3rd Conference
Active Safety through Driver Assistance

Safe, superior and comfortable driving
-
Market needs and solutions

Dr. Werner Struth - President, Chassis Systems Control

BOSCH

Global trends

Legislation

- Safety legislation being tightened
- Enhanced passenger and pedestrian protection

-> *Safe driving*

Economy

- Steep growth in emerging markets

-> *Increased mobility*

- Growing globalization

-> *Networks and standards growing*

Politics & Environment

- "Global warming"
- Rising oil prices

-> *Energy efficiency*

Society

- Ageing society
- Urbanization

-> *Comfortable driving*

Technology

- Higher share of electronics/ software
- Driver assistance

-> *Superior driving*

Consumer behavior

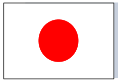
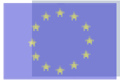
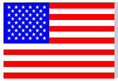
- Individualization

-> *Fun to drive*

Accident research is used for evaluation and identification of vehicle motion systems on the way towards Vision Zero.

	Bottom-up Approach *from existing systems to accident data*	Top-down Approach *from accident data to new systems*
Driver	Existing Functions	Vision, Strategy, Market
Analysis	1 **field of effect:** chronological classification during event of accident 2 **efficiency:** potential of accident avoidance or mitigation 3 **multiple system assessment:** interaction in behavior between other systems	
Result	function efficiency	new function idea

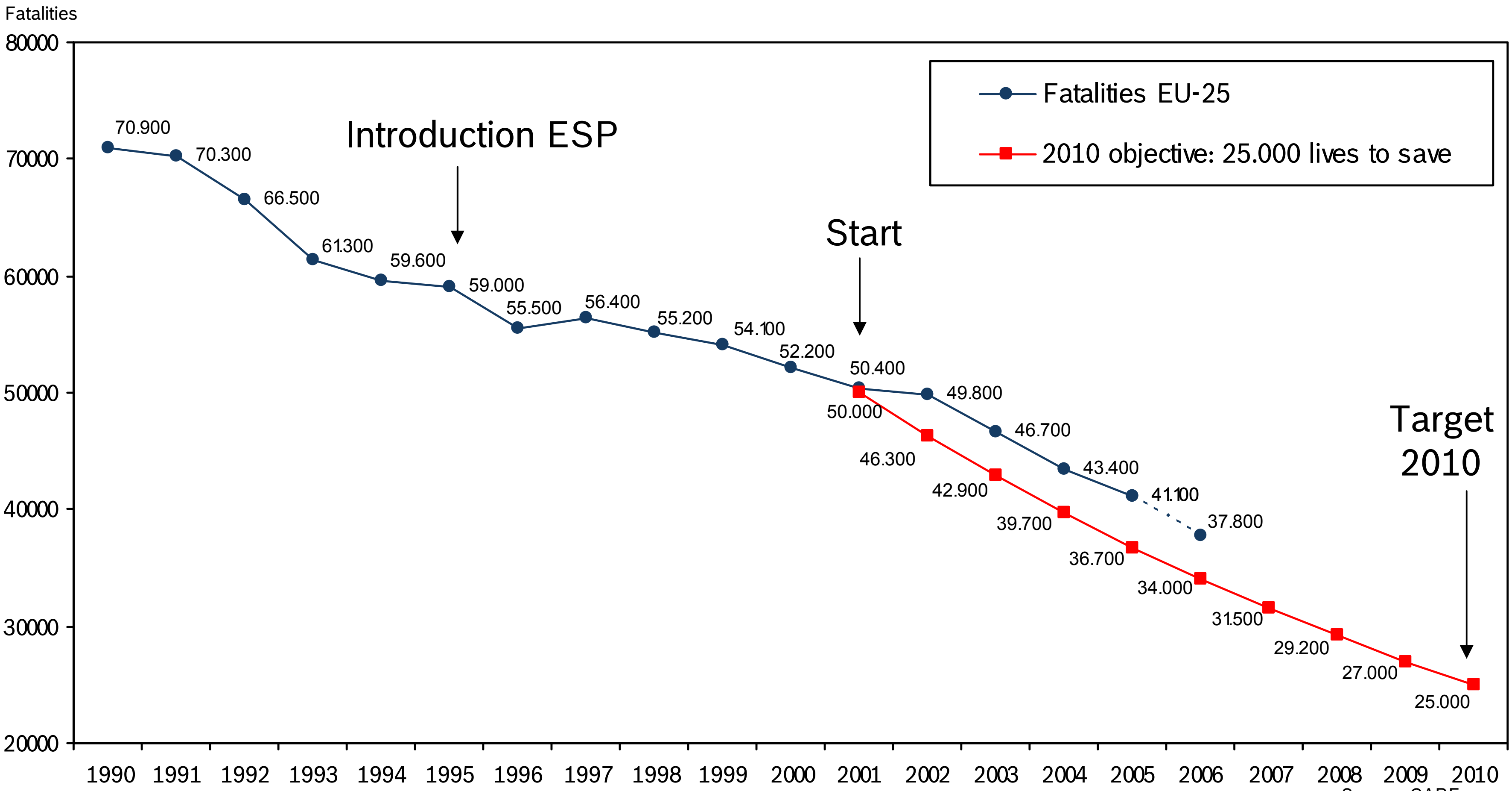
Road safety in 2005 – a public health issue

	Registered motor vehicles [Mio]	Road accidents involving injuries [Mio]	Fatalities	Fatality risk per vehicle
	91.4	0.93	7,931	1 : 11,500
	268.2*	1.26	41,600	1 : 6,400
	242.7	1.85	43,443	1 : 5,600
	19.0	0.22	6,376	1 : 3,000
	130.4	0.45	98,738	1 : 1,300
	23.3	0.38	26,409	1 : 880
	72.7*	0.44	94,968	1 : 770

Sources: DfT- Transport Statistics GB 2006, IRTAD 2005, IATSS 2005, Yearbook 2005 Traffic Accidents China, Sindipeças 2006, DENATRAN 2005, Government of India: Department of road transport and highways 2007

* 2004

Evolution EU Road Fatalities 1990 -2010



Source: CARE

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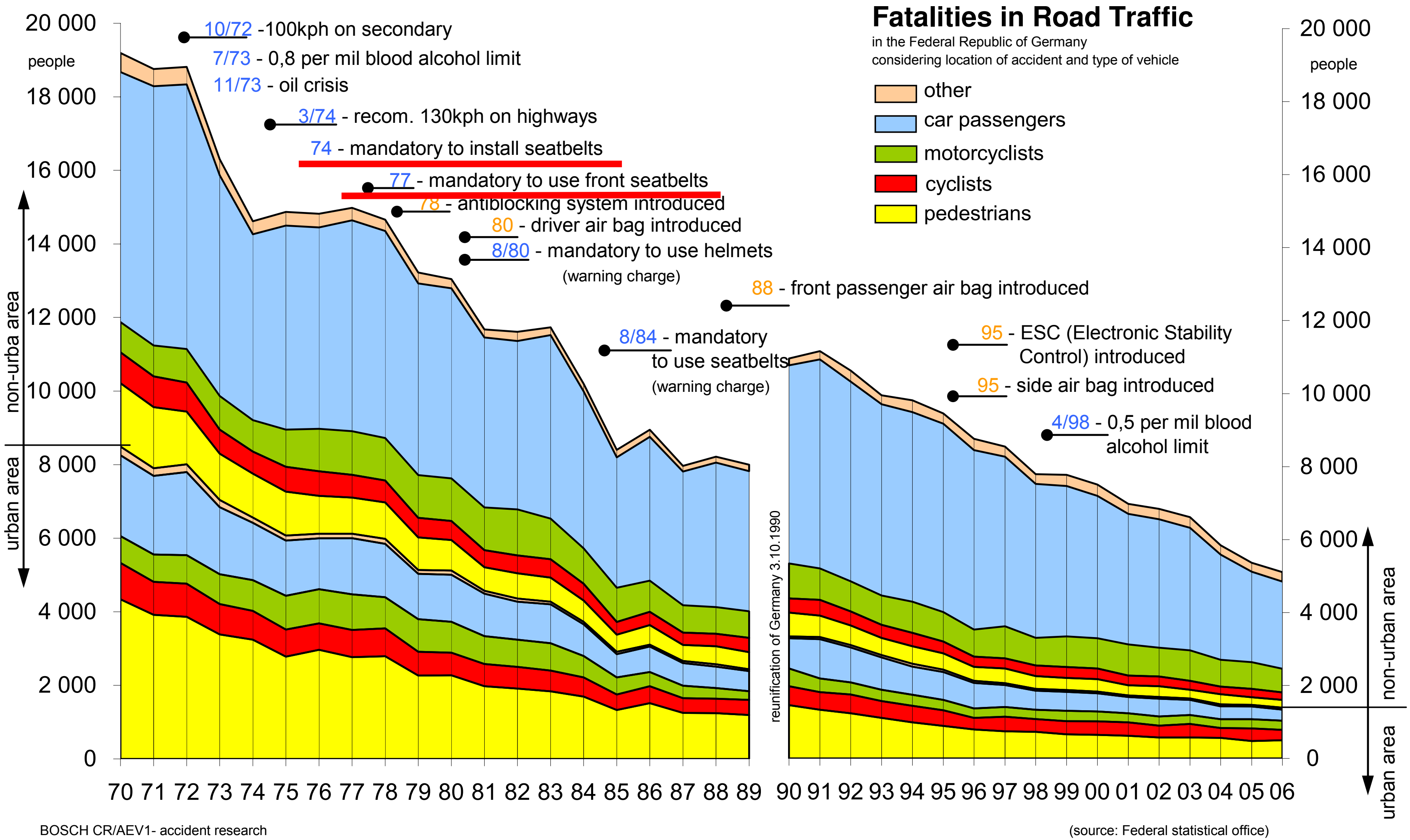
Safe, superior & comfortable driving



Chassis Systems Control

Safe, superior & comfortable driving

Safe

Superior

Comfortable

Safety functions - Examples

Side View Assist: US-based Blind Spot Detection

→ Monitoring of the adjacent and rear lanes

Reduction of accident risk while changing lanes

Lane Departure Warning

→ Tracking the vehicle position within lane markings

Early correction of driving mistakes

Night Vision and Night Vision Plus

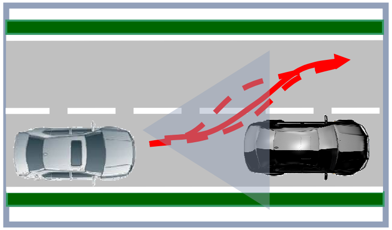
→ Light detection with infrared sensitive camera

Early recognition of possible dangers

Evasive Steering Support (ESS-T)

→ improve steerability and brake performance

Optimal steering support to avoid collisions



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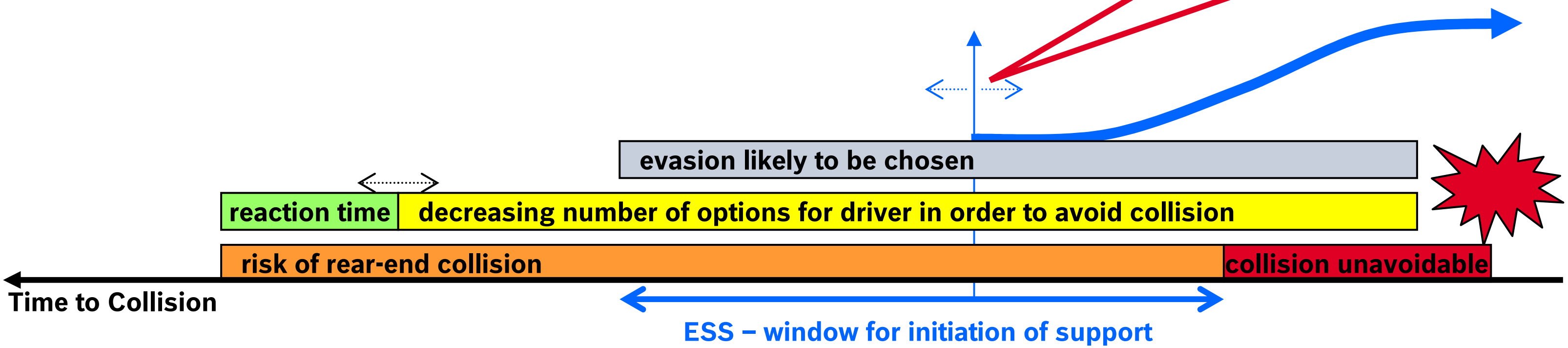
ESS-T Function Description

critical driving situation

potential driver intention: avoidance by evasion

evasion support ***triggered*** *by driver*



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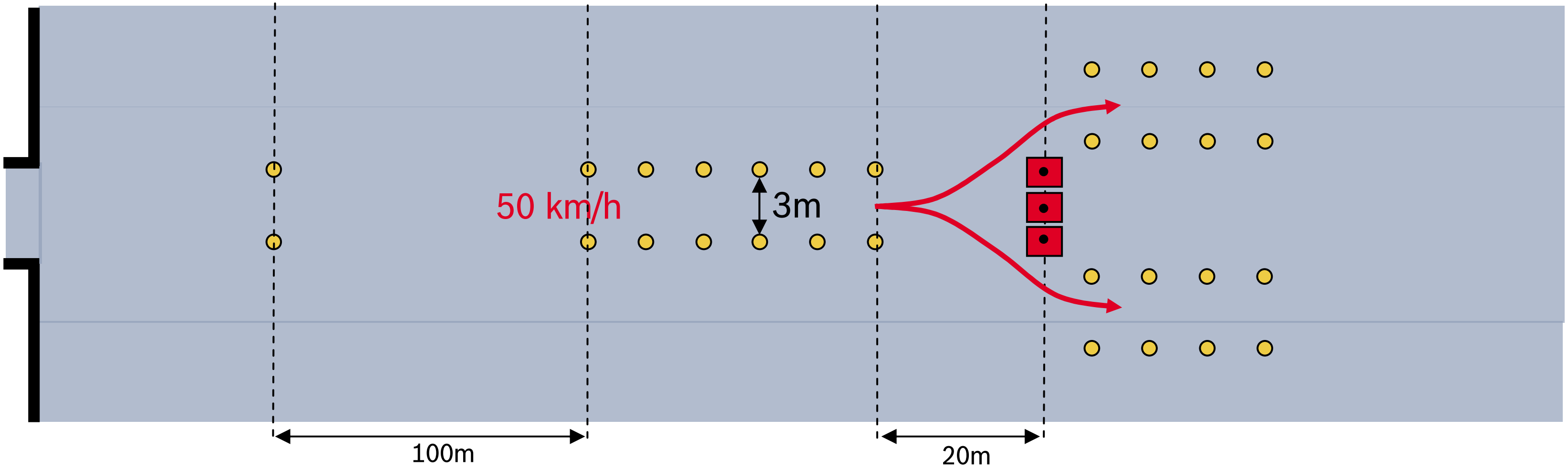
Demonstration maneuver description

Test track plan



What the driver does:

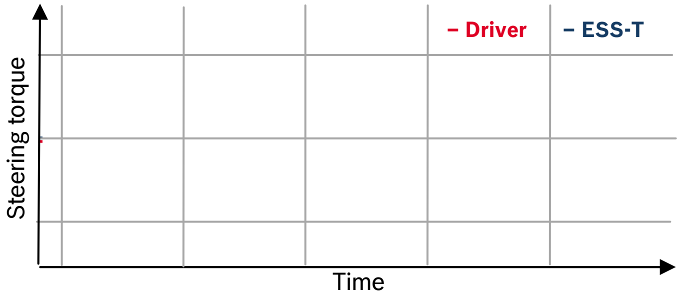
- Approaches the obstacle with a constant speed of 50 km/h
- Does not brake
- Performs an evasive maneuver to avoid the obstacle

What ESS-T does:

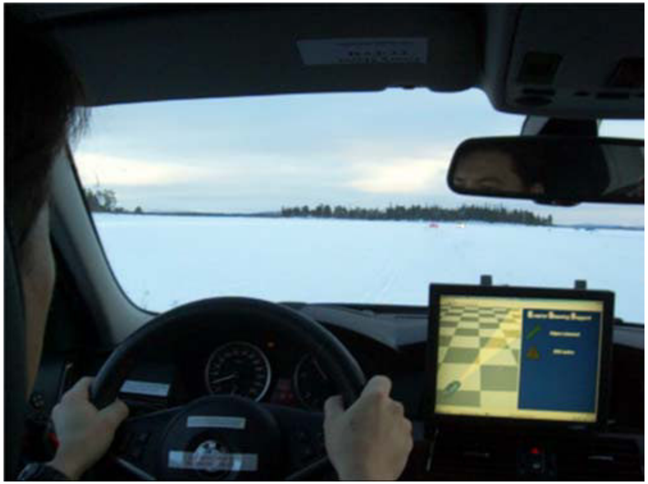
- Provides no support at all as long as the driver does not decide to perform an evasive maneuver
- Supports the driver during evasion by either:
  - **Additional torque** on the steering wheel (in case the driver has under-reacted)
  - **Corrective torque** on the steering wheel (in case the driver has over-reacted)

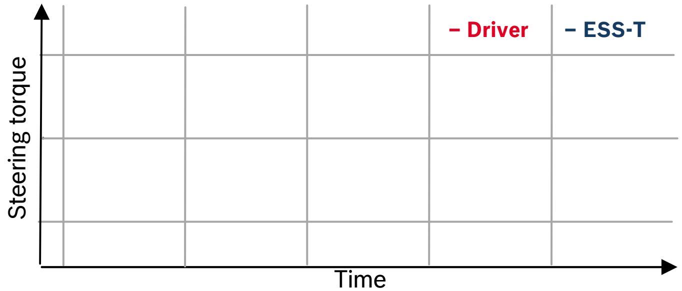
Demonstrations: over and under-reaction

1. Driver under-reacts (with ESS-T)



2. Driver over-reacts (with ESS-T)





➔ ESS-T corrects the driver's insufficient input in case n°1 and the excessive reaction in case n°2. In both cases the right amount of steering torque is finally input. The obstacle is safely avoided.

Demonstrations: over and under-reaction

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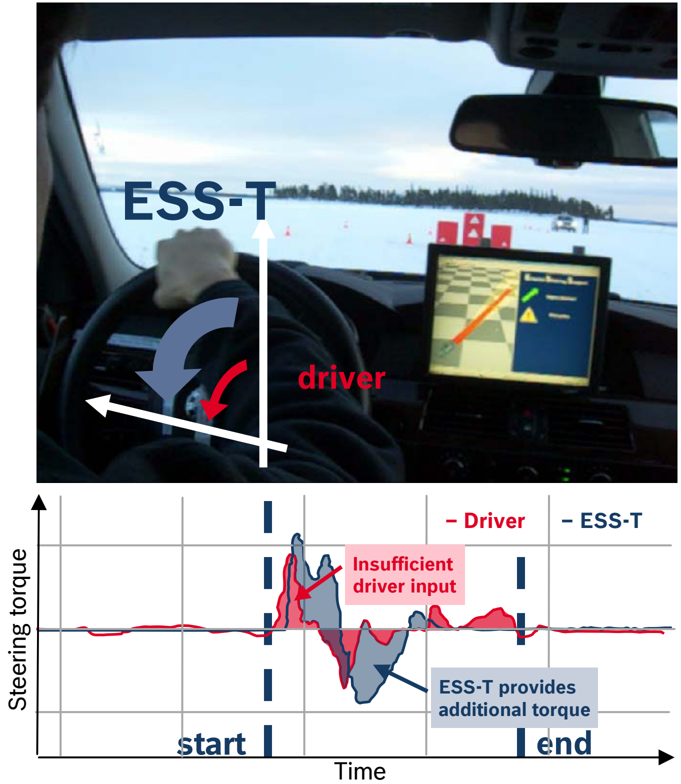

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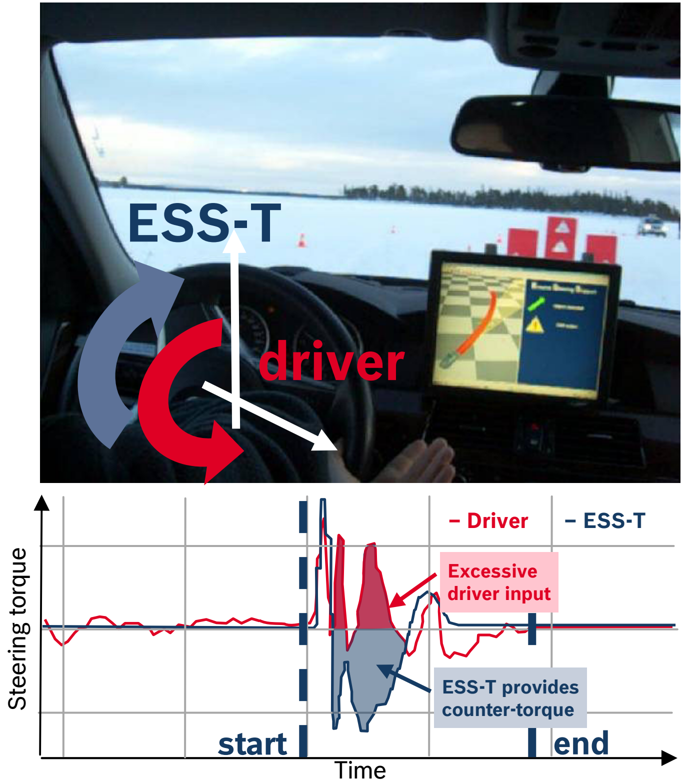


→ ESS-T corrects the driver's insufficient input in case n°1 and the excessive reaction in case n°2. In both cases the right amount of steering torque is finally input. The obstacle is safely avoided.

Evasive Steering Support by Torque (ESS-T)

Situation

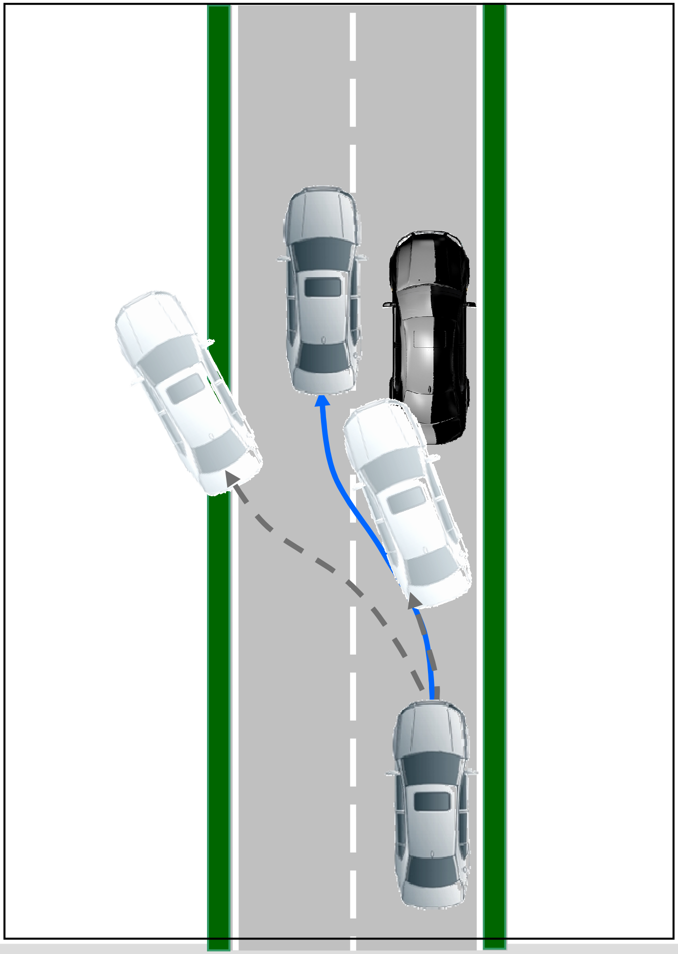
- Potential rear-end collision
- Emergency braking is insufficient to avoid accident
  - Evasive maneuver must be undertaken
  - Driver inexperienced and stressed
- **Driver likely over-reacts or under-reacts**

Hazards

- Getting off road
- Incomplete manoeuvre (rear-end collision)
- **High risk of even more severe crashes**

ESS-T

- Optimal steering support to avoid front crashes
- Reduced risk of crashes and injuries



Safe, superior & comfortable driving

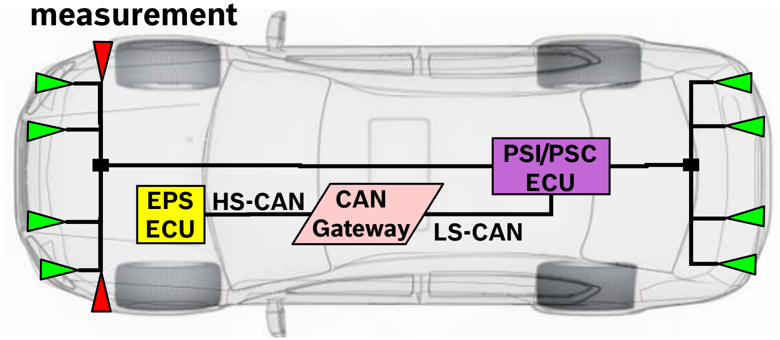
Semi-Autonomous Parking

Specifications

- Functional extension of Park Pilot and Parking Space Measurement
- Driver guided via HMI to follow a calculated trajectory
  - Coupled with steering angle sensor
  - Dynamic recalculation in case of false steering
- System consists of ECU and up to 10 ultrasound sensors (incl. 2 sensors with a detection range of approx. 4 m)

Customer benefits

- Easier and more convenient parallel parking
- Avoidance of long or unsuccessful parking attempts
- Available parking space is used more efficiently



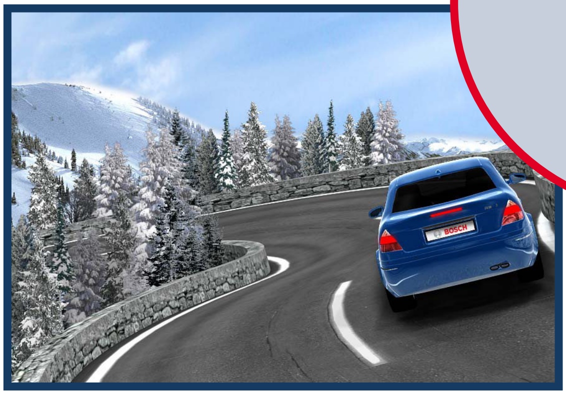
Semi-Autonomous Parking

Safe, superior & comfortable driving

Safe

Superior

Comfortable



Highlights of Vehicle Dynamics Management functions (VDM)

Dynamic Steering Torque Control (DST)

→ motivate the driver to more adequate steering

Improve the driver's steering reactions

EPS – Electric Power Steering

Picture:
ZF Lenksysteme GmbH

Dynamic Steering Angle Control (DSA)

→ improve yaw stability and straight running

Steering like a perfect driver

AFS – Active Front Steering

Picture:
ZFLS GmbH

Dynamic Wheel Torque Control (DWT)

→ enhance agility, traction and stability

Emphasize the sporty characteristics of a vehicle

ETV – Electr. Torque Vectoring

Picture:
GKN

Dynamic Damper Force Control (DDF)

→ improve steerability and brake performance

Comfortable support for ESP®

Semi-active damper control

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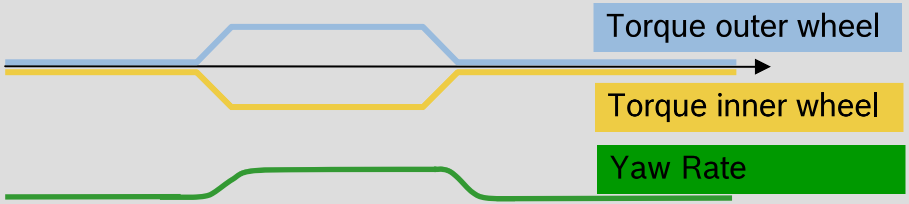
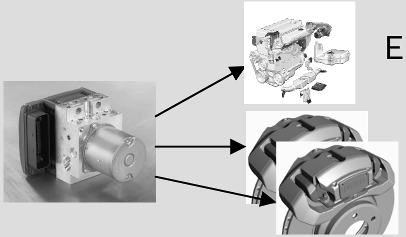
Principle of Dynamic Wheel Torque Control (DWT)

Physical effects for DWT - general

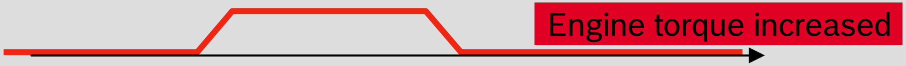


DWT-B with ESP®*premium*

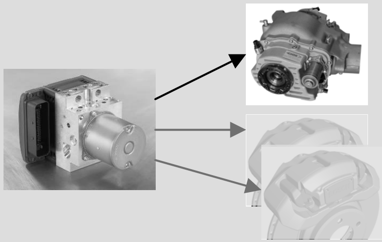


Engine

Brakes



DWT-D: Combination of differential and ESP® interventions



Active Differential

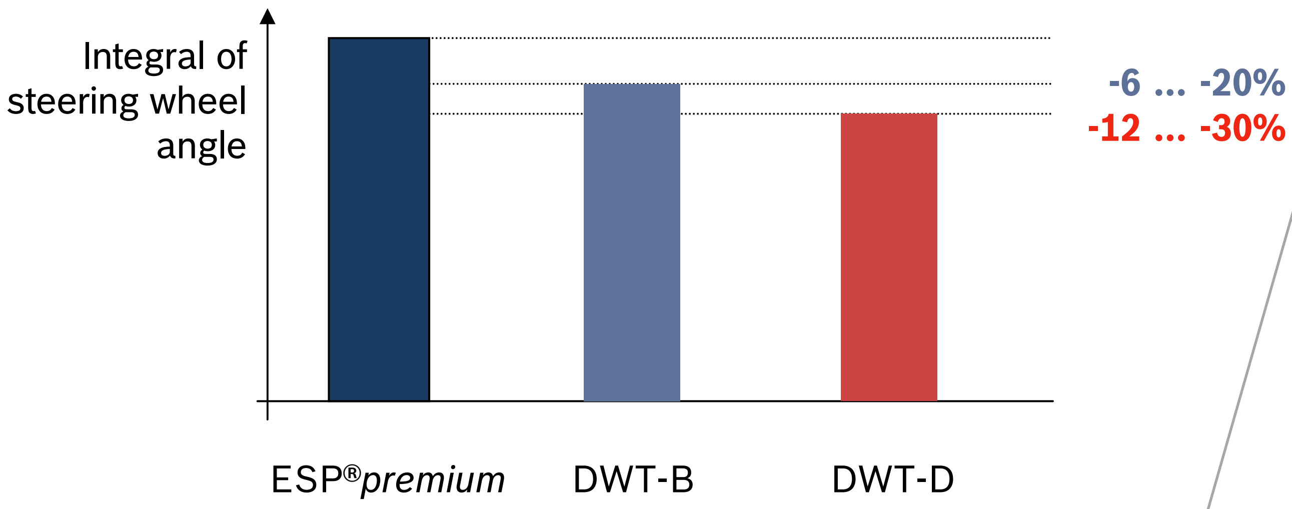
Reduced brake interventions

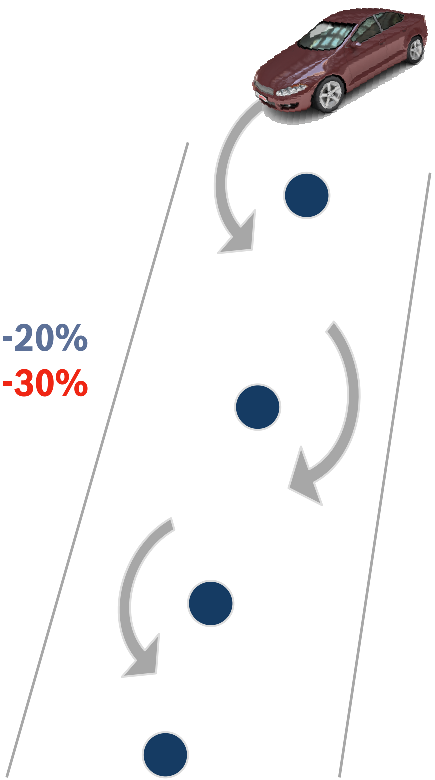
DWT-B: Dynamic Wheel Torque Control by Brake
DWT-D: Dynamic Wheel Torque Control by Differential

Comfortable interventions for improved agility without deceleration.

Dynamic Wheel Torque Control
Reduced steering effort

Maneuver: 18 m slalom on high-µ at vehicle speed 55 kph
Vehicle: Rear wheel drive vehicle of E segment, sporty ESP calibration





DWT-B: Dynamic Wheel Torque Control by Brake
DWT-D: Dynamic Wheel Torque Control by Differential

Significant agility improvements for quick steering wheel inputs

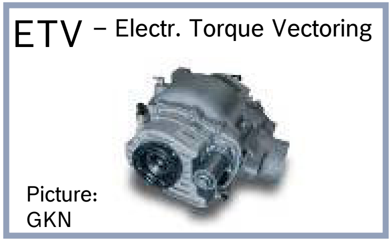
VDM Functional Integration of three Actuators

ESP® premium

+

DSA
Dynamic Steering
Angle Control

+



DWT-D
Dynamic Wheel
Torque Control
by Differential

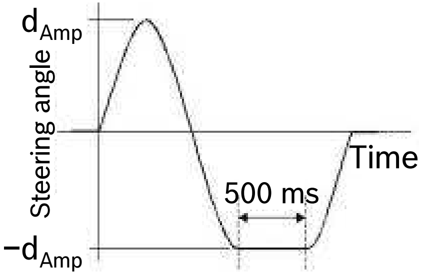
Synergies between functions

➔ Acceleration on split-µ
- optimized traction by DWT-D
- automatic counter-steering by new DSA function

➔ Oversteering control w/ optimized distribution to actuators
- increased intervention comfort
- reduced brake interventions
- reduced speed loss

Drive presentation at 2008 winter testing in Sweden

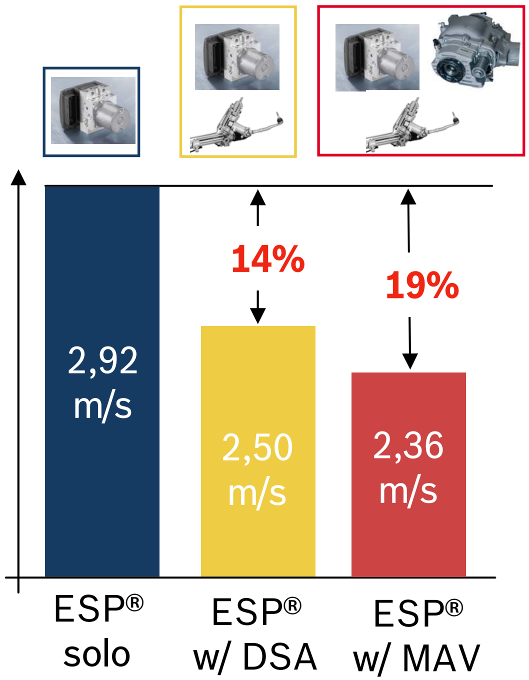
Multi Actuator Vehicle (MAV) Benefit: Optimal Distribution of Interventions



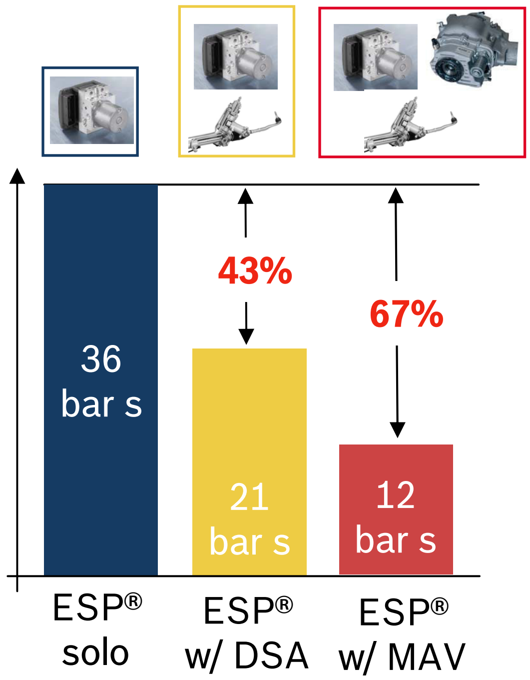
Test conditions:
- 80 km/h,
- 100 deg steering amplitude,
- μ=1,
- stability always maintained

AFS: Active Front Steering
TV: Torque Vectoring
MAV: Multi-Actuator VDM

speed loss
(velocity difference start to end)



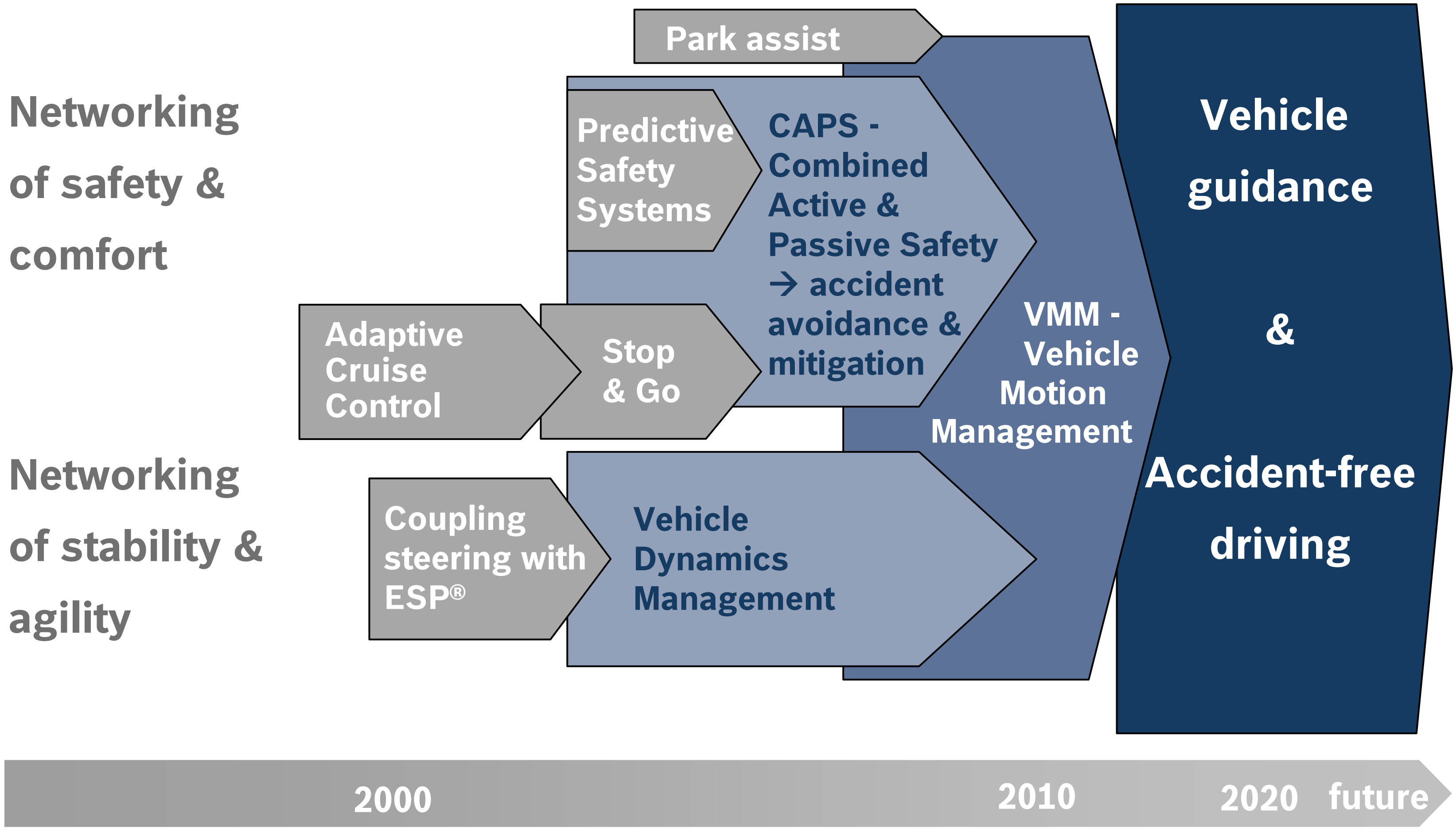
brake interventions
(integral of sum of all wheel pressures)



Significant speed and comfort benefit by networking ESP® + AFS + TV

Safe, superior & comfortable driving

Visions future networking of vehicle domains



Thank you very much for your attention