Presentation on the Outcome of the Phase 3 Advanced Safety Vehicle (ASV) Promotion Project

Date: May 18, 2006

Venue: International Conference Hall, Tokyo International Exchange Center

Organizers: Study Group for Promotion of the Advanced Safety Vehicle

Road Transport Bureau, Ministry of Land, Infrastructure and Transport (MLIT)

Presentation on the Outcome of the Phase 3 Advanced Safety Vehicle (ASV) Promotion Project

Contents

Greeting

Greeting from the Organizer

Masakazu Iguchi
Chairman
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3

The Advanced Safety Vehicle project was initiated through the concerted efforts of academics, businesspeople, and government officials 15 years ago. Referring to traffic accidents, the White Paper on Traffic Safety for 1992 described a very serious situation it termed “the second traffic war,” as traffic fatalities broke the ten thousand mark for the fourth consecutive year. The Institute for Traffic Accident Research and Data Analysis was established in the same year.

At that time automobile safety measures already included requirements for automakers to install seatbelts, and vehicles were designed to absorb the impact of a collision. In response to an increase in traffic accidents, however, there were calls to shift the focus from passive safety measures to active accident prevention strategies.

Advanced safety vehicles, or ASVs, are equipped with rapidly evolving electronic technologies to deliver higher levels of safety and comfort. In the first phase of the ASV project we explored the potential of ASV technologies for passenger cars and in the second phase we worked on the development of ASV technologies for all vehicles, including trucks, buses, and motorcycles.

In the third phase, we examined ways to promote the popularization of ASV technologies and pressed ahead with the development of next-generation safety systems utilizing communications technologies. Last year 14 Japanese automobile manufacturers trialed inter-vehicle communication type driver assistance systems in Tomakomai City in Hokkaido. The tests demonstrated the effectiveness of communication technology-based driver assistance systems, thus making tremendous headway toward the development of future of ASV technologies.

During the 15-year period of the ASV promotion project, diverse ASV technologies such as collision damage mitigation brake control system and lane keeping assistance control system have been commercialized. In 2000, the then Ministry of Transport set the goal of reducing traffic accident fatalities by 1,200 over the next ten years. I understand this goal has been met already, and I am delighted that the ASV project has made some contribution to this achievement.

The control of a vehicle is its driver’s responsibility, and this precept will remain unchanged. The basis of ASV technologies lies in assisting the driver to operate the vehicle safely. ASV technologies must operate seamlessly with driver control. To this end, we must continue our in-depth studies of drivers and human nature. At the same time we must help drivers gain a better understanding of ASV technologies and use them to operate vehicles in a safe manner.

Although problems remain to be solved, we hope that ASV technologies will evolve further and that a safer and more secure driving environment will be created by effectively fusing human skills and technological capabilities.

In closing, I would like to thank the members of the Study Group for Promotion of ASV for their efforts in making this presentation possible. Allow me also to express my gratitude to all those involved in the field, including automobile manufacturers. Lastly, I would also like to extend my thanks to everyone here today for taking the time to attend this presentation.

Program

Program

13:30 **Opening**

13:35-13:40 **Opening Address**

Masakazu Iguchi, Chairman, Study Group for Promotion of the Advanced Safety Vehicle, Phase 3

13:40-13:50 **Overview of Phase 3 ASV Promotion Project**

Masakazu Kume (Director-General, Engineering and Safety Department,
Road Transport Bureau, Ministry of Land, Infrastructure and Transport)

13:50-14:00 **Activities to Promote Popularization of ASVs — Summary Report**

Masayoshi Aoki (Chairman, Subcommittee for Promotion of Popularization;
Chairman, Special Group of the Subcommittee on Guideline for Commercialization;
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3)

14:00-14:25 **Report on Activities to Promote Popularization of ASVs — Study from the Technological Perspective**

Toshiaki Matsumoto (Leader, Task-Specific Working Group; Special Group of the Subcommittee on Guideline for Commercialization; Study Group for Promotion of the Advanced Safety Vehicle, Phase 3)

14:25-14:50 **Report on Activities to Promote Popularization of ASVs — Study from the Policy Perspective**

Kenji Sato (Executive Member of the Subcommittee for Promotion of Popularization;
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3)

14:50-15:10 **Break (20 minutes)**

15:10-15:20 **Activities Relating to Technology Development — Summary Report**

Kenichi Yoshimoto (Chairman, Subcommittee of Next Generation Technology;
Chairman, Subcommittee of Coordination with Roadside Infrastructure;
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3)

15:20-15:45 **Report on Technology Development Activities — Development of Roadside Information-based Driver Assistance Systems**

Hiroyuki Kanemitsu (Leader of the Systems Study Working Group;
Subcommittee of Coordination with Roadside Infrastructure;
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3)

15:45-16:10 **Report on Technology Development Activities — Development of Inter-Vehicle Communication Type Driver Assistance Systems**

Yoshimi Furukawa (Leader of the Communications Technology Study Working Group;
Subcommittee of Next Generation Technology;
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3)

16:10-16:30 **The Next ASV Promotion Project**

Kenji Wani (Director, International Affairs Office, Engineering and Planning Division, Engineering and Safety Department, Road Transport Bureau, Ministry of Land, Infrastructure and Transport)

Presentation Materials

Masakazu Kume

Overview of Phase 3 ASV Promotion Project

Masakazu Kume
Director-General, Engineering and Safety Department, Road Transport Bureau
Ministry of Land, Infrastructure and Transport

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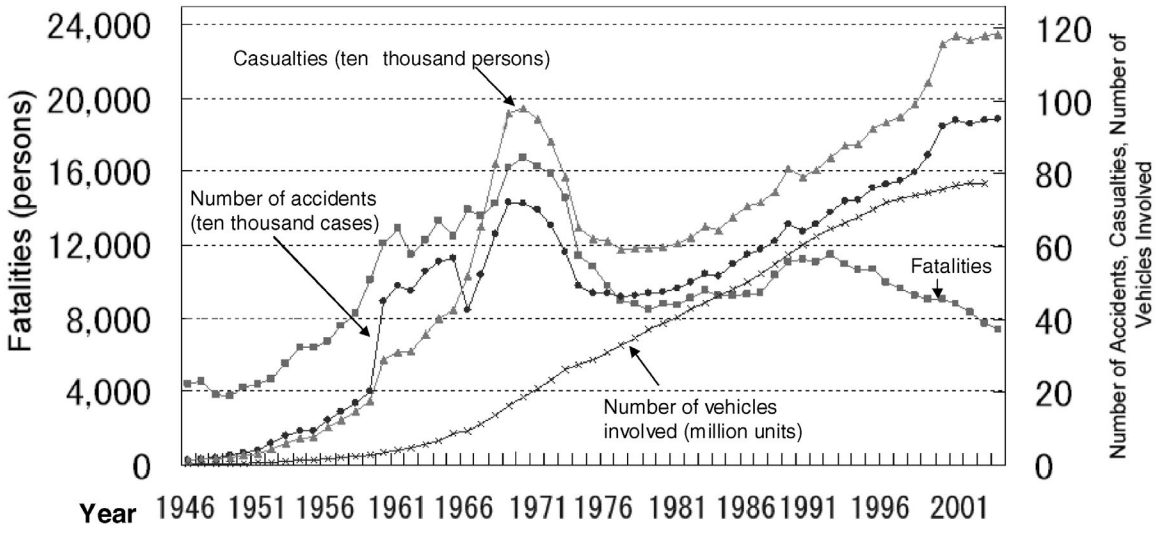
Trend in Traffic Accident Fatalities 1946–2004



Source: Traffic Accidents in 2004, February 24, 2005, Traffic Bureau, National Police Agency.

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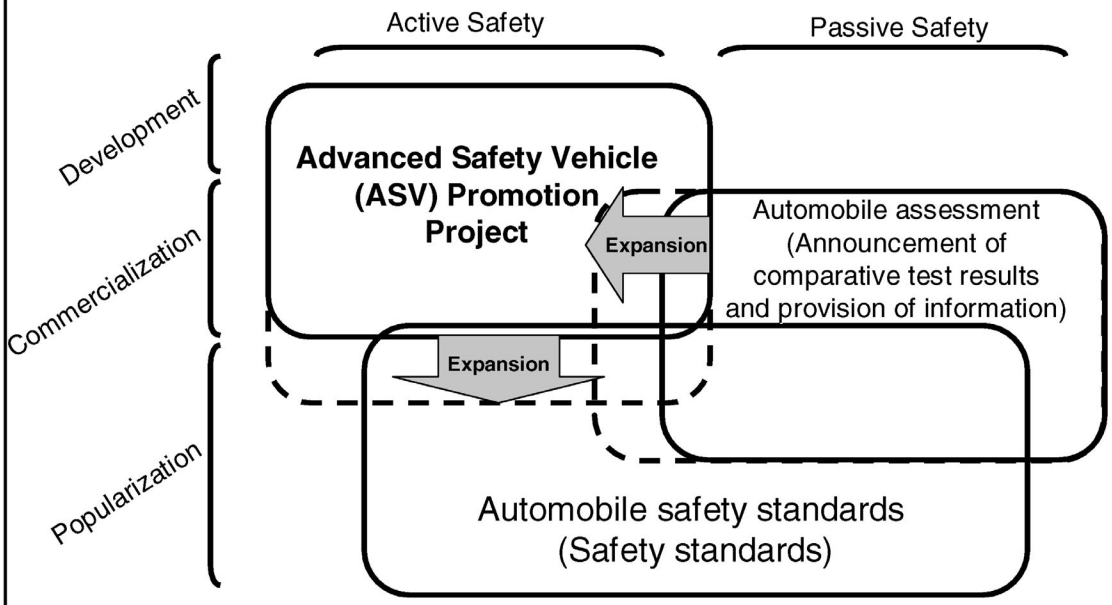
Policy Measures Designed to Reduce Fatal Accidents



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What Are Advanced Safety Vehicles (ASVs) ?

- ASVs are highly intelligent vehicles which enhance driving safety and convenience through state-of-the-art technologies such as electronics
- ASVs aim to prevent the driver making mistakes and reduce the number of fatalities and injuries

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Design Principles of ASV

- Driver Assistance
  - The driver plays a central role while the ASV assists the driver in operating the vehicle safely
- Driver Acceptance
  - HMI design that makes the system easy for the driver to use
- Social Acceptance
  - Correct understanding and public acceptance of ASV technologies

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Outline of the ASV Promotion Project (Phases 1–3)

	Phase 1	Phase 2	**Phase 3**
Implementation Periods	FYs 1991–1995	FYs 1996–2000	FYs 2001–2005
Objectives	Verification of technological potential	Research and development for commercialization	**Study for promotion of popularization** **Development of new technologies**
Target of Study	Passenger cars	All types of vehicles (passenger cars, trucks, buses, and motorcycles)	All types of vehicles (passenger cars, trucks, buses, and motorcycles)
Technologies studied	ASV systems (On-board sensor type)	ASV systems (On-board sensor type) Coordination with roadside infrastructure	ASV systems (On-board sensor type) **Cooperation with other vehicles** Coordination with roadside infrastructure

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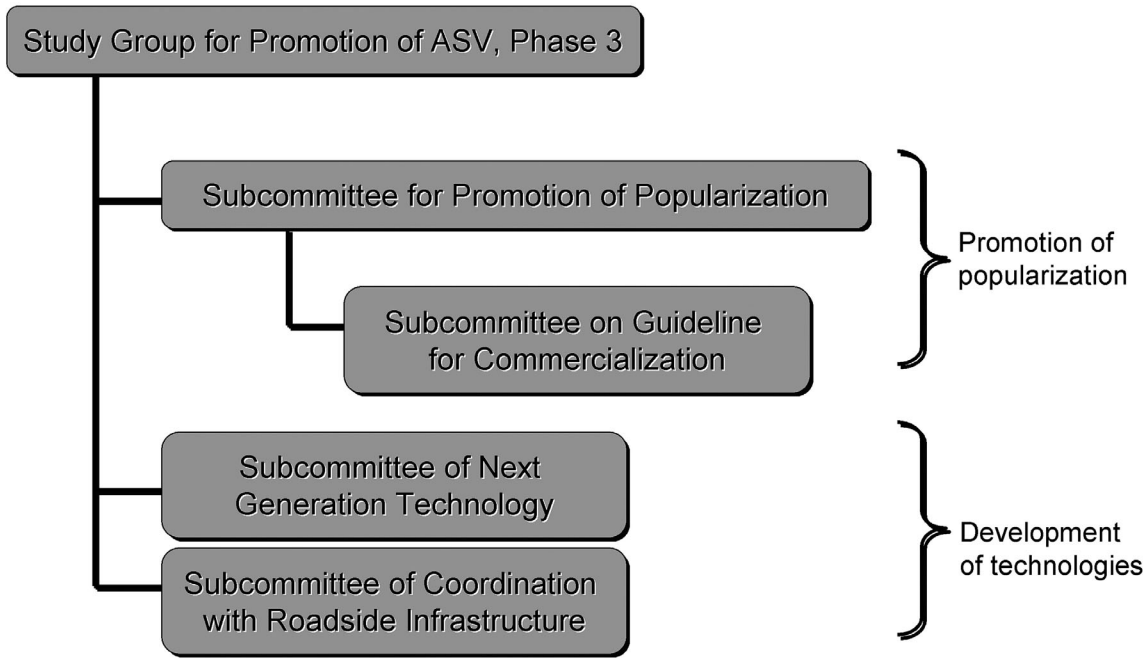
Phase 3 ASV Promotion Project: Organization Chart



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Results of the Phase 3 ASV Promotion Project

- Promotion of popularization
  - Concept of Driver Assistance
  - Arrangement of commercialized ASV technologies
  - ASV technologies public information activities
- Development of new technologies
  - Development of roadside information-based driver assistance systems
  - Development of inter-vehicle communication type driver assistance systems

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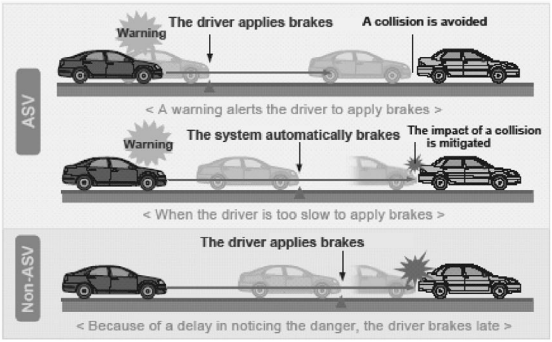
Representative ASV Technologies

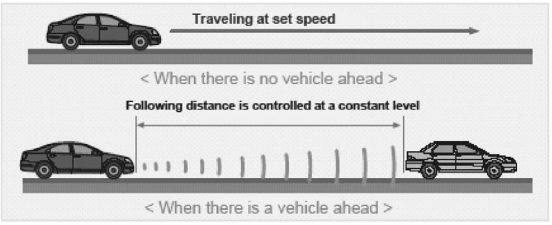
● Forward collision damage mitigation brake control system (common-use name: damage mitigation braking system)

This system alerts the driver to take evasive action if the vehicle is likely to collide with a forward obstacle. If the system determines that a collision is unavoidable, it automatically brakes in order to mitigate damage that may result from the impact of a collision.



● Constant speed cruising/following distance control system (common-use name: ACC)

Using laser radar technology, this system keeps a watch on the road ahead and maintains vehicle speed at a constant level and, if there is a vehicle ahead, keeps a certain following distance from it.



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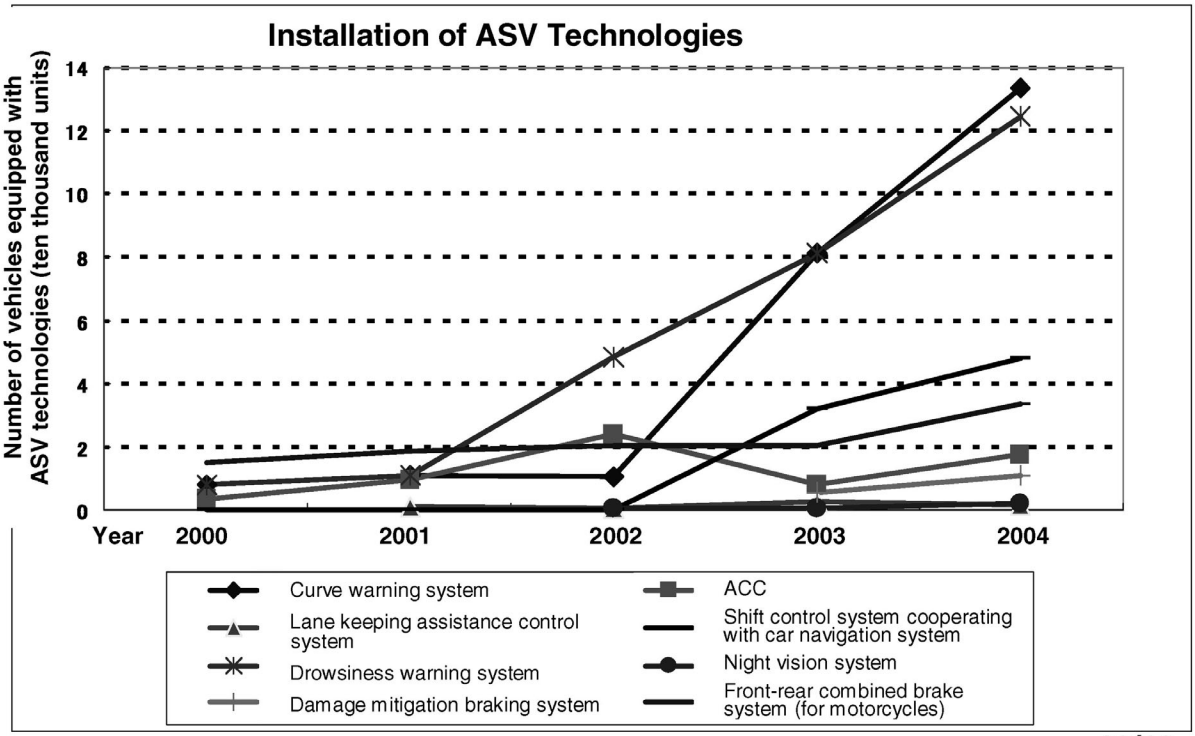
Installation of ASV Technologies



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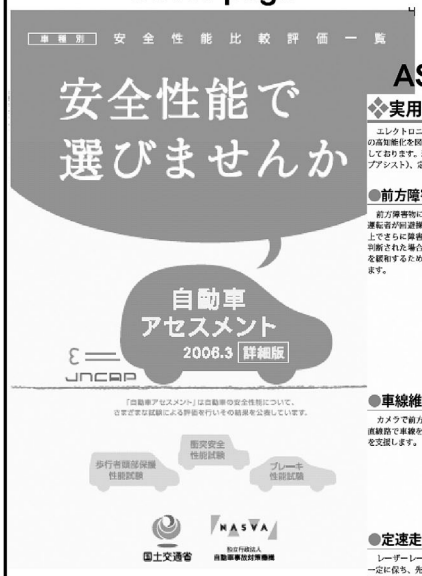
Information in an Automobile Assessment Brochure

Cover page



ASV device explanations

Additional columns for ASV devices

Main ASV technologies		
Damage mitigation braking system	ACC	Lane keeping assistance system

List of vehicles equipped with safety devices

ASV Technology Trials

Venue of trial:

The Civil Engineering Research Institute of Hokkaido in Tomakomai City, Hokkaido

Duration of trial:

July 4 – October 28, 2005

Participants:

14 Japanese automotive manufacturers (9 passenger cars, 4 motorcycles, and 4 trucks)

(Collisions when making a right turn and making a left turn)

(Collisions at intersection corners)

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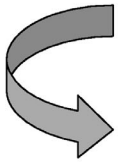
International Perspective

- **At the World Forum for Harmonization of Vehicle Regulations of the United Nations Economic Commission for Europe (UN/ECE/WP29), an ITS informal group was established in order to build a common understanding among countries about the concept of driving safety assistance based on highly intelligent vehicles and to exchange information about technological trends in various countries. The group also described the concept of driver assistance aided by ASVs.**
- **We actively took part in the ITS World Congress and outlined ASV activities.**
- **We exchanged information with the ISO working group, IHRA*.**



It is important to continue disseminating information about Japan's basic policy on the safety of new technologies to the rest of the world and work together with IHRA in solving research problems.

*IHRA (International Harmonized Research Activities):
A project for international cooperation in research aimed at harmonization of standards (participants: Japan, the United States, Europe, Australia, and Canada)

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Masayoshi Aoki

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Activities to Promote Popularization of ASVs

Summary Report

Masayoshi Aoki

Chairman, Subcommittee for Promotion of Popularization
Chairman, Special Group of the Subcommittee on Guideline for Commercialization
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3

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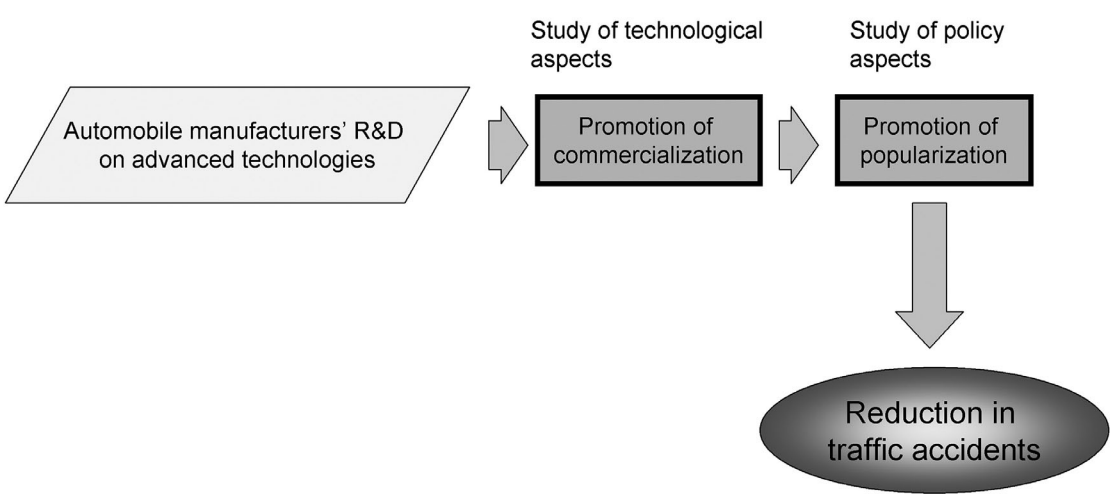
The Role of the Subcommittee for Promotion of Popularization/ Subcommittee on Guideline for Commercialization

To conduct a study of the policy aspects and the technological aspects of promoting the widespread use of ASV technologies



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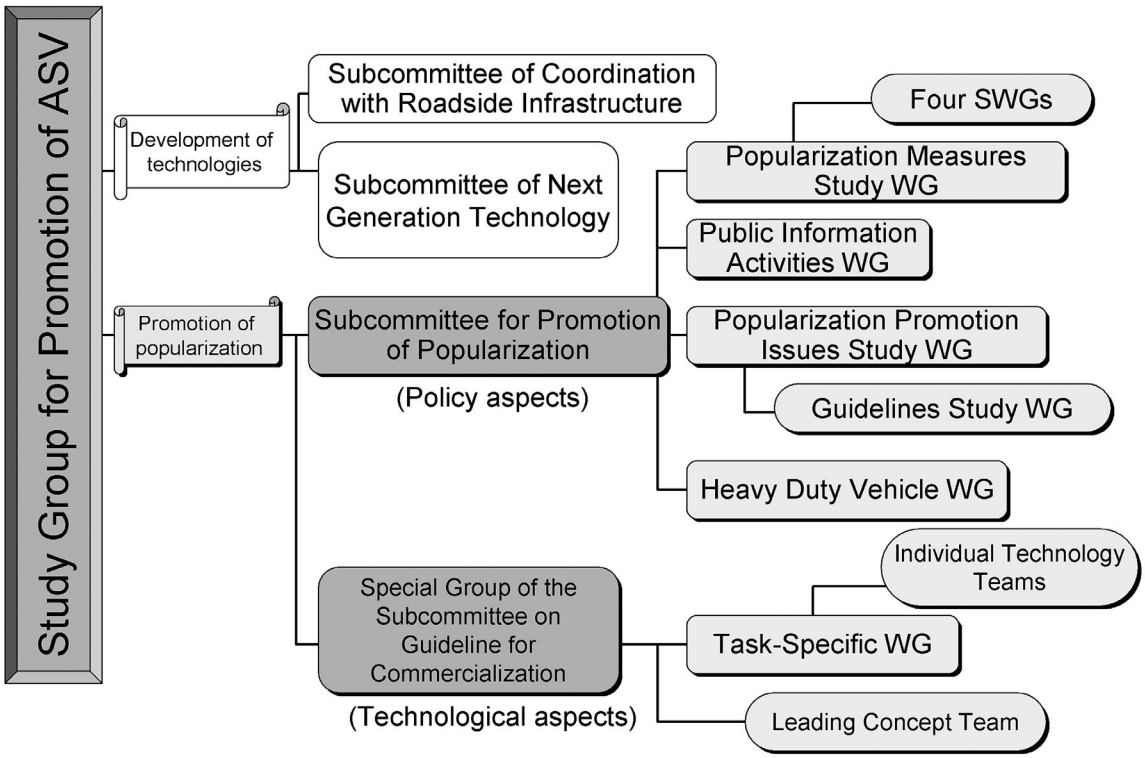
Structure of Study Including Positioning of the Subcommittee for Promotion of Popularization and Subcommittee on Guideline for Commercialization



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Special Group of the Subcommittee on Guideline for Commercialization

Activities of the Task-Specific WG (1)

Study of technological problems constituting bottlenecks for the commercialization of ASVs

[1] Study of detailed design principles of ASV
[2] Study of technological problems in line with the Concept of Driver Assistance
[3] Study on driver characteristics and behaviors

- Concept of Driver Assistance
- Guidelines for commercialization of Damage Mitigation Braking System
- The Concept of full speed range adaptive cruise control system
- Considerations for vehicles equipped with multiple ASV systems

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Activities of the Task-Specific WG (2)

Study of influence of ASV systems on drivers

[1] Study on drivers' dependence on ASV systems
[2] Study on drivers' situation awareness

- How to prevent ASV systems engendering driver overconfidence in system capabilities
- Method of assessing the extent to which driver attentiveness declines

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Subcommittee for Promotion of Popularization

Activities of the Popularization Measures Study WG

Priorities for possible popularization measures examined from four angles

[1] Provision of information to users
[2] Purchase incentives
[3] Enhancement of social acceptance
[4] Analyses of the effects of ASV technologies

An ASV popularization strategy was formulated, defining the phases, issues, and actions for high-priority popularization measures

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Activities of the Popularization Promotion Issues Study WG

Issues for consideration under the ASV Popularization Strategy were examined

[1] Arrangement of ASV technologies
[2] Examination of considerations for explaining ASV technologies
[3] Examination of effect assessment methods and prediction of effects

- Common names and definitions of commercialized ASV technologies
- Lists of commercialized ASV technologies and vehicles equipped with ASV systems
- Guidelines for preparation of explanatory materials on ASV technologies and actual explanatory materials on five representative technologies
- Prediction of the effects of commercialized ASV technologies

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Activities of the Public Information Activities WG

In line with the actions defined by the ASV Popularization Strategy, this working group conducts publicity activities in order to promote understanding of ASV concepts and technologies

[1] Exhibition at the International Technical Conference on the Enhanced Safety of Vehicles:
March 2003 in Nagoya

[2] Exhibition at the Tokyo Motor Show:
October-November 2003 in Makuhari

[3] Organization of the ASV-3 Interim Presentation Meeting:
March 2004 in Tokyo

[4] Exhibition at the ITS World Congress and Organization of Test-Ride Event:
October 2004 in Nagoya

* Organization of Demonstrations and an International Symposium:
October 2005 in Tomakomai (Content arranged by the Subcommittee of Next Generation Technology)

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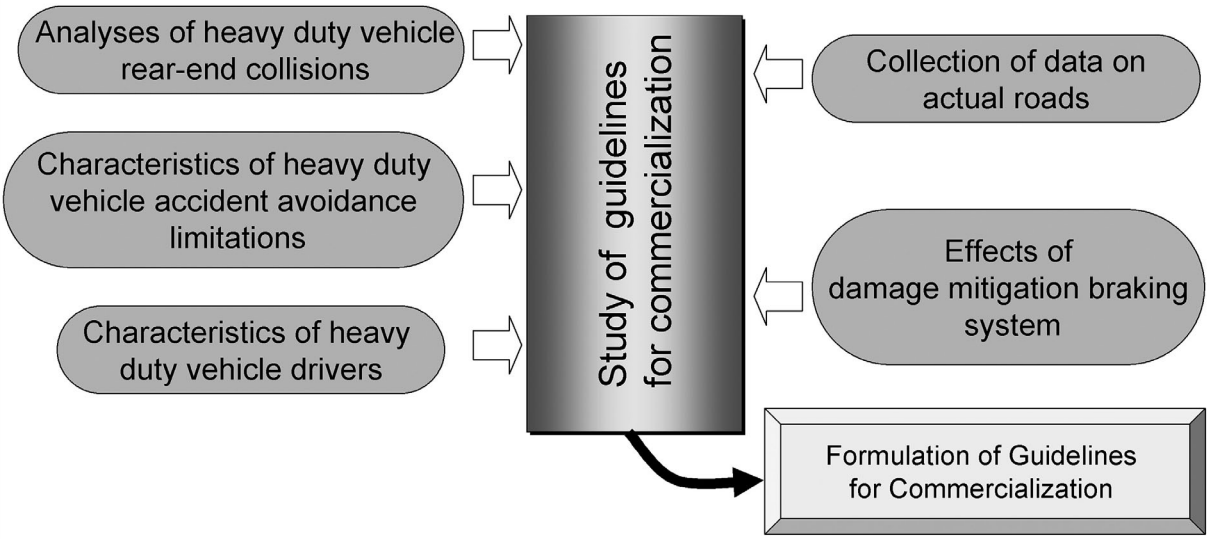
Activities of the Heavy Duty Vehicle WG

Study designed to achieve the early commercialization and widespread use of damage mitigation braking systems in heavy duty vehicles. Such systems have already been commercialized in passenger vehicles.



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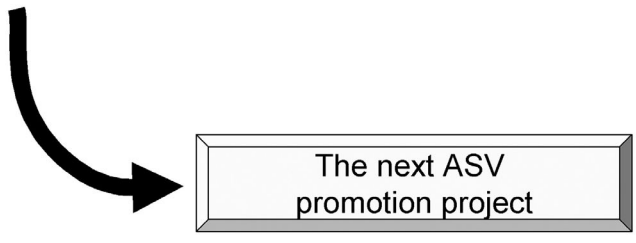
Challenges Ahead for Promotion of Popularization

- Examination of techniques for assessing the effects of ASV technologies and formulation of mechanisms
- Examination of possible incentives for vehicles equipped with ASV technologies
- Study on promoting understanding of ASV technologies among users



Toshiaki Matsumoto

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Report on Activities to Promote Popularization of ASVs

Study from the Technological Perspective

Toshiaki Matsumoto
Leader, Task-Specific Working Group,
Special Group of the Subcommittee on Guideline for Commercialization,
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3

2

Role of the Subcommittee on Guideline for Commercialization (Task-Specific WG) and Main Items for Consideration

Study of technological problems constituting bottlenecks for the commercialization of ASVs and promote the commercialization of ASV technologies through common understanding among stakeholders

1. Study of detailed Design Principles of ASV
2. Study of Guidelines for the commercialization of damage mitigation braking system
3. Study of expanded operating range for damage mitigation braking system
4. Study of the concept of full speed range adaptive cruise control system
5. Study of considerations for vehicles equipped with multiple ASV systems

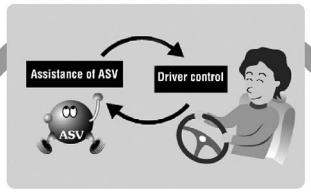
3

Study of Detailed Design Principles of ASV (1)

Design Principles of ASV
(Formulated in the ASV-2 Project)

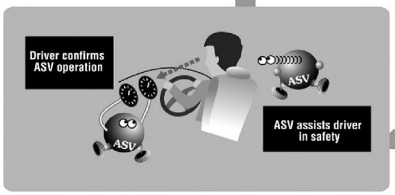
Driver Assistance

ASV technologies should understand driver's wills and support their safe driving based on the concept of driver responsibility.

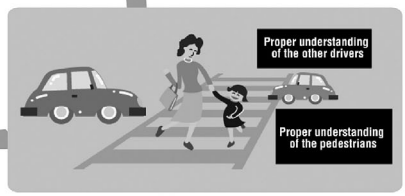


ASV technologies should be easy to use and be trusted by drivers. This means that a human-machine interface design should be appropriately implemented.

ASV technology-equipped vehicle must operate with unequipped vehicles and pedestrians. Therefore, we must consider how to obtain proper understanding of the public.



Driver Acceptance



Social Acceptance

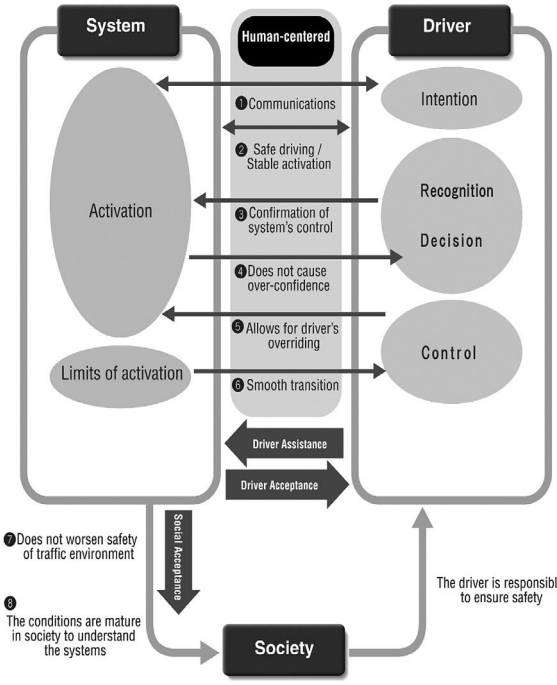
The concept of driver assistance was formulated for driver load reduction and accident avoidance assistance technologies in order to facilitate the interpretation of Design Principles of ASV

4

Study of Detailed Design Principles of ASV (2)

- Relationship of ASV systems, driver and society defined and concept of driver assistance systems narrowed down to eight points
- Principles defined for driver load reduction and accident avoidance assistance technologies

Concept of Driver Assistance



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Study of Detailed Design Principles of ASV (3)

Concept of Driver Assistance
(Driver load reduction technologies)

① Communications

The system should act after confirming the will and intention of the driver

② Safe driving / Stable activation

The system should assist driver in safety.

③ Confirmation of system's control

The system should be checked by the driver at any time.

④ Does not cause over-confidence

The system should inspire a proper amount of confidence in the driver, not causing him to place too much confidence nor distrust in the system.

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Study of Detailed Design Principles of ASVs (4)

Concept of Driver Assistance
(Driver load reduction technologies)

⑤ Allows for driver's overriding

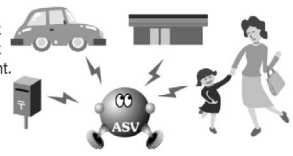
The system should be overridden by the driver.

⑥ Smooth transition

The system's control should be smoothly passed over to the driver when the situation goes beyond the range of assistance of the system.

⑦ Does not worsen safety of traffic environment

The system should not make a negative impact to the traffic environment.



⑧ The conditions are mature in society to understand the systems

There should be mature society to accept the system.

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Study of Guidelines for the Commercialization of Damage Mitigation Braking System (1)

Approach to Brake Control

- Brake control by ASV systems is effective in reducing/avoiding collisions
- There is a concern that if braking is automatically applied in a dangerous situation, the driver may neglect to take evasive action he/she should essentially perform (driver overconfidence in the system).
- If the damage mitigation braking system is designed to brake when it determines that a collision is physically unavoidable, it is assumed the driver will not put too much confidence in the system.*

➢ System starts applying brakes if it determines a collision is unavoidable
- Physical avoidance limit by braking
- Physical avoidance limit by steering

➢ Based on the Design Principles of ASV, system issues a warning to alert the driver to take evasive action before it applies brakes

*This has been verified by a study of drivers' dependence on ASV systems

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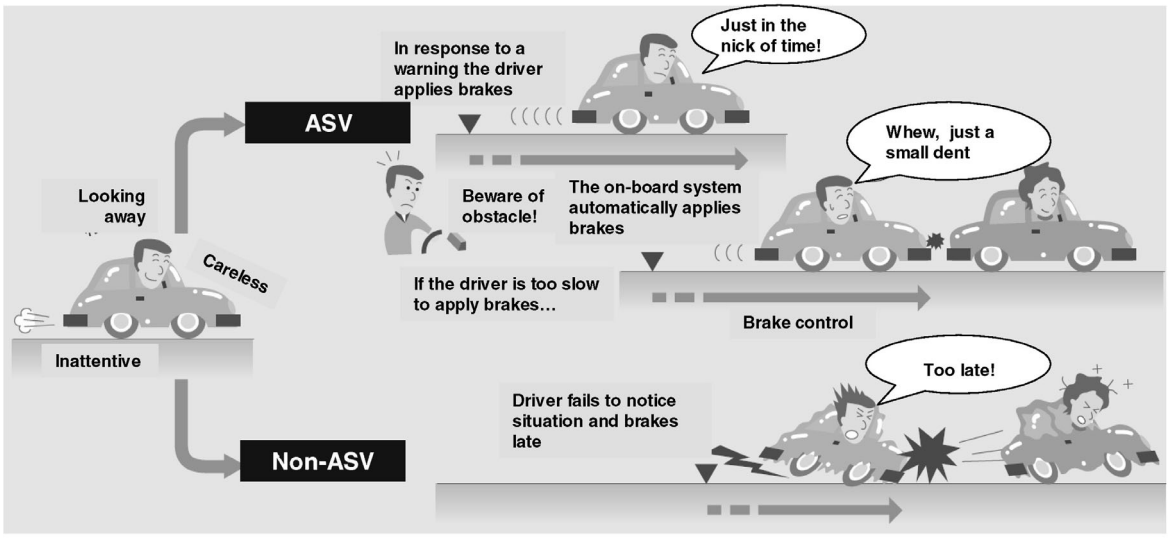
Study of Guidelines for the Commercialization of Damage Mitigation Braking System (2)

How Damage Mitigation Braking System Work



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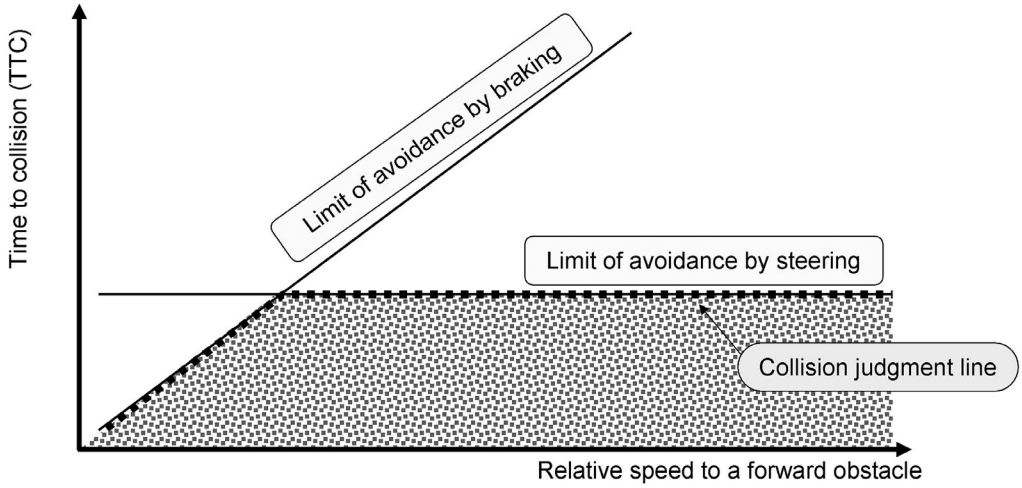
Study of Guidelines for the Commercialization of Damage Mitigation Braking System (3)

Timing of Brake Control Start

Brake control begins at the point the driver is unable to avoid a collision through either braking avoidance or steering avoidance (collision judgment line)



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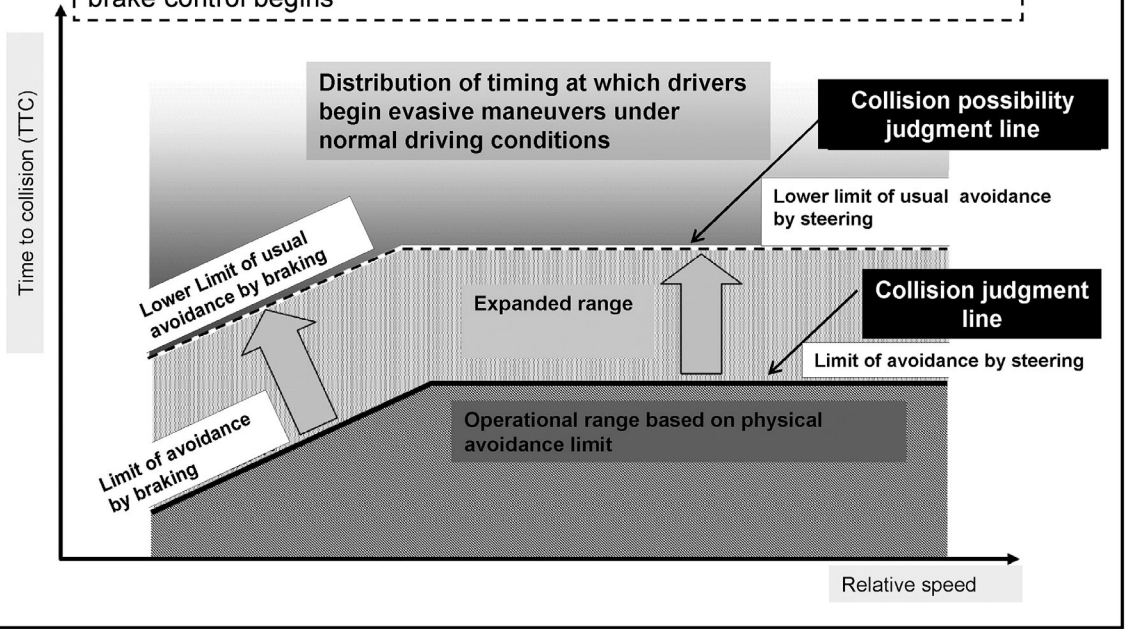
Study of Expanded Operational Range for Damage Mitigation Braking Systems (1)

Concept of Expanded Operational Range

To enhance the damage-reducing effect, we examined how far the operational range can be expanded by bringing forward the timing at which brake control begins



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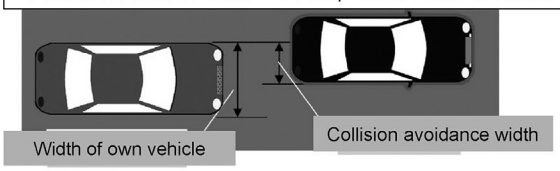
Study of Expanded Operational Range of Damage Mitigation Braking System (2)

Approach to Expanded Operational Range

- If the damage mitigation braking system is timed to cut in later than the driver would take evasive action during normal operation, it will not interfere with the driver's evasive action
- Based on data on the timings of avoidance by braking and by steering under normal conditions, the minimum value of the timing distribution is established as the upper limit for the expanded operational range
- Based on data on changes in the timing of the driver's evasive action when an obstacle is a moving object and depending on the overlap rate*, a method of compensating for the "collision possibility judgment line" is formulated

*Overlap rate: The extent to which the vehicle overlaps a forward obstacle.

Collision avoidance width = Overlap rate x Width of vehicle



The expanded operational range for heavy duty vehicles will be examined separately based on the principles applicable to passenger cars

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Study of Expanded Operational Range of Damage Mitigation Braking System (3)

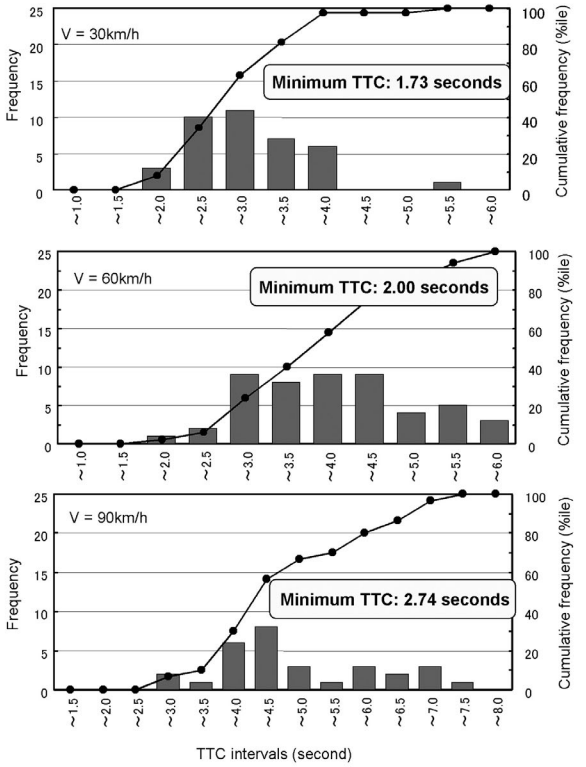
Timing of drivers' braking avoidance during normal operation

- Depending on the initial braking speed, the minimum TTC changes in a linear manner

The lower limit of usual avoidance by braking is set by a linear equation that does not fall short of any minimum TTC:

$T = 0.0167 \cdot V_r + 1.00$

T: TTC (second), V_r: Relative Speed (km/h)



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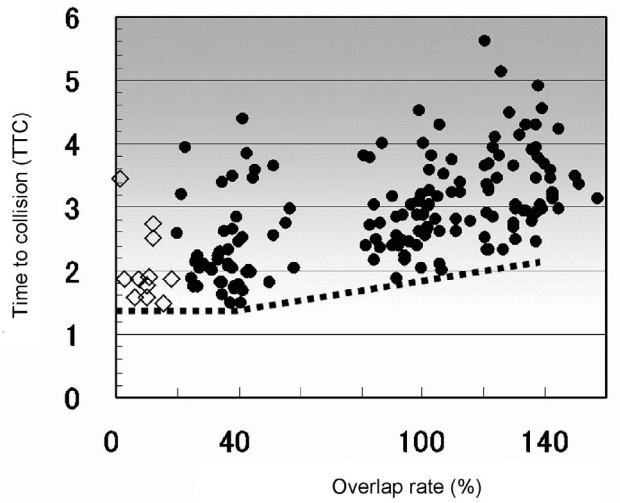
Study of Expanded Operational Range for Damage Mitigation Braking System (4)

Timing of drivers' avoidance by steering during normal operation

- The minimum value of avoidance timing, not affected by the overlap rate, is 1.4 seconds
- When the overlap rate ranges from 0% to 40%, the minimum value of avoidance timing is constant
- When the overlap rate exceeds 40%, the minimum value of avoidance timing increases in linear fashion



The lower limit of avoidance by steering is set at the minimum TTC of 1.4 seconds, which does not fall short of drivers' avoidance timing at any overlap rate

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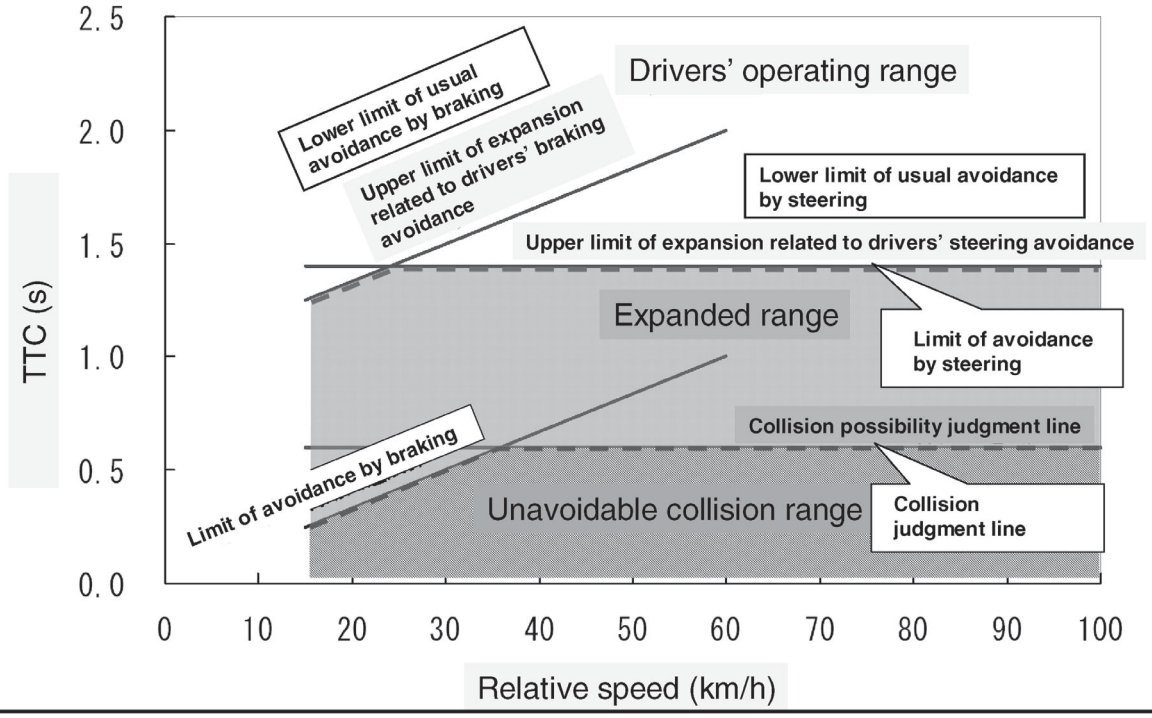
Study of Expanded Operational Range for Damage Mitigation Braking System (5)

Upper Limit Established for the Expanded Operational Range



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Study of Expanded Operational Range for Damage Mitigation Braking System (6)

Testing Driver Dependence on ASV Systems

- Tests with driving simulator and actual vehicle

  - If the system is designed so that its braking alone cannot avoid a collision, the driver is less likely to become dependent on it
  - If the system is designed so that it will not interfere with the driver's evasive action, the driver is less likely to become dependent on it
  - If the action of the system feels odd to the driver, he or she is less likely to become dependent on it

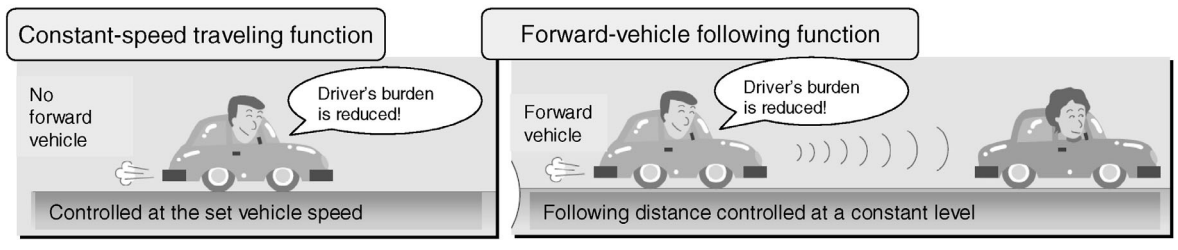
16

Study of the Concept of Full Speed Range Adaptive Cruise Control System (FSRACC) (1)

Concept of FSRACC

A system that:

- Is capable of constant-speed traveling and following forward vehicles
- Operates in all vehicle-speed ranges including stopping range
- Is capable of stopping the vehicle in the stopping range and keeping it at rest
- Is capable of setting vehicle speed in the all vehicle-speed range for constant-speed traveling (however, the system does not need to be capable of setting vehicle speed in the low-speed range)
- In the forward-vehicle following mode, is capable of automatically switching from one target to another in the all vehicle-speed range
- Is designed to generally select four-wheeled vehicles as targets to follow
- Is deactivated by driver's braking action



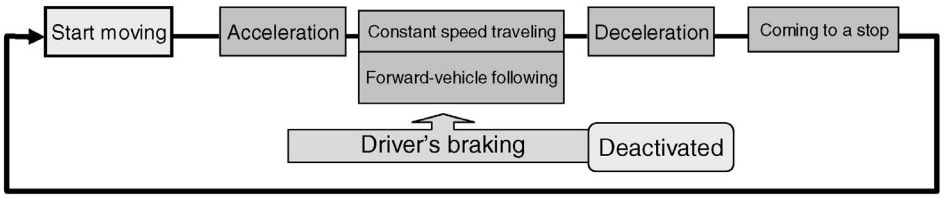
17

Study of the Concept of Full Speed Range Adaptive Cruise Control System (FSRACC) (2)

Considerations for FSRACC [1]

In order to develop a system in line with the Concept of Driver Assistance:

- The system should not have the capability to automatically follow a forward vehicle that starts moving
  - ✓ Essential operating maneuvers are left in the hands of the driver
- The system should be designed so that it deactivated when the driver brakes
  - ✓ Compatibility with conventional ACC systems



18

Study of the Concept of Full Speed Range Adaptive Cruise Control System (FSRACC) (3)

Considerations for FSRACC [2]

In order to develop a system in line with the Concept of Driver Assistance:

System designed for use on expressways

- System informs driver that it is for use on roads used exclusively by motor vehicles
- User is informed of danger of recklessly using system on ordinary roads

System designed for use on all kinds of roads

- Activation of the system does not result in violation of traffic rules
- System does not jeopardize the safety of pedestrians and cyclists
- System does not jeopardize the safety of vehicles at rest

19

Study of the Concept of Full Speed Range Adaptive Cruise Control System (FSRACC) (4)

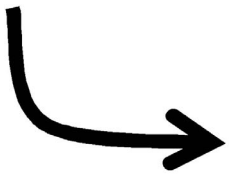
Situations Specific to FSRACC

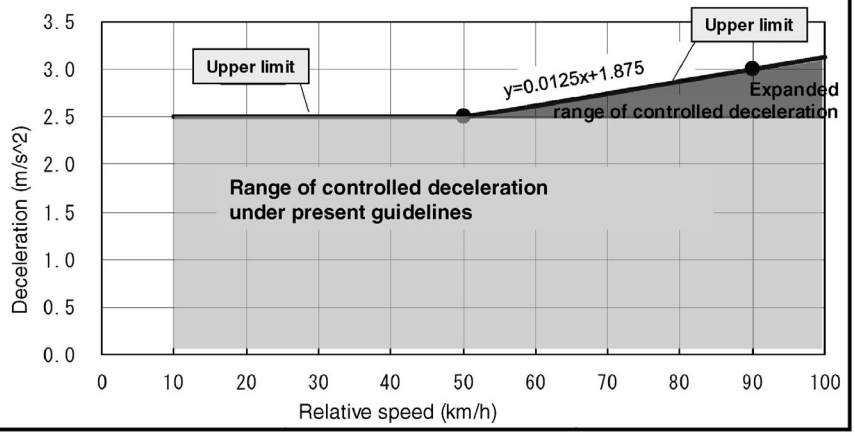
To deal with specific situations encountered while FSRACC is in operation, the upper limit of deceleration must be expanded

Example of situation specific to FSRACC

Traveling at constant high speed → Begins to follow a forward vehicle

Vehicle cruising at low speed





20

Study of the Concept of Full Speed Range Adaptive Cruise Control System (FSRACC) (5)

Survey of the Effects of Functions of FSRACC on Driver Behavior

- Is it conceivable that while an FSRACC capable of stopping the vehicle and keeping it at rest is in service, the driver may become so careless that he/she is unable to take necessary action as the need arises?
- Using a driving simulator, a study was conducted to see if the driver is able to take proper action in response to changes in the situation, such as sudden braking by a forward vehicle
  - System that deactivates before the vehicle comes to a stop
  - System capable of bringing the vehicle to a stop
  - System capable of keeping the vehicle at rest

➢ Study found that all systems are properly operated in situations requiring driver action and FSRACC does not induce the driver to become less attentive in assuring safety

21

Study of Considerations for Vehicles Equipped with Multiple ASV Control Systems

Study on Vehicle Equipped with Damage Mitigation Braking System with Expanded Operational Range and FSRACC

- Distinction between deceleration by the FSRACC and braking by the damage mitigation braking system
  - When one system switches over to the other, the FSRACC issues a warning regarding approaching objects or alerts the driver to the system limit, while the damage mitigation braking system sounds a warning, making it possible for the driver to identify which system is in effect
- Driver's response to sudden change from normal situation to emergency situation
  - A warning issued by the damage mitigation braking system must prevail in order to allow the driver to take quick action in response to a sudden change to an emergency situation
- Necessity for driver to be able to sense deceleration by either system
  - The damage mitigation braking system should be designed to decelerate more rapidly than the FSRACC

Kenji Sato

1

Report on Activities to Promote Popularization of ASVs

Study from the Policy Perspective

Kenji Sato

Executive Member of the Subcommittee for Promotion of Popularization
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3

2

The Role of the Subcommittee for Promotion of Popularization and Main Items for Consideration

This subcommittee's role is to facilitate public understanding of the ASV project and ASV technologies and to encourage the popularization of commercialized ASV technologies

1. Survey of similar examples to promote widespread use of ASV technologies
2. Study of possible measures to facilitate the spread of ASVs
3. Arrangement of commercialized ASV technologies
4. Examination of considerations for explanation of ASV technologies
5. ASV public information activities
6. Study on commercialization of damage mitigation braking systems for heavy duty vehicles

3

Promoting Widespread Use of ASV Technologies: Survey of Similar Examples

Survey of similar examples in society prior to study of possible measures to promote popularization of ASV technologies

Examples:

1. **Providing information on environmental performance: Low-emission vehicle certification system**
2. **Providing information on safety performance: Vehicle assessment system**
3. **Providing information in other fields: Informed consent**
4. **Providing information directly to automobile users: Driver training**
5. **Current situation of providing information at dealers: Questionnaire**
6. **Incentives concerning environmental performance: Green Taxation and Subsidiary System**
7. **Incentives concerning safety devices: Auto insurance premium discount**
8. **Fleet tests on actual roads: The U.S. DOT's Intelligent Vehicle Initiative (IVI) Field Operational Tests (FOTs)**
9. **ACC mock trial in the United States**
10. **Symposiums/Fairs**

4

Study of Possible Measures to Facilitate the Spread of ASVs (1)

Possible popularization promotion measures identified from four angles

1. **Providing information to users**
   Measures to make information on ASVs readily available
2. **Purchase incentives**
   Giving incentives to prospective purchasers
3. **Improvement of social acceptance**
   Measures designed to help the general public gain sound understanding of ASV technologies
4. **Analyses of the effects of ASV technologies**
   Techniques to analyze the effects of ASV technologies

5

Study of Possible Measures to Facilitate the Spread of ASVs (2)

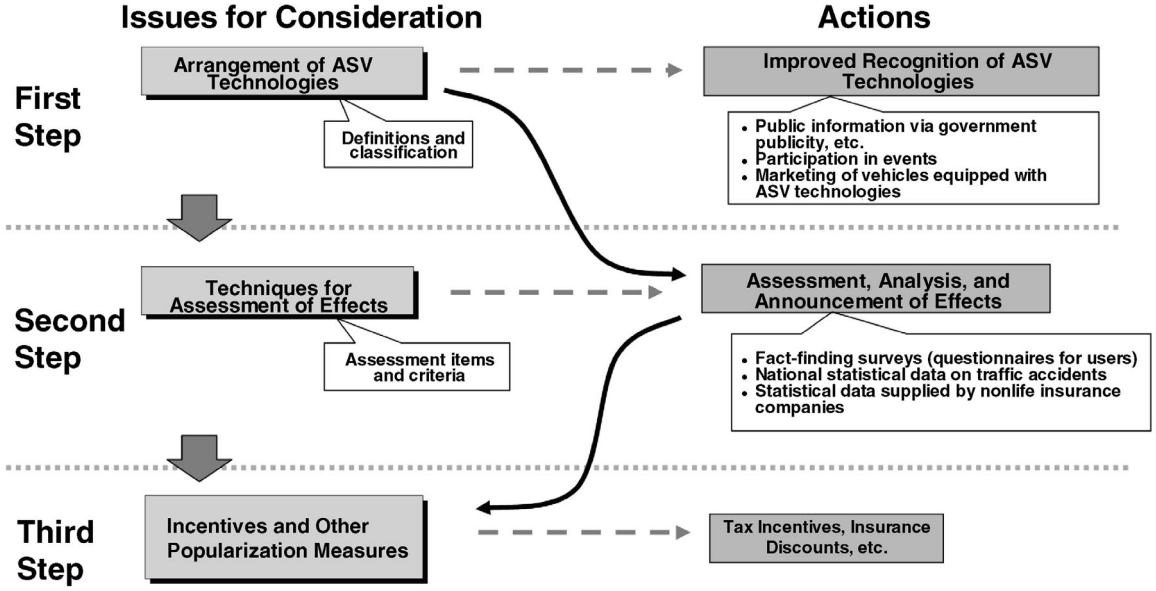
Examination of priorities among the popularization promotion measures identified

(1) Popularization measures related to provision of information to users	· Systematized classification of ASV technologies by function and purpose · Formulation of guidelines for explanation of ASV technologies · Announcement of status of projects to commercialize ASV technologies
(2) Popularization measures related to incentives	· Automobile tax reductions · Automobile insurance premium discounts
(3) Popularization measures related to social acceptance	· Early ASV System Introduction Program · Public information activities through Japanese government publicity · Projects and exhibitions at events publicizing ASVs · Public information activities through journals of user organizations
(4) Popularization measures related to analyses of effects of ASVs	· Survey of purchasers/users · Analyses of effects of ASVs based on national statistical data on traffic accidents · Analyses of effects of ASVs based on statistical data supplied by nonlife insurance companies

6

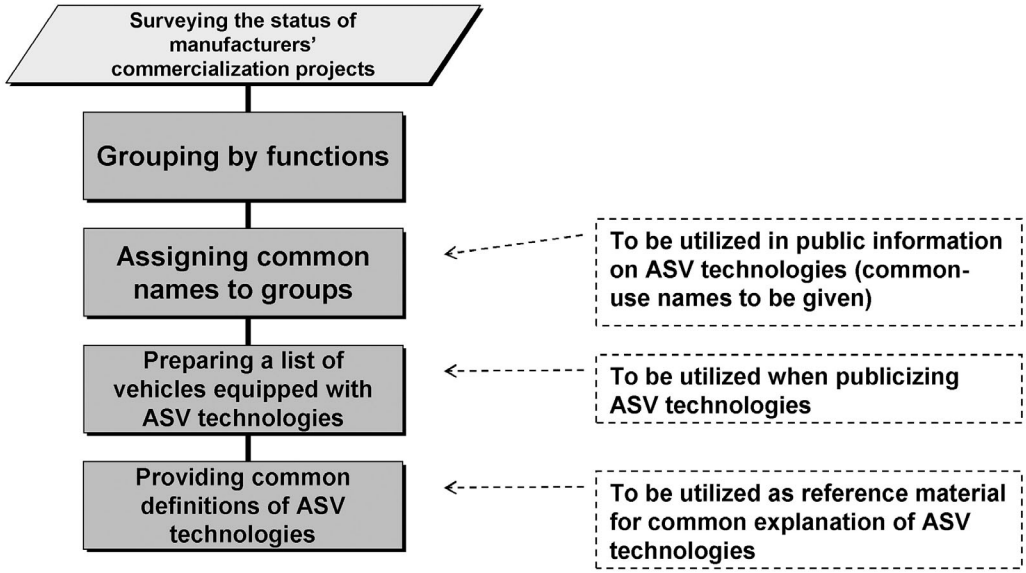
Study of Possible Measures to Facilitate the Spread of ASVs (3)

Formulation of popularization strategy based on results of study of possible popularization measures



7

Arrangement of Commercialized ASV Technologies (1)



8

Arrangement of Commercialized ASV Technologies (2)

Functional classification of ASV technologies

Classification of Functions	Description of Assistance	Applications (Common-use name)
Perception expansion	Assisting driver to perceive the traffic environment around the vehicle easily	AFS, etc.
Providing information	Providing driver with information about objects to the rear that are not easily seen in rear view mirror	Rear view cameras, etc.
Providing cautionary information	Alerting driver to dangerous situations	Tire pressure warnings, etc.
Warning	Prompting driver to take evasive action	FVCWS, etc.
Accident avoidance assistance control	In an emergency the on-board system controls the vehicle at its discretion	Damage mitigation braking system, etc.
Driver load reduction control	On-board system controls the vehicle to alleviate driver load in normal driving conditions	ACC and LKAS, etc.
Control for improving vehicle stability	Control to improve vehicle stability	ESC, etc.

9

Arrangement of Commercialized ASV Technologies (3)

Common names for ASV technologies (example)

Common Names of ASV Technologies (Common-use Names)	Functions of ASV Technologies
Variable light distribution headlights (AFS)	Perception expansion
Nighttime front visibility information system (Night view cameras)	Providing information
Nighttime forward pedestrian advisory system (Nighttime pedestrian warning)	Providing cautionary information
Zigzag driving advisory system (Zigzag warning)	Providing cautionary information
Forward vehicle collision warning system (FVCWS)	Warning
Lane departure warning system (LDWS)	Warning
Forward collision damage mitigation brake control system (Damage mitigation braking system)	Accident avoidance assistance control
Constant-speed cruising/following distance control system (ACC)	Driver load reduction control
Low-speed range following distance control system (LSF)	Driver load reduction control
Lane keeping assistance control system (LKAS)	Driver load reduction control
Reverse parking assistance control system (Parking assistance)	Driver load reduction control
Electric stability control system (ESC)	Control for improving vehicle stability

10

Arrangement of Commercialized ASV Technologies (4)

List of vehicles equipped with ASV technologies (example)

[Legend] ◎ Standard equipment (◎) Standard equipment for some models ○ Optional (○) Optional for some models

* As of end of December 2005

Names of Vehicles	Common Names of Individual ASV Technologies													
	AFS	Night view cameras	Nighttime pedestrian warning	Zigzag warning	FVCWS	LDWS	Damage mitigation braking system	ACC	LSF	LKAS	Parking assistance	Emergency braking seatbelt winding control system	ESC	Remarks
Suzuki Escudo													(◎)	Escudo 2. 7XS
Daihatsu Move Custom								(○)					(○)	
Daihatsu Mira-Avy													(○)	
Toyota Lexus GS 430	◎					○	○	○		○		◎	◎	
Toyota Lexus GS 350	◎						○	○				◎	◎	
Toyota Lexus SC 430	◎												◎	
Toyota Lexus IS 350	◎						○	○				○	◎	
Toyota Lexus IS 250	◎						○	○				○	◎	
Toyota Century													◎	
Toyota Celsior	◎						(○)	○				(○)	◎	
Toyota Crown Majesta	◎	○				○	(○)	○	(○)	○		◎	◎	
Toyota Crown	◎	(○)				(○)		(○)		(○)		(◎)	◎	
Toyota Progrés								(○) *					◎	*Without main brake control
Toyota Brevis								(○) *					◎	*Without main brake control
Toyota Mark X	(◎)							(○)			(○)		(◎) (○)	
Toyota Windom													(◎) ○	
Toyota Prius											(◎) (○)		(◎)	
Toyota Corolla													(○)	
Toyota Belta													(○)	
Toyota Crown Estate													(◎)	
Toyota Mark II Blit													(○)	
Toyota Caldina													(◎)	
Toyota Alphard Hybrid						(◎) ○		(○)					◎	
Toyota Alphard G	(◎)					○		(○)					(◎) (○)	
Toyota Alphard V	(◎)					○		(○)					(◎) (○)	
Toyota Estima Hybrid								(○)					◎	
Toyota Estima T								(○)					(◎) (○)	
Toyota Estima L								(○)					(◎) (○)	
Toyota Voxy													(○)	
Tonota Noah													(○)	
Toyota Isis													(○)	
Toyota Ipsum						○							(○)	
Toyota Wish													(◎)	

Posted at http://www.mlit.go.jp/jidosha/anzen/asv/ASV3.htm

11

Examination of Considerations in Explanation of ASV Technologies (1)

- ASV technologies aim to support the driver in operating a vehicle safely
- For ASV technologies to have the intended effects, users must have a correct understanding of the technologies and use them properly
- Need to provide substantial explanatory material to help users gain a correct understanding of ASV technologies
- Examining guidelines (considerations) for preparation of explanatory materials based on the concept of ASVs

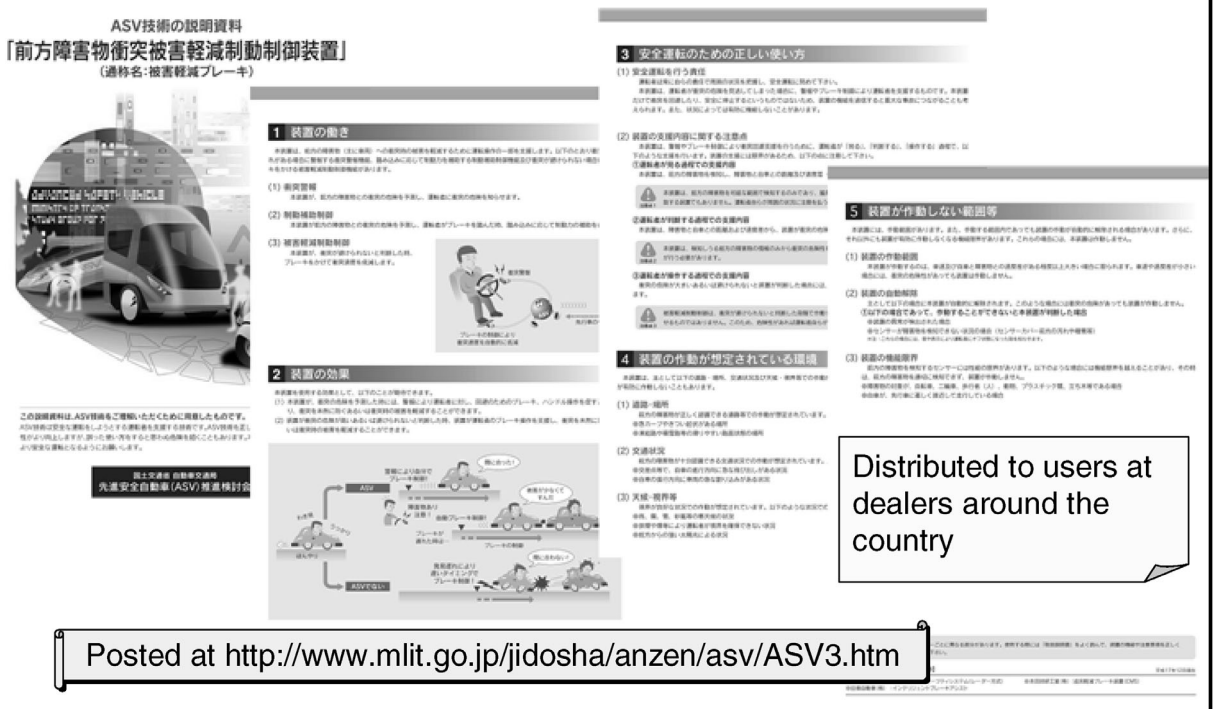
Representative ASV technologies are selected and considerations for preparing explanatory materials are identified

1. Constant-speed cruising/following distance control system
2. Low-speed range following distance control system
3. Lane-keeping assistance control system
4. Forward collision damage mitigation brake control system
5. Reverse parking assistance control system

12

Examination of Considerations in Explanation of ASV Technologies (2)

Example of explanatory material in line with the guidelines



Distributed to users at dealers around the country

Posted at http://www.mlit.go.jp/jidosha/anzen/asv/ASV3.htm

13

ASV Public Information Activities (1)

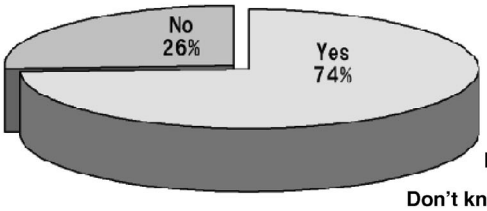
Exhibition at the ESV International Technical Conference

May 2003 in Nagoya
Participants: Experts on automotive safety

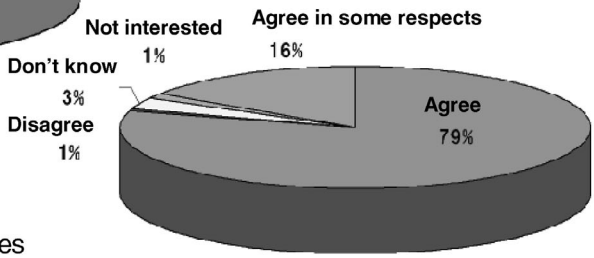
Questionnaire survey conducted

- Familiarity with ASVs
- Concept of Driver Assistance

Do you know what ASVs are?



Do you agree with the Concept of Driver Assistance?



ESV: Enhanced Safety of Vehicles

14

ASV Public Information Activities (2)

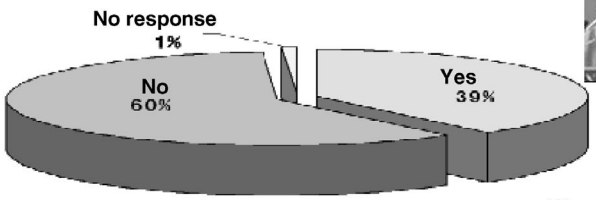
Exhibition at the Tokyo Motor Show

October-November 2003 in Makuhari
Participants: General automobile users

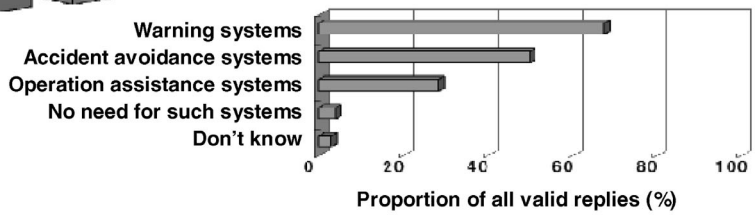
Questionnaire survey conducted

- Familiarity with ASVs
- Desirable ASV technologies

Do you know what ASVs are?



What kind of ASV systems would you like on your car?



Note: Multiple responses permitted.

15

ASV Public Information Activities (3)

Organization of the ASV-3 Interim Presentation Meeting

- Reports on ASVs
- Exchange of views with visitors
- Exhibition of commercialized ASV technologies
- Exhibitions by manufacturers

March 2004 in Tokyo
Participants: Mainly media representatives

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ASV Public Information Activities (4)

Exhibition at the ITS World Congress and Organization of ASV Technology Test-Ride Event

October 2004 in Nagoya
Participants: ITS experts and the general public

Exhibition

- Exhibition on the ASV Project and technologies
- Demonstration stage linked to test-ride site

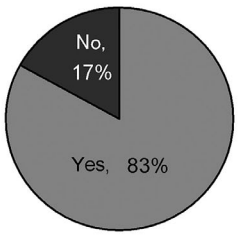
Test-Ride Event

- Test-ride in vehicles equipped with damage mitigation braking systems and low-speed following systems
- Exhibition and demonstration of vehicles equipped with other ASV technologies
- Questionnaire survey conducted

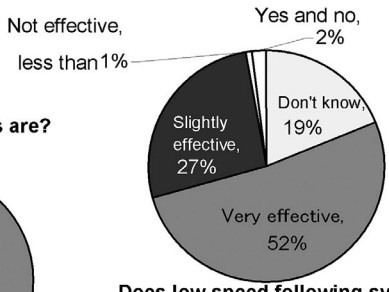
17

ASV Public Information Activities (5)

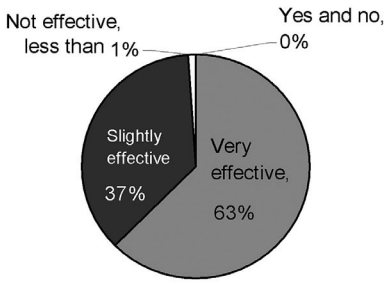
Do you know what ASVs are?



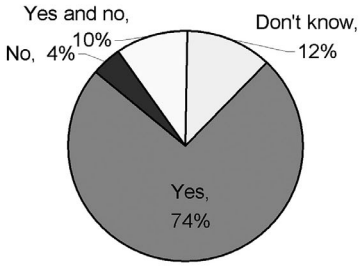
**Do you think damage mitigation braking system is effective?
- Before Test-Ride -**



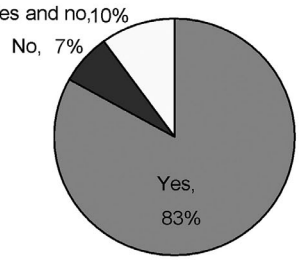
**Do you think damage mitigation braking system is effective?
- After Test-Ride -**



**Does low speed following system make driver easier?
- Before Test-Ride -**



**Does low speed following system make driver easier?
- After Test-Ride -**



Respondents:
Japanese: 202
Other nationalities: 22

18

Study on Commercialization of Damage Mitigation Braking System for Heavy Duty Vehicle (1)

Early commercialization of damage mitigation braking system for heavy duty vehicle

- **Heavy duty vehicles tend to have fewer road accidents than passenger cars, but once a heavy duty vehicle accident occurs it is likely to cause serious damage**
- **Within the total number of traffic accidents caused by heavy duty vehicles, the percentage of rear-end collision accidents is higher than that for passenger cars**

Early commercialization of damage mitigation braking system for heavy duty vehicle is desirable as a means of reducing rear-end collision accidents

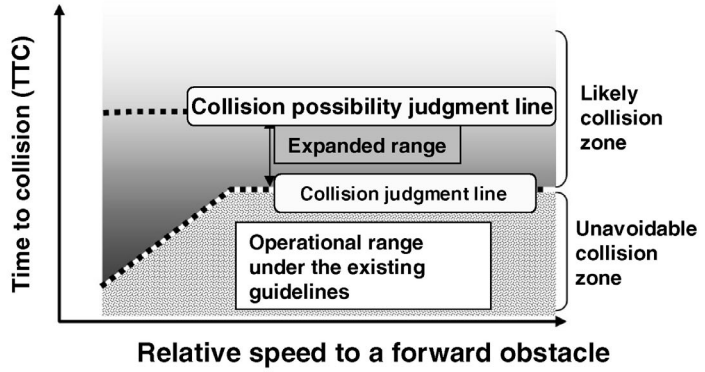
Study of guidelines for early commercialization of damage mitigation braking system for heavy duty vehicle

19

Study on Commercialization of Damage Mitigation Braking Systems for Heavy Duty Vehicle (2)

Approach to Guidelines for Commercialization

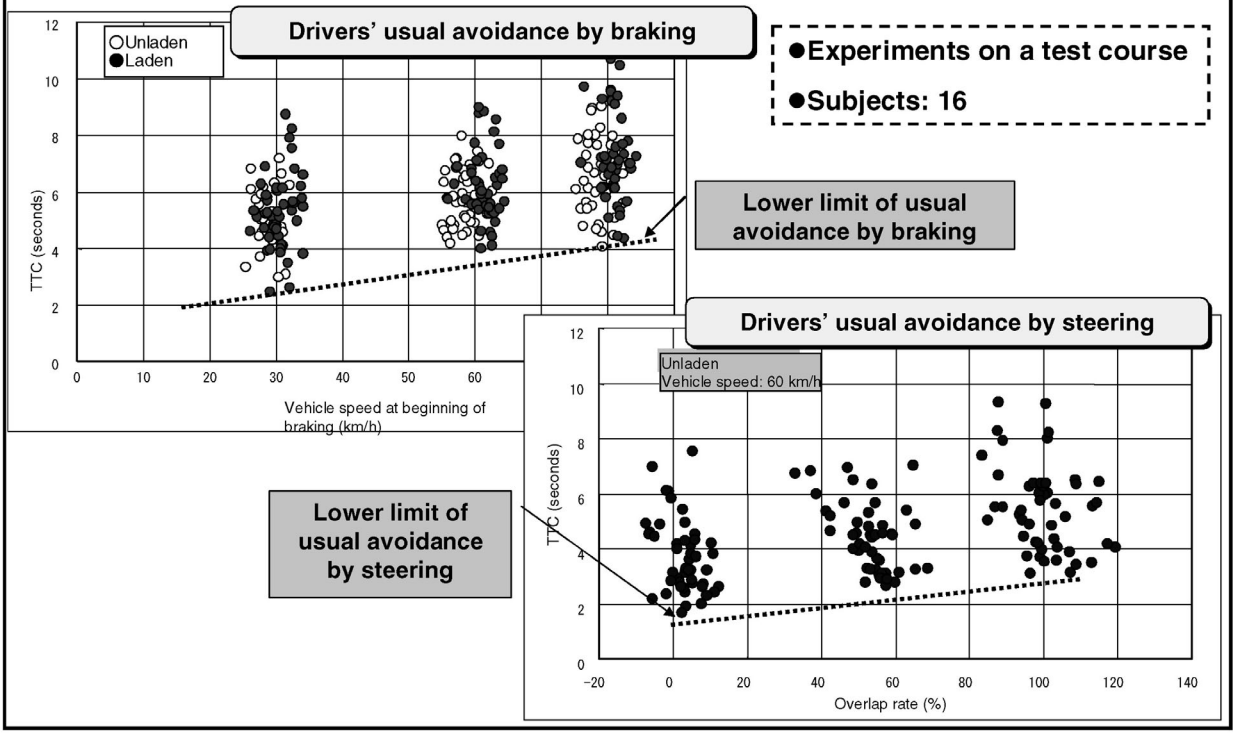
- A "collision judgment line" should be established as a timing criterion whereby it is judged that due to limits of avoidance by braking and by steering, it is not possible to avoid a collision by either braking or steering
- If the collision judgment line is exceeded, braking control equivalent to emergency braking is carried out
- A "collision possibility judgment line" should be established on the basis of the distribution of timings at which drivers perform evasive maneuvers while driving under normal conditions
- If the collision possibility judgment line is exceeded, braking control may be commenced
- At the stage prior to braking control, a warning is issued to alert the driver to take evasive action



20

Study on Commercialization of Damage Mitigation Braking System for Heavy Duty Vehicle (3)

Collection of basic data to set a collision possibility judgment line



- Experiments on a test course
- Subjects: 16

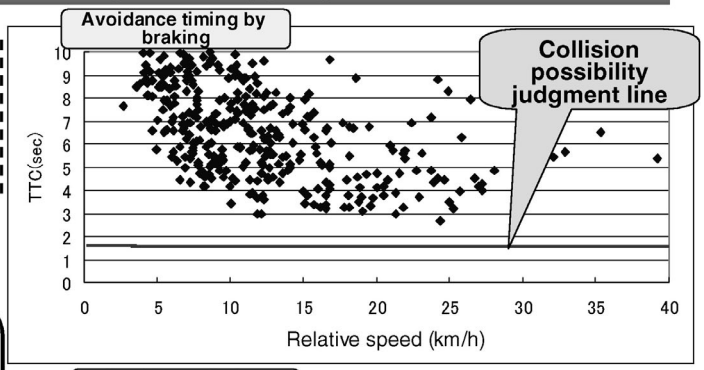
21

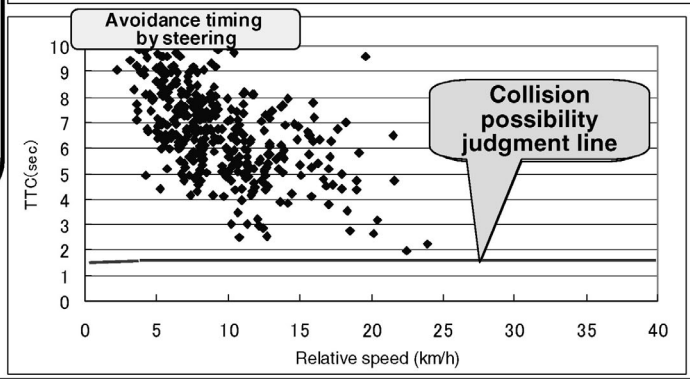
Study on Commercialization of Damage Mitigation Braking System for Heavy Duty Vehicle (4)

Verifying the validity of the collision possibility judgment line established

With the cooperation of the Japan Trucking Association, data were gathered on drivers' avoidance by braking and by steering during actual operation of large trucks

- **Survey covered a total of 20 vehicles with a total traveled distance of 230,000 km**
- **All data show values exceeding the possible collision line**
- ✧ **The validity of the collision possibility judgment line established was confirmed**





Kenichi Yoshimoto

1

Activities Relating to Technology Development

Summary Report

Kenichi Yoshimoto

Chairman, Subcommittee of Next Generation Technology
Chairman, Subcommittee of Coordination with Roadside Infrastructure
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3

2

Roles of the Subcommittee of Coordination with Roadside Infrastructure and the Subcommittee of Next Generation Technology

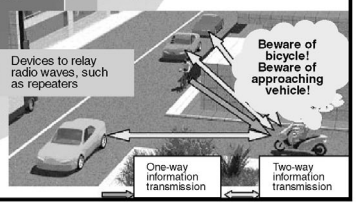
To promote the development of roadside infrastructure-linked (roadside information-based) and vehicle-to-vehicle communication-based (inter-vehicle communication type) driver assistance systems

On-board sensor type driver assistance systems
Response to events visible to the driver

Communications technology-based driver assistance systems
Response to events invisible/obscure to the driver

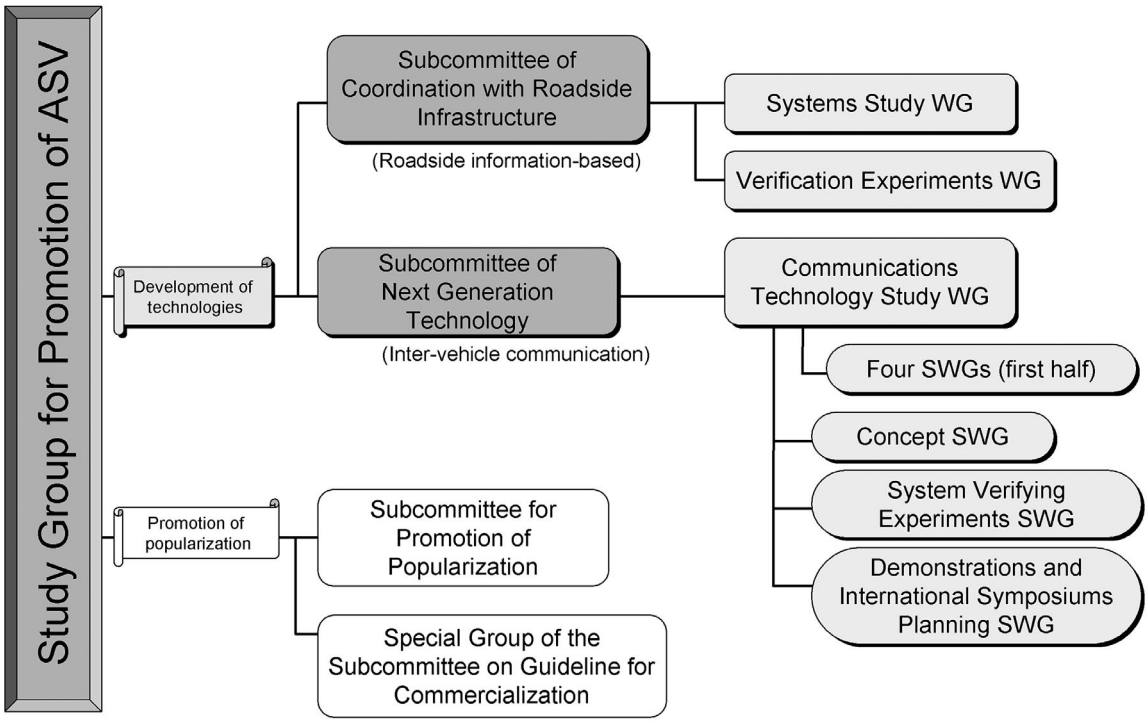
Roadside information-based driver assistance systems

Inter-vehicle communication type driver assistance systems



3

Structure of Study Including Positioning of Subcommittee of Coordination with Roadside Infrastructure and Subcommittee of Next Generation Technology



4

Subcommittee of Coordination with Roadside Infrastructure
Activities of the Systems Study WG

Examining definitions of systems

[1] Relevant items for services
[2] Content of services

Definitions of ASV-AHS coordinated systems

- System functions
- Driver assistance methods
- Installation positions of roadside infrastructure
- Content of roadside information
- Vehicles covered by services

AHS: Advanced Cruise-Assist Highway Systems

5

Activities of the Verification Experiments WG

Examination of methods to conduct experiments verifying system functions

[1] Study of verification experiment plans and procedures
[2] Implementation of verification experiments and summary of results

Arrangement of technological problems related to both roadside infrastructure and vehicles, including

- Problems in terms of detection by roadside infrastructure
- Problems concerning road-to-vehicle communications
- Issues concerning methods to provide drivers with information

6

Subcommittee of Next Generation Technology

Activities of the Communications Technology Study WG (1)

Continuing survey of trends in elemental technologies associated with development of next-generation ASV technology

- Trends in communications technologies in Europe and the United States
- Trends in positioning technologies

7

Activities of the Communications Technology Study WG (2)

Study of specifications for inter-vehicle communication type driver assistance systems

[1] Study of the concept of inter-vehicle communication type driver assistance systems

[2] Examination of possible effects of communications characteristics on driver assistance

Specifications of system concept for inter-vehicle communication type driver assistance:

- Systems functions (in accident situations)
- Driver assistance methods
- Communication methods and scope
- Content of information to be communicated

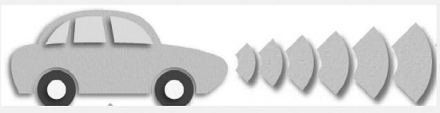
8

Activities of the Communications Technology Study WG (3)

Study of experiments to verify system functions

[1] Examination of experiment plans and procedures
[2] Implementation of verification experiments and summary of results

Identification of technological problems to be solved for the commercialization of inter-vehicle communication type driver assistance systems:



- Effectiveness of systems
- Driver dependence on ASV systems in traffic conditions where ASVs and non-ASVs mix
- Validity of concept specifications

9

Activities of the Communications Technology Study WG (4)

Organization of demonstrations and an international symposium to publicize the ASV project

[1] Presentation of results of verification experiments on ASV inter-vehicle communication type driver assistance systems

[2] Exchange of views on the concept of ASV inter-vehicle communication type driver assistance systems

- Participants in demonstrations: 382
- Attendants at the international symposium: 301

10

Challenges Ahead for the Development of Technologies

Promoting the development of technologies for the commercialization of communications technology-based driver assistance safety systems

- Examination of the concept of driver assistance safety systems with due consideration of the following options: inter-vehicle communication type, roadside information-based, on-board sensor type, and independent roadside infrastructure
- Active involvement in the development of communications systems by proposing vehicle-side requirements

→ The next ASV promotion project

Hiroyuki Kanemitsu

1

Report on Technology Development Activities

Development of Roadside Information-based Driver Assistance Systems

Hiroyuki Kanemitsu
Leader of the Systems Study Working Group
Subcommittee of Coordination with Roadside Infrastructure
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3

2

Role of the Subcommittee of Coordination with Roadside Infrastructure and Main Items for Consideration

To promote the development of roadside information-based driver assistance systems

1. Study of the positioning of roadside information-based driver assistance systems
2. Study of system concepts and definitions
3. Conducting of system trials

3

Functions and Role of On-board Sensor Type Driver Assistance Systems

On-board system sensors autonomously recognize events around the vehicle and assist the driver in operating the vehicle

- Perception Expansion
- Providing information (at all times)
- Providing information (Providing cautionary information)
- Warning
- Accident avoidance assistance control
- Driver load reduction control

- Events that cannot be seen by the driver are also hard for on-board sensors to detect
- The on-board system finds it difficult to recognize intersections and traffic lights

Difficult to deal with accidents at intersections
- Collisions at intersection corners
- Collisions when making a right turn
- Collisions with pedestrians and others

4

Response to Events That Are Difficult for On-Board Sensor Type Driver Assistance Systems to Detect

- Method to utilize information from roadside infrastructure

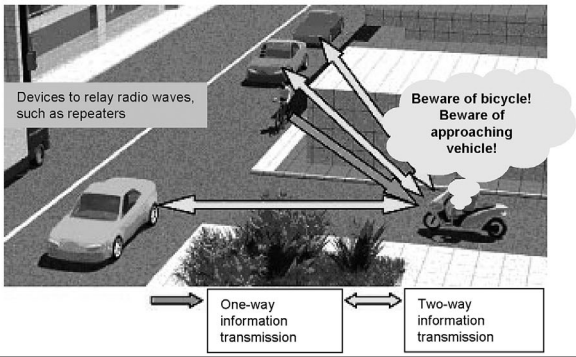
Roadside information-based driver assistance systems

(Road-vehicle communication)

- Method to exchange information with other road users

Inter-vehicle communication type driver assistance systems

(Vehicle-to-vehicle communication)



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Roadside Information-Based Driver Assistance Systems

Approach to the systems

- System capable of covering a range that cannot be handled by on-board sensor type driver assistance systems → On-board sensor type driver assistance systems used within the range they can handle
- Method to utilize roadside information (driver assistance level) → Depending on the functions of the on-board system
- On-board system uses roadside information to assist the driver in operating the vehicle → Locations for infra-structure installations are limited
- Upper limit imposed on the vehicle speed at which roadside information can be effectively used → Roadside information is received at a fixed point

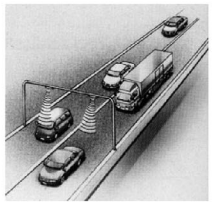
Considerations for enabling the driver to understand and use information

Cooperation with AHS Project

AHS: Advanced Cruise-Assist Highway Systems

6

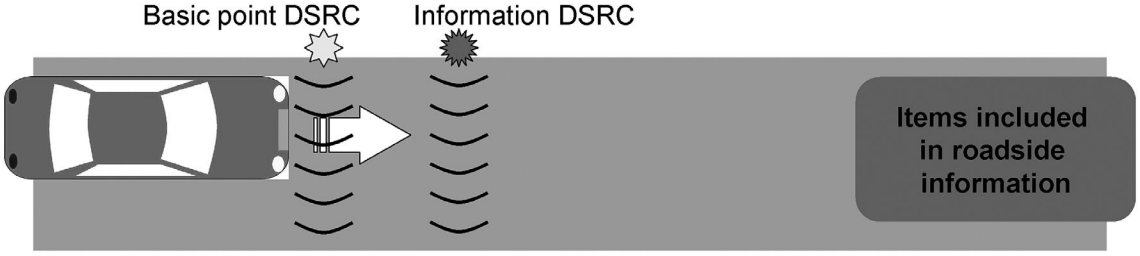
The Concept of Roadside Information-Based Driver Assistance Systems (1)



Method of Transmitting Roadside Information (Road-Vehicle Communication)

- **ETC radio technology-based dedicated short-range communications (DSRCs) are used**
- **A combination of basic point DSRC and information DSRC is used to transmit roadside information to the vehicle**

Basic point DSRC	Preliminary information on a basic point and services is transmitted.
Information DSRC	Information necessary for each service is transmitted.



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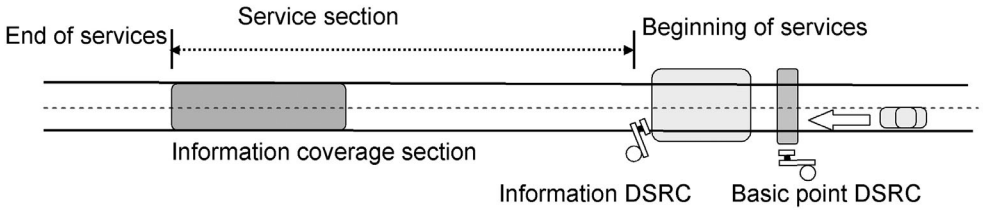
The Concept of Roadside Information-Based Driver Assistance Systems (2)

Infrastructure to disseminate roadside information is not installed on all roads, and locations where roadside information can be used are limited. Thus systems must be designed so that the driver is aware of the sections where roadside information is provided.

- **The availability of services should be made clear to the driver**
- **Service sections must be made clear to the driver**
- **Information coverage sections must be made clear to the driver**
- **The content of information must be made clear to the driver**



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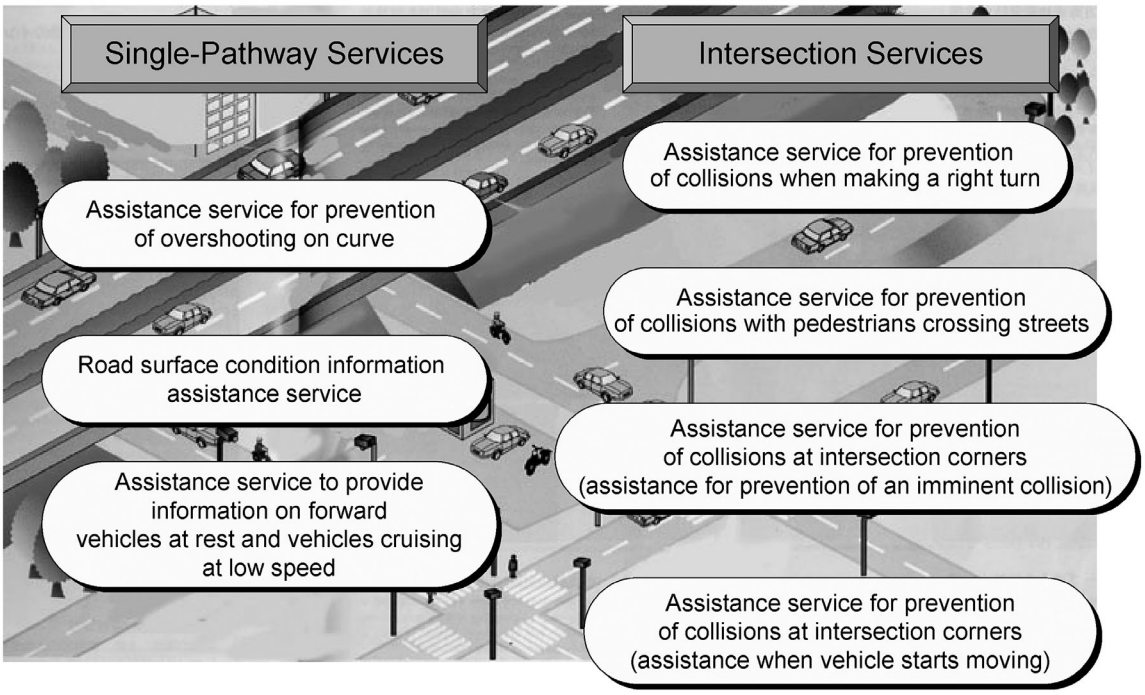
Possible Roadside Information-Based Driver Assistance System



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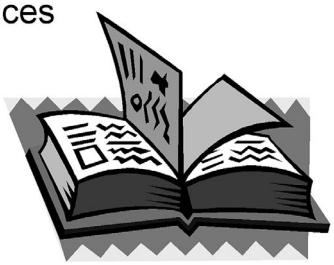
Study of Roadside Information-Based Driver Assistance Systems

Formulation of Definition of ASV-AHS coordinated Systems

- System functions
- Driver assistance methods
- Installation positions of roadside infrastructure
- Content of roadside information
- Vehicles covered by services
- Combinations of services

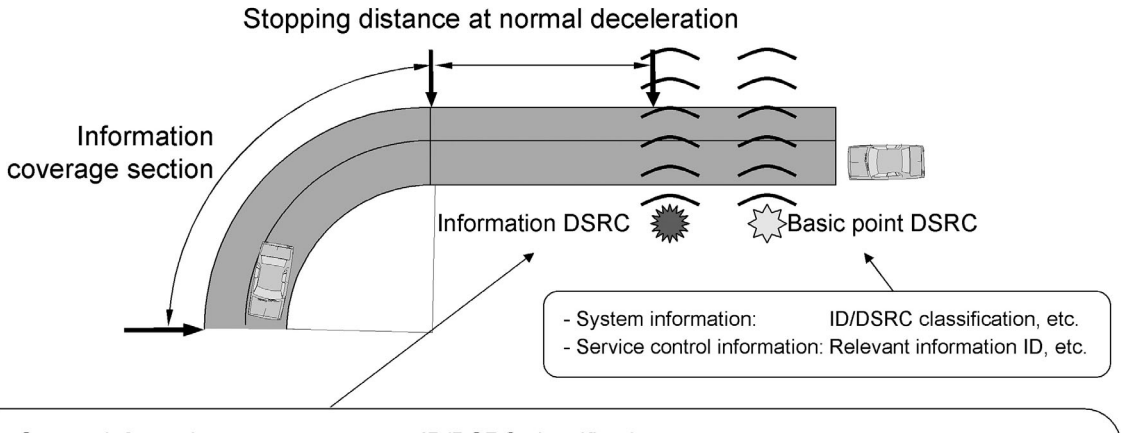


AHS: Advanced Cruise-Assist Highway Systems

10

Example of System Definition

Example of driver assistance service to provide information on forward vehicles at rest and vehicles cruising at low speed



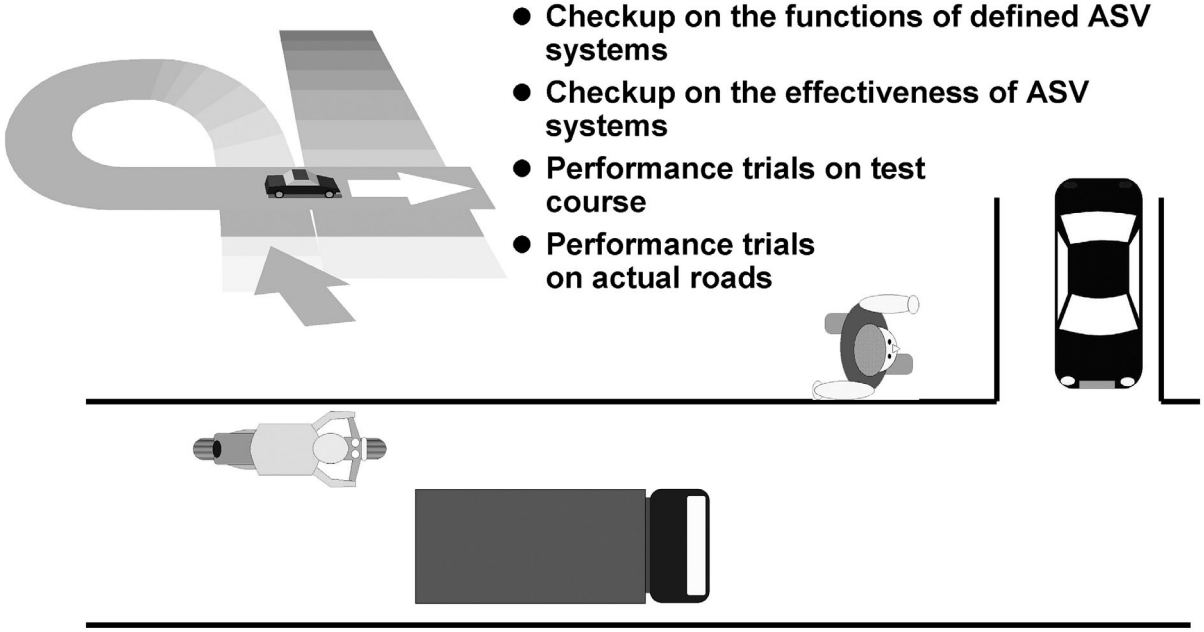
•System information	ID/DSRC classification, etc.
•Service control information	Relevant basic point ID, etc.
•Service status information	Availability, etc.
•Access road connection information	Road connection up to the information coverage section
•End of service information	End of service point
•Individual service information	Distance from a vehicle at rest or a vehicle cruising at low speed

11

Study of Roadside Information-Based Driver Assistance Systems

ASV-AHS Joint Trials

- **Checkup on the functions of defined ASV systems**
- **Checkup on the effectiveness of ASV systems**
- **Performance trials on test course**
- **Performance trials on actual roads**



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Outline of ASV-AHS Joint Trials

Period of Trials: October 2002 – March 2003

Venue of Trials:

■Test course of the National Institute for Land and Infrastructure Management (NILIM)

Experiments were carried out under fixed trial conditions, including vehicle speeds and number of vehicles

■Actual roads (R25 Maitani, Tomei Expressway Osawagawa, and R246 Matsuda-Soryo)

Trials aimed to verify the acceptability of systems and identify problems during normal operation

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Outline of Results of Joint Trials

Single-Pathway Services

It was concluded that at current technological levels, the possibility of commercializing single-pathway systems alone is remote

- Roadside information is inaccurate and unclear
- Communications are sometimes uncertain
- The availability and content of assistance are unclear to the driver

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Summary of Results of Joint Trials

Intersection Services

It was concluded that although there is a need for commercialization of driver safety assistance systems, there are a number of technological problems that must be resolved before commercialization

- Roadside information that the system can provide is not accurate enough to be commercially feasible
- Communications are sometimes uncertain
- Consideration should be given to the method of providing the driver with information (not providing too much information for the driver)

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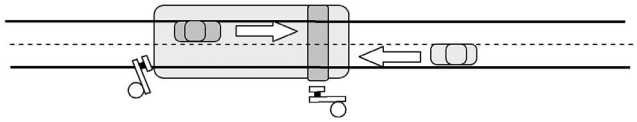
Results of Joint Trials: Example 1

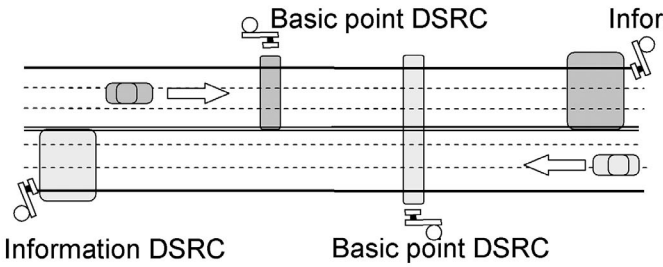
Communications are sometimes uncertain

- Communications are sometimes interrupted alongside a heavy duty vehicle
- Wrong combination of DSRCs sometimes occurs due to spread or leakage of radio waves



Spread of radio waves

Information DSRC　　Basic point DSRC



Leakage of radio waves

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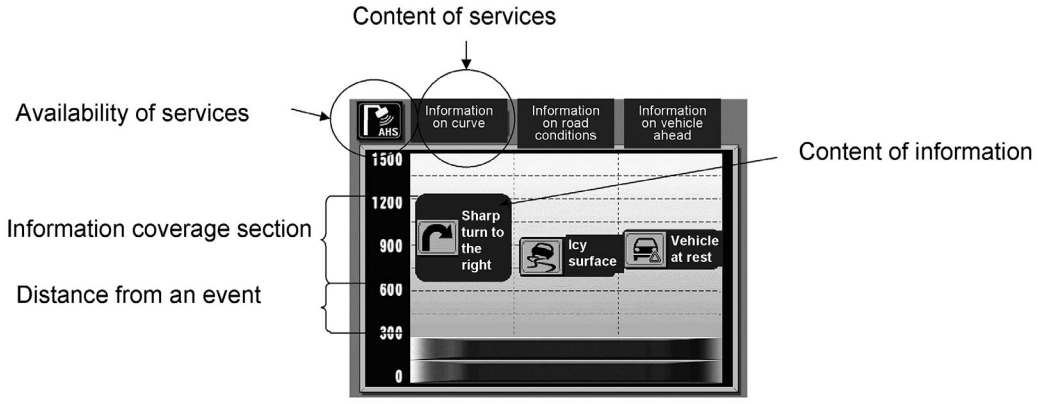
Results of Joint Trials: Example 2

Availability and content of assistance are unclear to the driver

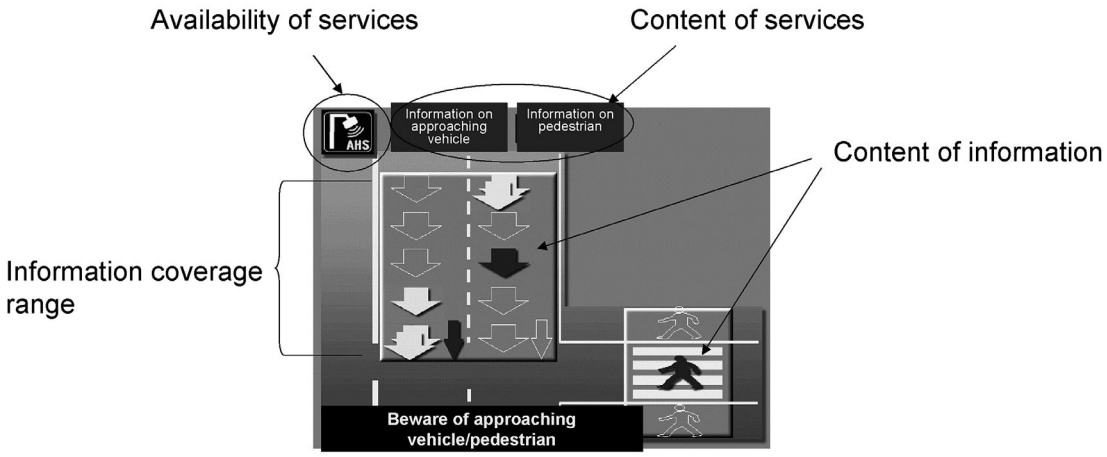


Example of Single-Pathway Information Provision

17

Results of Joint Trials: Example 3

Consideration should be given to the method of providing the driver with information

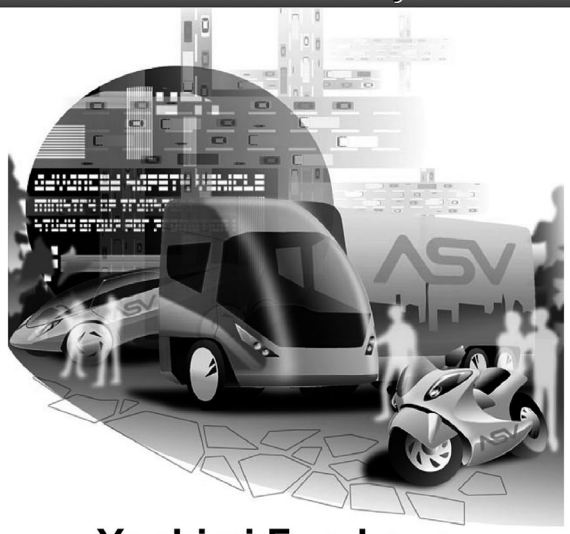


Example of Intersection Information Presentation

Yoshimi Furukawa

Report on Technology Development Activities

Development of Inter-Vehicle Communication Type Driver Assistance Systems



Yoshimi Furukawa
Leader of the Communications Technology Study Working Group
Subcommittee of Next Generation Technology,
Study Group for Promotion of the Advanced Safety Vehicle, Phase 3

Main Items for Consideration

Promoting the development of driver assistance systems that enhance safety through an exchange of information among all road users including pedestrians

1. Role of Inter-vehicle communication type driver assistance systems
2. Concept study
3. Summary of verification experiments and results
4. Public information activities
   - Demonstrations
   - International symposium

Positioning

Role of Inter-Vehicle Communication Type Driver Assistance Systems

On-board Sensor Type Driver Assistance Systems
Response to events that can be seen by the driver

Cooperative Driver Assistance Systems
Response to events that cannot be seen or can barely be seen by the driver
Communications technology-based driver assistance systems

Road-to-Vehicle Communications
Roadside information-based driver assistance systems

Vehicle-to-Vehicle Communications
Inter-vehicle communication type driver assistance systems

Concept Study

Procedure to Formulate Concept Specifications

Survey of communications technologies

- Cutting-edge technologies
- WLAN technology
- Antenna technology
- Radio wave propagation
- Multipath

Analysis of accidents

Modeling of accidents

Categorization of accidents

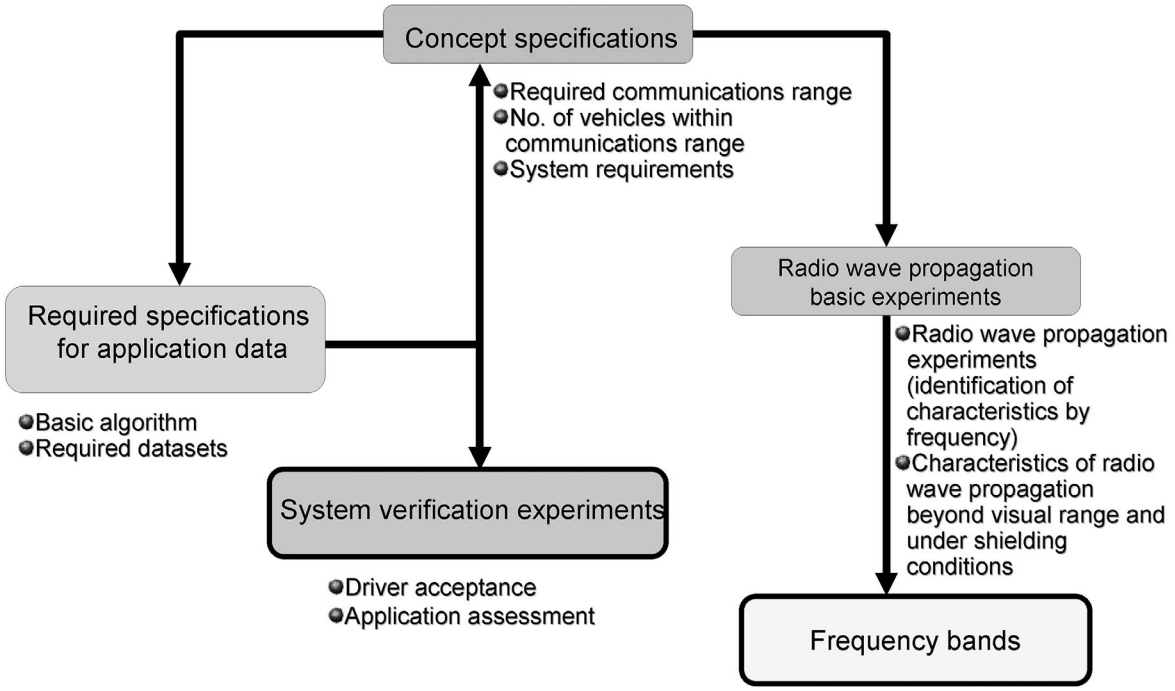
Survey of positioning technologies

- GPS positioning accuracy
- Delay
- Urban streets lined with high-rise buildings
- Shielding environment
- DGPS/RK-GPS

Concept specifications

Concept Study

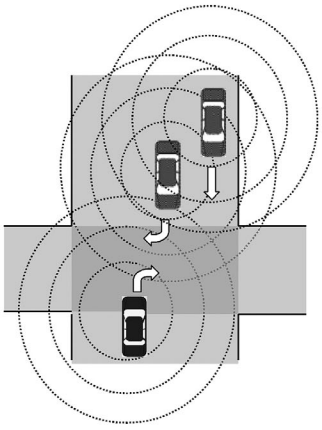
Verification of Concept Specifications

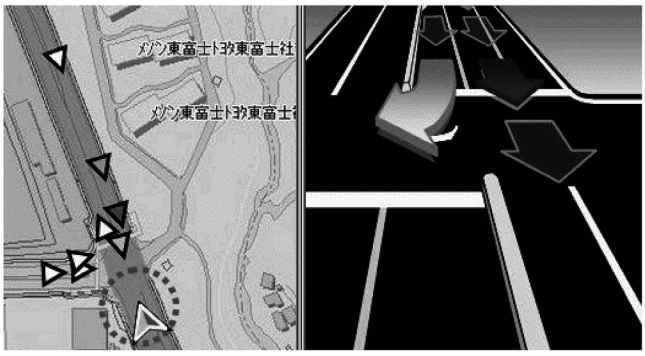


Concept Study

Concept of Inter-vehicle Communication Type Driver Assistance Systems

- Each vehicle periodically communicates information on its speed, position and status
- Information from other vehicles allows the driver to get a picture of the surrounding traffic environment



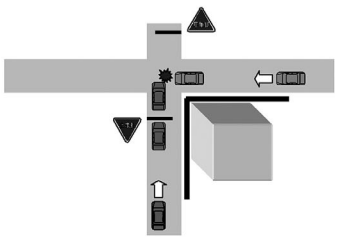


Concept Study

Collision Accident Categories

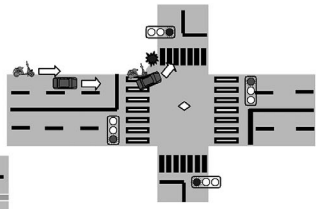
■ Accidents primarily caused by oversight

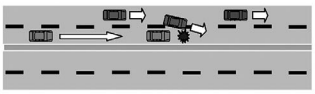
- ✓ Collisions when making a right turn
- ✓ Head-on collisions
- ✓ Collisions at intersection corners
- ✓ Collisions with pedestrians



■ Accidents resulting in serious damage and requiring serious public attention, regardless of the number of occurrences

- ✓ Rear-end collisions
- ✓ Collisions when making a left turn
- ✓ Collisions when changing lanes

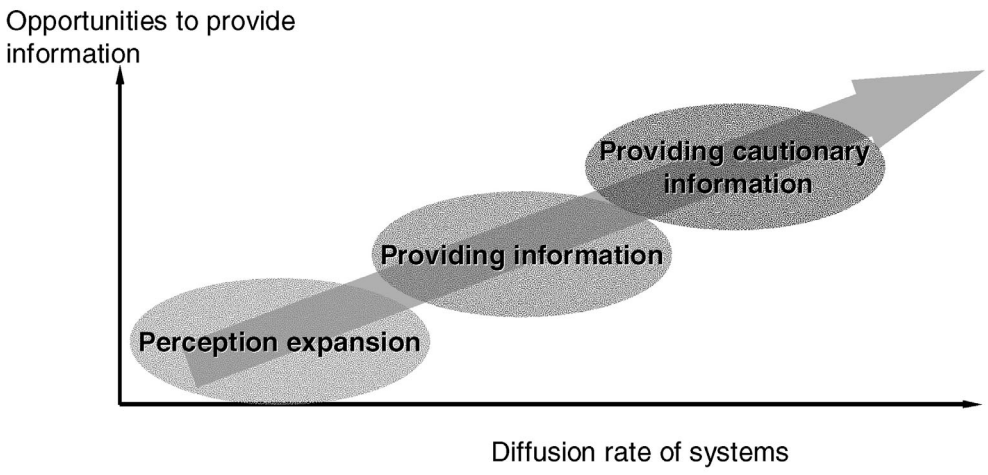




Concept Study

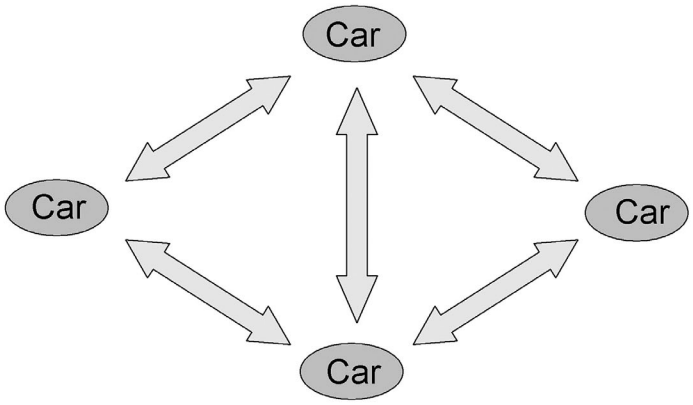
Functions and Diffusion Rate of AVS Systems

■ With a rise in the proportion of vehicles with AVS systems installed (the diffusion rate), system functions are expected to become more sophisticated



Trials

Communications Systems



Information

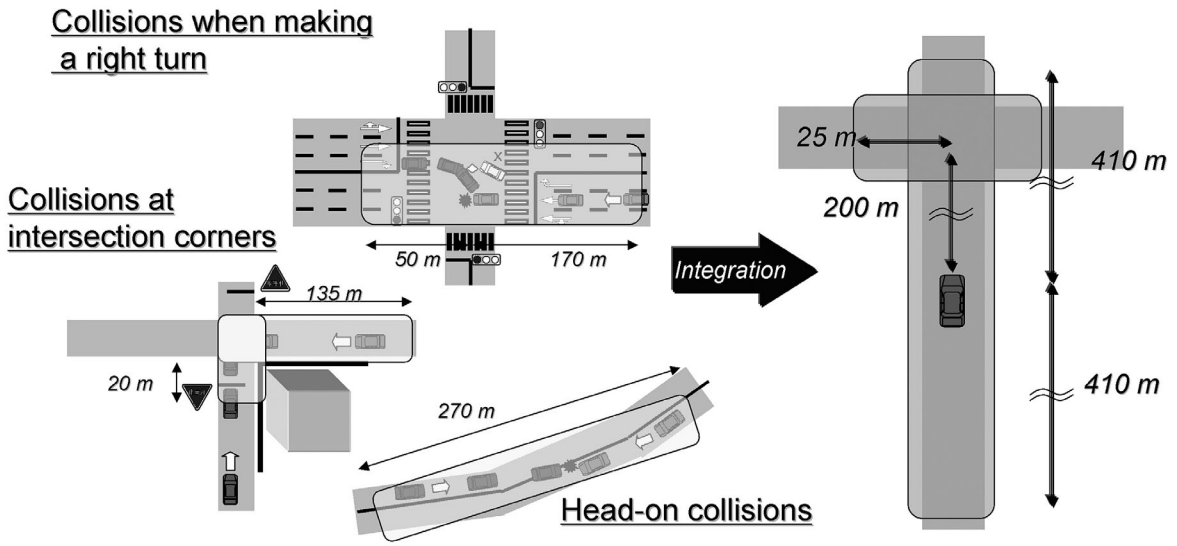
■Basic information
- Vehicle ID
- Vehicle type
- Present position
- Vehicle speed
- Direction of travel

■Equipment information
- Gear position
- Braking
- Direction indicators
- Hazard lights

Trials

Required Communications Range

■System's communications range derived from analyses of accident categories



Supposition based on passenger cars and motorcycles

Passenger cars, motorcycles, and trucks are considered.

Trials

Purpose of Assessment

- To verify how effectively information from surrounding vehicles will help the driver of a vehicle equipped with an inter-vehicle communication type driver assistance system to drive safely under conditions close to actual traffic conditions

Trials

Checkpoints

(1) Was there any deficiency in the temporarily established communications area?

(2) Could the positioning accuracy of the currently available vehicle-positioning technology fulfill the intended functions of the system?

(3) Is the timing of information provision appropriate?

(4) Were data formatting and signal processing as expected?

(5) Was the driver able to understand the meaning of information provided?

(6) Is it possible to provide the driver with effective information without misleading or confusing him/her in a traffic environment where there are many vehicles that are not equipped with driver assistance systems?

Note: Communications were conducted under experimental conditions that would allow secure communications within the communications range prescribed by the concept specifications, and communications technologies were not assessed.

Trials

Period and Location of Trials

- ✓ Preliminary trials
  June 2005
- ✓ Assessment trials
  August-October 2005

Cold Climate Test Course in Tomakomai

Civil Engineering Research Institute of Hokkaido

Trials

Accidents Assessed

(1) Collisions when making a right turn

(2) Collisions at intersection corners

(3) Collisions with pedestrians

(4) Head-on collisions

(5) Rear-end collisions

(6) Collisions when making a left turn

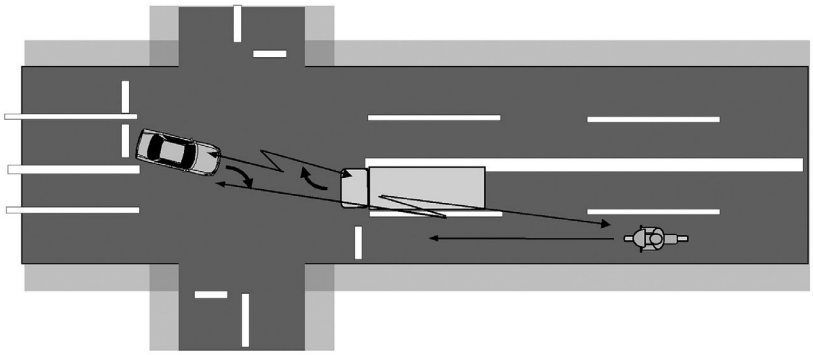
(7) Collisions when changing lanes

Trials

Vehicles Used in Demonstrations

Trials

Trials on Collisions When Making a Right Turn

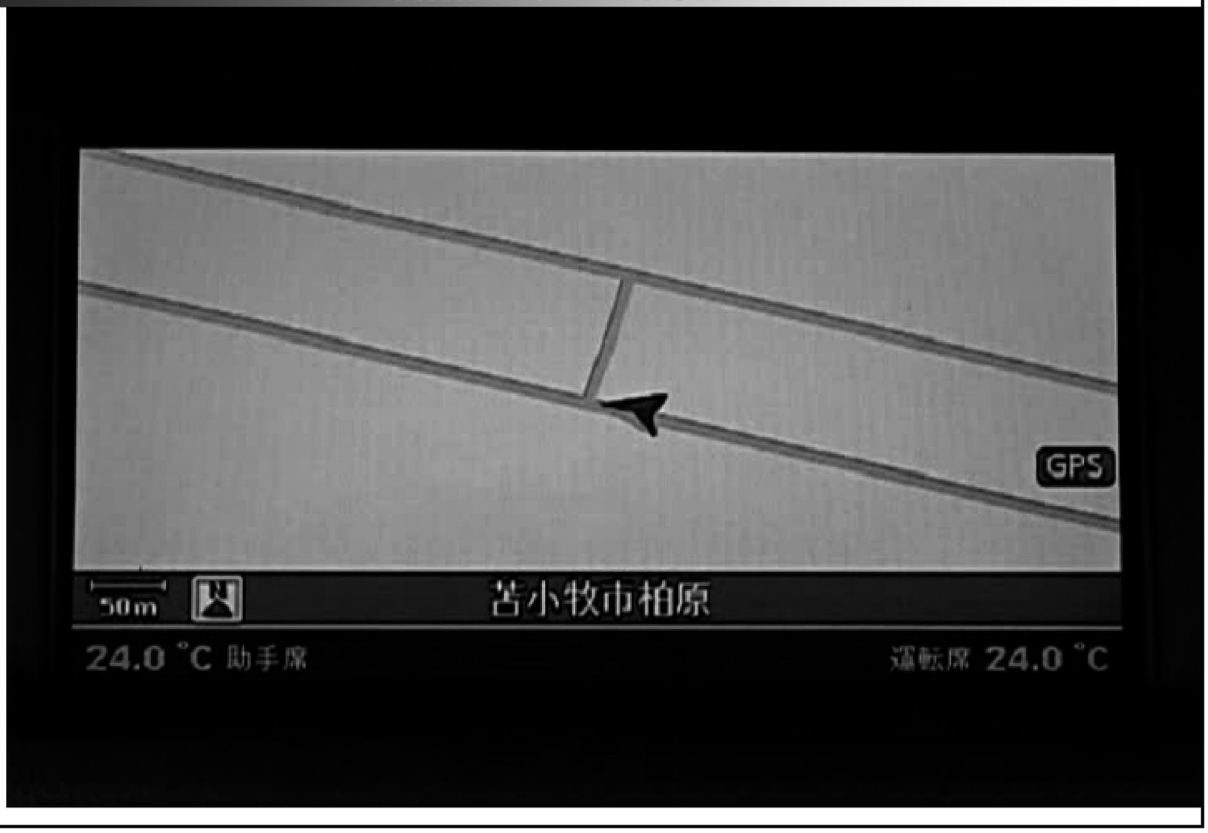


Trials

Collisions When Making a Right Turn

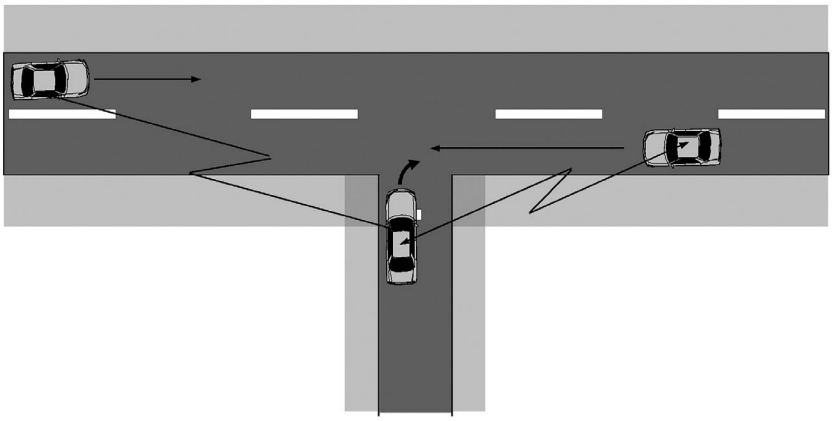
Trials

HMI Activation



Trials

Trials on Collisions at Intersection Corners



Trials

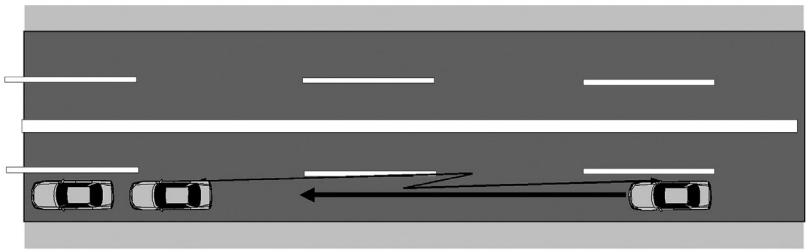
Collisions at Intersection Corners

Trials

HMI Activation

Trials

Trials on Rear-end Collisions




Trials
Rear-end Collisions


Trials
HMI Activation
TEMP
AUTO
OFF
DUAL
A/C
TV

Trials

Results of Trials

Items for Assessment	Results of Trials	Tasks Ahead
Communications area	No specific deficiency was observed	Identify communications area that would be available with a commercialized system.
Positioning accuracy	It was found that ordinary GPS accuracy would not identify correlations for some services (to be described later)	Hard to evade because of GPS-based system configuration. Identify effects when accuracy declines in urban areas.
Timing	It was found that a delay in positioning would cause data delay by up to 2 seconds or so.	Hard to evade because of GPS-based system configuration. Identify compensatory effect on receiving side by simultaneously transmitting anticipated data delay.
Data formatting	Although there was no significant deficiency, inadequate rules on the above timing and a flaw in the specifications for interpretation of data were found.	Need to determine maximum data delay and additionally define the extent of delay. Detailed definitions are needed for the interpretation of data, such as bearing and speed.
Signal processing	It was confirmed that the vehicle to be noted by the driver could be identified from among data on numerous vehicles	Identify effects of decline in positioning accuracy in urban areas on the extraction logic
HMI	It was confirmed that the situations could be communicated to the driver within the prescribed range of information provision	Capability to provide information about the existence of vehicles not equipped with ASV systems (providing information all the time to alert the driver) Examination of HMI approach at the time of change

Trials

Results of Trials

Items for Assessment	Results of Trials	Tasks Ahead
Collisions at intersection corners Collisions when making a right turn	Capability to provide information to alert the driver is feasible but some device must be provided to deal with the existence of vehicles not equipped with ASV systems	Need to identify problems at intersections, including the presence of traffic signals, various types of traffic signals, and diverse conditions
Collisions with pedestrians	Degree of positioning accuracy proved sufficient for the limited function of detecting presence of pedestrians	Need to define limitations and conduct trials to verify effectiveness
Head-on collisions	Degree of positioning accuracy proved sufficient for the limited function of detecting presence of vehicles coming from the opposite direction on a mountain pass	Need to define the limitations and conduct experiments to verify effectiveness
Collisions when making a left turn	Degree of positioning accuracy proved sufficient for the limited function of detecting presence of motorcycles and other objects that could be involved in an accident	Need to define limitations and conduct experiments to verify effectiveness
Rear-end collisions	Degree of positioning accuracy proved sufficient for the limited function of detecting presence of vehicles on the roadway that are stopped or traveling at low speed	Need to define limitations and conduct experiments to verify effectiveness
Collisions when changing lanes	It was confirmed that this capability would be hard to achieve because of insufficient positioning accuracy	

Public Information Activities

Demonstrations

- ✓ October 12-13, 2005
- ✓ Cold climate test course in Tomakomai, Civil Engineering Research Institute of Hokkaido
- ✓ Participants: 382

- ✓ Questionnaire:

  90 percent of the participants responded that the system is effective in reducing accidents.

Public Information Activities

International Symposium

- ✓ October 14, 2005
- ✓ Grand Hotel New Oji, Tomakomai, Hokkaido
- ✓ Participants: 301
- ✓ Program:

  - Current status of communication technologies in Japan, the United States, and Europe
  - Initiatives for the Development of Advanced Safety Vehicles (ASVs)
  - Discussion: “Toward the Realization of Driver Assistance through Vehicle-to-Vehicle Communications”

和迩　健二

The Next ASV Promotion Project

Kenji Wani
Director, International Affairs Office, Engineering and Planning Division,
Engineering and Safety Department, Road Transport Bureau,
Ministry of Land, Infrastructure and Transport

Future Advanced Safety Vehicle (ASV) Promotion Project (Draft)

Project Title

Phase 4 ASV Promotion Project

Items for Consideration

Promotion of popularization of ASVs:
1. Assessment of the effects of ASV technologies
2. Driver training on ASV technologies
3. Promotion of popularization of ASV technologies (incentives and measures for heavy duty vehicles, etc.)

Promotion of technology development
1. Basic design for inter-vehicle communication type driver assistance systems
2. Formulation of a comprehensive safety strategy

Note: To facilitate more substantial safety measures for heavy duty vehicles, the position of such vehicles in the ASV promotion project will be clarified in light of the results of discussion in the Traffic Policy Council

Goals

Promotion of popularization of ASVs:
- Full-scale use of on-board sensor type driver assistance systems

Promotion technology development
- Commercialization of some inter-vehicle communication type driver assistance systems

Project Period

5 **years from fiscal 2006 to fiscal 2010**

Promotion of Popularization of ASVs 1

Assessment of the Effects of ASV Technologies

Establish an ASV technology prior assessment method (e.g., simulation)

- **Establish a method of assessing effects through driving simulations modeling a road traffic environment**
- **Assess effects of various ASV technologies**

Establish an ASV technology post-assessment method (e.g., use of drive recorder)

- **Collect data through operation of vehicles on public roads using various on-board equipment, such drive recorders**
- **Assess effects of ASV technologies via data obtained and establish methods to assess effects of ASV technologies**

Assess effects of ASV technologies using an established assessment method and utilize data in formulating standards and incentives

Promotion of Popularization of ASVs 2

Driver Training on ASV Technologies

Develop driving simulator for experience with ASV technologies

- **Safe driving assistance requires the driver to have a correct understanding of ASV technologies and use them in a proper manner**
- **In order to promote correct understanding of ASV technologies, a driving simulator will be developed to allow people to experience ASV technologies. The simulator will enable many people to become aware of ASV technologies and gain familiarity with their effects and functional limits.**

Promotion of Popularization of ASVs 3

Promotion of Popularization of ASVs

Public information activities to promote user understanding

- **Promote user understanding of ASVs through brochures and symposiums**
- **Post information on the Website of the Ministry of Land, Infrastructure and Transport**

Introduction of incentives, etc.

- **Examine possible popularization measures with due consideration for the effects of damage mitigation and accident reduction as well as for social needs**

Spread ASV concept internationally

- **Disseminate the basic idea of ASVs throughout the world and actively participate in international conferences and symposiums in order build common understanding of the basic philosophy behind ASVs**

Promotion of Technology Development 1

Basic Design for Inter-Vehicle Communication Type Driver Assistance Systems

Survey of technological trends in inter-vehicle communication type driver assistance systems, etc.

- **Survey of overseas initiatives for communications technology-based driver assistance systems**
- **Study of future ASV technologies from the medium- and long-term perspective**

Basic design for inter-vehicle communication type driver assistance systems

- **Solve problems for the commercialization of communications technology-based driver assistance systems and promote technology development**

Promotion of Technology Development 2

Formulation of Comprehensive Safety Strategy

Defining the respective roles of on-board sensor type driver assistance systems and communication technology-based driver assistance systems to reduce traffic accidents effectively and efficiently

- **Communication technology-based driver assistance systems are effective in dealing with events (invisible events) that on-board sensor type driver assistance systems cannot handle**
- **Effective and efficient driver assistance systems designed to reduce accidents will be examined based on analyses of accidents (to define the respective roles of on-board sensor type, vehicle-to-vehicle communication, and road-to-vehicle communication driver assistance systems by accident category)**
- **The results of the above study will be appropriately reflected in a new information technology reform strategy**

Other Measures

Measures for Heavy Duty Vehicles

Surveys and research specifically targeting heavy duty vehicles must be carried out because:

- **The characteristics of accidents involving heavy duty vehicles differ from those involving passenger cars. (Heavy duty vehicle accidents tend to cause serious damage, and rear-end collisions account for a large percentage of such accidents.)**
- **Heavy duty vehicles differ in structure and performance from passenger cars**
- **Characteristics of Heavy duty vehicle drivers differ from those of general drivers**

Study Schedule for Phase 4 ASV Promotion Project (Draft)

Items for Consideration under the Phase 4 ASV Promotion Project			FY2006	FY2007	FY2008	FY2009	FY2010	Remarks
Promotion of popularization of ASVs	Assessment of effects of ASV technologies using drive recorders, etc.	Establishing ASV technology prior assessment method (e.g., simulation)	→	→	→			Establishing effect prediction and analysis method
		Establishing ASV technology post-assessment method (e.g., use of drive recorders)	→	→	→			Establishing effect prediction and analysis method
		Assessment of ASV technologies				→	→	Assessment of ASV technologies
	Development of driver training system on ASV technologies	Development of driving simulator for experience with ASVs	→	→	→	→	→	Promoting user understanding of ASV technologies
			Development of driving simulator			Utilization of driving simulator		
	Promoting popularization of ASVs (incentives, etc.)	Public information activities to promote user understanding	→	→	→	→	→	Promoting user understanding of ASV technologies
		Introduction of incentives, etc.	→	→	→	→	→	Promoting popularization of ASVs
		Dissemination of ASV concept internationally	→	→	→	→	→	Expanding recognition of ASVs overseas
Promoting technology development	Commercialization of some inter-vehicle communication type driver assistance systems	Survey of technological trends in inter-vehicle communication type driver assistance systems	→	→	→	→	→	Results of survey used to develop basic design for inter-vehicle communication type driver assistance systems
		Basic design for inter-vehicle communication type driver assistance systems	→	→	→ Trials	→ Assessment of Trials	→ Commercialization (in part)	Commercialization of some inter-vehicle communication type driver assistance systems
	Formulation of ASV technology-based comprehensive safety strategy	Defining respective roles of on-board sensor type driver assistance systems and communications technology-based driver assistance systems to reduce traffic accidents effectively and efficiently	→	→	→	→	→	Reducing traffic accidents with ASV technologies

Reference 1

Design Principles of ASV

Design Principles of ASV

Since the basic concepts underlying advanced safety vehicles (ASV) play an important role in developing technologies to assist drivers in driving safely, this paper summarizes Design Principles of ASV.

1. Driver Assistance

The ASV system leaves the driver in control of the vehicle. Even though cutting-edge electronics enable support in areas beyond the scope of driver control, a human must control the vehicle. If a driver uses ASV technologies beyond their intended scope, these technologies may not fulfill their functions properly. Thus, the driver remains in control of the vehicle, and **ASV technologies assist the driver**.

Specific forms of driver assistance can be readily understood if one imagines the driver actually operating a vehicle. Driving a vehicle can be schematized thus: the driver experiences stimuli and obtains information from the vehicle's surroundings, selects appropriate actions, and then performs actual driving tasks. Driving-related activities are typically referred to as recognition, decision, and control, as shown in Fig. 1.* ASV technologies provide assistance for these activities.

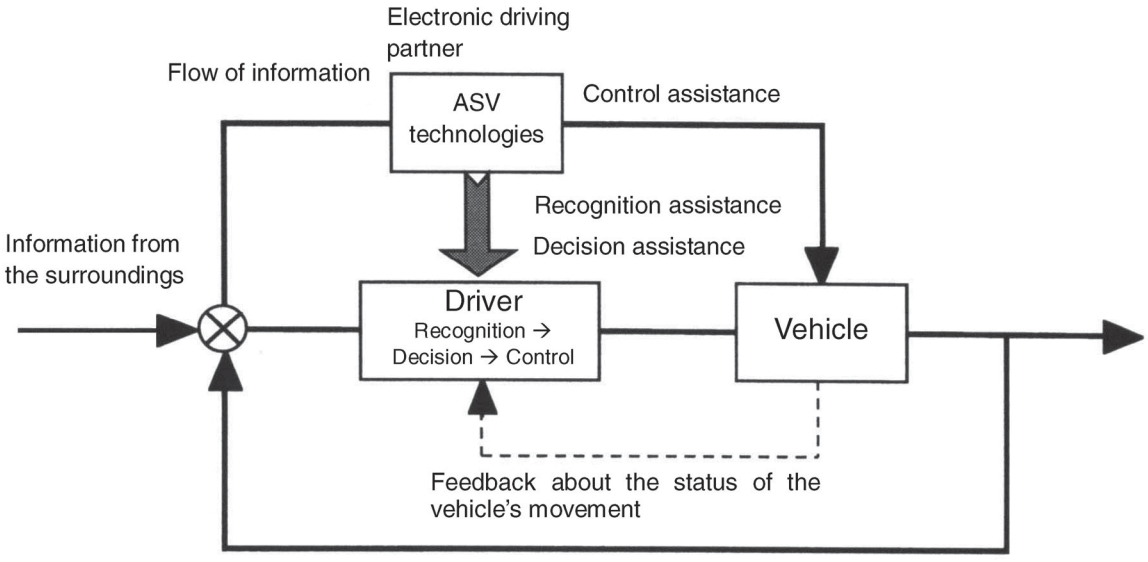


Fig. 1. Vehicle-Driving

* Internationally, academics often use the terms "perception," "decision-making," and "action" to express driving behavior, but because Japanese academics have customarily used "recognition," "decision" and "control," we have decided to uniformly use these terms in Phase 2 Advanced Safety Vehicle (ASV) Project.

Because most of the information needed to operate a vehicle is obtained through the driver's visual sense, **recognition assistance** mainly aids this sense, expanding the driver's perception and supplying information. Applications of perception expansion include enhanced headlight function. Information provision supplies information to assist in driving and to attract the driver's attention to potential dangers. For example, a night-vision system can detect and warn the driver of a pedestrian who would otherwise be difficult to see, and sensor systems can provide information about possible hazards at places such as blind corners. The capability to expand sensory functions and provide information can be regarded as a means of prompting the driver to be aware of the driving environment.

An example of **decision assistance** is a warning to prompt the driver to take appropriate action to avoid hazards or to act in response to a dangerous situation on the road.

Table 1. Relationship between Various Forms of Driver Assistance and Functions

Form of Assistance	Functions		
	Name of Function	Description of Function	Examples
Recognition Assistance	Perception Expansion	Expanding the driver's perceptive ability, mainly the visual sense	Use of high-intensity discharge headlamps; removal of rainwater from the windshield, etc.
	Information Provision	Providing information to assist the driver in operating the vehicle	Night-vision systems to provide information while driving at night
		Providing information to attract the driver's attention	Providing information about obstacles ahead at such places as blind corners
Decision Assistance	Warnings	Issuing a warning to prompt the driver to take evasive action against a hazard	Warnings about obstacles ahead, deviation from lane, etc.
Control Assistance	Accident avoidance assistance control	Control based on the driver's decision to avoid a hazard in an emergency	Braking systems to mitigate damage when a collision with an obstacle is unavoidable, etc.
	Driver load reduction control	Assistance to reduce the driver's load in operating the vehicle and supplement the driver's skills	Adaptive cruise control system (ACC), etc.

Control assistance is designed to assist a driver through two special control systems. One is the accident avoidance assistance control system, which provides intervention in maneuvering based on the vehicle's automatic judgment in order to avoid a hazard in an emergency that results from inattentive driving such as falling asleep at the wheel. The other is the driver load reduction control system, represented by ACC.

Table 1 shows the relationship between recognition, decision, and control assistance

and the functions in these assistance categories.

Thus, various forms of assistance are available to the driver. In order to perform a series of functions, such as issuing an artificial-intelligence-based warning to avoid a hazard in an emergency, followed by subsequent intervention in maneuvering, the accident avoidance assistance control system aids the driver based on the premise that priority should be on the driver's independent control of driving maneuvers rather than on mechanical control thereof. In other words, the idea is that if the driver performs a driving action while the accident avoidance assistance control system is operating, priority is given to the driver's action; that is, the direction and force of the driver's action override the direction and force of the automatic system. This idea is based on the principle that ASV technologies assist a driver.

2. Driver Acceptance

Driver acceptance refers to giving consideration to making a series of ASV technologies acceptable to drivers. ASV systems that are hard to understand or difficult to use do not allow drivers to benefit from assistance technologies that would otherwise be very useful. For example, a system to display various types of information and a procedure to handle the information must be designed with due consideration to suitable interface with drivers. There must be certain rules that govern the details and methods of specific functions, such as providing information, issuing warnings, and exercising accident avoidance assistance controls. In commercializing ASV systems, it is crucial to consider the **human interface for information provision*** **and system operation**.

For issuing warnings, the following considerations are important. The prerequisite for judgment assistance is that an ASV system must provide a driver with accurate information regarding any hazard(s) on the road in front of the vehicle, while eliminating as far as possible **missed warning** (i.e., failure to issue a warning despite an emerging dangerous situation) and **false warning** (i.e., a warning issued in the absence of a dangerous situation). Although there can be some tolerance of false warnings since there is no actual danger, missed warnings must be avoided as far as possible, because the driver is not alerted to an imminent dangerous situation.

However, even though false warnings can be tolerated to a certain degree, frequent

* In this case, information provision means that an onboard system in an ASV vehicle provides the driver with information through image displays or acoustic signals, but it does not refer to the ASV's information-providing function.

incidence of false warnings due, for instance, to a mismatch between the timing of warnings and driving behavior can cause the driver to distrust the warning system, as a result of which the warnings fail to serve their intended purpose. **Distrust** of the warning system should be minimized as much as possible by, for example, allowing the driver to adjust the level of warning that is given.

Although drivers might become distrustful of warnings, conversely they might expect so much from the warning system that they might **overtrust** it. A driver who is operating an ASV vehicle equipped with a warning system might become so reliant on it that he or she could become an inattentive driver. Under these circumstances, there is also a risk that pedestrians and cyclists may become careless at intersections believing that an ASV vehicle will unfailingly take evasive action. In this sense, it is important to educate drivers, pedestrians, and other road users about the dangers of placing too much confidence in vehicular warning systems at the same time as explaining the dangers of distrusting such systems.

These observations point to the need to recognize that, as mentioned at the beginning of this chapter, ASV technologies in themselves do not encourage driver inattentiveness or careless driving and the driver should ultimately retain control of the vehicle. They also indicate that ASV technologies are developed as tools to aid a driver in avoiding dangerous situations which may be encountered while operating the vehicle safely in normal circumstances.

3. Social Acceptance

Social acceptance refers to the question of how ASV technologies can be made socially acceptable. Some ASV technologies are preventive safety technologies intended to prevent accidents, while others are designed to minimize damage and injuries in the event of a collision. These technologies are basically developed by automakers and other manufacturers, but the final cost is borne by vehicle owners. ASV technologies should therefore be worth the price that vehicle owners pay for them.

In this sense, it is of paramount importance to determine the extent to which various ASV technologies can actually reduce the load of operating vehicles or decrease fatalities in traffic accidents. The effects of ASV technologies on reducing driving load are difficult to identify because of the unclear correlation of such technologies with safety. However, as a minimum **the effects of ASV technologies on reducing traffic**

accidents and consequent fatalities and injuries should be fully examined from the perspective of social acceptance, including the economic viability of such technologies.

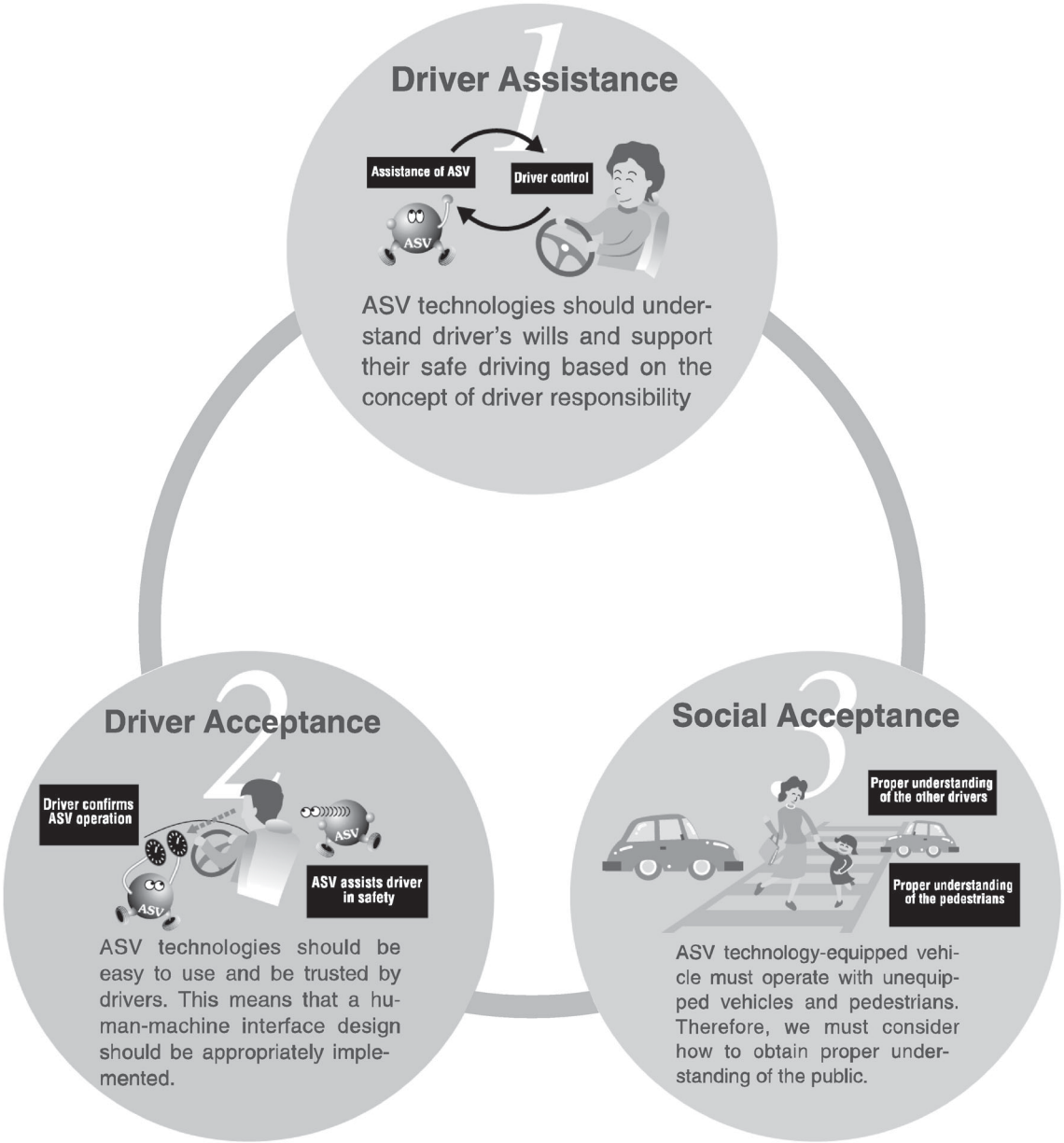
As indicated by the principle of driver assistance, ASV technologies can fail to fulfill their essential purposes if they are used beyond their capabilities. ASV technologies can only perform their functions if they are used under their intended working conditions. Intentionally putting a vehicle in a dangerous situation in order to test the ASV system just because the assistance provided by ASV technologies is difficult to appreciate under normal driving conditions is an example of how ASV technologies could be misused. Thus, it is important **to educate drivers about the functional limitations and system operating conditions** of ASV technologies.

While it is essential that drivers correctly understand ASV technologies, as mentioned earlier such technologies need to reflect consideration of driver acceptance, particularly in terms of human interface. For ease of understanding and operation by the driver, it is important that basic methods of providing information and operating procedures do not differ greatly from product to product, so that there is a certain degree of consistency. This is particularly important in regard to automobiles that are distributed internationally. To achieve international consistency, it is crucial to standardize not just the human interface but also the functions of ASV technologies. That being the case, **standardization of ASV technologies** should be studied.

In terms of legislation, it is necessary to **create a structure for incorporating ASV technologies into the legal system**, including legal standards for approval of such technologies and the handling of these technologies in case of accident, especially accidents involving ASV-technology vehicles and non-ASV vehicles.

Design Principles of ASV

Design principles have been established in order to facilitate the development and subsequent spread of ASV technologies.



Reference 2

The Concept of Driver Assistance

The Concept of Driver Assistance

1. Background to Study of the Concept of Driver Assistance

The sophistication of driver-assistance (control) technologies now makes it possible to allow the system (the vehicle) to perform some driving actions previously performed only by the driver. In order for that to occur, it is necessary to clearly differentiate the roles that the driver and the system should play in order to secure and enhance safety.

Having established the necessity of the principle of driver assistance, driver acceptance, and social acceptance as basic design principles, the Phase 2 ASV Project has proceeded with plans for the development and subsequent spread of ASV technologies based on these principles.

In the course of commercializing ASV technologies, the principles should be further refined as detailed guidelines. It is necessary to examine basic considerations to deal with, for example, the problem that a driver's excessive dependence on advanced systems might compromise safety.

Therefore, we have embodied the concept of driver assistance in the form of detailed guidelines for ASV design principles.

2. Drivers, Systems and Society

A driver who is operating a vehicle is required by society to follow traffic safety rules. Accordingly, it must be kept in mind that vehicle safety cannot be achieved without drivers accepting responsibility for it. Given this principle, the results of a study into the relationship linking the driver, the system, and society are summarized in Fig. 1.

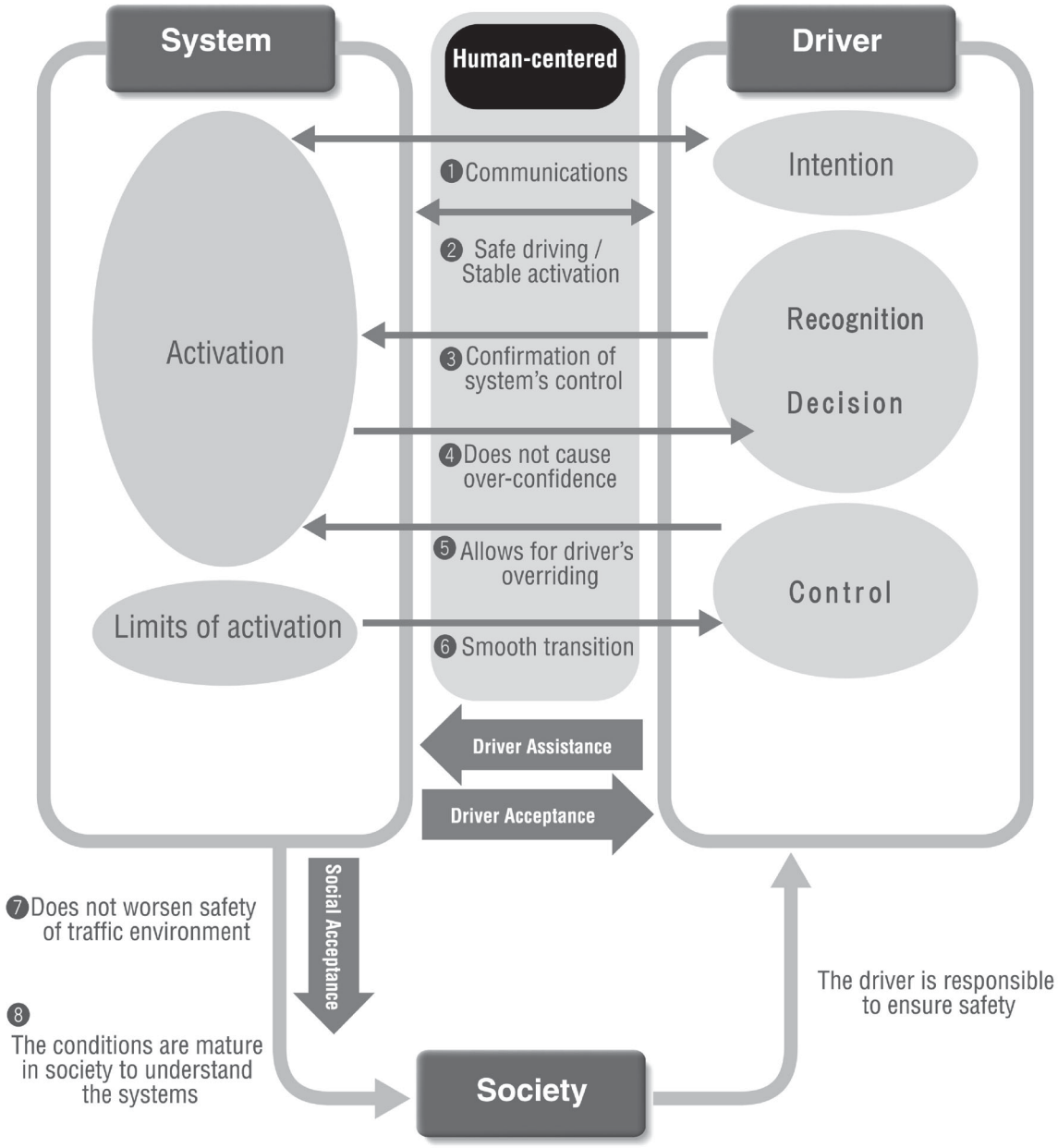


Fig. 1. The Driver, the ASV System and Society

In order for a driver to rely on the driver-assistance system without worry, the relationship between the two must be kept effective; i.e., (1) there must be two-way communication of intent between the driver and the system, and (2) the system must provide assistance in a safe and steady manner.

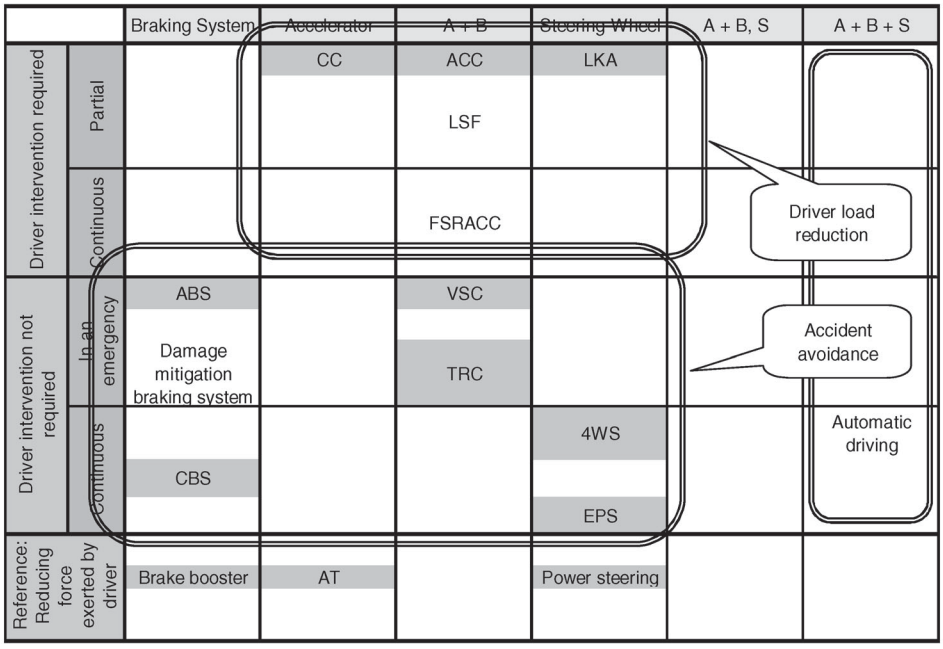
However, because there is no guarantee that the system will operate perfectly in all cases, (3) the driver must monitor system operation and, conversely, (4) the system must not engender overtrust or distrust in its capabilities that would interfere with such monitoring, i.e., the system must gain an appropriate level of trust.

Meanwhile, (5) the driver must intervene in the system's operation as necessary, and (6) the system must transfer operational control to the driver when it recognizes its operational limits.

Regarding the relationship between the system and society, (7) naturally the system must not compromise safety. However, (8) because advanced systems need some time to gain social acceptance, the gradual progress of current technologies will facilitate the process of winning public acceptance.

3. Categorization of ASV Technologies

As shown in Fig. 2, ASV technologies can be categorized in terms of driver intervention, system operation and controls.



Legend:
CC: Conventional cruise controls (commercially available)
ACC: Commercial ACC (commercially available)
LSF: ACC operational in the low-speed range (bumper-to-bumper traffic)
FSRACC: ACC operating at all speeds (seamless control from low speed to high speed)
ABS: Antilock-braking systems (commercially available)
4WS: Four-wheel steering (commercially available)
LKA: Lane-keeping assistance (commercially available)
VSC: Enhanced vehicle-stability control within operational limits (commercially available)
TRC: Traction control (commercially available)

Fig. 2. Categorization of ASV Technologies

ASV technologies can be categorized in terms of controls, namely accelerator (A), braking system (B), and steering (S); ASV technologies or a combination of technologies for these components have already been introduced.

ASV technologies can also be classified according to systems operation. Some ASV technologies are designed to function in an emergency while others are intended to function continuously or partially under specified conditions. The introduction of emergency technologies has progressed, and technologies that function continuously are now very close to technologies that function in an emergency. Technologies that function partially are used solely on expressways.

In regard to whether driver intervention is needed or not, ASV technologies can be classified into driver load reduction technologies and accident avoidance technologies. Driver load reduction technologies, which have indirect safety effects by helping a driver to alleviate fatigue and stay attentive by performing some of the actions that normally would be performed by the driver, can be regarded as requiring driver intervention.

Automatic-driving technologies aim to allow the vehicle itself to secure safety on behalf of the driver through a combination of accident avoidance and driver load reduction technologies. However, it is difficult to produce such systems with current levels of technology.

As mentioned earlier, existing technologies can be classified roughly into three groups: accident avoidance technologies, driver load reduction technologies, and automatic-driving technologies. Because automatic-driving technologies are still some years away from commercialization, they are excluded from consideration in the discussion here about the concept of driver assistance.

4. Eight Requirements of the Driver Assistance Concept

Given the above, the following eight requirements of the driver assistance concept must be considered in designing driver assistance technologies. It should be noted that the driver's responsibility for safe driving is the most fundamental factor in designing driver assistance technologies and, needless to say, it is required by society.

(1) Driver load reduction technologies
   (a) When the system is in operation, it must confirm the driver's intent or aim.
   (b) The system must assist the driver in operating the vehicle safely.
   (c) The driver must be able to confirm the details of assistance provided by the system.
   (d) The system must be designed so that it will engender the appropriate level of driver trust without inducing overdependence or distrust.
   (e) The driver must be able to override the control being performed by the system.
   (f) If the system exceeds its limits of assistance, it must smoothly transfer control to the driver.
   (g) The activation of the system must not compromise safety.
   (h) Groundwork must be done to gain public acceptance of the system.

(2) Accident avoidance technologies
   (a) The system must provide assistance in line with the driver's intent.
   (b) The system must assist the driver in operating the vehicle safely.
   (c) The driver must be able to confirm the details of assistance provided by the system.
   (d) The system must be designed so that it will engender the appropriate level of driver trust without inducing overdependence or distrust.
   (e) When the driver operates the vehicle in a safer manner, the driver's actions must override control by the system.
   (f) If the system exceeds its limits of assistance and if there are actions that should be performed by the driver, the system must smoothly transfer control to the driver.
   (g) The activation of the system must not compromise safety.
   (h) Groundwork must be done to gain public acceptance of the system.

5. Examples Relating to the Eight Requirements of the Driver Assistance Concept

Specific examples are presented below in order to provide a better understanding of the eight requirements of the driver assistance concept.

It should be noted that these examples are representative only, and some systems that use other principles might also be able to maintain safety. The validity of the examples should be examined on the basis of the outcome of future research or the performance of products introduced in the market.

(1) Driver load reduction control

(a) When the system is in operation, it must confirm the driver's intent or aim.

To meet this requirement, the system is designed so that:

- It can be operated by the driver using an on/off switch
- It can be operated by controls set by the driver

(b) The system must assist the driver in operating the vehicle safely.

The system is designed so that:

- Driver assistance does not exceed the limits of actions that the driver usually performs
- It provides assistance in a steady manner that allows the driver to use the system with security.

(c) The driver must be able to confirm the details of assistance provided by the system.

The system is designed so that:

- It provides visual, acoustic, and tactile signals that can be recognized by the driver.

(d) The system must be designed so that it will engender the appropriate level of driver trust without inducing overdependence or distrust.

The system is designed so that:

- The range of driver assistance can be easily understood by the driver
- If the range of assistance is exceeded, the driver can readily understand what to do
- It leaves some continuous tasks, such as monitoring system operation and awareness of the traffic environment, to the responsibility of the driver
- It does not perform all operations necessary to start the vehicle, accelerate, control the vehicle's movement, decelerate, and stop, leaving important operations such as starting the vehicle to the responsibility of the driver

(e) The driver must be allowed to override the control being performed by the system.

The system is designed so that:

- If the driver acts to control a component that normally is controlled by the system in operation, the driver's action prevails

(f) If the system exceeds its limits of assistance, it must smoothly transfer control to the driver.

The system is designed so that:

- If assistance is switched over to control by the driver, the timing and driving conditions of the switchover allow the driver to perform actions easily

(g) The activation of the system must not compromise safety.
The system is designed so that:
- It prevents safety from declining to a level lower than that provided by vehicles not equipped with ASV technologies

(h) Groundwork must be done to gain public acceptance of the system.
The system is designed so that:
- Levels of assistance are not excessively higher than those provided by conventional technologies
- The range of assistance provided is easily understood by the general public

(2) Accident Avoidance Control – Example of Collision Damage Mitigation System

A collision damage mitigation system is presented here as an example of accident avoidance technologies. Requirements of such a system are described below.

(a) The system must provide assistance in line with the driver's intention.
- Applying the brakes to avoid imminent collision is an action that the driver should naturally perform for safety reasons. Accordingly, the collision damage mitigation system reflects the driver's intention.
- In addition, the system must be designed so that it issues a warning to prompt the driver to take evasive action.

(b) The system should assist the driver in operating the vehicle safely.
- The collision damage mitigation system is intended to apply the brakes in order to alleviate damage from collisions, and therefore it enhances safety.

(c) The driver must be able to confirm the details of assistance provided by the system.
- Because the collision damage mitigation system allows the driver to detect whether the brakes are activated or not, it enables the driver to easily grasp the details of the assistance being provided.

(d) The system must be designed so that it will engender the appropriate level of driver trust without inducing overdependence or distrust.
- Because the collision damage mitigation system is intended to mitigate damage from collisions, the likelihood of overdependence is low.
- The system will gain the driver's trust if it is designed so that the driver readily knows when and where the system will be activated.

(e) When the driver can operate the vehicle in a safer manner than the system can, the driver's actions must override control by the system.
- The system must be designed so that the driver's actions override control by the system if driver control is likely to promote safety.

- The system must also allow the driver to avoid an accident by steering the vehicle.

(f) When the system exceeds its limits of assistance and if there are actions that should be performed by the driver, the system must smoothly transfer control to the driver.

- Because the collision-damage mitigation system is activated when a collision is unavoidable, there will be no circumstances that will require control to be transferred to the driver while the system is in operation.

(g) The activation of the system must not compromise safety.

- Because most traffic accidents are vehicle-to-vehicle collisions, a collision damage mitigation system that is highly effective in reducing damage from collisions is beneficial to society.
- Because the collision damage mitigation system is intended to provide control in an emergency, it must be designed so that it helps to prevent other vehicles from being involved in a collision.

(h) Groundwork must be done to gain public acceptance of the system.

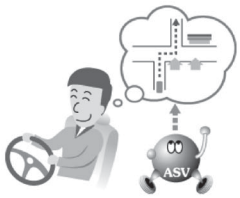
- Because the collision damage mitigation system is intended to control the vehicle to alleviate collision damage, it will be able to gain social acceptance as long as the other requirements are met.

Concept of Driver Assistance: Driver Load Reduction Control

In order that the car manufactures bring ASV technologies into practical use based on the Design Principles, we have established “Concept of Driver Assistance” for safety check points.

① Communications

The system should act after confirming the will and intention of the driver



② Safe driving / Stable activation

The system should assist driver in safety.

③ Confirmation of system’s control

The system should be checked by the driver at any time.

④ Does not cause over-confidence

The system should inspire a proper amount of confidence in the driver, not causing him to place too much confidence nor distrust in the system.

⑤ Allows for driver’s overriding

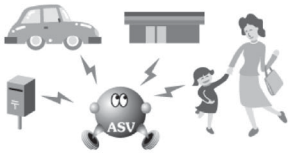
The system should be overridden by the driver.

⑥ Smooth transition

The system’s control should be smoothly passed over to the driver when the situation goes beyond the range of assistance of the system.

⑦ Does not worsen safety of traffic environment

The system should not make a negative impact to the traffic environment.



⑧ The conditions are mature in society to understand the systems

There should be mature society to accept the system.