Vehicle Motion & Safety

Presented by

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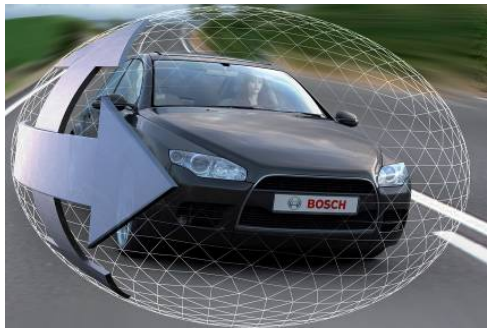
Robert Bosch LLC





All abbreviations within this presentation used for purpose of simplification

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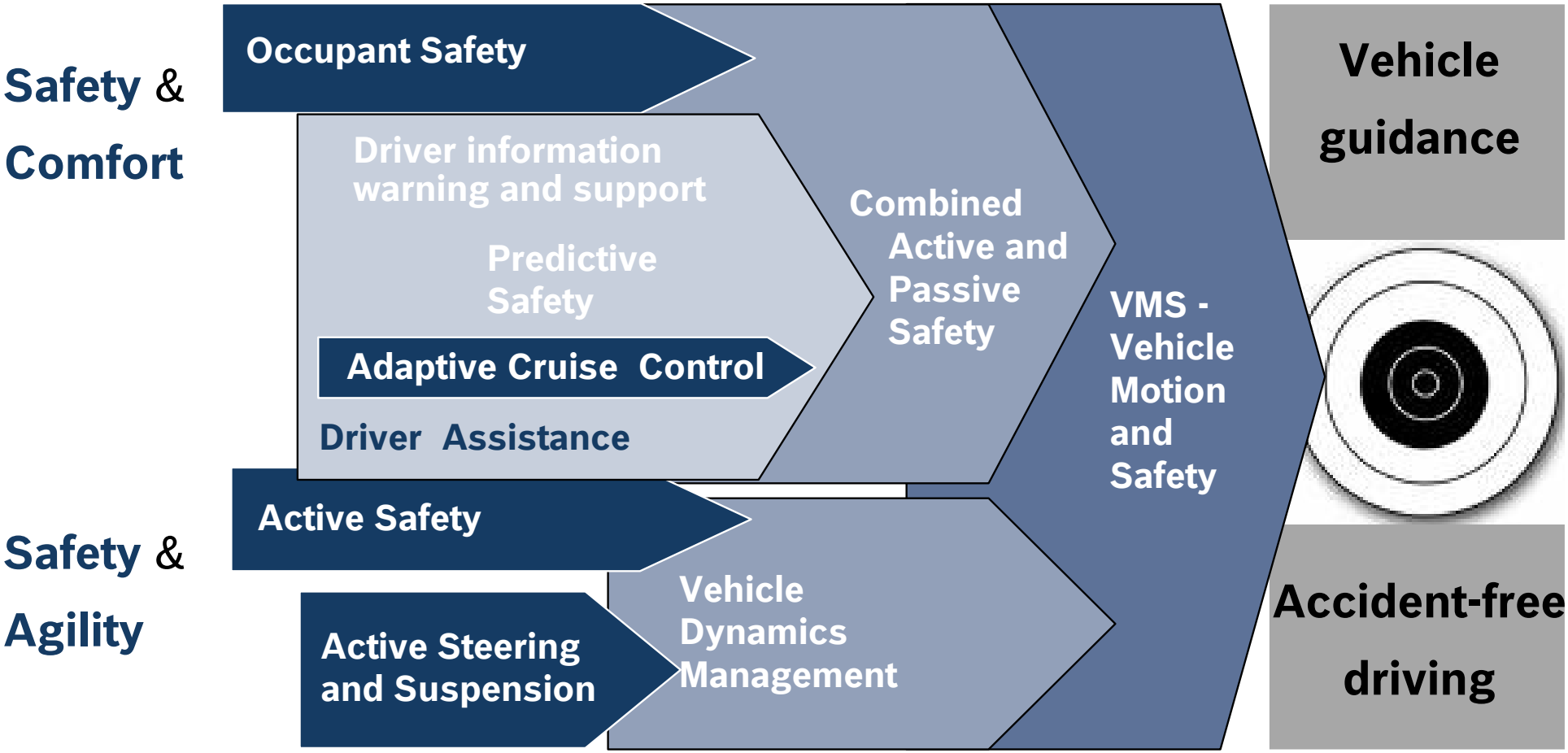
Visions for Vehicle Motion and Safety



VMS – Vehicle Motion and Safety

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Information sources (Sensing domains)

Actual vehicle status

Passive safety data

VMS

Vehicle surroundings

Traffic surroundings

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Information sources (Sensing hardware)

Actual vehicle status

ESC

Yaw rate sensor
Steering angle sensor
Wheel speed sensor

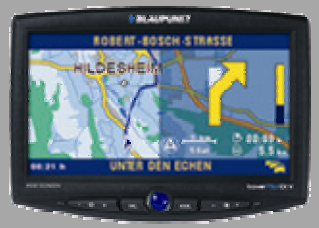
Passive safety data

Airbag system

VMS

Radar Sensors
Video camera

Vehicle surroundings



Map data
Positioning data
Traffic data

Traffic surroundings

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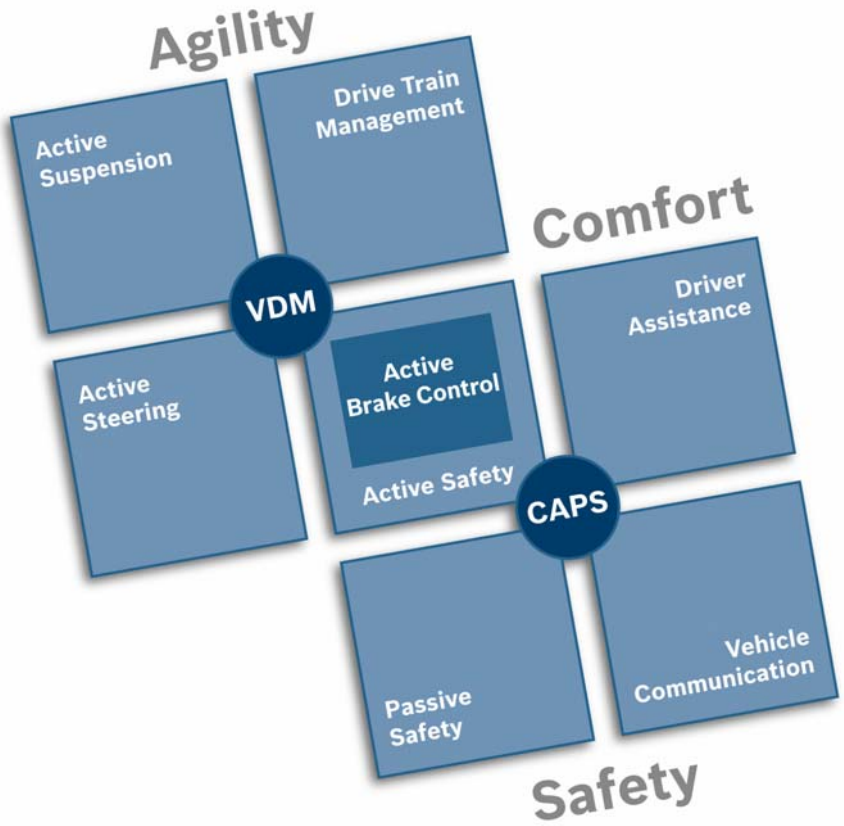
VDM – Vehicle Dynamics Management

Definition

Within Vehicle Motion and Safety (VMS)

VDM is a set of software and electronic systems networking ESC with other active vehicle-dynamics systems

- for coordinating vehicle dynamics control mainly related to agility and safety
- thus leading to improved chassis characteristics without trade-offs regarding safety



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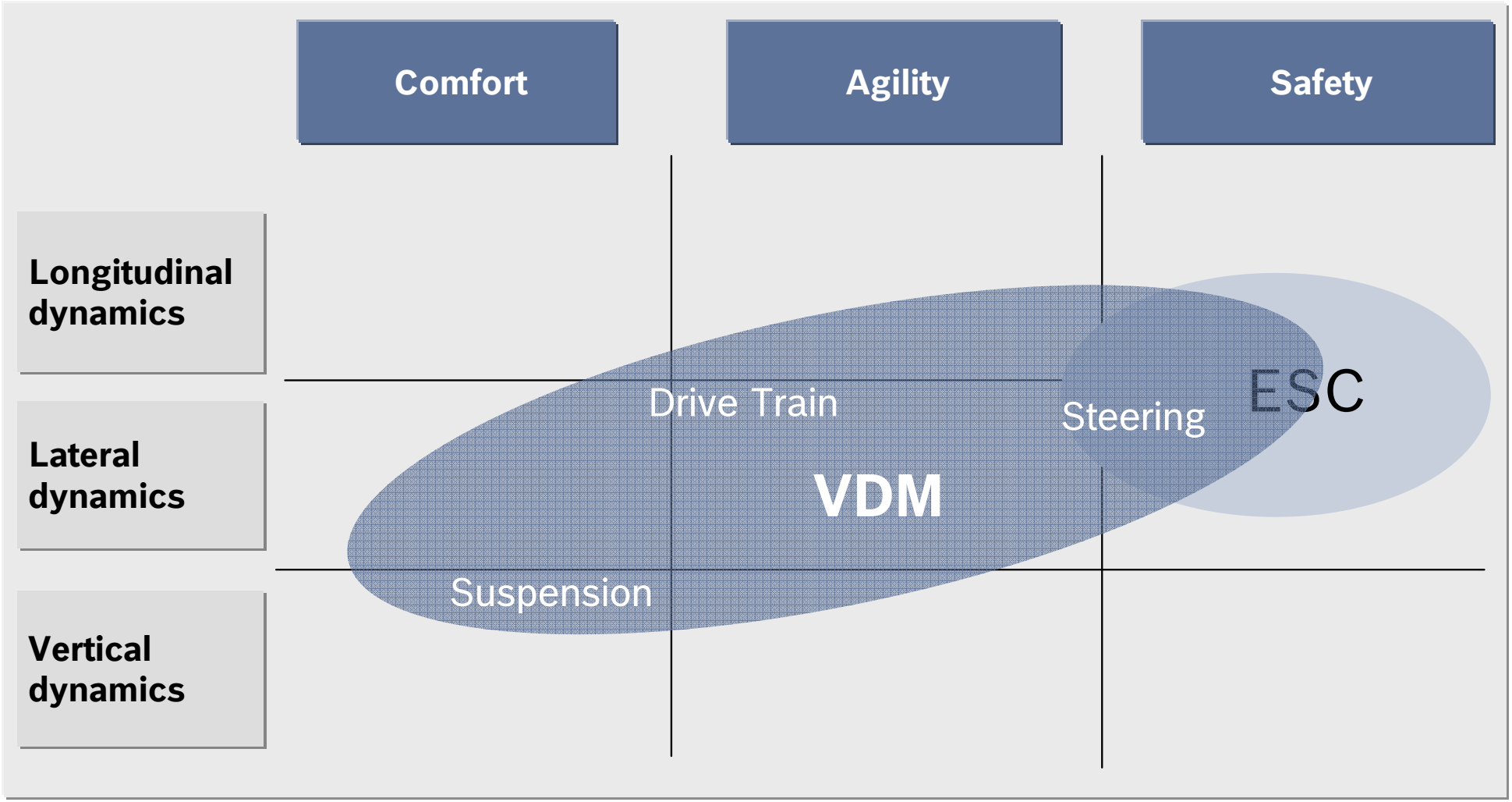
Dynamics domain vs. functional aspects

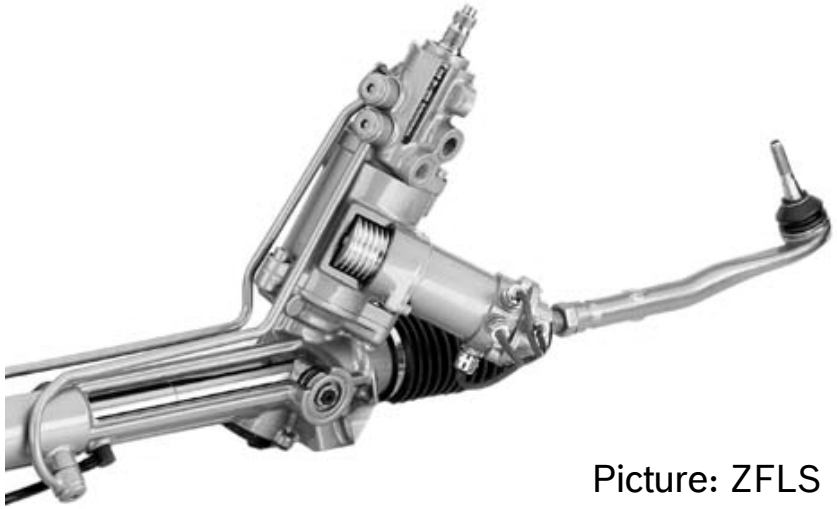


All abbreviations within this presentation used for purpose of simplification

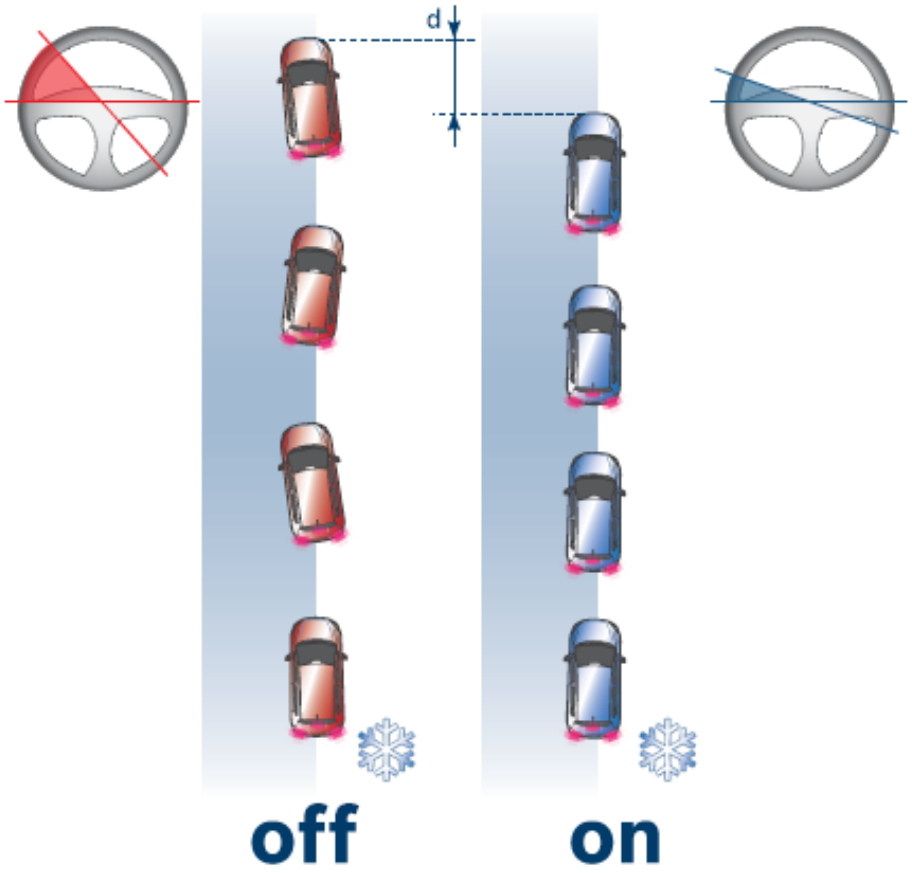
Dynamic Steering Angle Control

Principle

ESC controlled modification
of steering angle using
Active Front Steering



Picture: ZFLS



➔ Improve yaw stability and straight running

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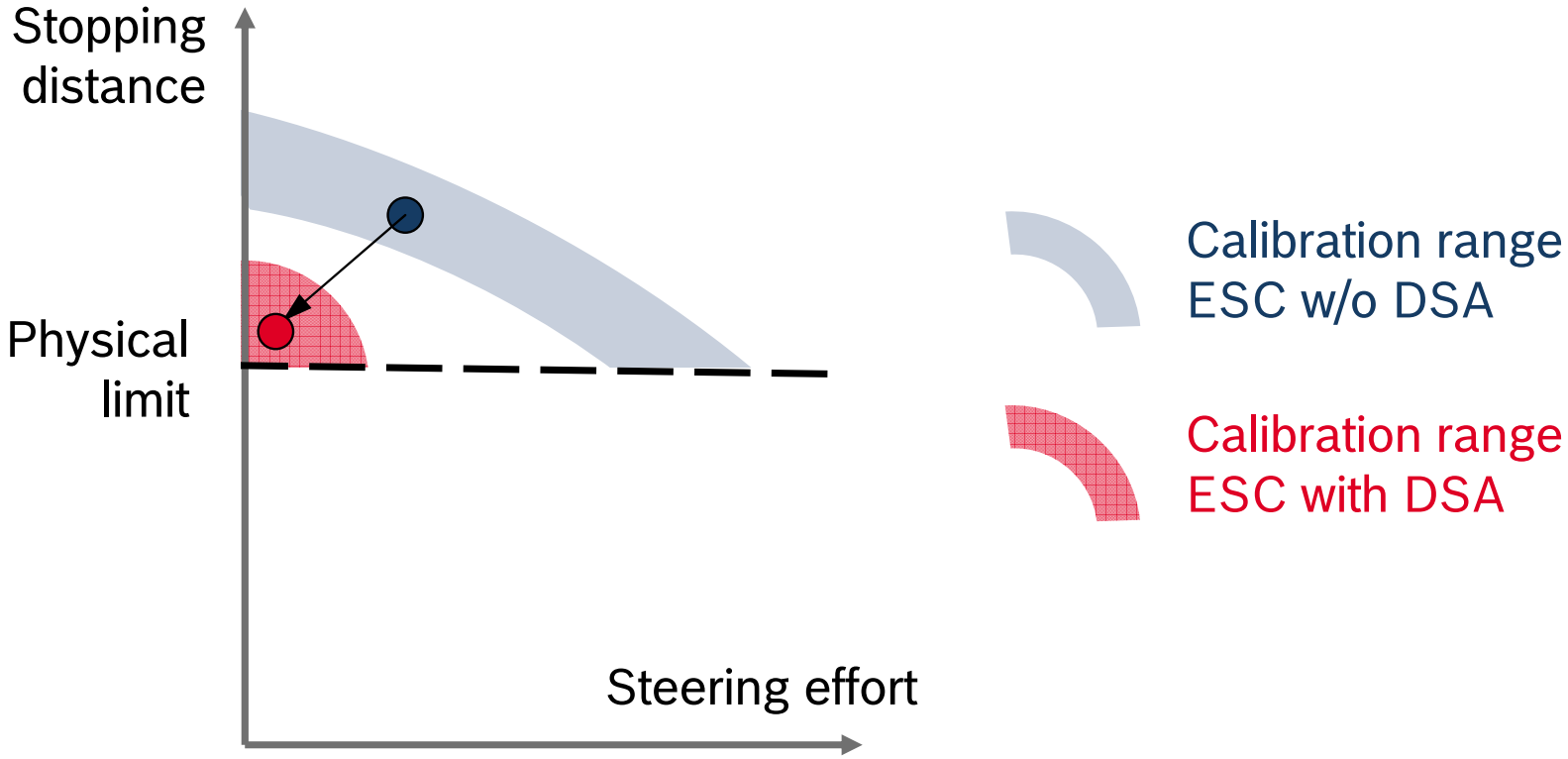
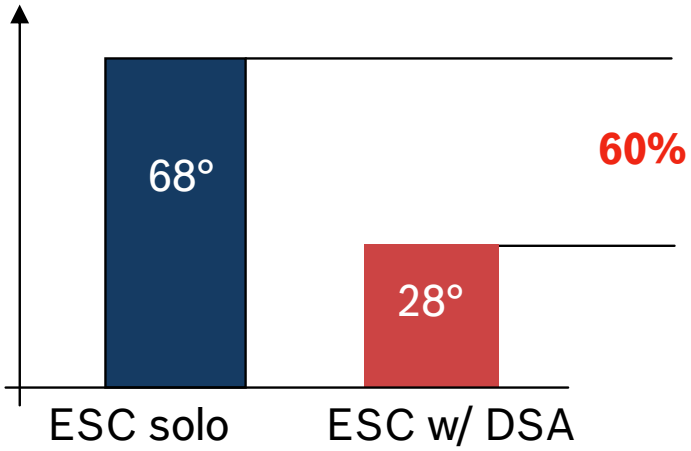
Principle of DSA improvements
Example: Braking on split-µ



➔ Improvement of the relation of steering effort vs. braking distance depends on the calibration of ESC (before networking with DSA)

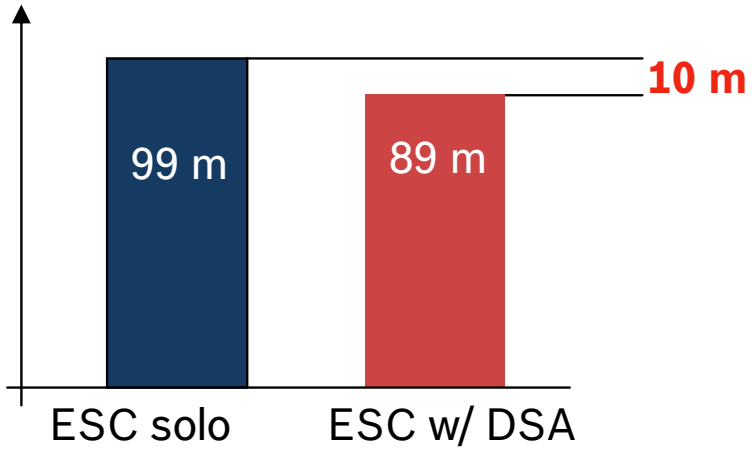
Benefits of Dynamic Steering Angle Control
Example: Braking on split-µ

Driver comfort / vehicle stability



Max. steering-wheel angle

Active Safety



Braking distance 100 kph → 0 kph

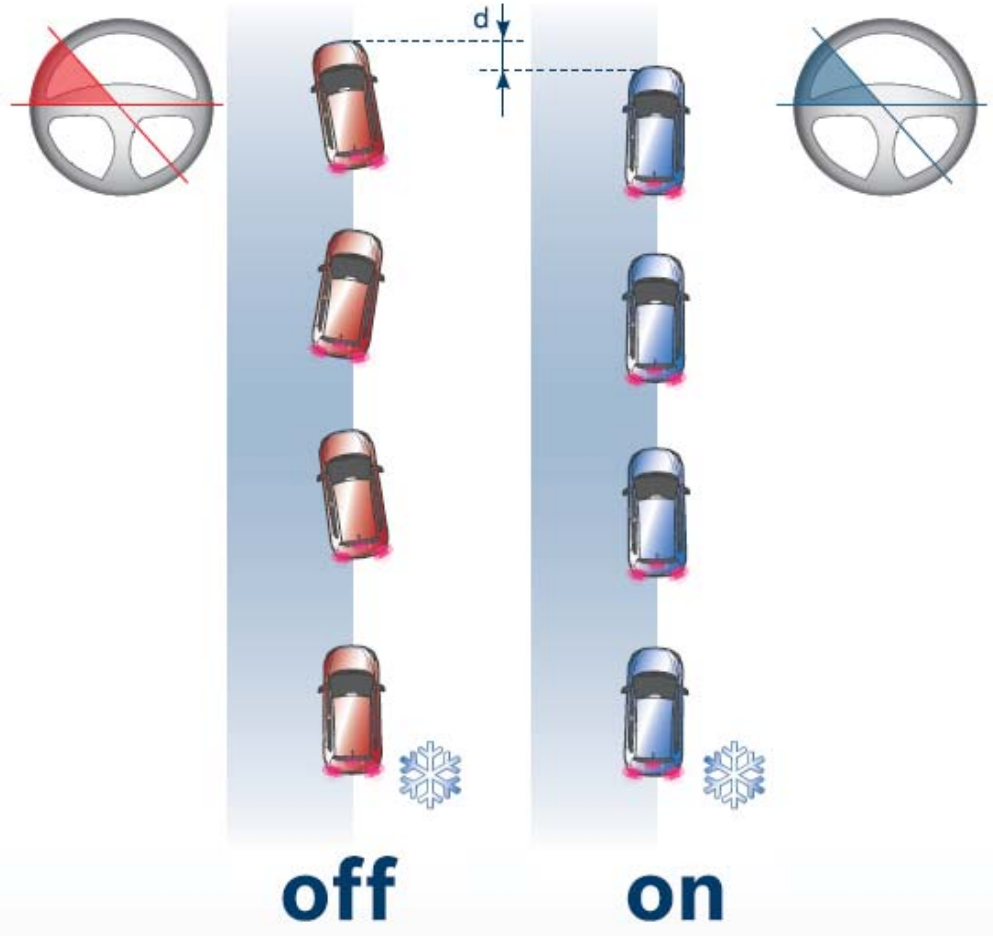
→ Significant benefits in vehicle stability, driver comfort and active safety

Dynamic Steering Torque Control

Principle

ESC controlled steering torque modification for guiding the driver using Electric Power Steering

Picture: ZFLS



➔ Motivate the driver to adequate steering input

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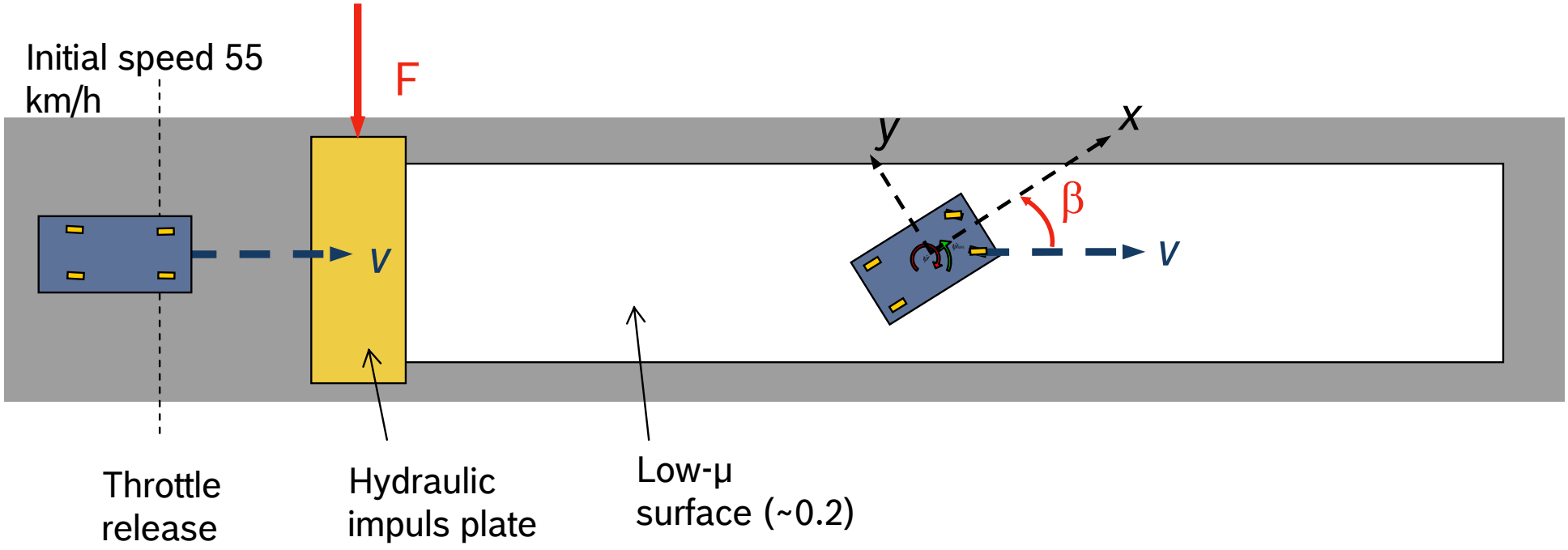
Benefits quantified: Oversteer Maneuver

- Maneuver: Vehicle speed 55 km/h over pulse plate, driver tries to stabilize vehicle
- Measurement data: Side slip angle β (from Inertial System)



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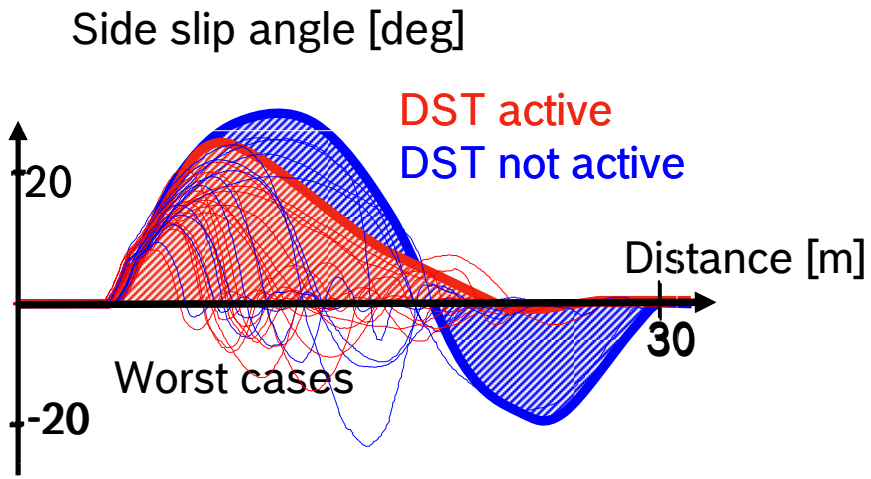
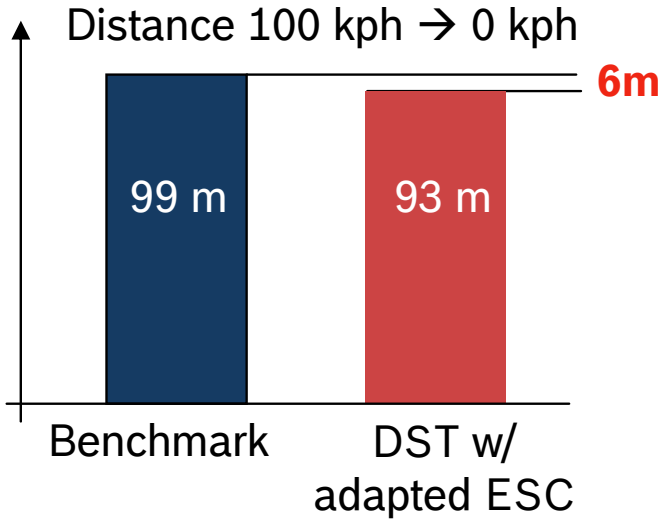
Dynamic Steering Torque Control

Degree of benefits depending on driver reaction to steering torque intervention

Oversteer compensation at 55 kph on impulse plate, low-µ



µ-split braking



Results depend on ESC calibration

➔ Increased vehicle stability and reduced braking distance due to more adequate driver steering reaction

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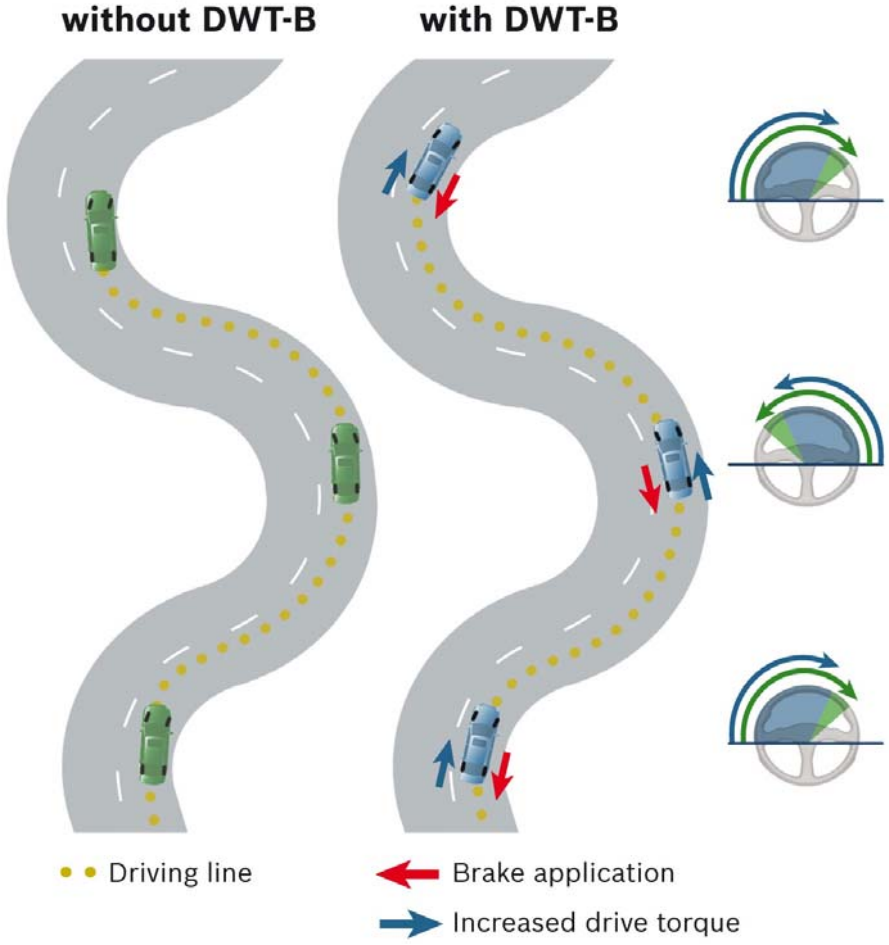
Dynamic Wheel Torque Control – by Brake or by Differential

Principle

ESC controlled modification of drive torque for specific wheels

Picture: GKN



➔ Improved agility through under-steer reduction without loss of speed

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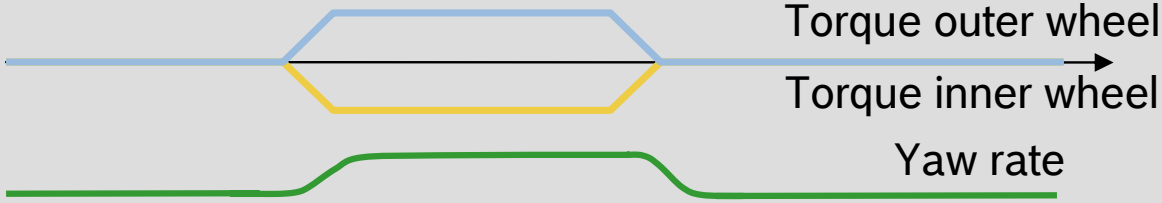
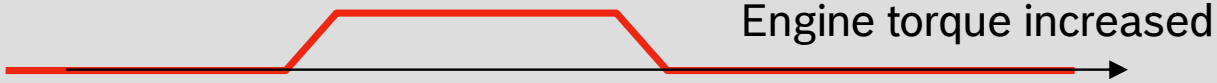
Principles of Dynamic Wheel Torque Control

Physical effects for DWT



By Brake

DWT-B: utilizes active brake interventions



By Differential

DWT-D: combination of active differential and brake interventions

➔ Comfortable interventions for improved agility without deceleration

DWT-B: Dynamic Wheel Torque Control with Brakes
DWT-D: Dynamic Wheel Torque Control with Differential

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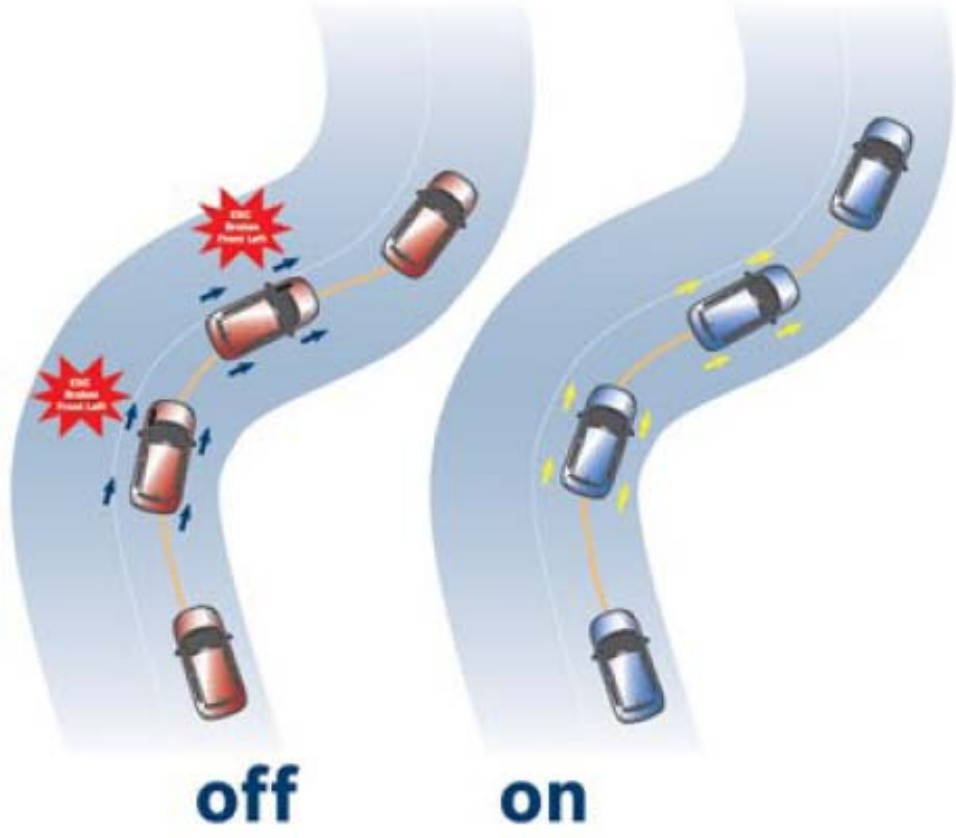
Dynamic Roll Stabilizer Force Control

Principle

ESC controlled roll-torque distribution between front and rear axle using active roll stabilizers

Picture: ZF Sachs



➔ Comfortable interventions to support vehicle stabilization

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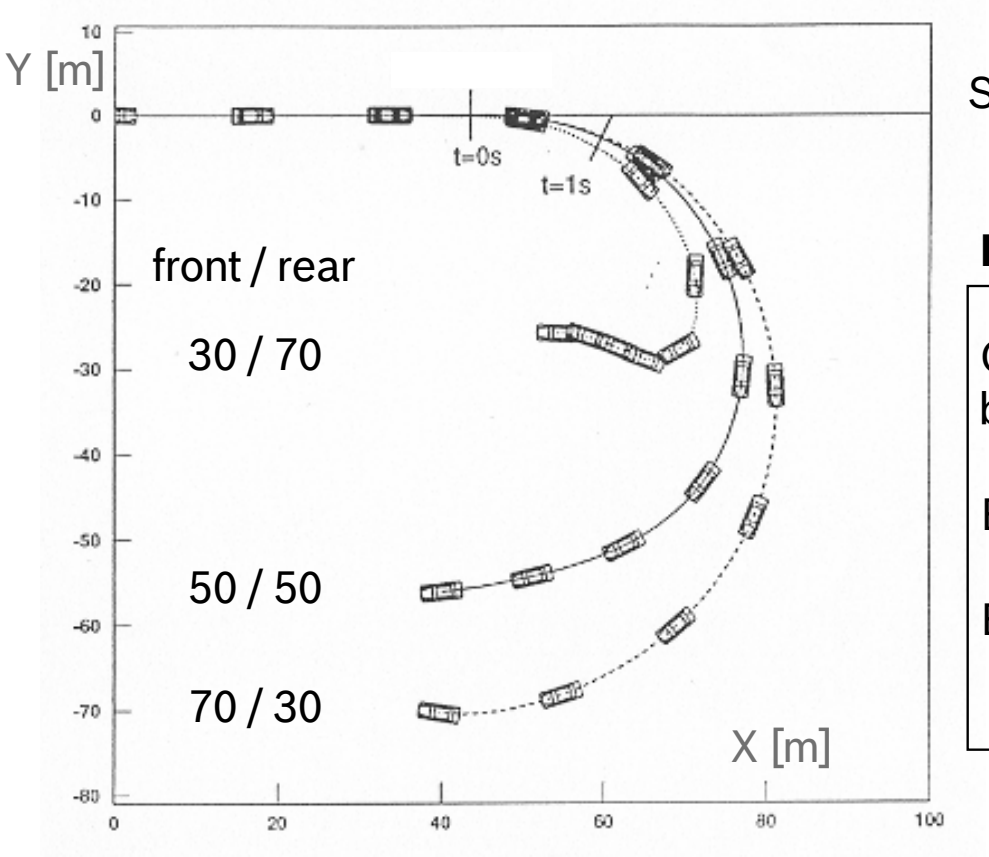
Variable self-steering properties



Steering wheel angle = 140°, v = 60 kph

Roll moment distribution (front / rear)	[%]
Conventional understeering behavior, passive stabilizers	70 / 30
Enhanced agility, neutral	50 / 50
Extreme case, oversteering behavior	30 / 70

➔ Controllable self-steering properties –
adjustment of vehicle behavior to specific driving situations

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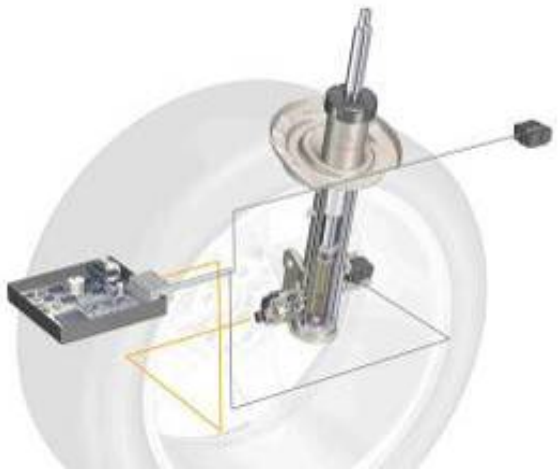
Dynamic Damper Force Control

Principle

ESC controlled modification of damping coefficients using controllable dampers



Picture: ZF Sachs

Benefits in typical driving maneuvers

- Cornering
  - Improved oversteering mitigation
  - Improved steerability w/o compromising stability
- Full braking
  - Brake distance reduction, especially on rough-road

→ Improve steerability and brake performance

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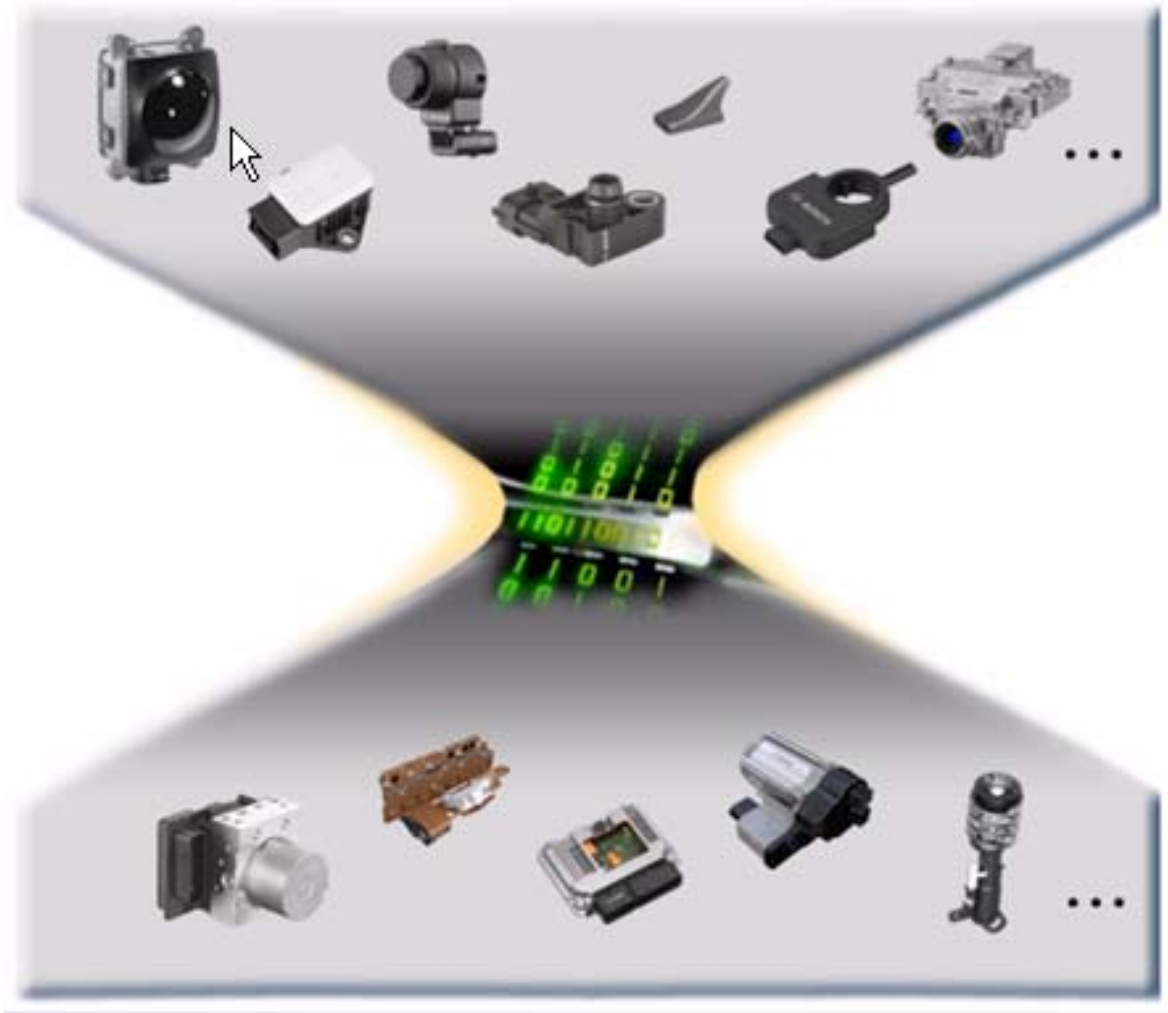
Phases of Vehicle Motion and Safety

- Sensing
- Evaluating
- Controlling
- Intervening



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