



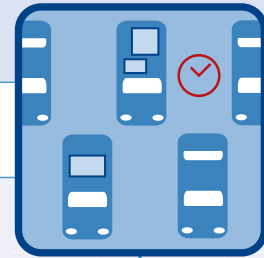
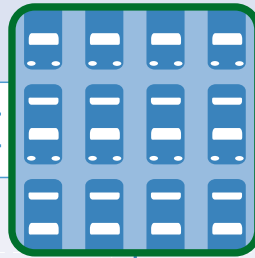
Traffic Performance Assistance VLA

INVENT

Driver Assistance
Active Safety

Traffic
Management
2010

Traffic
Management
in Transport
and Logistics



Detection and
Interpretation of
the Driving
Environment

Anticipatory
Active
Safety

Congestion
Assistance

Driver Behavior
and Human
Machine
Interaction

Traffic Impact,
Legal Issues
and Accept-
ance

Traffic
Performance
Assistance

Network
Traffic
Equalizer

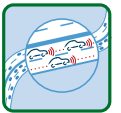
Traffic
Management in
Transport and
Logistics

Traffic Performance Assistance 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 can we find sustainable solutions to these problems and, in the face of ever expanding demands, make traffic safer and more efficient in the future.

The research initiative INVENT (intelligent traffic and user-oriented technology) is designed to bring this goal closer. 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.

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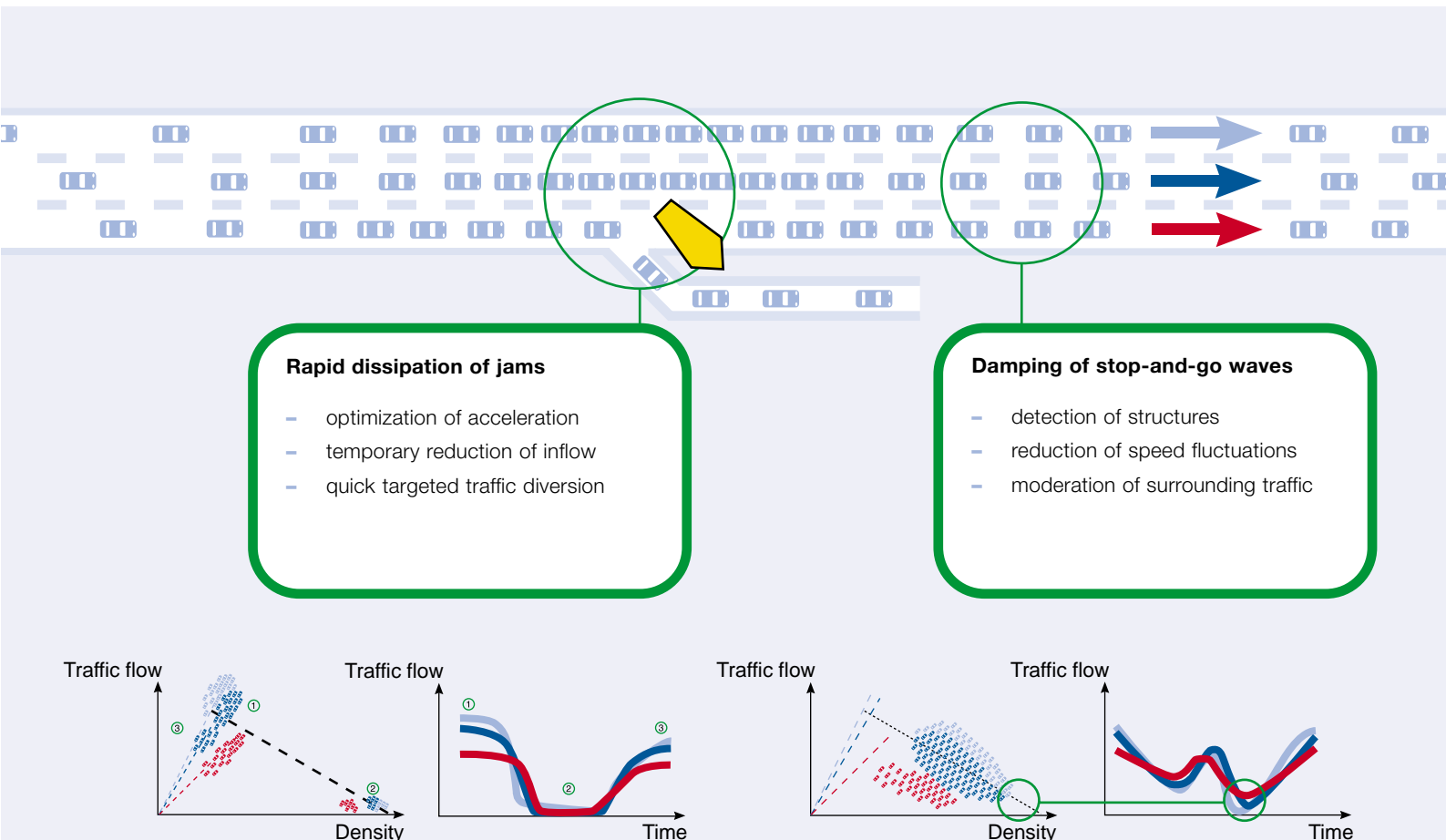
The goal of Traffic Management 2010 is to apply future progress in vehicle and communication technologies – especially driver assistance, as developed in the project Driver Assistance Active Safety – in order to utilize traffic infrastructure more efficiently and improve the performance of the roadway network. In particular, Traffic Performance Assistance will concentrate on optimizing the flow of traffic.

Motivation

According to a study performed by the official German Automobile Club (ADAC), traffic jams on German „Autobahns“ are mostly attributable to accidents (33%), road construction (31%), and inadequate capacity/excess demand (32%). The resulting losses to the economy have been estimated at about 250 million Euros per day.

The INVENT component project Traffic Performance Assistance is designed to make traffic flow more smoothly and relieve traffic jams.

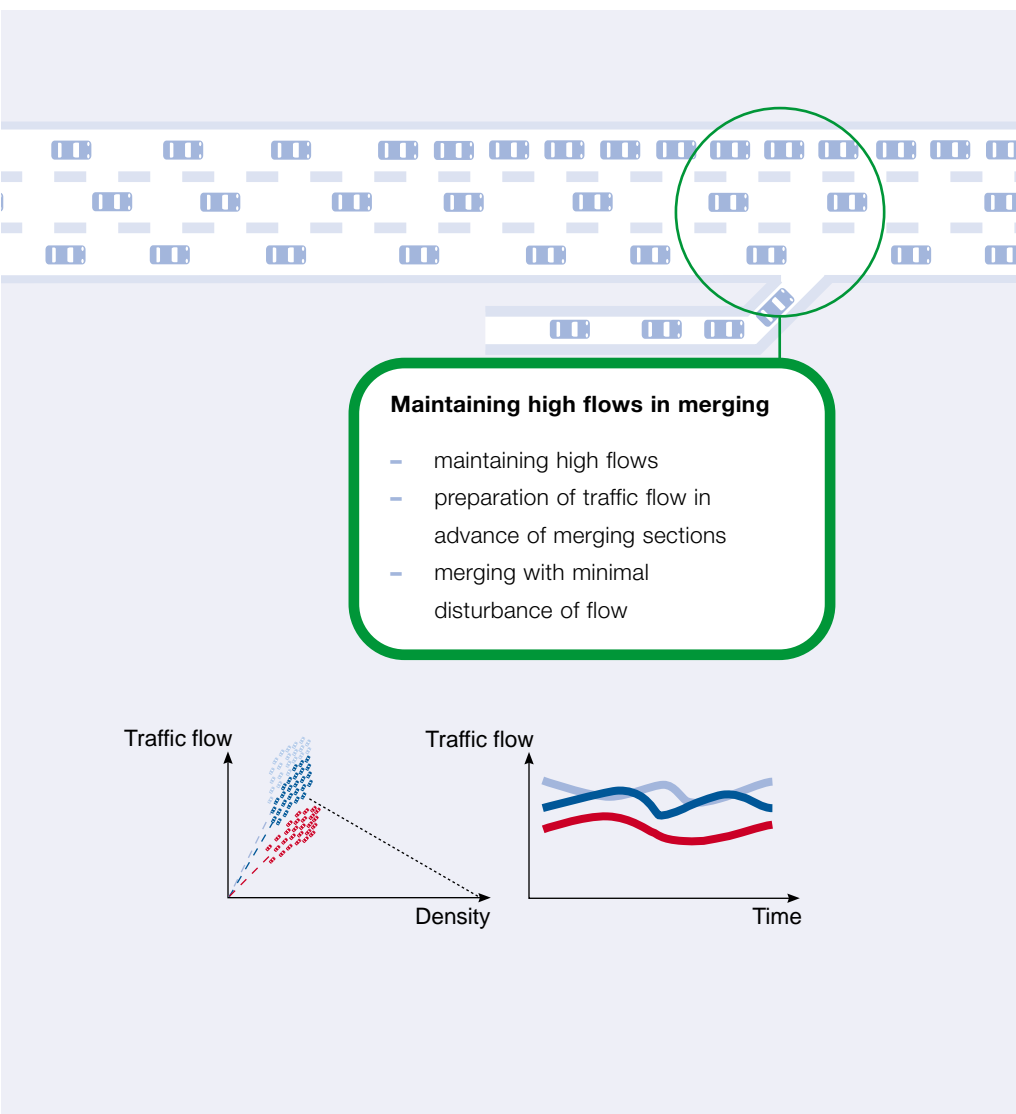
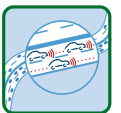
Focussing on highways, the project will distinguish three critical areas of application: maintaining high (uncongested) flows in merging sections, preventing transitions to stop-and-go traffic, and accelerating recovery from jams (congestion dissipation).



Goal

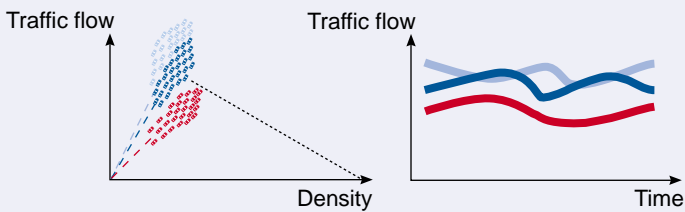
The goal is a smoother flow of traffic with fewer incidents and disturbances and hence lower economic costs. Every participant in traffic will benefit, since better traffic flow means shorter trip times, better gas mileage, reduced emissions, as well as decreased driving stress and increased traffic safety.

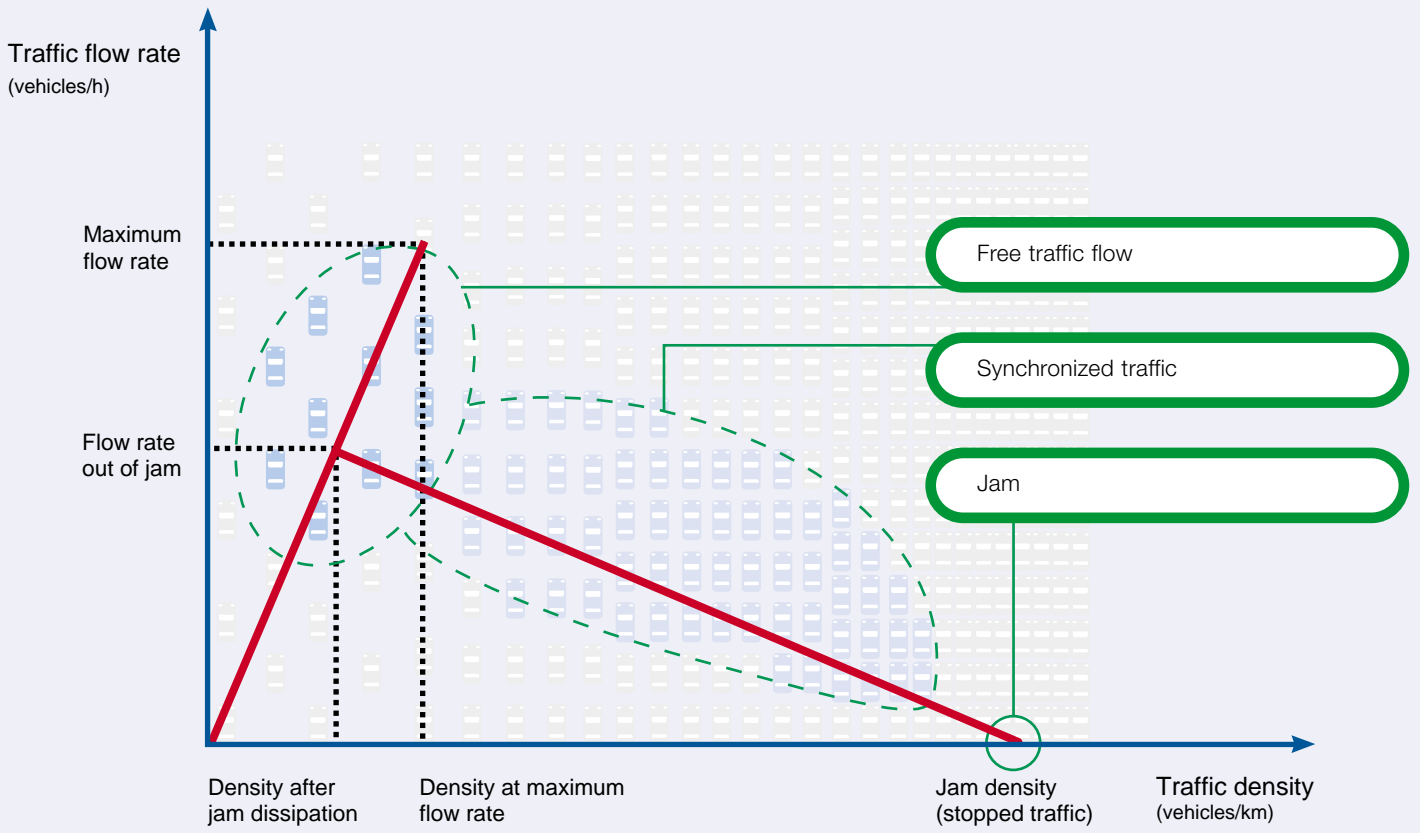
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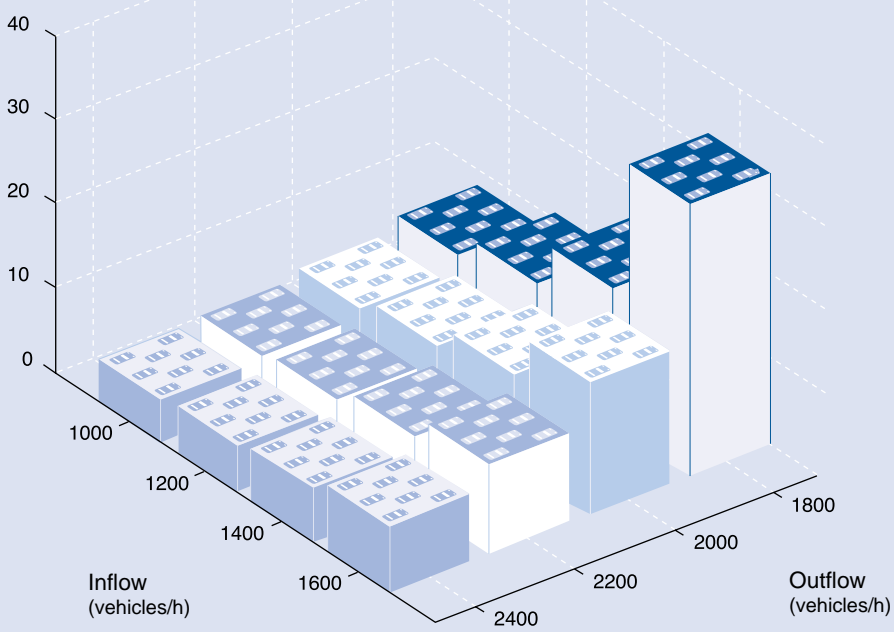
Maintaining high flows in merging

- maintaining high flows
- preparation of traffic flow in advance of merging sections
- merging with minimal disturbance of flow





Time to dissipate a 1 km long jam in minutes



Strategies for Dissipating Congestion

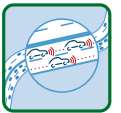
Investigations in previous projects such as Sandy or MoTiV have shown that in many traffic situations, the traffic volume (flow rate, or rate at which vehicles pass a point) actually attained is lower than the volume that could be carried under favorable conditions. A familiar example is the limited flow rate at the downstream end of a traffic jam amounting to only about 1800 vehicles per hour (per lane), i.e., about one vehicle every two seconds.

This flow rate is about one third lower than the maximum attainable traffic volume in free, undisturbed flow. As long as this limitation holds, it is impossible for a traffic jam to dissipate at medium to high traffic volumes (i.e., between about 1800 to 2000 vehicles per hour).

Evidently, there are just two distinct approaches one can take to dissipating jams: either raise the outflow or reduce the inflow.

A combination of these two strategies appears particularly promising.

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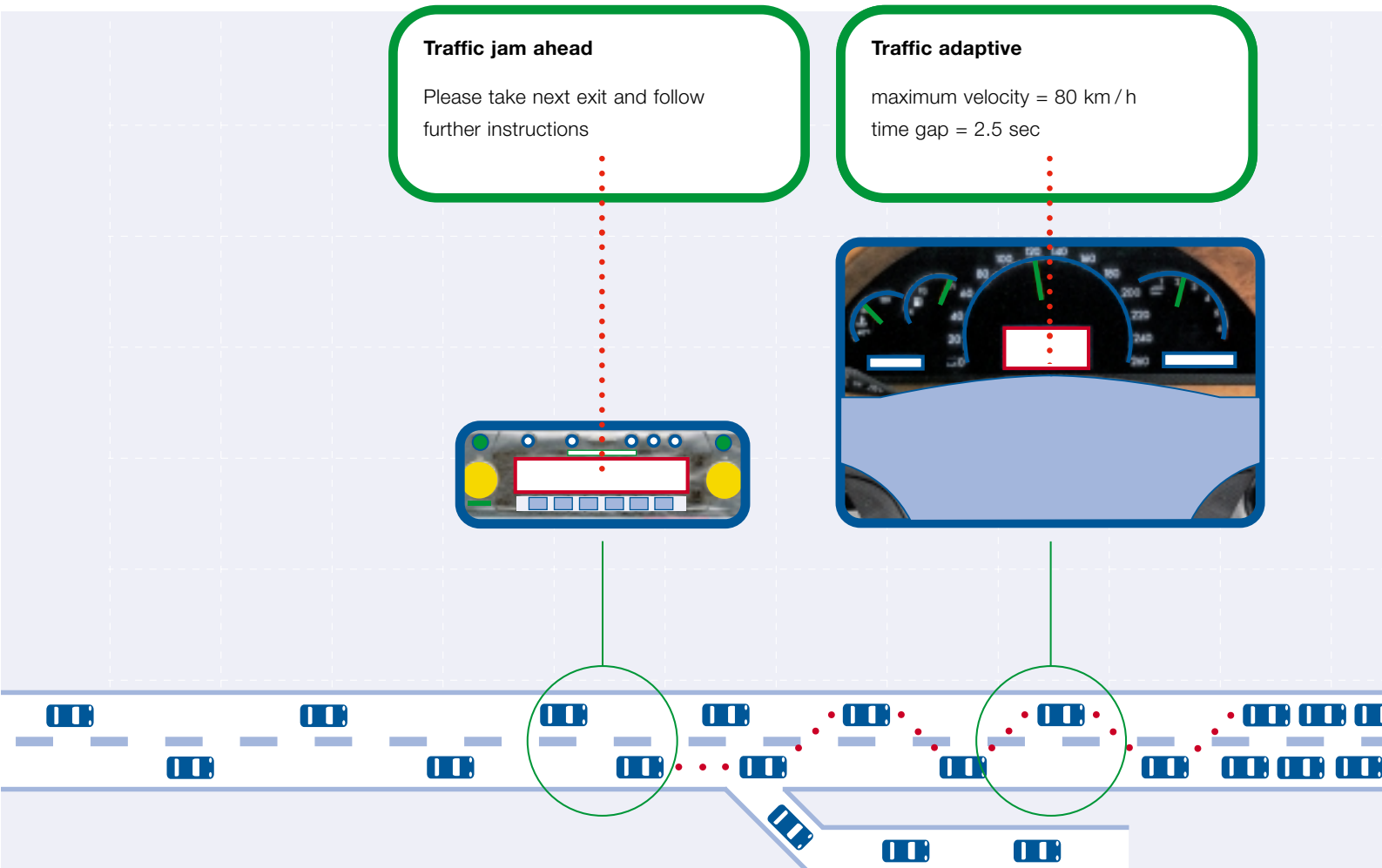


Reduction of Inflow

Reduction of inflow into the jam can be achieved in several ways:

One possibility is diversion of vehicles onto an alternate route. This of course requires detailed information not only for the original congestion, but also for the alternate route, in order to be certain that the recommended detour indeed represents the better alternative.

In theory -- i.e., assuming the density or, equivalently, the average vehicle spacing remains constant -- a second possibility is to reduce the mean vehicle speed in the region upstream of the jam. However, in practice, the effect of an upstream speed reduction on traffic volume (e.g., using variable message signs) has usually been quite small up to now, because the average space between vehicles also decreases, i.e., drivers usually reduce their headways as they lower their speed. If the vehicle spacing is maintained, however, then a significant reduction of traffic volume is indeed possible. For example, using automatic intelligent cruise control, a reduction could be achieved quite effectively by appropriately increasing the time gap settings. Finally, we mention a third method known as ramp metering, which is already practiced in various countries.

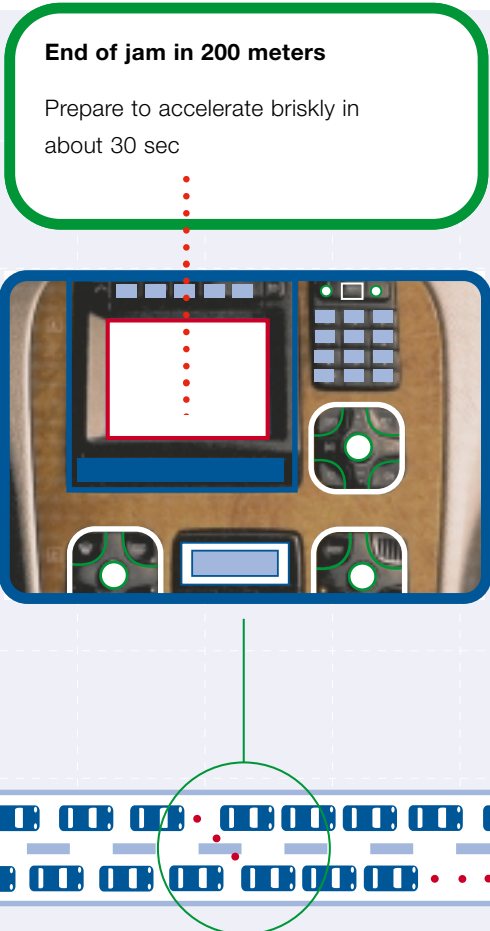
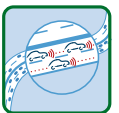


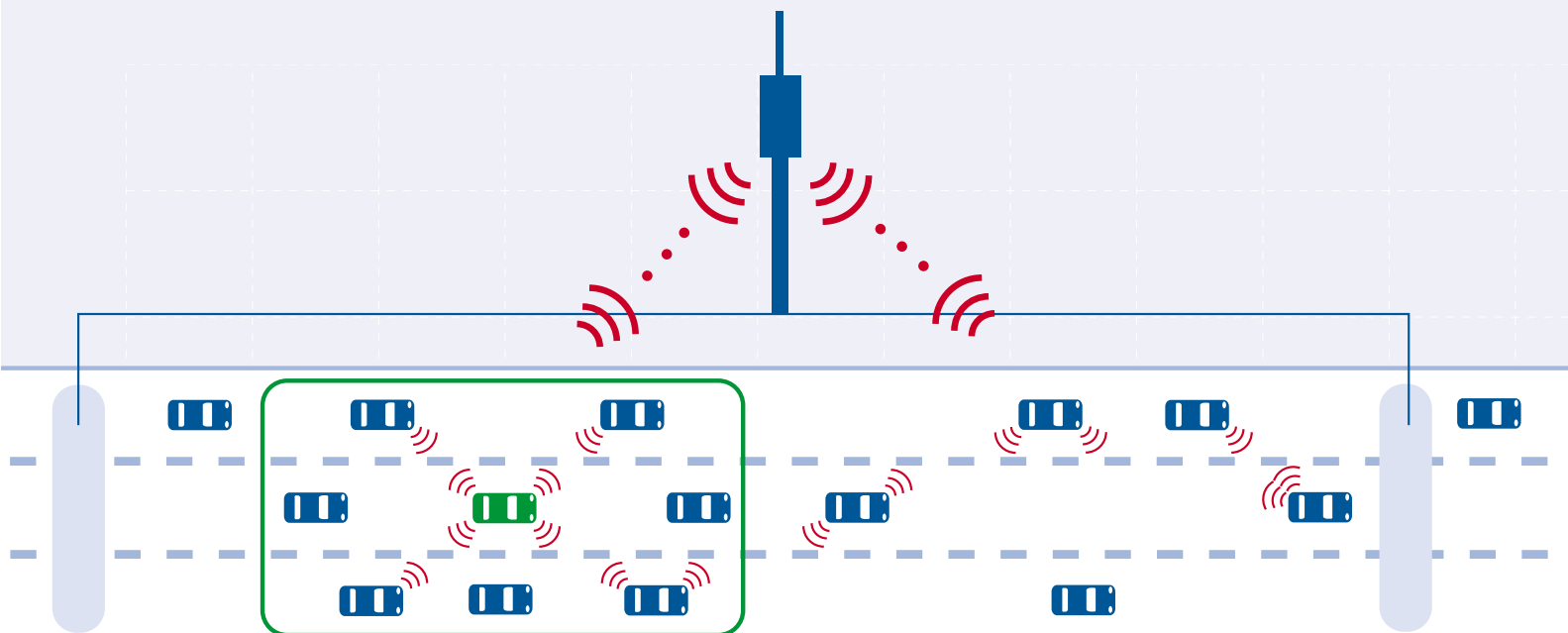
Raising the Outflow

Comparing vehicles leaving a traffic jam with vehicles starting from rest when a typical city traffic light turns green, one observes significantly shorter reaction times at the green light and consequently higher flow rates. The change from red to green is a signal that prepares the driver to accelerate to normal speed to start. If drivers leaving a jam were to receive a similar signal, this could shorten their reaction times, accelerate recovery to normal speed, and thus enable a higher outflow from the jam.

Implementation of this strategy requires precise localization of the downstream jam end in space and time. Based on this information, accelerated jam dissipation could be implemented in three stages: first by simply providing the information to drivers, second by providing explicit verbal or visual driving recommendations, and finally by using autonomously acting driving assistance systems.

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Data collection

- vehicle sensors
- stationary infrastructure

Mobile communication

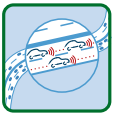
- short-range communication
- mobile, ad-hoc networks
- vehicle-based infrastructure



Communications and Information Supply

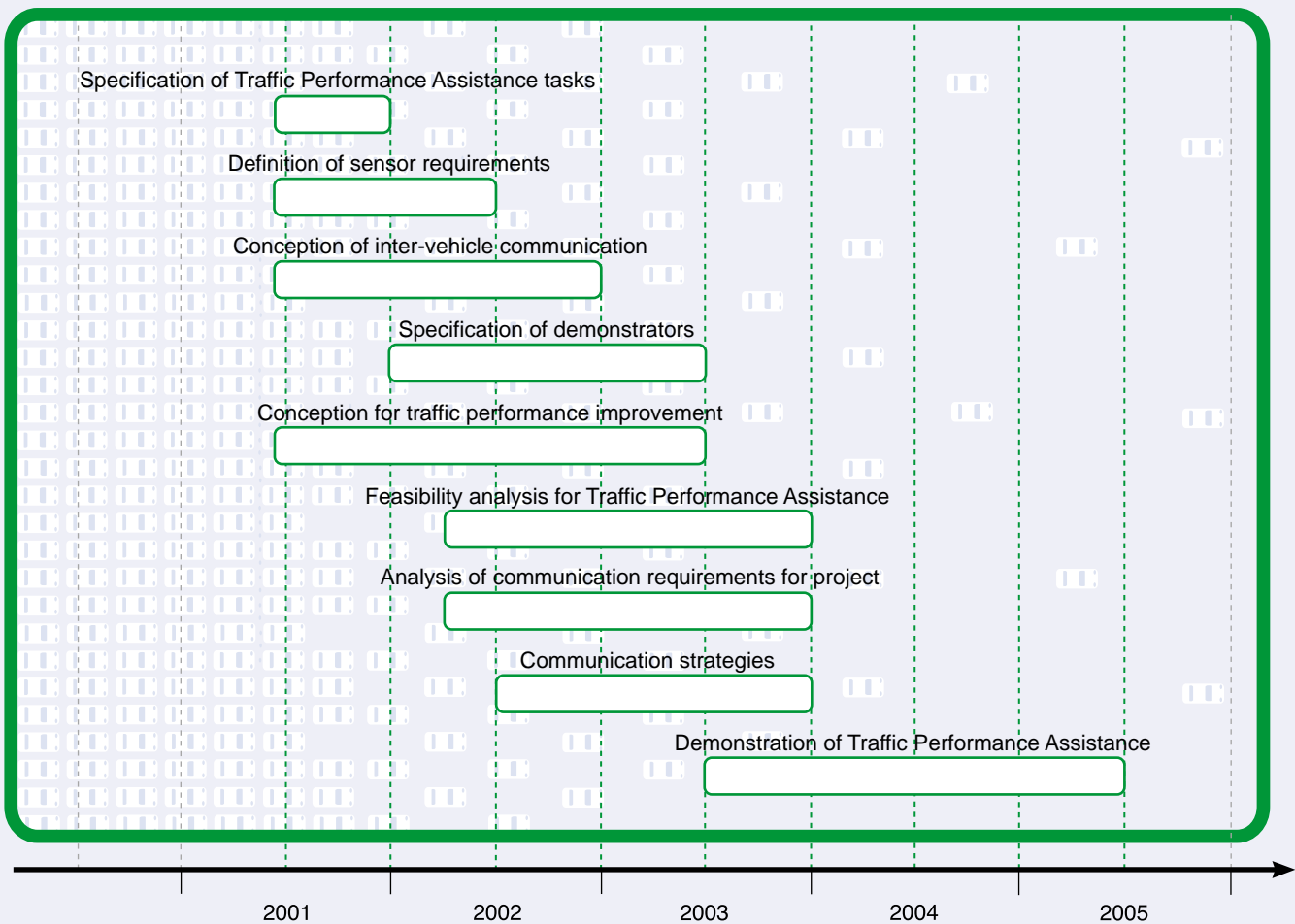
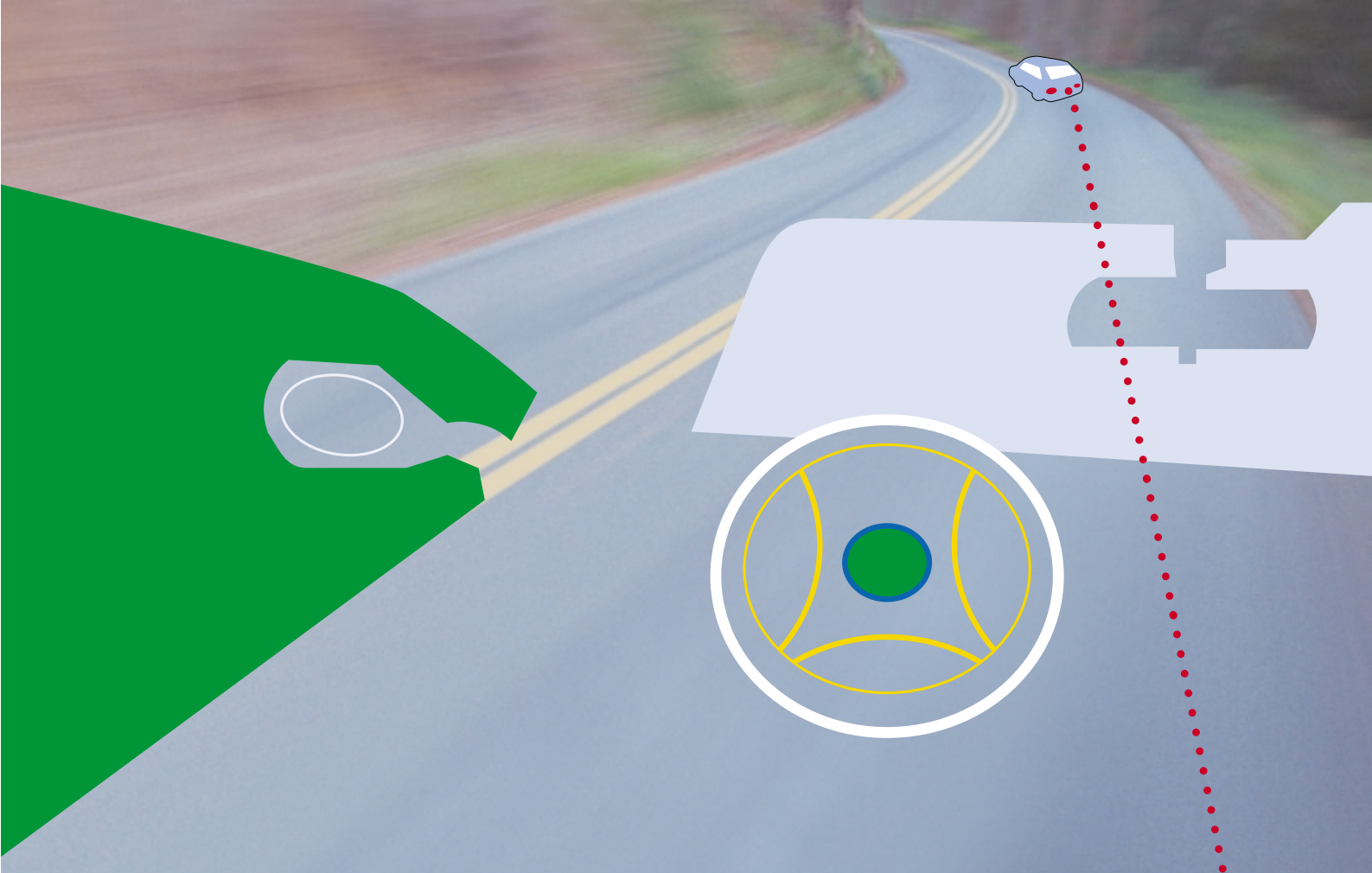
In order to implement the applications described above on a section of highway, detailed information concerning the current traffic state with high temporal and spatial resolution needs to be available throughout the section. This could of course be accomplished directly by complete video surveillance with image processing, but usually one does not have this luxury. Instead, one seeks to reconstruct the picture by indirect means: One way of obtaining the required high-resolution reconstruction of the traffic state is to use installed infrastructure where available such as induction loop measurements in conjunction with sophisticated algorithms for traffic state estimation. A second way, which is effective even without roadway infrastructure, is to use data from suitably equipped probe vehicles. By constructing and implementing appropriate communication pathways and strategies, the required data can be acquired and distributed to vehicles, either centrally by collecting "Floating Car Data" (FCD) or in a decentralized manner by direct inter-vehicle communication

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User Acceptance and Strategy for Market Introduction

In order to establish the safety, robustness, and effectiveness of traffic performance assistance systems not only for improving traffic flow as a whole, but also from the point of view of individual drivers, the first step in the INVENT component project Traffic Performance Assistance is to implement proposed algorithms in a simulated traffic environment and evaluate all of the complex phenomena comprehensively, under a variety of circumstances. After simulation in the computer, implementation of algorithms in driving simulators will then enable not only a demonstration of functionality, but also user-oriented testing of acceptance and ease of operation. Strategies for market introduction in stages will be developed in parallel.

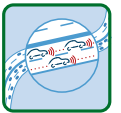


Demonstration of Results

The results of the component project Traffic Performance Assistance are to be shown by means of three demonstrators:

- Damping and prevention of stop-and-go waves on highways by reduction of inflow and by harmonization of traffic flow utilizing adaptive driving assistance
- Stabilization of traffic flow by lane use planning and lane change assistance functions. These will be designed to avoid or suppress flow disturbances that would otherwise occur due to inappropriate lane changes and to induce more efficient lane utilization.
- Dissipation of traffic jams by outflow increase, temporary diversion, and inflow reduction

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Time Frame

A stepwise procedure is planned for the demonstrators:

- Show effectiveness in traffic and demonstrate the functions using traffic simulation and 3-D animations
- Demonstrate the user acceptance of individual, vehicle based traffic performance assistance strategies in a traffic simulator
- Demonstrate the basis functionalities such as data acquisition, (inter-vehicle) communication, driving recommendations and implement traffic-adaptive assistance systems in the vehicle

Summary and Outlook

Traffic Performance Assistance functions have a considerable potential for improving highway performance, traffic safety, resource utilization, as well as driving comfort. Creating an awareness that properly designed systems of this kind provide not only collective, but also individual benefit, is a challenge for the future. Key technologies such as driving assistance systems or inter-vehicle communication are essential for realization of traffic performance assistance in practice. Hence, future developments will depend strongly on proliferation of these technologies. Further requirements for successful introduction of traffic performance assistance systems will include development of an appropriate design for a human-machine interface, supported by user acceptance surveys. In developing an effective strategy for introduction to the market, it is important for the systems to provide advantages and benefits that can be clearly recognized and appreciated by the customer.

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Robert Bosch GmbH

Volkswagen AG

supported by the



Federal Ministry
of Education
and Research

In close cooperation with the
Federal Ministry of Transport,
Building and Housing

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Glossary

FAS	INVENT Project Driver Assistance Active Safety
Driver Assistance Systems	Systems such as automatic intelligent cruise control that support driving.
FCD	Floating Car Data: A method for mobile acquisition of current traffic data using individual probe vehicles as sensors. When a vehicle enters jammed or congested traffic, it can send an automatic report (including its position and the traffic situation encountered) by mobile communication to an evaluation center. Theoretically, any vehicle participating in traffic telematics services could act as a mobile transmitter or transponder.
MoTiV	Research Consortium program supported by the Ministry of Research and Education BMBF in „Mobility and Transport in inter-modal Traffic“, completed in 2000.
Sandy	BMBF Project „Applications of Nonlinear Dynamics in Highway Traffic“, completed in 2000.
Traffic-adaptive	The assistance system reacts to the current traffic state.
Traffic state estimator	Algorithm that is designed to reconstruct the traffic state along a stretch of highway by traffic data measurements using a mathematical model of traffic flow
VLA	INVENT Component Project Traffic Performance Assistance
VMTL	INVENT Project Traffic Management in Transport and Logistics
VM 2010	INVENT Project Traffic Management 2010

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