Right on track to enhanced driving safety

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Outline

- CAPS motivation & content of activity
- Accident analysis & development methodology
- Market, drivers, trends & challenges
Reduction of crash fatalities

Fatalities EU 25

- 52K
- 26K

Airbag (1980)
ESP® (1995)
ACC (2000)
CAPS - Combined Active & Passive Safety

System integration

eSafety goal (EU): 50% fatality reduction
CAPS - Combined Active & Passive Safety

CAPS is …

**Active Safety**
Accident mitigation
- e.g. ABS, ESP®, VDM

**Passive Safety**
Injury reduction
- e.g. airbag, seatbelt tensioner

**Driver Assistance**
Assistance
- e.g. Adaptive Cruise Control (ACC)

**Communication**
Traffic information/guidance
- e.g. navigation, display technology

Vehicle movement sensing & control

Crash sensing
Occupant protection

Surround sensing

Vehicle communication
CAPS - Combined Active & Passive Safety

CAPS – the route to enhanced driving safety

**Driver Assistance**
- Vehicle stabilizing
- Brake functions
- Vehicle dynamics

**Active Safety**
- Radar based systems
- Ultrasonic based systems
- Video based systems

**Passive Safety**
- Detection and sensing
- Occupant protection
- Pedestrian protection

**Communication**
- Navigation systems
- Display technology
- Car-to-x

**CAPS**
- Preventive information
- Coordinated interaction
- Added value functions

**Targets:**
- Accident mitigation and reduced accident severity
Selection of safety functions – Predictive Safety Systems

Active Safety

- PBA (Predictive Brake Assist)
  - Adaptive Brake Assist (ABA)
  - Automatic Brake Pre-fill (ABP)
  - Reduced braking distance

- PCW (Predictive Collision Warning)
  - PBA + driver warning (e.g. short brake pulse)

- PEB (Predictive Emergency Brake)
  - PCW + automatic emergency braking before an inevitable collision
Selection of safety functions – occupant protection

Active Safety

- Vehicle stabilizing
- Brake functions
- Vehicle dynamics

Passive Safety

- Detection and sensing
- Occupant protection
- Pedestrian protection

RoSe II (Roll-over Sensing)
- Earlier deployment of curtain airbags based on ESP® sensor signals in roll-over situations

EPCD (Early Pole Crash Detection)
- Earlier deployment of restraint devices in case of a door intrusion after a lateral trip of the vehicle

PREFIREESP
- Activation of reversible belt tensioners in critical driving situations
## CAPS multiphase safety concept

### Risk phases

1. **Risk avoidance: Traffic guidance**
   - Warn driver in advance in case of e.g. traffic jam or improper speed

2. **Increased risk: Brake preparation**
   - Raise brake efficiency

3. **High risk: Driver warning / Accident mitigation**
   - Guide the driver's attention towards crash avoidance

4. **Crash inevitable: Accident preparation**
   - Prepare occupant protection, slow down vehicle

5. **In-crash: Occupant protection**
   - Optimize occupant protection

6. **After crash: Information**
   - Inform rescue services, warn following traffic
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Main fatalities categories

- Vehicle-to-vehicle: 46%
- Single vehicle: 6%
- Vehicle-to-pedestrian: 36%
- Others: 4%

Fatalities versus kinds of accidents

- Leaving the carriageway to the right or left (36%)
- Collision with another oncoming vehicle (12%)
- Collision with another vehicle which turns into or crosses a road (14%)
- Collision between vehicle and pedestrian (10%)
- Collision with another vehicle which is moving ahead or waiting (6%)
- Others (22%)

Function examples:
- Preventive Information & Assistance System (PIA)
- Advanced Driver Assistance Systems (ADAS)
- Lane Keeping Support (LKS)
- PREFIRE
- Early Pole Crash Detection (EPCD)
- Advanced Roll-over Sensing (RoSe II)

Source: GIDAS, 2004, BaSt 2004
Fatalities causes

Cause: collision while leaving the carriageway to the right or left

- Speed: 48%
- Other mistakes by the driver: 35%
- Driving fitness: 14%
- Improper driving: 2%
- Others: 1%

Source: GIDAS, 2004, BaSt 2004
Fatalities causes

Cause: collision with another oncoming vehicle

- Speed: 36%
- Improper driving: 35%
- Overtaking: 13%
- Driving fitness: 8%
- Technical or maintenance faults: 5%
- Others: 3%

Source: GIDAS, 2004, BaSt 2004
Methodology – Top-down process, steps

Step 1: Identification of main area of function focus (cause, kind related) ✔

Step 2: Identification of system benefit focus

System benefit corridor

Benefit for driver / passenger is mostly given within the corridor

Risk avoidance
Increased risk
High risk
Crash inevitable
In-crash
After crash

Assistance phases

- Autonomous intervention
- Help to act
- Help to decide
- Help to understand
- Help to recognize
Methodology – Top-down process, steps

Step 1: Identification of main area of function focus (cause, kind related) ✓
Step 2: Identification of system benefit focus ✓
Step 3: Identification of system cost

⇒ System cost and complexity is lowest in the optimum cost zone
### Methodology – Top-down process, steps

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#### Autonomous intervention
- Help to act
- Help to decide
- Help to understand
- Help to recognize

#### E.g.
- Assistant for crossings & intersections

- Avoidance of Risk
- Increased Risk
- High Risk
- Crash Inevitable
- In Crash
- After-Crash
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Active Safety
- Collision-warning
- Predictive Safety Systems (PSS)
- PreCrash-Sensing
- Pedestrian recognition
- Predictive occupant protection

Passive Safety
- PreCrash-Sensing
- Pedestrian recognition
- Predictive occupant protection

Vehicle Guidance
- ACC
- ACC plus
- ACC FSR
- Parkstop
- Parkpilot
- Park assist
- Nightview assist
- Lane Keeping Assist (LKA)
- ACC
- Surround-view
- Video
- Radar
- Ultrasonic
- Blind Spot Detection (BSD)
- Lane Departure Warning (LDW)

Driver Assistance
- Parkstop
- Collision-warning
- Predictive Safety Systems (PSS)
- PreCrash-Sensing
- Pedestrian recognition
- Predictive occupant protection

Safety

Comfort
Maturity of the Driver Assistance markets

- Networked systems
- Segmentation in LDW-only and multifunctional systems
- Increasing system attractiveness
- Market segmentation (function, price)

- SDF**
- Video
- ACC
- Park-Pilot (US*)

* US = Ultrasonic sensors
** SDF = Sensor data fusion

Market development in years

0 10 20

Innovation phase
Market penetration
Mature market

Increasing system attractiveness

Market volume
Market environment – Trends and drivers

- Improved safety in traffic
- Higher comfort-orientation
- Higher mobility/flexibility

- Traffic accident statistics
- Traffic safety laws
- Vehicle safety laws

- Regional traffic safety targets (EU-guidelines, targets)
- Development guidelines

- Increased traffic concentration
- Increasing mobility/flexibility
- Changing driver age-structure

- Safety features as USP
- Value adding to vehicle function portfolio
- Competitors pressure

- Reduced damage related expenses
- Lower contributions/policy

- Traffic situation
- Consumer
- Insurances
- OEM
Mainstream ("state of the art")
- Stand alone systems in "peaceful coexistence"
- Dedicated sensors for dedicated systems
- Side effects might still be covered with manageable testing effort
- Mainly iterative development process

Front end
- Sensor data fusion for function prototypes
- First usages of sensor cluster for comfort- and safety functions
- Safety related requirements increase testing effort excessively
- Enormous cost increase for iterative development process
Trends & challenges 2/2

Future

- Driver Assistance Systems: Step by step evolution from comfort systems to safety systems
- Safety applications become a dominant driver for surround sensing systems
- Increasing requirements regarding safety systems (ASIL D) → vehicle architecture
- Covering of side effects in high complex systems will not allow anymore iterative development process
- Core competences such as vehicle dynamics, trajectory control, identification of traffic situation and safety systems will be combined increasingly → „CAPS“
- High potential to improve driving safety especially for the domain „Active Safety“
Halving the number of road accident victims in the EU by 2010

A shared responsibility