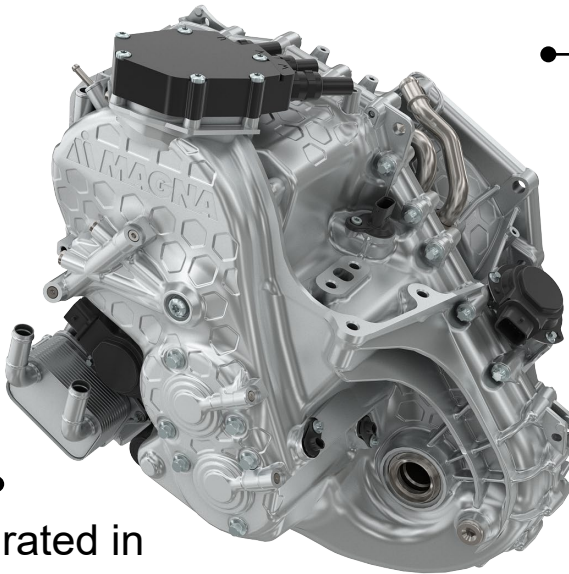
for B-C Segment

Inverter

- Water cooled, transmission mounted inverter

E-motor

- PSM e-motor integrated in transmission housing, cooled by common oil circuit for wet dual clutch and gearset



Cost Optimized Design

- DCT-based DHD concept with four physical gears, eLaunch & eReverse

Best-in-class Torque-to-weight Ratio

- DCT-based P2.5 architecture
- High speed e-motor concept with 120 kWp

Magna DHD Eco

Efficiency*

-74 % fuel consumption vs. DCT (WLTC)

Safety

Low risk by reuse of matured technologies & building blocks, ASIL C

Convenience

Adjustable drivability by clutch modulation & SW functions to support individual OEM branding

Up to 2,650 Nm pure eDrive axle torque

Dynamics

Strong 120 kW e-motor peak power to support any all-day driving conditions with pure electric drive

Benefits

Short y-length of 350 mm

Suitable interchangeable flexibility to adapt with market dynamics



* 1.0l 120kW 3-Cyl. Gasoline; Capacity 12kWh (useable)

EtelligentEco Benchmark for Efficient PHEVs



Magna EtelligentEco is an advanced PHEV solution that improves range and efficiency for high-volume applications with front-wheel drive without compromising drivability, even in electric mode. The software and DHD Eco dedicated hybrid drive reduce greenhouse gas emissions.



Features/Specifications

Engine type: 1.5 l gasoline engine

Engine power: 100 kW

Engine torque: 230 Nm

Range (WLTP): 100 km

Front Electric Drive System Magna DHD Eco

Up to 3,000 Nm axle torque with e-boost capability

E-motor: 120 kW at 350 V,
200 Nm peak

HV battery: 19 kWh (usable)



Pre-Development Released for Acquisition Serial Development Serial Production



Eco



Comfort



Sport

Architecture

AWD

FWD

RWD

Hybrid Mode

PHEV

HEV

MHEV

EV

DCT

Magna EtelligentCommand

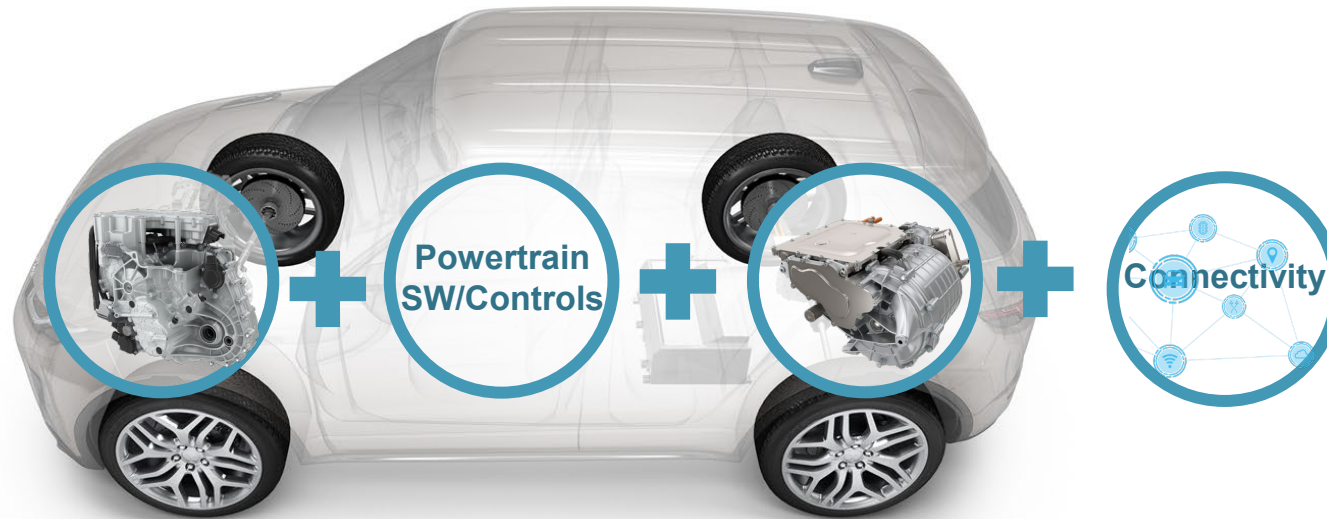


EtelligentCommand for Drivability and Range in all Driving Situations



optional

EtelligentCommand is a PHEV/HEV system featuring a dedicated hybrid drive DHD Plus at the front and an eDrive Mid+ with torque vectoring at the rear, combined with advanced software and controls. Various driving modes are available on command with uncompromised performance, outstanding drivability, as well as superior power handling and control.



Front Electric Drive System

- DHD Plus

Software/Controls

- Magna drive controller
- Magna operating strategy

Rear Electric Drive System

- eDS Mid+ with torque vectoring

Connectivity

- Magna operating strategy

Pre-Development

Released for Acquisition

Serial Development

Serial Production

Magna EtelligentCommand

Efficiency

Enables CO2 saving in real-world driving conditions and 110 km pure electric range (WLTP)

Safety

Up to 15% safety margin

Convenience

Best-in-class drivability including eLaunch and modes for any driving situation

Dynamics

Extended e-boost capability on front and rear axle

Sustainability

- 40% life cycle CO2 emissions (LCA 2025 to 2035)



Hybrid modes and use cases



Think
Electric !



EtelligentCommand

147kW ICE

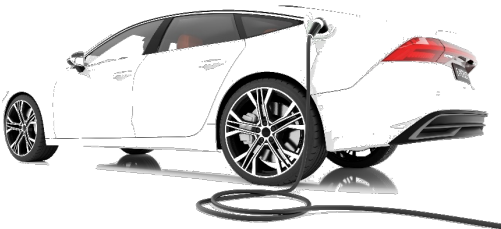


160kW eDS

120kW DHD

City			2WD
Rural			2WD/AWD
Highway			2WD
Mountain			AWD
Offroad			AWD
Sport			AWD

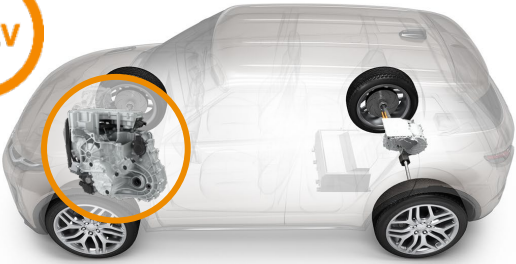
State-of-the-art PHEV



- electric
- hybrid
- ICE

Dedicated Hybrid Drive DHD Plus

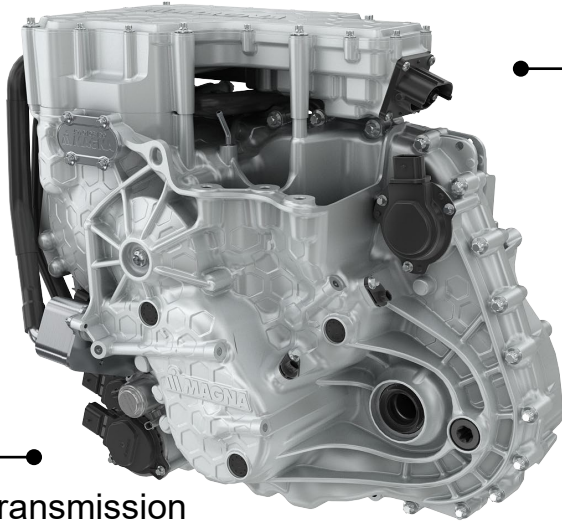
Front Axle



DHD Plus, as part of the 400 family, uses a smart, modular scalable approach for high torque and voltage applications - acting as a dedicated hybrid transmission with eLaunch, eReverse and two gears in electric driving. It provides full powershift capability in all modes.

Inverter

- Water cooled, transmission mounted inverter



E-motor

- PSM e-motor integrated in transmission housing, cooled by common oil circuit for wet dual clutch and gearset. Increased power density & higher efficiency compared to coaxial design

for C-D Segment

Cost and Efficiency Optimized Design

- DCT-based DHD concept with five physical gears, eLaunch & eReverse, long overdrive gear ratio, e-motor can be disconnected

Best-in-class Torque-to-weight Ratio

- DCT-based P2.5 architecture
- High speed e-motor concept with 120 kWp

Magna DHD Plus

Efficiency*

-83 % fuel consumption vs. DCT (WLTC)

Safety & Reliability

Low risk by reuse of matured technologies and building blocks with ASIL C

Convenience

Smooth e-power shiftability
Best NVH behavior

Dynamics

Strong 120 kW e-motor peak power to support any all-day driving condition with pure electric drive
eCrawler for creeping and high towing capability

Packaging & Integration

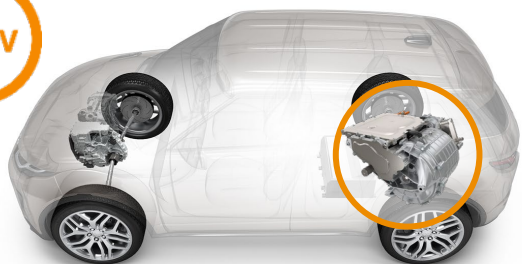
Short y-length of 360 mm
Suitable interchangeable flexibility to cope with market dynamics



* 1.4l 120kW DHP-optimized 4-Cyl. Gasoline; Capacity 21kWh (useable)

eDS Mid+

Rear Axle with Torque Vectoring



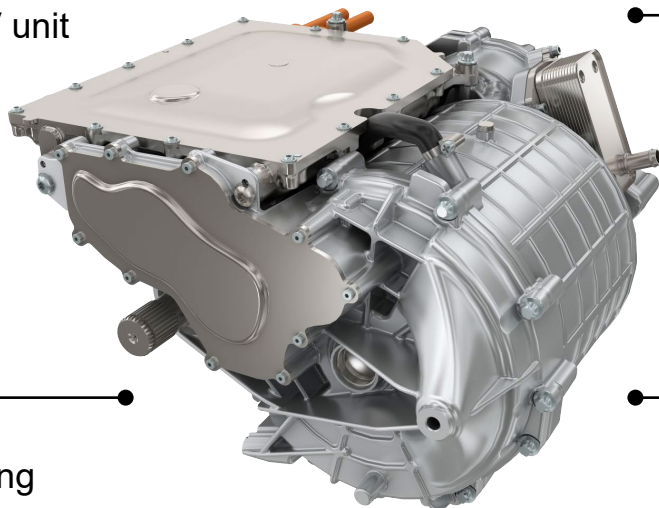
The eDrive system on the rear is equipped with the small-packaged twin-clutch torque vectoring system for best-in-class dynamics and safety. It provides up to 160 kW and can be applied to hybrid and battery electric vehicles.

Package

- Highly integrated TV unit (left & right clutch)

E-motor

- PSM e-motor with highly efficient winding technology



Inverter

- Native speed interface for fast interaction w/ vehicle controls

Torque Vectoring Units

- Smart Actuator with serial proven software
- TV clutches feature decoupling function

Magna eDS Mid+ w/ Torque Vectoring

Efficiency

91.6 % efficiency in WLTC or 150 W drag loss

Safety

2,250 Nm TV superposition torque

Convenience

1 ms control loop of native speed interface

Dynamics

< 100 ms response time

Package

Package-neutral torque vectoring clutch integration



EtelligentCommand for Drivability and Range in all Driving Situations



EtelligentCommand is a PHEV system featuring a dedicated hybrid drive DHD Plus at the front and an eDrive Mid+ with torque vectoring at the rear, combined with advanced software and controls. Various driving modes are available on command with uncompromised performance, outstanding drivability, as well as superior power handling and control.



Features/Specifications

Front Electric Drive System Magna DHD Plus

Engine type: 1.5 l 3-Cyl. gasoline engine
Engine power: 147 kW
Engine torque: 280 Nm
Range (WLTP): 110 km
E-motor: 120 kW at 350 V, 200 Nm peak

Rear Electric Drive System Magna eDS Mid+ w/ TV

Peak axle power: 160 kW for 30 s
Peak axle torque: 3,750 Nm
Continuous axle torque: 1,500 Nm
Ratio RA: 11,307

HV Battery: 21.5 kWh (usable)



Pre-Development Released for Acquisition Serial Development Serial Production

A horizontal banner with a dark background. It features blue wireframe architectural structures and vibrant red light streaks. The word 'EtelligentReach' is centered in white. On the right side, there is a large white circular graphic containing a stylized, winding path.

EtelligentReach



 MAGNA

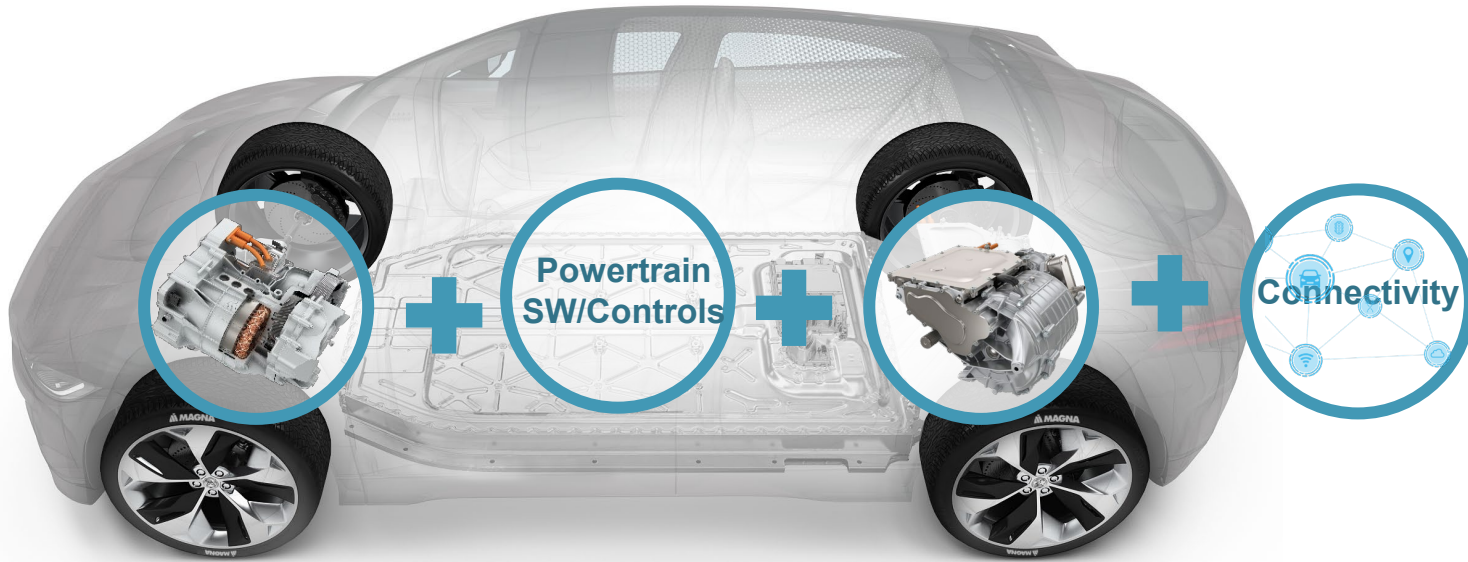


Magna
EtelligentReach

EtelligentReach Benchmark for Range and Dynamics

BEV

EtelligentReach is a BEV powertrain solution with highly integrated Magna eDrive systems on the front and rear axles, as well as an intelligent operating strategy that allows for outstanding drivability in any situation with the most efficient energy use and an extended range.



Front Electric Drive System

- eDS Mid+ w/ Decoupling+

Software/Controls

- Drive controller
- Integrated eDrive and Brake Controls
- Active Sideslip Angle Control

Rear Electric Drive System

- eDS Mid+ w/ torque vectoring

Connectivity

- Motion & Energy Control

Pre-Development

Released for Acquisition

Serial Development

Serial Production

EtelligentReach BEV solution

Efficiency

+ 16 % range through powertrain efficiency optimization

Safety

Up to 15 % safety margin

Convenience

- 50 % steering wheel angle demand

Dynamics

+ 0.1 g lateral acceleration

New in
2023

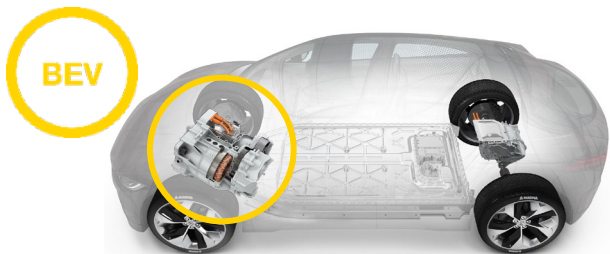
Integrated eDrive and Brake Controls

Active Sideslip Angle Control



eDS Mid+ with Next-Gen Technologies

Secondary Axle (Front)



Magna's eDrive system on the front provides up to 160 kW. It can be applied to both hybrid and battery electric vehicles. Next-gen technologies support best-in-class efficiency, safety, convenience and dynamics.

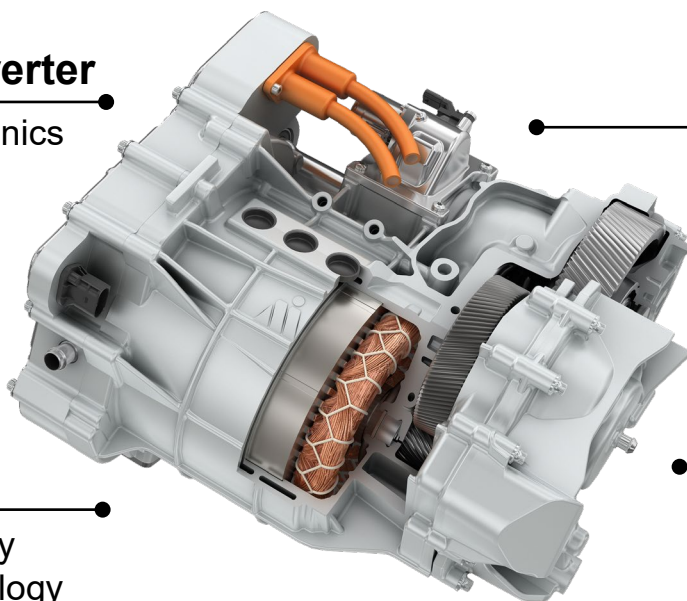
for C, D, E, VAN Segment

Fully Integrated Inverter

- Si or SiC power electronics
- Boost option for higher torque & power
- Native speed interface for fast interaction w/ vehicle controls

E-motor

- PSM e-motor with highly efficient winding technology



Decoupling+

- Proven AWD technology combined with new controls strategy leading to improved efficiency (2WD) while maintaining performance and safety

Gearset

- Rotor shaft with 2 bearings
- Ball bearing or roller bearing w/o preload
- Low loss gears applied for 2nd gearset

Magna eDS Mid+

Efficiency

35 W drag loss at 50 kph or
94 % max. efficiency

91.6 % avg. efficiency WLTC

Safety

< 200 ms fast reconnect time

Convenience

1 ms control loop of native speed interface

Dynamics

+ 8 % torque boost (7 sec.)
+ 22 % power boost (7 sec.)

Sustainability

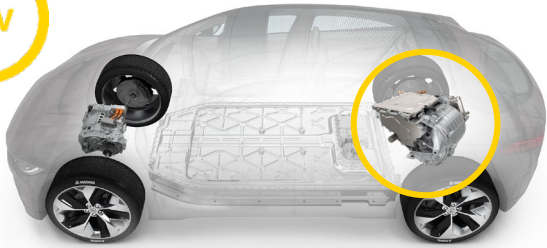
Optional ASM rare earth free
dedicated secondary drive available



Pre-Development Released for Acquisition Serial Development Serial Production

eDS Mid+ with Torque Vectoring

Primary Axle (Rear)

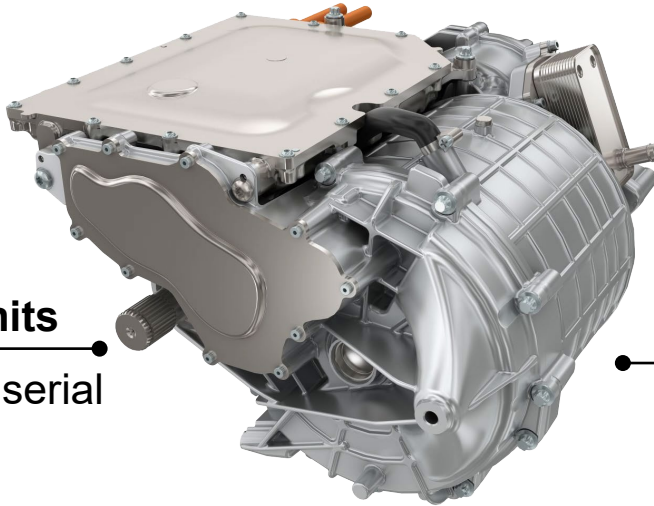


The eDrive system on the rear is equipped with the small-packaged twin-clutch torque vectoring system for best-in-class dynamics and safety. It provides up to 160 kW and can be applied to hybrid and battery electric vehicles.

for C, D, E, VAN Segment

Package

- Highly integrated TV unit (left & right clutch)



Torque Vectoring Units

- Smart Actuator with serial proven software
- TV clutches feature decoupling function

Inverter

- Native speed interface for fast interaction w/ vehicle controls

E-motor

- PSM e-motor with high efficient winding technology

Magna eDS Mid+ w/ Torque Vectoring

Efficiency

150 W drag loss at 50 kph or
94 % max. efficiency
91.6 % avg. efficiency WLTC

Safety

2,250 Nm TV superposition torque

Convenience

1 ms control loop of native speed interface

Dynamics

< 100 ms response time

Package

Package neutral torque vectoring
clutch integration



Pre-Development Released for Acquisition Serial Development Serial Production

EtelligentReach Benchmark for Range and Dynamics

BEV

EtelligentReach is a BEV powertrain solution with highly integrated Magna eDrive systems on the front and rear axles, as well as an intelligent operating strategy that allows for outstanding drivability in any situation with the most efficient energy use and an extended range.



Features/Specifications

Rear Electric Drive System Magna eDS Mid+ w/ TV

Peak axle power	160 kW for 30 s
Peak axle torque	3,750 Nm
Cont. axle torque	1,500 Nm
Maximum capacity per clutch	3,000 Nm
Ratio rear axle	11,307

Front Electric Drive System Magna eDS Mid+ w/ DC

Peak axle power	160 kW for 30 s
Peak axle torque	4,000 Nm
Continuous axle torque	2,000 Nm
Ratio front axle	11,720

Motion & Energy Control



Pre-Development Released for Acquisition Serial Development Serial Production

Magna SmartBridge™ Software - Energy & Motion Control





Off-board Connectivity



Vehicle Energy Control

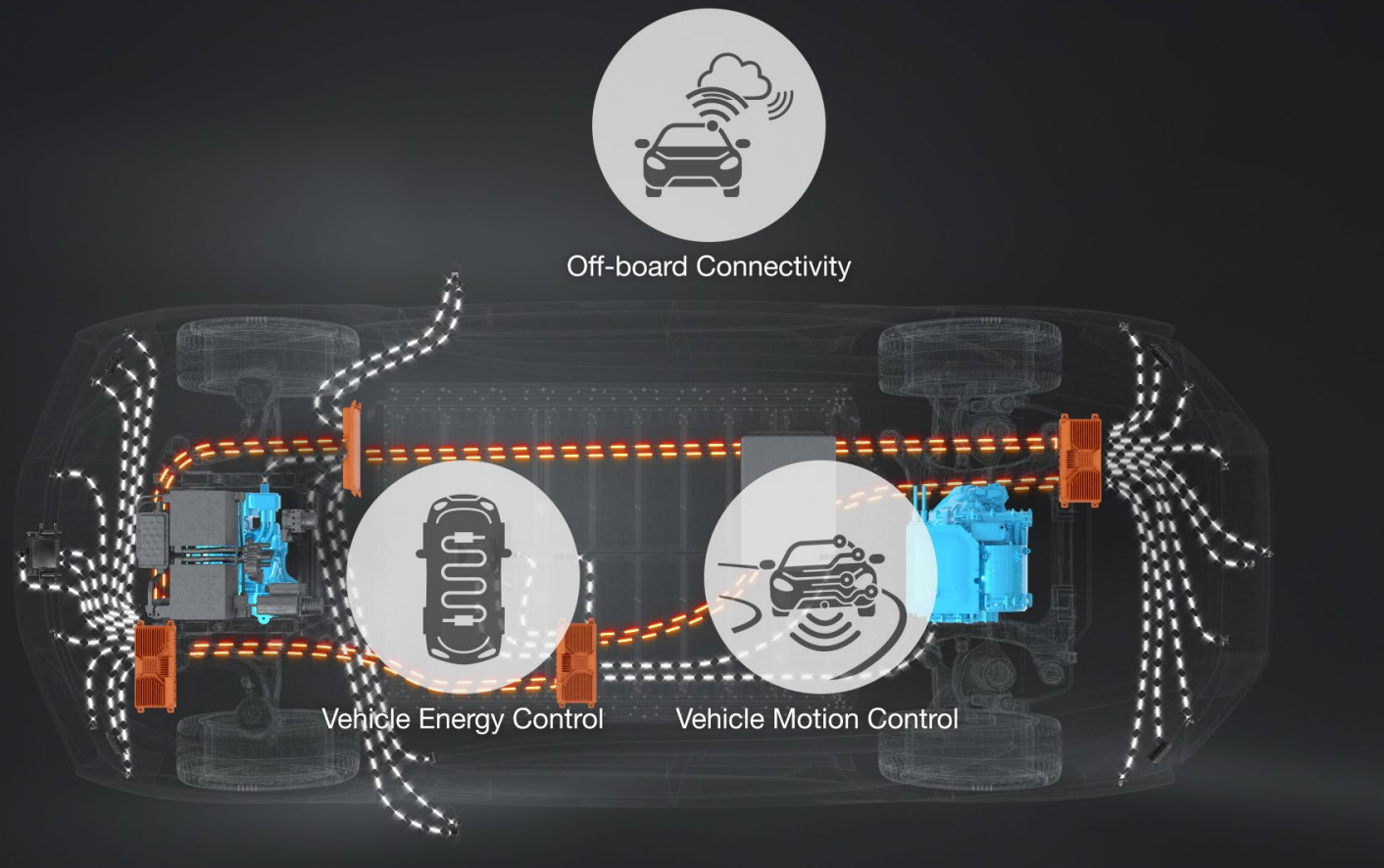


Vehicle Motion Control



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

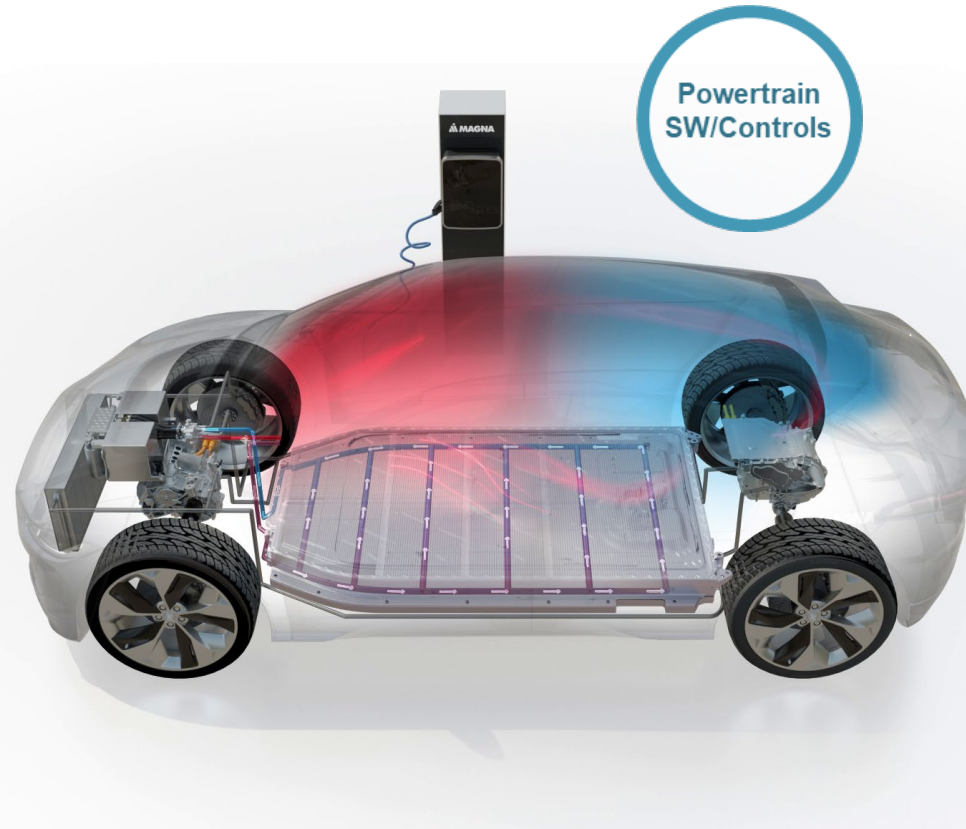
Powertrain conditioning

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

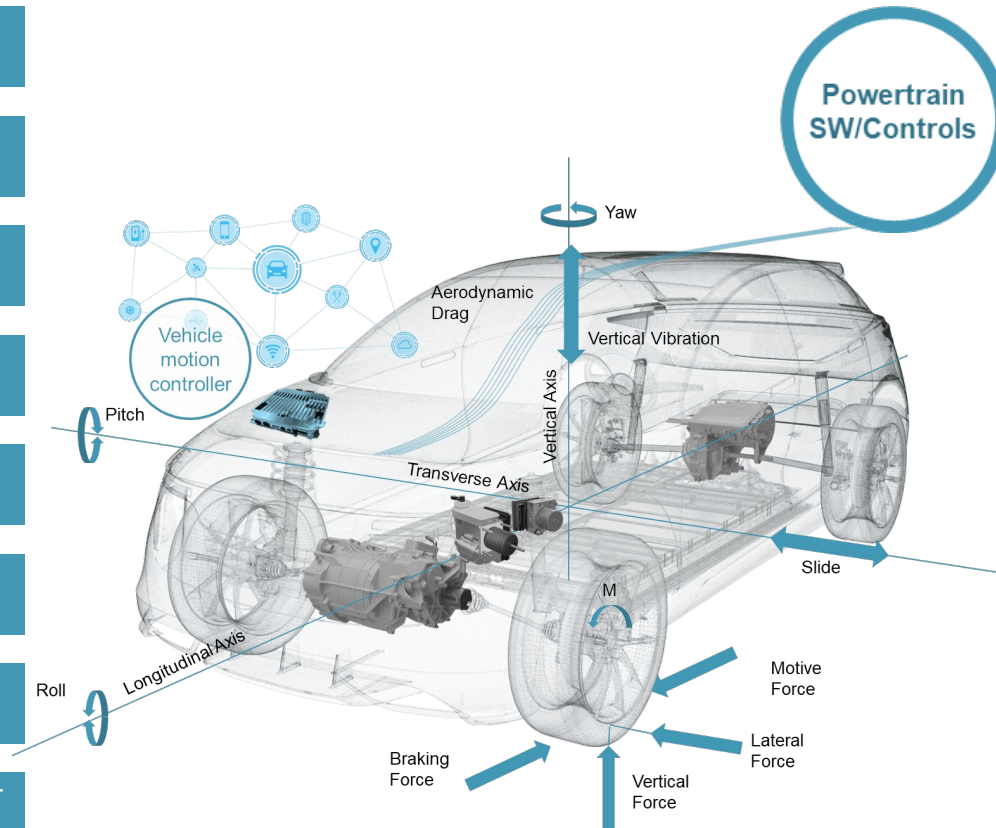
Lateral torque vectoring incl. integrated eDrive and brake controls

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 red light rays emanating from the left, intersecting with blue wireframe structures that resemble architectural or mechanical frameworks. The overall color palette is dark, with the red and blue elements providing high contrast.

Integrated eDrive and Brake Control

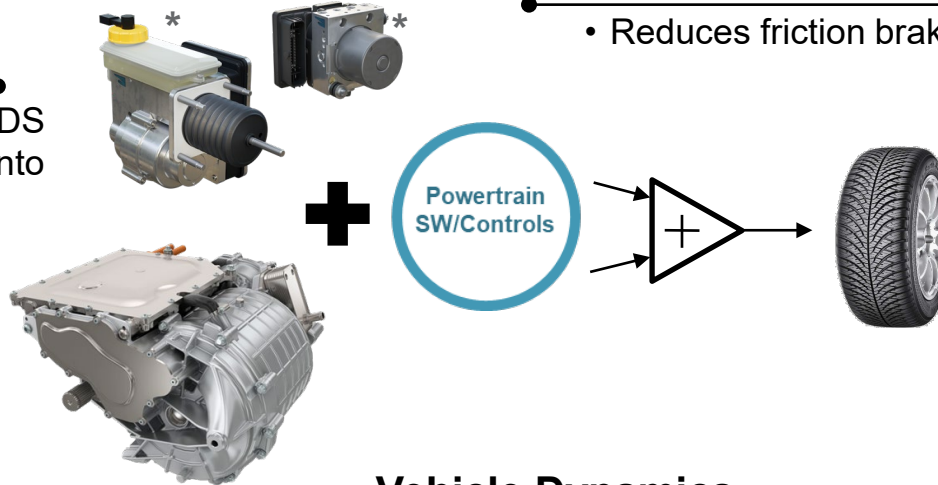
Integrated eDrive and Brake Control



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



Wheel Torque Interface

- Enables accurate torque and speed control for each wheel individually

Advanced Brake Blending

- Reduces friction brake losses

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

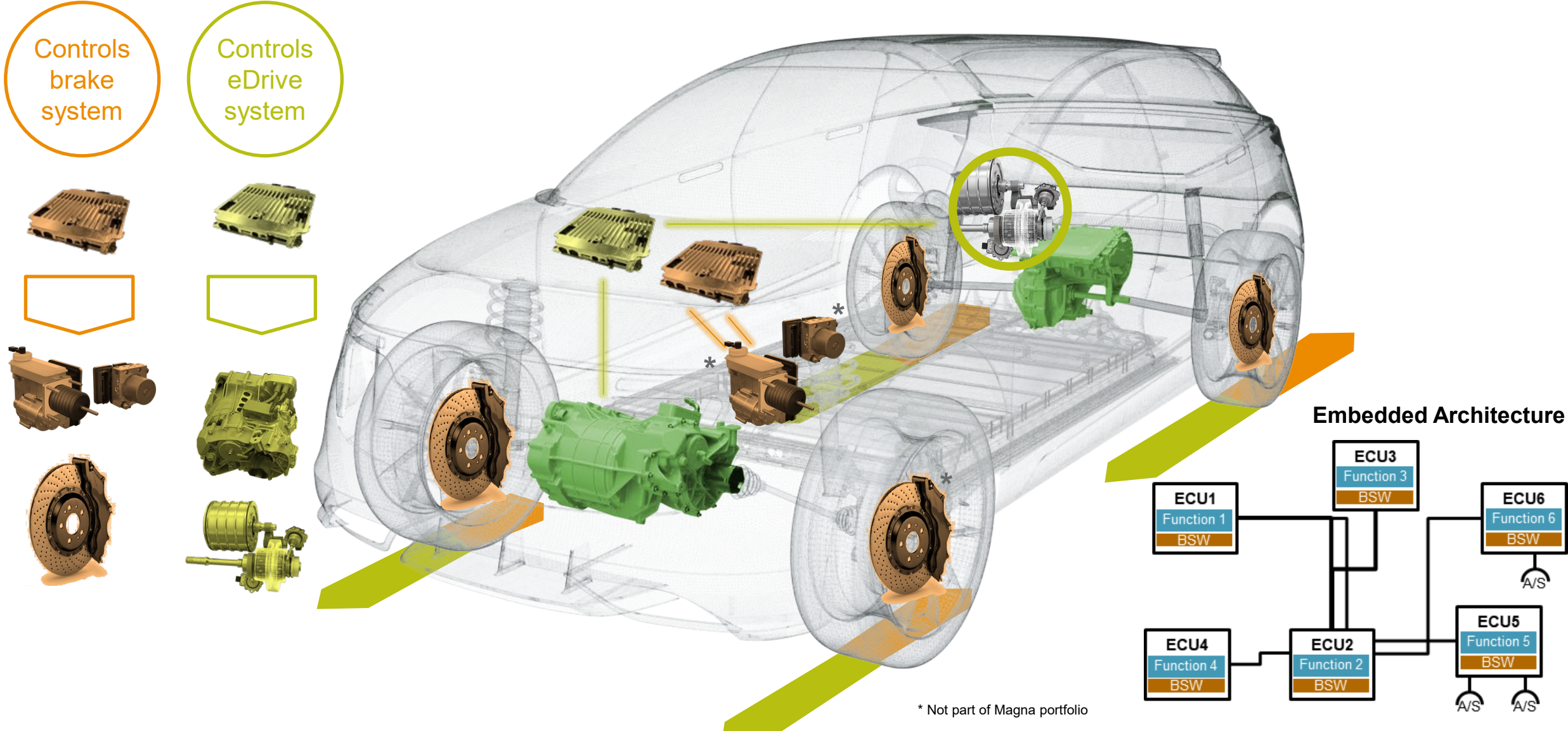
- 50 % steering wheel angle demand

Dynamics

+ 0.1 g lateral acceleration



Propulsion System and Brake System



Integrated eDrive and Brake Control



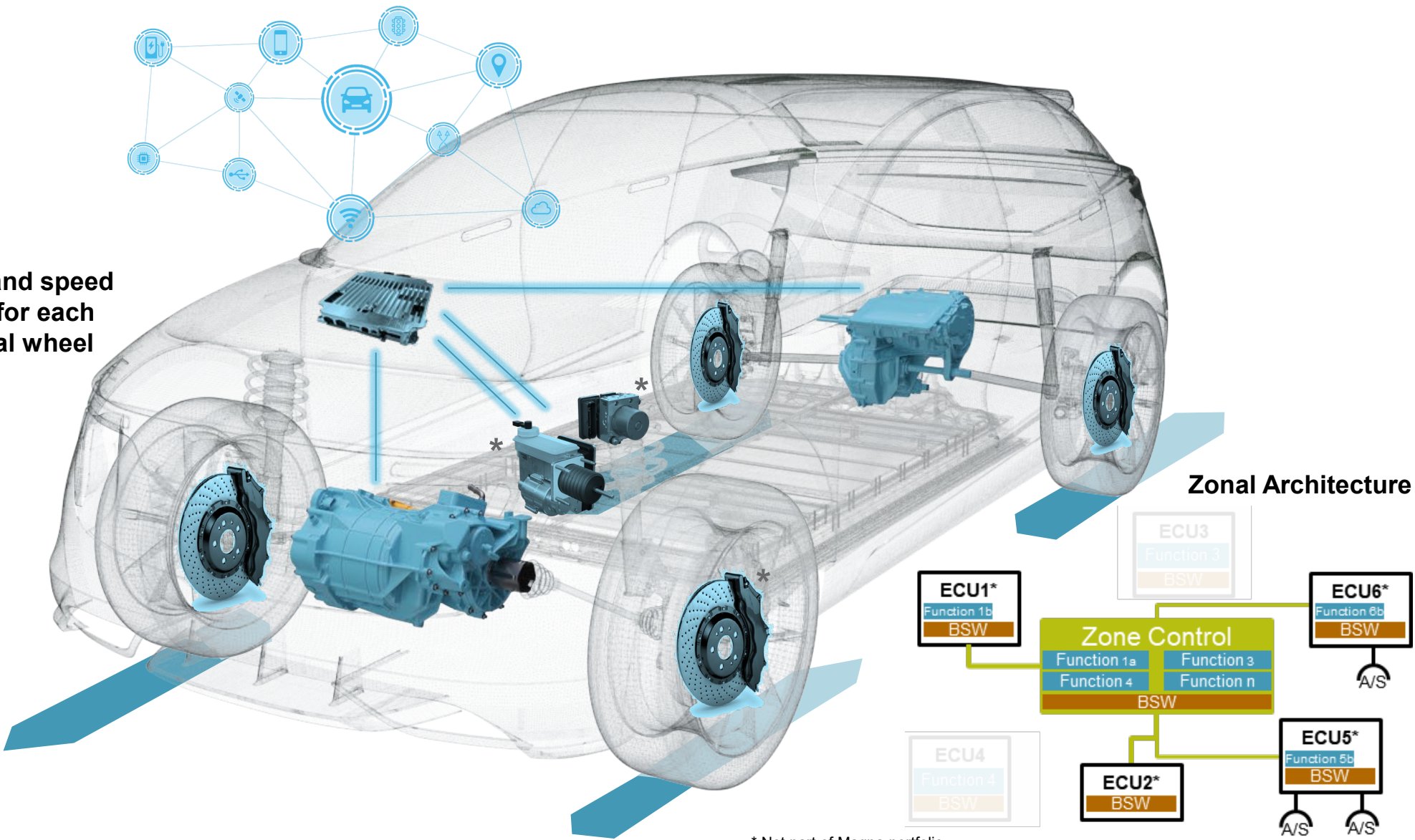
Vehicle Motion Controller



Torque and speed request for each individual wheel

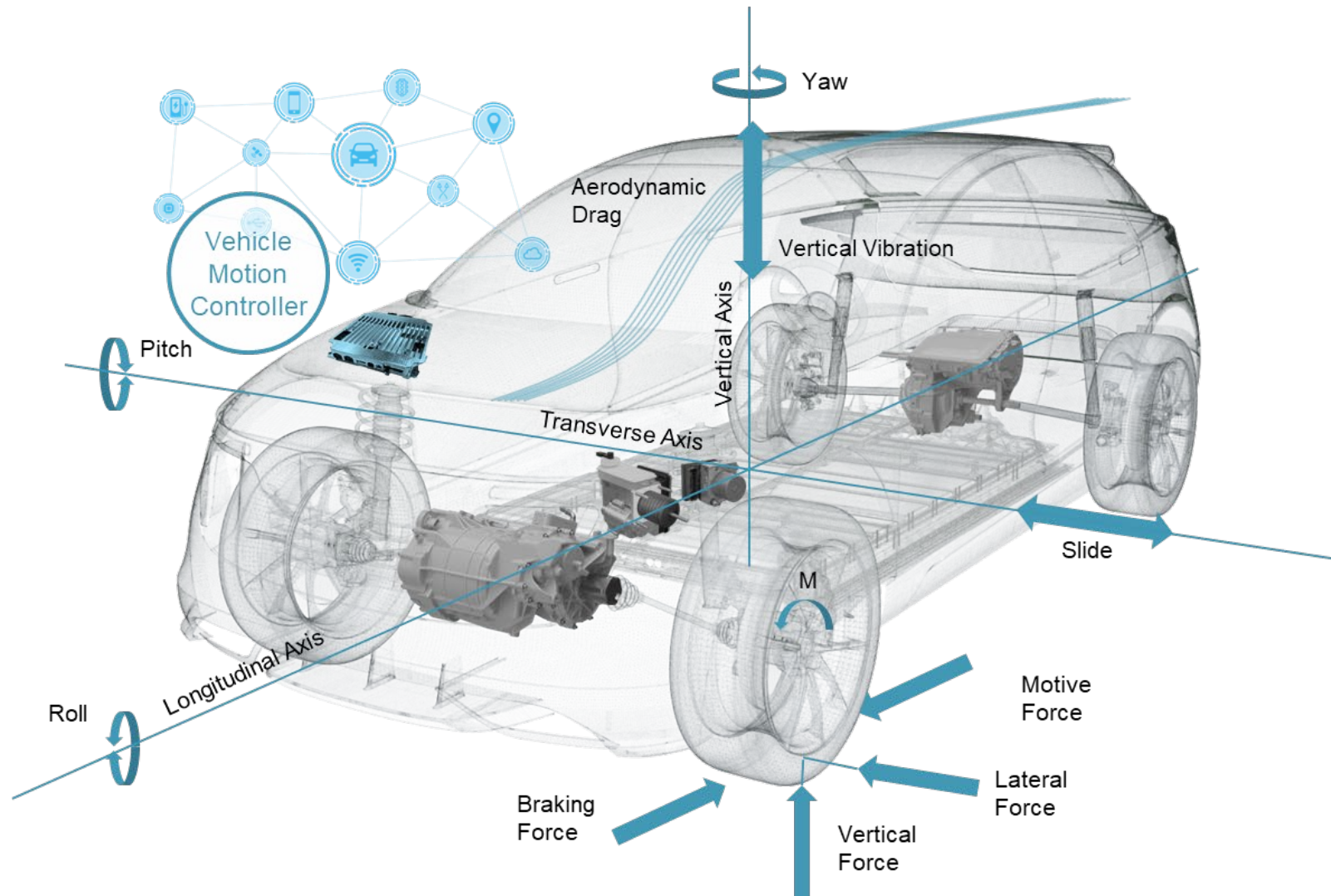
eDrive system

Brake system



* Not part of Magna portfolio

Integrated eDrive and Brake Control



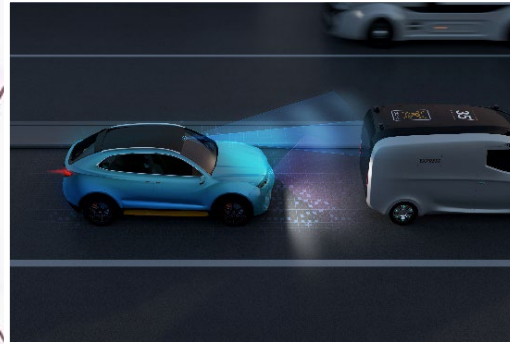
- Superior vehicle motion control resulting in best-in-class drivability
- Optimized interfaces
- Significantly reduced control loop time
- Reduced system complexity and cost
- Synergies in terms of redundancies for brake system for autonomous level ≥ 3

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

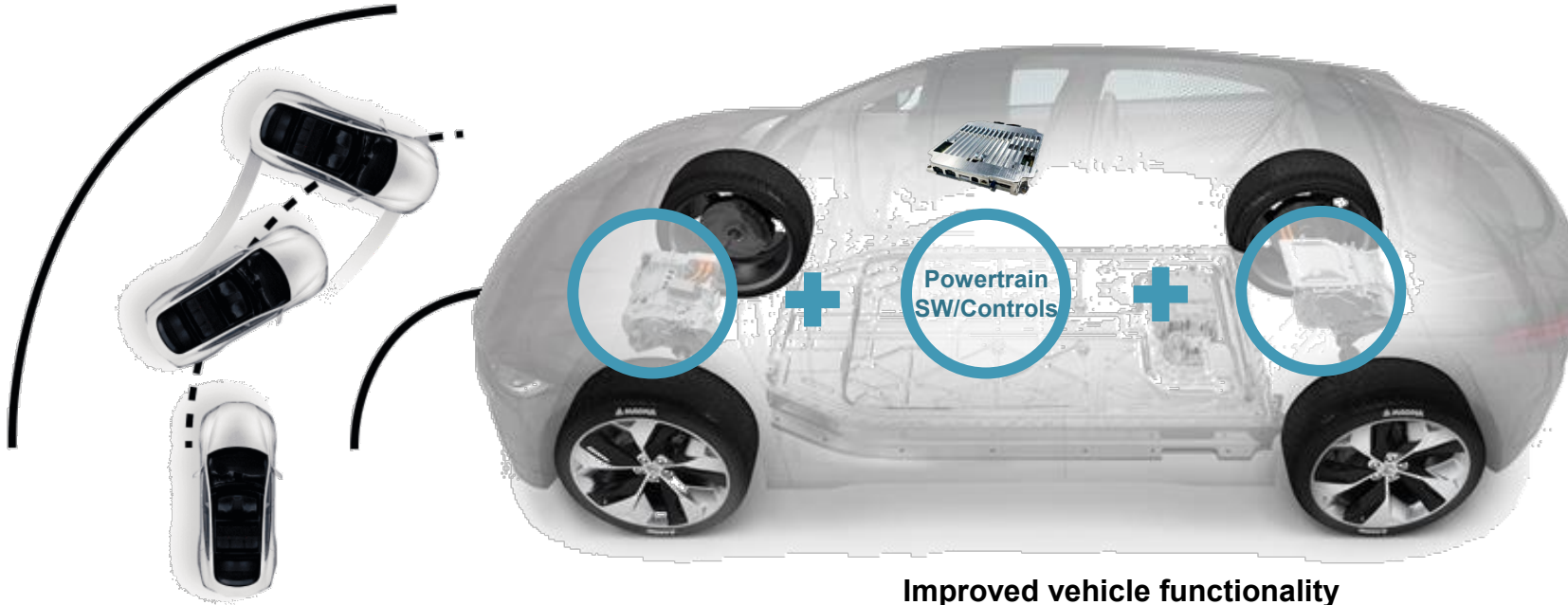


Advanced physical vehicle model

- 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, possibly representing a bridge or a complex system. The overall aesthetic is high-tech and futuristic.

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 of bright red light streaks and rays emanating from the center.

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

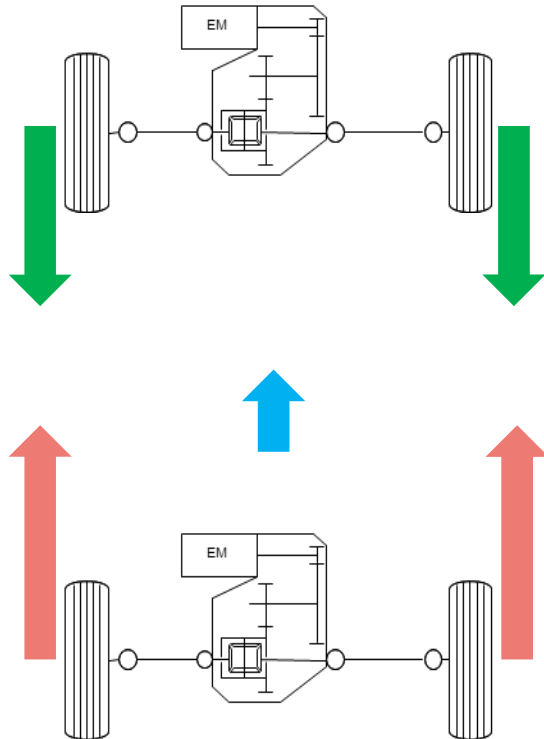
Vehicle Motion Controller



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



Vehicle State Observer & Predictor

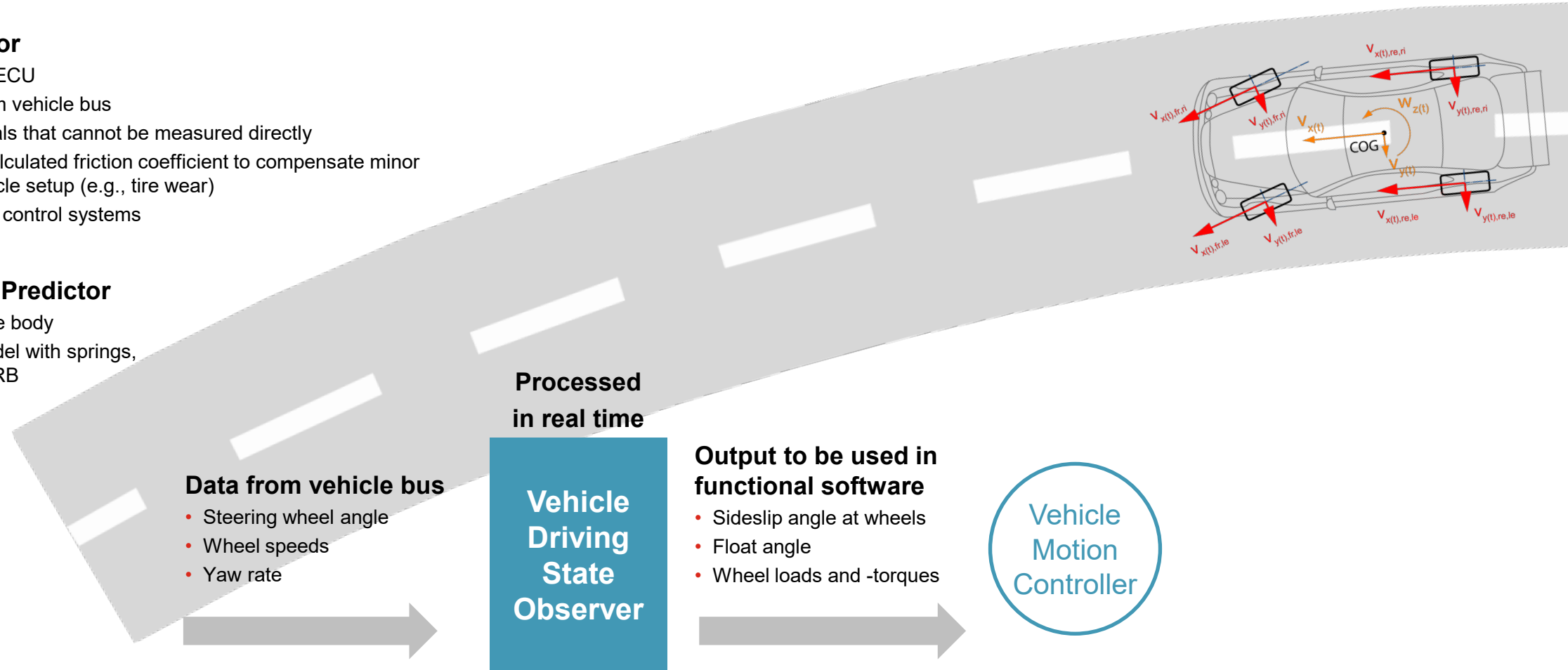
Vehicle Driving State Observer

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**

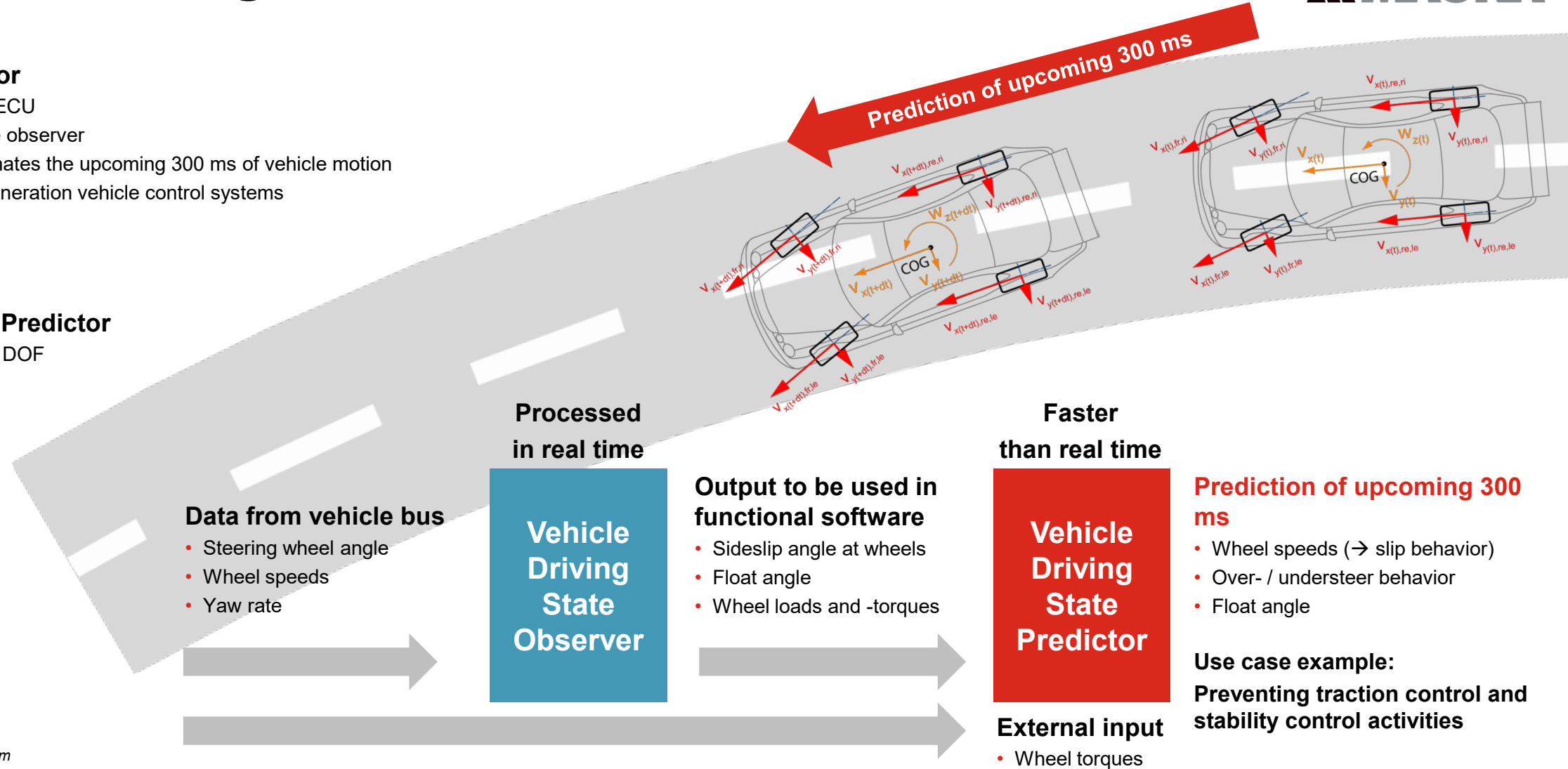
Vehicle Driving State Predictor

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*

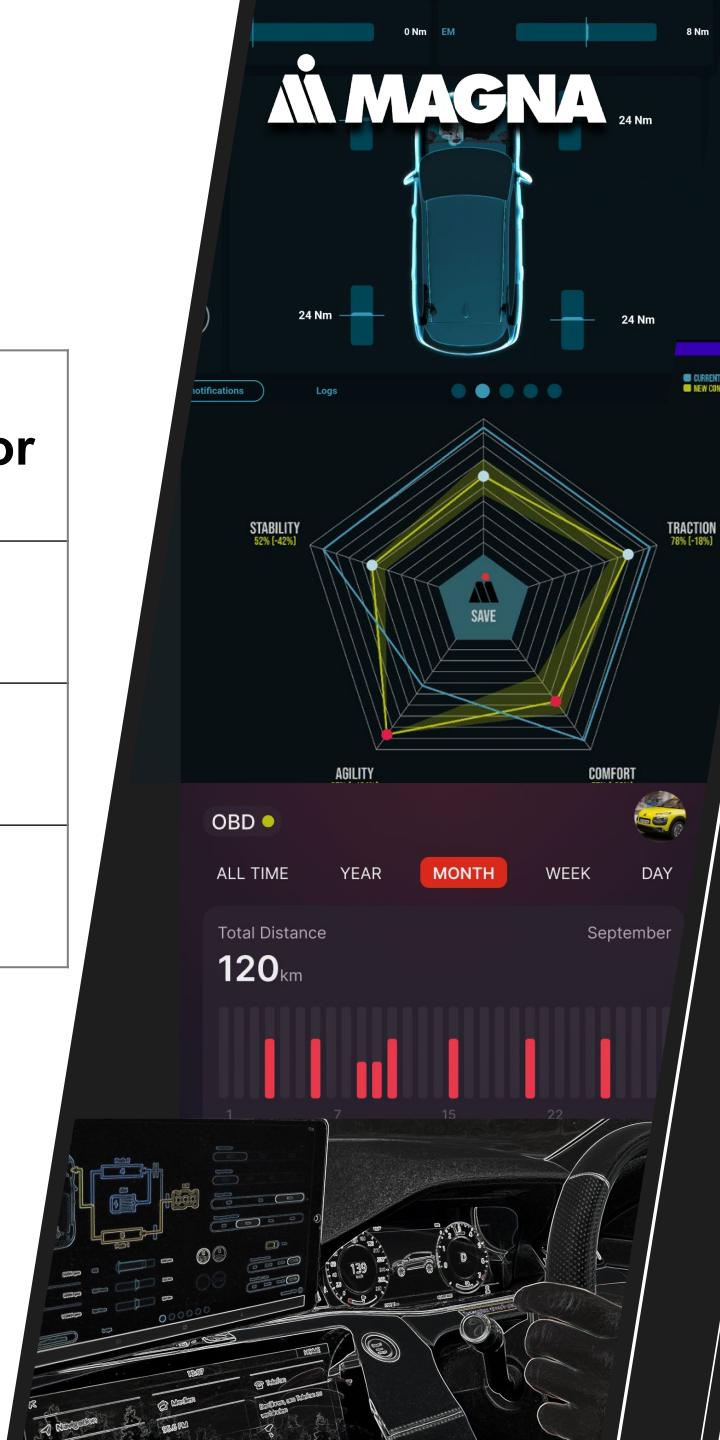
An abstract background featuring a dark blue wireframe grid that recedes into the distance, overlaid with vibrant, diagonal red light streaks that create a sense of motion and depth.

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

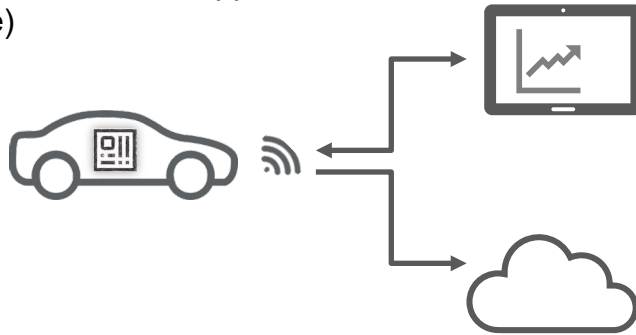
Magna DriveInsights



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.

Intuitive user experience

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

Fully customizable

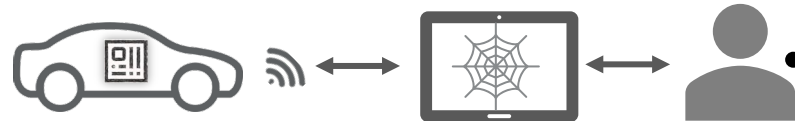
- An arbitrary amount of vehicle settings is supported and can be added to the app
- The amount and characteristics of end-consumer values can be freely defined
- The SliderSpider approach is independent of vehicle type, powertrain or E/E architecture

Understand mutual dependencies

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

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

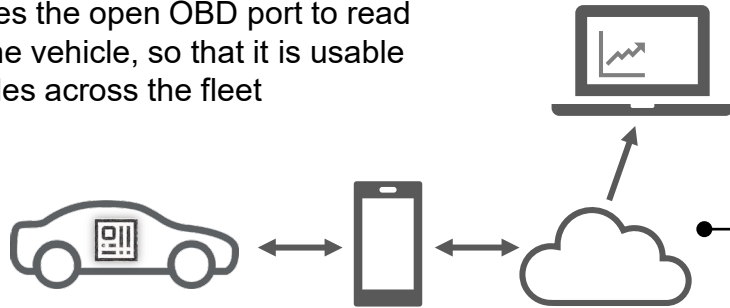
- Historic recordings can be analyzed automatically by cloud-powered algorithms

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



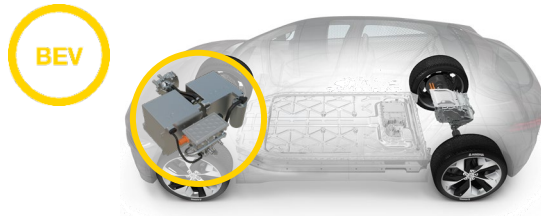
The Driva app enables both live view and consolidation of comprehensive trip data for one vehicle or across a fleet in a single platform, available everywhere and any time

Magna ThermalCore



Cross-Domain Product – ThermalCore

Advanced Vehicle Thermal Management System



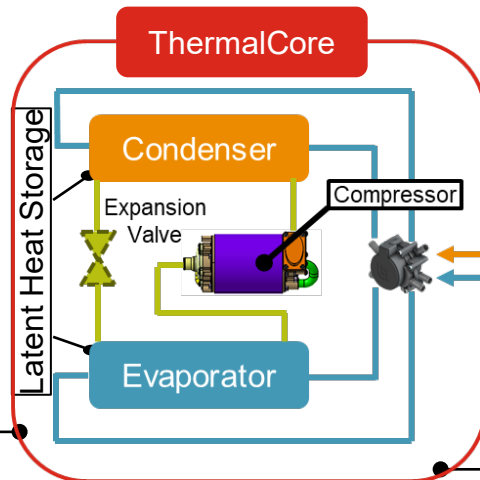
ThermalCore is a simplified architecture for the complete Vehicle Thermal Management (VTM) System of electric vehicles. It reduces complexity and cost of the system while performing equal or better compared to current state-of-the-art solutions.

Heat storage

- Works as a buffer to keep thermal system in highly efficient operating points
- Allows storage and utilization of waste heat

Distribution Valve

- Disc valve for highly integrated coolant flow management
- Fast switch times and very low coolant pressure drop



Compressor

- Highly efficient compressor with reduced lubrication requirements
- Low maintenance, low noise level

Simplified VTM Architecture

- Only two external heat exchangers needed in complete system, no refrigerant lines outside Thermal Core
- Highly integrated valve solution

Merits on system level

Simplicity and Cost Reduction

Package reduction by ~10% vs. best-in-class benchmark, Fewer components and no external refrigerant lines reduce system costs and allow utilization of new refrigerants

Efficiency

Highly efficient heat and cold generation based on new compressor technologies and thermal storage allows excellent performance and efficiency on system level (energy savings of HVAC system up to 20%, target)

Scalability

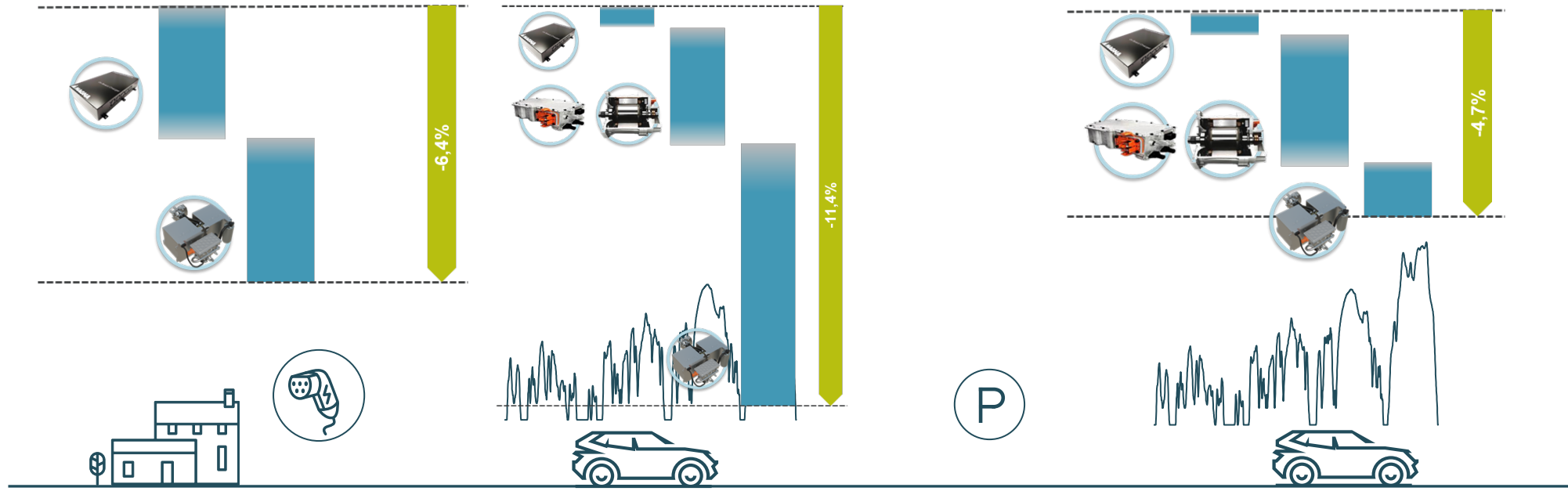
Choosing different sizes of thermal storages allows scaling to different electric vehicle (EV) segments

Superior real-world efficiency over full range of relevant temperatures and use cases (vs. WLTP) with extended functionality

Pre-Development Released for Acquisition Serial Development Serial Production

ThermalCore

Advanced Vehicle Thermal Management System



Phase I

AC charging at home
with pre-conditioning

Phase II

Driving to POI starting with
pre-conditioned vehicle

Phase III

Vehicle parked and is
not plugged

Phase IV

Driving back home
without pre-conditioning

Total
Driving

Total

OBC + DCDC	-3,4%	-0,6%
Drivetrain		-3,4%
ThermalCore	-3,1%	-7,5%
Total	-6,4%	-11,4%

-0,5%	-0,5%	-1,7%
-3,0%	-3,2%	-1,8%
-1,2%	-4,2%	-3,7%
-4,7%	-7,9%	-7,3%