ITSWC Beijing SS31
Acceptance & Implementation of Cooperative Systems in the Global Marketplace

Smartway 2007

October 2007

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Intelligent Transport Systems Division,
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   -Demo on the Tokyo Metropolitan Expressway

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1. Concept of Smartway - Purpose

Definition of Smartway

- Smartway refers to a road system that allows the exchange of various types of information among cars, drivers, pedestrians, and other users.

Foundation for the deployment of various ITS services

- Integrated realization of ITS to provide safe, smooth road transportation and a positive environment.

Foundation for affluence and comfort in life and society

- More efficient movement of people, goods, and information
- Realization of comfortable living spaces
- Building a national infrastructure that provides safety and peace of mind

• Smartway refers to a road system that allows the exchange of various types of information among cars, drivers, pedestrians, and other users.

• Integrated realization of ITS to provide safe, smooth road transportation and a positive environment.

• More efficient movement of people, goods, and information
• Realization of comfortable living spaces
• Building a national infrastructure that provides safety and peace of mind
1. Concept of Smartway
- Development of the service platform

Concept of the service platform

- We have already developed VICS, ETC. But, these systems were developed independently.
- We try to develop common platform to provide various services.

![Diagram showing VICS, ETC, and OBU components with common software and hardware]

- Common software
- ITS on-board units
- Open platform
- Joint public-private research

Common Hardware
- Enhanced VICS beacons
- More sophisticated digital maps
- Fiber-optic networks, etc.
1. Concept of Smartway - Development of the platform

Public-private cooperation for platform development

- 23 companies are participating, and a cooperative research office has been established.
- A report on joint research for platform development was issued in March 2006.
- Now, we are working for developing official standards and specification based on this joint research program’s report.

DEC. 2004 - Jan. 2005
Public recruiting for joint research

Feb. 2005
Commencement of joint research

July 2005
Interim report

Feb. 2006
SMARTWAY DEMO2006

Mar. 2006
Final report

Mar. 2007
Development of standards and specifications

Oct. 2007
Smartway 2007

Companies participating in government-private joint research

President Watanabe, DSRC Forum Japan
Bureau Manager Taniguchi, Road Bureau (past)
1. Concept of Smartway - Spread of VICS

Spread of VICS

- Started in April 1996
- Provide real-time road traffic information on car-navigation system
- A cumulative total of over 18 million VICS units have been shipped

Example of Display

Level 2: Simple diagrams

Level 3: Map Display
1. Concept of Smartway - Spread of ETC

Spread of ETC

- As of August 30 2007, about 19 million ETC on-board units have been marked in.
- The nationwide utilization rate is 68%. ETC has been used to make highway toll payments totaling 15 billion US dollars.
- The target utilization rate is 80% by next spring

ETC utilization rate

**Trends in the use of ETC**

**ETC utilization rates**

- **Aug. 24-30, 2007**
  - About 5.50 million per day
  - Utilization rate: 68.0%

- **After nationwide deployment in December 2001**
  - About 50,000 vehicles per day
  - Utilization rate: 0.9%

Source: Mitsubishi Electric
1. **Concept of Smartway - Standardization**

- Platform for the “Smartway” Road-Vehicle Cooperation System adopts various international standardized technologies.

<table>
<thead>
<tr>
<th>WG</th>
<th>Title of items</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WG 3.2</td>
<td>Navigation Data Delivery Structures and Protocols (NP)</td>
<td>• Standard for map updating for navigation systems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• This item is comes from one of the “Smartway” related activity.</td>
</tr>
<tr>
<td>WG5</td>
<td>Interface Definition for On-board Account Using integrated Circuit Card (PWI)</td>
<td>• Definition of interface for road-vehicle communication to read/write data concerning clearance etc. from/to IC Card to/from road-side unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The item is adopted by the ITS Onboard equipment.</td>
</tr>
<tr>
<td>WG15</td>
<td>Application Layer for Dedicated Short Range Communication – DSRC Layer 7 (ISO 15628)</td>
<td>• Definition of Road-Vehicle communication interface.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Road-vehicle communication for the “Smartway” is compliant.</td>
</tr>
<tr>
<td>WG16.1</td>
<td>CALM-Media Adopted Interface Layer (DSRC) (PWI)</td>
<td>• Definition of CALM media interface including DSRC Layer 7 (ISO15628).</td>
</tr>
<tr>
<td>WG16.3</td>
<td>Configuration of Vehicle Probe Data for Wide Area Communication (CD22837)</td>
<td>• Standard for vehicle probe data from vehicle to center.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Probe data of “On-road information provision services“ will be compliant with the item.</td>
</tr>
<tr>
<td></td>
<td>Basic Principles for Personal Data Protection in Probe Vehicle Information (PWI)</td>
<td>• Basic principle for personal data protection in probe information services.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Probe data of “On-road information provision services“ will be compliant with the item.</td>
</tr>
</tbody>
</table>
1. Concept of Smartway -Various Services

New Platform Deployment

- 1995 2001 2007
- Diverse media
- Car navigation
- ITS On-board unit
- 5.8GHz DSRC
- Wide range of VICS information
- Parking lot payment
- Information in a timely manner
- Collection of probe information
- Information on conditions ahead
- Safety information (Merging assistance)
- Roads merging ahead! Drive carefully
- Parking lot payment
- Information on conditions ahead
- Safety information (Merging assistance)

- Car navigation
- VICS
- ETC
- Information provision
- Cashless payment
- Two-way communication
- Large-volume communication

/:Service  :On-board unit
1. Concept of Smartway - Private Sector Services

Payment of public parking fees and private sector services

• Fee payment services in a variety business situations.
[1] Timely services
Safely information will be provided in a timely manner, based on road traffic conditions on the route where the vehicle is traveling.

[2] Services that are reliable and understandable
Drivers will be provided with prompt, reliable information regarding safety and so on by means of 5.8 GHz DSRC, which supports highly reliable communications for the instantaneous supply of large volumes of information.

[3] Services that are easily noticed by drivers
Audio and visual information will be provided using on-board units, which have a higher driver recognition rate than roadside signs and the like.
2. Smartway 2007

Vehicle safety system enters the field operation phase

- Field test started on 14 May 2007 at Tokyo Metropolitan Expressway.
- 29 companies cooperate.
2. Smartway 2007
- Location of the demonstration (1/2)

1) Overview of the Metropolitan Expressway

- The Metropolitan Expressway includes nine radial roads linked to a loop line.
- Average daily traffic volume is approximately 1.2 million vehicles (as of September 2006).
  The number of accidents is 11,944 (fiscal 2006).

Routes with high accident rates (cases per 100,000,000 vehicle-km)

<table>
<thead>
<tr>
<th>Accident rates in descending order</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total accidents</td>
<td>Yaesu Line</td>
<td>Inner Circular Route</td>
<td>Route 6 Misato Line</td>
<td>Route 4 Shinjuku Line</td>
<td>Kanagawa Route 5 Daikoku Line</td>
</tr>
<tr>
<td>Fatal and injury accidents</td>
<td>Yaesu Line</td>
<td>Inner Circular Route</td>
<td>Route 11 Daiba Line</td>
<td>Route 2 Meguro Line</td>
<td>Route 4 Shinjuku Line</td>
</tr>
</tbody>
</table>

Routes with greater accident density (cases/km/year)

<table>
<thead>
<tr>
<th>Accident rates in descending order</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total accidents</td>
<td>Inner Circular Route</td>
<td>Route 4 Shinjuku Line</td>
<td>Route 5 Ikebukuro Line</td>
<td>Route 1 Haneda Line</td>
<td>Route 11 Daiba Line</td>
</tr>
<tr>
<td>Fatal and injury accidents</td>
<td>Inner Circular Route</td>
<td>Route 4 Shinjuku Line</td>
<td>Route 6 Misato Line</td>
<td>Route 5 Ikebukuro Line</td>
<td>Route 1 Haneda Line</td>
</tr>
</tbody>
</table>
2) Test locations on the Metropolitan Expressway

- On the Metropolitan Expressway, tests were conducted on the Loop Line, Route 4, and Route 5, which have high rates and high densities of accident occurrence.
Introduction of Voice only OBU

Voice ITS OBU

Beep! Congestion ahead. Drive Carefully!

Car Navigation Correlated ITS OBU

Beep! Congestion ahead. Drive Carefully!
### 2. Smartway 2007
#### Lineup of service (1/2)

<table>
<thead>
<tr>
<th>System</th>
<th>System summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Providing information on obstacles ahead</td>
<td>- Roadside sensors detect stopped vehicles or congestion beyond a curve with poor visibility and warn drivers entering the curve by visual and audio information.</td>
</tr>
<tr>
<td>Providing information on conditions ahead</td>
<td>- Road conditions ahead are communicated to drivers in visual form to call their attention.</td>
</tr>
<tr>
<td>Providing information on conditions ahead</td>
<td>- Road traffic information on congestion, etc., is supplied in audio form by highway radio.</td>
</tr>
<tr>
<td>Merging assistance</td>
<td>- Roadside sensors detect vehicles approaching a merge point. Just before the merge point, drivers are alerted to the presence of merging vehicles by visual and audio information.</td>
</tr>
</tbody>
</table>
## 2. Smartway 2007
### - Lineup of service (2/2)

<table>
<thead>
<tr>
<th>System</th>
<th>System summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information provision (IP data link)</td>
<td>• Using 5.8 GHz DSRC, wireless LAN, etc. to provide Internet connectivity to vehicles parked at service areas, parking areas, etc.</td>
</tr>
<tr>
<td>Use of various Communications media</td>
<td>• Using various communications media, including public wireless LAN.</td>
</tr>
<tr>
<td></td>
<td>• Studying uses such as simple bus location services in rural areas, based on the results of proving tests.</td>
</tr>
<tr>
<td>Map-linked services to call attention and</td>
<td>• Calling attention to speed, etc. while driving, based on map databases in car navigation systems, including road curvature data.</td>
</tr>
<tr>
<td>provide information</td>
<td>• Providing information on locations with frequent accidents, as well.</td>
</tr>
<tr>
<td>Smart parking</td>
<td>• Using ETC user vehicle numbers to provide parking fee payment services based on ETC on-board units.</td>
</tr>
<tr>
<td>Information provision (electronic signs)</td>
<td>• Support for determining one's location at entrance ramps, etc.</td>
</tr>
<tr>
<td></td>
<td>• Providing simple sign information as well.</td>
</tr>
</tbody>
</table>
2. Smartway 2007

-Demo on the Tokyo Metropolitan Expressway-

- Test Ride on MEX
  - 14 test cars
  - English voice announce

- Symposia
  - Smartway Symposium
  - AHS Symposium
  - JSCE Symposium

- Exhibitions
  - ITS Onboard Units
  - Equipped cars

Visit www.smartway2007.jp

- Smartway 2007 Demo will be held on the Tokyo Metropolitan Expressway from October 14 to October 17, 2007.
3. Future Plans

- After these tests on the Tokyo Metropolitan Expressway, testing will be expanded to regions throughout Japan.

<table>
<thead>
<tr>
<th>Deployment of Services</th>
<th>FY 2006</th>
<th>FY 2007</th>
<th>FY 2008</th>
<th>FY 2009 and on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metropolitan Expressway</td>
<td></td>
<td></td>
<td></td>
<td>Smartway 2007</td>
</tr>
<tr>
<td>Three main urban regions, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other locations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expressways</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National roads under direct jurisdiction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private-sector utilization</td>
<td>Ferries, public parking lots, etc.</td>
<td>Automatic fee payment tests</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thank you for your kind attention.
1) Providing information on obstacles ahead

- Roadside sensors detect stopped vehicles or congestion beyond a curve with poor visibility, and drivers entering the curve are warned using visual and audio information.
- Information is provided at 5.8 GHz DSRC (visual plus audio, or audio alone).
- We will consider approaches that provide adequately detection performance and have lower implementation costs.

**Conceptual image of system**

**Anticipated benefits**
- Fewer rear-end collisions beyond curves with poor visibility
- Lower frequency of near-misses (rapid deceleration)
- Lower speeds when entering the curve

**Test Location**
High Accident Curve(Sangubashi, Shinjuku, Akasaka TN)
2) Providing information on conditions ahead (audio + visual)

- In the service to provide information on conditions ahead, drivers receive visual information on road conditions ahead as a means of support for their route selection.
- Using 5.8 GHz DSRC, camera images of tunnels and locations of frequent congestion are provided as still images; and the content of nearby information signs is supplied in audio form.

**Conceptual image of system**

**Anticipated benefits**

- Providing visual information on road conditions ahead
  - Improved peace of mind for drivers; improved safety margin when driving; assistance for route selection by drivers.
- Providing audio information on road conditions ahead
  - Improved recognition rate when combined with visual information; improved peace of mind for drivers.

**Test Location**

Short of Traffic Area

- Kasumigaseki TN
- Gaien
- Edobashi JCT
- Kitonmaru TN
Merging assistance

- To prevent impact accidents at merge points, vehicles approaching a merge point are detected from the roadside; and just before the merge point, drivers are provided with easy-to-understand information on the presence of other merging vehicles.
- 5.8 GHz DSRC is used to call attention by sending information either in both audio and visual form, or in audio form only.
- Initially, only vehicles on the main route will receive information. Later, merging vehicles will also receive information. This will then be expanded to include information that will support cooperation between vehicles on both the main route and the merging lane.

Conceptual image of system

Anticipated benefits

- Reduced number of vehicle contact accidents at merge points with poor mutual visibility.
- Reduced frequency of near-misses (unusually close approaches and sudden lane changes)
- Reduced sense of anxiety at merge points

Test Location

High Accident Merging Point
4) Map-linked services to call attention and provide information

- Car navigation systems will be used to provide information to support safe driving over a broad area, including locations with relatively low accident densities.
- Based on map databases in car navigation systems, including road curvature and gradient data, drivers will be alerted in accordance with their speed of travel and other factors when entering a curve, and information will be provided on locations with frequent accidents.
- The effectiveness of the information service to improve driver safety will be verified.
- We will confirm the absence of hazardous behavior such as sudden braking and abrupt steering.

**Conceptual image of system**

**Items for verification**

<table>
<thead>
<tr>
<th>Items for verification</th>
<th>Summary</th>
<th>Verification method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verifying system functions</td>
<td>Timing of information supply and vehicle detection</td>
<td>Based on the on-board unit data (time of information supply)</td>
</tr>
<tr>
<td>Appropriateness of duplicated data processing in information supply</td>
<td>We will use on-board unit data to check the information output sequence and check for duplication, and we will verify the feasibility of logical design of output status and level of priority with other information.</td>
<td>Based on the on-board unit data (time of information supply)</td>
</tr>
<tr>
<td>Verifying system effectiveness based on vehicle behavior</td>
<td>Speed when entering the location in question, rapid deceleration, and sudden lane changes</td>
<td>We will verify changes due to use or non-use of the service, based on records of speed and acceleration from service engagement to the close of service.</td>
</tr>
<tr>
<td>Sudden braking and abrupt steering</td>
<td>We will check for sudden braking and abrupt steering, based on acceleration data just after drivers receive information.</td>
<td></td>
</tr>
<tr>
<td>Verifying system effectiveness based on driver opinions</td>
<td>Effectiveness of information supply</td>
<td>The results of a questionnaire survey of drivers will be analyzed.</td>
</tr>
<tr>
<td>Tolerance for bothersome or intrusive information supply</td>
<td>Tolerance for bothersome or intrusive information supply</td>
<td></td>
</tr>
</tbody>
</table>

**Test Location**

- Route 4 (Shinjuku Line): Akasaka S-Curve and Benkeibori Curve
- Route 5 (Ikebukuro Line): From Itabashi Hon-cho Curve to Takebashi Junction
- Inner Loop Line: Kitonomaru Tunnel and Sanbancho Curve
- Total: 11 locations
5) Information supply (IP data connection)

- To provide added convenience, users in parked cars at service areas, parking areas, and the like are provided with an Internet connected environment using 5.8 GHz DSRC and wireless LAN.
- The home page provides road traffic information, weather information, and information on the local area, including stores.
- Store information and the like is provided in audio form at the entrance to the service area or parking area.
- The effectiveness of this information service in improving driver convenience will be verified.

Conceptual image of system

Anticipated benefits

Improved user satisfaction

Daikoku PA

Test Location

Parking Area
There are few parking areas on the Metropolitan Expressway, and they are small in scale. There is a low level of service compared to the needs of users to take breaks to relieve the stress of driving and use restrooms during periods of traffic congestion.

To resolve this problem, parking area services based on ETC on-board units, using ETC user ID numbers, will be provided to vehicles equipped with ETC on-board units.

It is anticipated that these smart parking areas will be used as rest areas on the Metropolitan Expressway main line. We are studying the possibility of providing a discount on main line tolls when using these parking areas.

The effectiveness of this service in improving driver convenience will be verified.

Conceptual image of system

Test Location

Kabutocho Parking
In order to provide assistance for determining one's location, electronic signs will be installed at entrance ramps and other places where car navigation systems can easily mistake the vehicle's position.

Simple sign information will also be provided.

The effectiveness of this supply of information in improving driver safety will be verified.

Test Location

Takaido, Hatagaya Ramp