A brief supplement to the INVENT brochure
describing the component project
Anticipatory Active Safety VAS
INVENT

Driver Assistance
Active Safety

Detection and Interpretation of the Driving Environment
Anticipatory Active Safety
Congestion Assistant
Driver Behavior and Human Machine Interaction
Traffic Impact, Legal Issues, and Acceptance

Traffic Management
2010

Traffic Performance Assistance
Network Traffic Equalizer

Traffic Management in Transport and Logistics

Traffic Management in Transport and Logistics
Anticipatory Active Safety in the Context of INVENT

Traffic and transport continue to be key economic factors. They provide the basis for prosperity and progress and ensure our competitive ability. Mobility is also an important ingredient of quality of life, self-fulfillment, and personal freedom. However, in recent decades the increase in traffic has been accompanied by negative consequences such as accidents and congestion.

Only by using innovative technologies will it be possible to find sustainable solutions to these problems and to make traffic safer and more efficient in spite of future growth in demand.

The research initiative INVENT (intelligent traffic and user-oriented technology) is designed to contribute to this goal. To this end, 23 companies and institutions are cooperating in the three projects Driver Assistance Active Safety, Traffic Management 2010, and Traffic Management in Transport and Logistics.

The component project Anticipatory Active Safety aims to reduce the severity and the number of traffic accidents -particularly those leading to serious injuries and fatalities. VAS is part of the project Driver Assistance Active Safety and is closely coordinated with the related component projects Detection and Interpretation of the Driving Environment, Driver Behavior and Human Machine Interaction, and Traffic Impact, Legal Issues, and Acceptance.
Motivation

About 85 percent of all traffic accidents are attributable to driver distraction, fatigue, and perceptual errors. A large proportion of these accidents can be avoided or at least reduced in severity by active safety systems. In particular, assistance systems can help to prevent accidents typical of urban streets and rural roads – such as accidents occurring at intersections and driveways, accidents resulting from turns and entries, and accidents due to lateral conflicts. In this way, assistance systems will contribute significantly to protect vulnerable road users such as children, pedestrians, and cyclists.
According to the Federal Bureau of Statistics in Germany:

- Collisions with vehicles crossing, entering or turning at intersections or roadways represented a considerable proportion of injury accidents, corresponding to 37 percent of accidents with mild injuries, 29 percent of those with serious injuries, and 17 percent of those with fatalities.

- About 24 percent of injury accidents occur due to collisions with an obstacle on the road with a leading vehicle and/or one that is in the process of stopping, is already stopped, or is just beginning to accelerate after a stop.

- Twelve percent of persons injured fatally in traffic accidents lost their lives due to being struck by a vehicle; about eleven percent of serious injuries in traffic accidents are due to vehicle-pedestrian collisions.

- About 16 percent of all cases with traffic accident victims involved vehicles leaving the roadway (about 35 percent of fatal accidents and 26 percent of accidents with serious injuries).

![Source: Federal Bureau of Statistics / traffic accidents with personal injury 2001](image-url)
Goals

In the INVENT component project *Anticipatory Active Safety*, safety assistance systems are being developed that are designed to support the driver during safety-critical driving maneuvers and thus prevent accidents. Another important goal is to develop special solutions for effective protection of pedestrians and cyclists. The specification of these systems and their implementation as prototypes will be based on detailed causal analysis of the sequence of events taking place before and during an accident.

The focus of this component project is on four safety functions:

- Lateral control assistance
- Intersection assistance
- Protection of pedestrians and cyclists
- Predictive control of vehicle dynamics
**Goals and Benefits of the VAS-Project**

- **Lateral control assistance**
  - Protection against lateral collisions and leaving roadway
  - Safe performance of avoidance and lane-changing maneuvers

- **Intersection assistance**
  - Protection against failure to yield right of way
  - Turning and entering assistance
  - Support in finding and reaching navigation lanes

- **Protection of pedestrians and cyclists**
  - Safety of vulnerable road users by warning and protective mechanisms

- **Predictive control of vehicle dynamics**
  - Vehicle stabilization in critical situations by steering and braking support
Lateral Control Assistance

The high proportion of accidents due to vehicles leaving the roadway or caused by lane changes is substantiated by official accident statistics.

Lateral control assistance will comprise the following functions:

- Warning when the vehicle unintentionally leaves the lane
- Lane tracking support
- Lane-changing help on motorways and rural roads
- Compensation of external disturbances
- Avoidance assistance

To this end, both vehicle motion within the lane and the roadway itself will be continuously tracked and monitored. This monitoring will include additional information concerning key roadway characteristics.

In this way, an incipient loss of control that might cause the vehicle to leave the roadway can be immediately detected, and the driver can be appropriately warned in time. The system will also be designed to improve the safety of lane changes and to compensate for possible driver attention lapses by taking into account forward, lateral, and rear sensor information.

"External disturbances" refer to such influences as side winds and gusts, roadway banking, or road grooves, which will be automatically compensated for in commercial vehicles. Compensation for disturbances in vehicle dynamics for commercial vehicles will have a significant impact in reducing the burden of steering perfection required from the driver during critical lateral movements and passing, in particular. If the driver’s lane is blocked by an obstacle, the avoidance assistance function in commercial vehicles checks whether a lane change is possible, adjusts speed automatically if required, and informs the driver of an appropriate action.
VAS - Solution Approaches

Lane tracking support

Compensation of external disturbances

Lane-changing and avoidance assistance
Turning and entering assistance

Support in locating and entering turn bay

Traffic signal and right-of-way assistance

Turning and entering assistance
Intersection Assistance

Approximately 60 percent of accidents in city traffic occur at intersections. Failure to yield the right of way is frequently involved. A key underlying cause is the complexity of the traffic situation and hence the substantial increase in the burden on the driver’s attention at intersections. Here, driver assistance systems capable of reducing the driver burden and providing timely hazard warnings offer a considerable potential for preventing accidents.

In the component project Anticipatory Active Safety, assistance systems designed to protect drivers against (inadvertently) running red lights or failing to yield where required will first be developed. Next, these systems are to be extended by functions designed to prevent accidents during turning, by means of additional lateral surveillance as well as measurements providing surveillance and monitoring of cyclists, pedestrians, opposing traffic. Before active safety systems intervene, assistance systems are required that will support the driver during the intersection approach phase, e.g., in changing to the appropriate lane. This task could be accomplished using methods such as extended digital maps and high-precision satellite navigation. To this end, driver support before and during lane changes is also required, including monitoring of areas behind, next to, and in front of the vehicle.
Protection of Pedestrians and Cyclists

Pedestrians and cyclists are the most vulnerable road users. Solution approaches specially targeted to protection of pedestrians and cyclists are therefore a key focus of the INVENT component project Anticipatory Active Safety. To avoid or at least reduce the consequences of accidents and hopefully save lives, the project will develop safety systems in vehicles designed to warn vulnerable people outside the vehicle in hazardous situations or in case of driver attention lapses. Warning pedestrians and cyclists promises to be particularly effective in improving safety, because these people can often react to a hazard (e.g., by stopping suddenly or taking evasive action) more quickly / flexibly than the vehicle itself.

If a collision is imminent, pre-crash-sensors (24GHz Radar) and contact sensors will simultaneously activate protection mechanisms such as reversible extendible fenders and reversible tilting hoods (on flexible elements), which deform plastically during the collision itself to absorb the “crunch” and thus protect the pedestrians or cyclist.
Predictive Control of Vehicle Dynamics

Current vehicle dynamics solutions such as ESP or DSC are based exclusively on information from driver intentions, momentary vehicle kinematics (state of motion), and the friction potential between the tire and the roadway surface. However, the behavior of the vehicle relative to its surroundings (i.e., motion with respect to lane and other objects) has not been included up to now. Hence, by additionally utilizing environment sensors, existing systems could be considerably improved. Besides the steering actions of the driver, the position of the driver within the lane is taken into account. In situations where a typical driver could be in danger of losing control of the vehicle, targeted braking and steering interventions will support lane holding and prevent the vehicle from leaving the roadway. In a second phase, the assistance function will be extended to take early preventive measures - such as braking or improved orientation and positioning of the vehicle before a curve being approached too rapidly – so that the hazardous range of vehicle dynamics is avoided.
Operating Principle of an Assistance System

A driver assistance system consists of three levels:

- Environmental recognition: Identification of infrastructure, vehicle state, road users and their traffic state, traffic situation, driver intention, traffic signs
- Situation analysis and decision to act: Information fusion and evaluation, weighing of options for action decision
- Performance of the action: Interface to driver by optical, acoustic, and tactile information as well as warnings; interface to vehicle by active intervention in braking, engine control, and (if required) steering.

Goal: Identification of infrastructure, vehicle state, road users and their traffic state, traffic situation, driver intention, traffic signs
- Digital maps, GPS
- Image processing
- Radar/Lidar
- Internal vehicle sensors
- Data pre-processing
VAS - Solution Approaches

Anticipatory Active Safety VAS

- acoustic
- optical
- tactile

Situation analysis and action decision

- Situation analysis
- Identification of needed action
- Action planning
- Action decision

Performance of the action

- Active intervention in engine control, steering, braking
Summary and Perspectives

Anticipatory driver assistance systems can be particularly effective in city traffic and on country roads in avoiding accidents and protecting the most vulnerable road user. The INVENT component project Anticipatory Active Safety will design and develop solution approaches based on detailed cause analysis of the sequence of events before and during an accident.

For the most promising approaches, this component project identifies and describes the information and sensor requirements and investigates appropriate driver-system interfaces. This work is supported by cooperation with the component projects Detection and Interpretation of the Driving Environment, Driver Behavior and Human-Machine Interaction, as well as Traffic Impact, Legal Issues, and Acceptance. The solutions that are identified will be implemented within the course of the project in driving simulators and in test vehicles equipped with prototypes. The assistance functions of Anticipatory Active Safety will be evaluated with respect to feasibility and prospective safety benefits. To this end, the demonstrators will be used to carry out extensive tests in driving simulators, on test tracks, and in real traffic.

Timeline

At the first milestone after two years, the results of the accident analysis will be available. In addition, several options for system functions will be implemented in demonstrators and driving simulators.

Based on this milestone, system functionality will be extended and implemented in prototypes during the second phase of the project. The second milestone at the end of the project demonstrates the full range of system functions in test vehicles.
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Siemens Restraint Systems AG
Siemens VDO Automotive AG
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## Glossary

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<th>Acronym</th>
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<td>FUE</td>
<td>INVENT component project <em>Detection and Interpretation of the Driving Environment</em></td>
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<td>FVM</td>
<td>INVENT component project <em>Driver Behavior And Human-Machine Interaction</em></td>
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<td>VRA</td>
<td>INVENT component project <em>Traffic Impact, Legal Issues, and Acceptance</em></td>
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<tr>
<td>ESP</td>
<td>Electronic stability program</td>
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<td>DSC</td>
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