DSRC Standards for Multiple Applications

- ETC in Japan
- DSRC Multiple Applications
- Feature of current DSRC
- DSRC Application Sub Layer
- Next generation DSRC
- Standards related to DSRC

Yasuto Kudoh
OKI Electric Industry, Japan
ETC in Japan

- Nationwide Interoperable System
  **Service Providers:** Japan Highways, Metropolitan Express Ways, Hanshin Express Ways, Honshu-Shikoku Bridges, etc.

- Number of toll gates: 1,300 as of the end of March 2004.

- Number of OBU (On Board Unit): 3.77 million as of the end of September 2004
Growth of ETC On Board Units in Japan

Big potential market by the single standard
Rapidly growing OBU (On Board Unit) market
OBU Price Down

Mar. 2001 - Operation started at 63 toll gates
Mar. 2004 - Operation spread to 1,300 toll gates

List price of low-end OBU

3.77 million OBU
21.3% of total transactions

List price

Million

Number of Issued OBU

01/5 8 12 02/3 6 9 12 03/3 6 9 12 04/3 6

04/9

0.5 1 1.5 2 2.5 3 3.5 4

0 10 20 30

k yen

List price of low-end OBU
DSRC Multiple Applications being studied in Japan

- Information Providing (High-speed driving)
- Electronic Advertisements
- Road & Traffic Information Providing Services
- Paid Contents Delivery
- Car Ferry Fare Automatic Check-in & Settlement
- Parking Permission & Payment Settlements System
- Gas Pumping Stand Information Support System
- Information Station at Convenience Store
- Settlements System
- Gas Station
- Information Station at Convenience Store
- Parking Station
- Convenience Store
- 58,000 Stations
- Public Parking
- Private Parking
- 30,000 Locations
- 6,500 Locations
- 3,000 Locations
- 3,000 Locations
- 97,500 Locations
- 550 Locations

- Information Providing (Stationary)
- Customers Management (In-Out Control)
- Private Store, Parking Garage, etc.
- Road Station SA/PA

- Drive Through
- Drive Through Shopping Settlements System
- 3,000 Locations

- Driver Support
- Private Store, Parking Garage, etc.
- 97,500 Locations

- Logistics Management
- Trucks & Trailers Logistics Management System
- Taxies Management System

- Zone Tolling
- ERP (Road Pricing)
- Road & Traffic Information Providing Services
- 550 Locations

11th World Congress on ITS Nagoya, Aichi 2004
Development of DSRC applications in Japan

- **Smart Gateway** by TAO (Telecommunications Advancement Organizations): Development of a radio hand-over technology and a network hand-over technology over consecutive or discrete communication zones.

- **Smart Communications** by the Ministry of Land, Infrastructure and Transport: ITS Communication Services Platform Using 5.8GHz DSRC.

- **Multiple DSRC Applications Systems at Gas Station** by ITS Research Institute: Trial of multi-application DSRC system at Gas station.

- **Parking Garage Management Systems** by TOYOTA TSUSHO and TOWA Real Estate Group. **Use of DSRC in underground parking garage** by Mitsubishi Corp and Mitsubishi Estate Group:
Smart Communications

- **IP connection experiment using ETC communication technology**
  - ETC dedicated communication become multipurpose communication through the use of ASL (Application Sub Layer)
- **Various types of Smart Communication services are demonstrated**

Calsonic Kansei Corporation  
KDDI Corporation  
Sumitomo Electric Industries, Ltd.  
DENSO Corporation  
TOYOTA MOTOR Corporation  
Nissan Motor Co., Ltd.  
NEC Corporation  
Hitachi, Ltd.  
Fujitsu Limited  
Matsushita Electric Industrial Co., Ltd.  
Mitsubishi Heavy Industries, Ltd.  
Mitsubishi Electric Corporation  
Yazaki Corporation

11th World Congress on ITS Nagoya, Aichi 2004
Multiple DSRC Applications System at Gas Station

DSRC multiple application at Gas Station using ASL.

AUTOBACS SEVEN, Tsubasa Sytems, OMRON, Panasonic….
Worldwide DSRC Spectrum Allocations

<table>
<thead>
<tr>
<th>ITU-R</th>
<th>Europe</th>
<th>North America</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>5.795 - 5.815GHz</td>
<td>5.770 - 5.850GHz</td>
<td>5.725 - 5.9GHz</td>
</tr>
<tr>
<td>Next</td>
<td>5.875GHz</td>
<td>5.850GHz</td>
<td>5.850GHz</td>
</tr>
</tbody>
</table>

Frequency (GHz):
- 902 - 928MHz
- 5.725 - 5.875GHz
### Regional standards for DSRC

<table>
<thead>
<tr>
<th>Item</th>
<th>Japan (ARIB)</th>
<th>Europe (CEN)</th>
<th>America (ASTM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplex</td>
<td>OBU: Half-duplex</td>
<td>Half-duplex</td>
<td>Half-duplex</td>
</tr>
<tr>
<td></td>
<td>RSU: Full-duplex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication system</td>
<td>Active</td>
<td>Passive</td>
<td>Active</td>
</tr>
<tr>
<td>Radio frequency band</td>
<td>5.8GHz band 80MHz bandwidth</td>
<td>5.8GHz band 20MHz bandwidth</td>
<td>5.9GHz band 75MHz bandwidth</td>
</tr>
<tr>
<td>Channels</td>
<td>Down-link: 7</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Up-link: 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channel separation</td>
<td>5MHz</td>
<td>5MHz</td>
<td>10MHz</td>
</tr>
<tr>
<td>Data transmission rate</td>
<td>Down / Up-link: 1 or 4 Mbps</td>
<td>Down-link: 500kbps Up-link: 250kbps</td>
<td>Down / Up-link: 3 - 27Mbps</td>
</tr>
<tr>
<td>Coverage</td>
<td>30m</td>
<td>15 - 20m</td>
<td>1,000m (Max)</td>
</tr>
<tr>
<td>Modulation</td>
<td>2-ASK (1Mbps)</td>
<td>RSU: 2-ASK</td>
<td>OFDM</td>
</tr>
<tr>
<td></td>
<td>4-PSK (4Mbps)</td>
<td>OBU: 2-PSK (Sub-carrier modulation)</td>
<td></td>
</tr>
</tbody>
</table>
Characteristic of current DSRC

Communication Architecture of current DSRC*

(*Current DSRC: In 1992, standardization for the DSRC started in European Committee for Standardization)

Because of constraints specific to a DSRC link, such as limited transmission capacity, discontinuous coverage, random arrival/exit of the vehicles in the area, current DSRC operations have been limited.

- **Network layer is eliminated**
- Transport layer is eliminated
- Session layer is eliminated
- Presentation layer is eliminated
Concept of application Sub Layer (ASL)

- **Internet application**
- **Non-Internet application**
- **Existing application**

**ASL**

- **TCP/IP or local port**

**Service of DSRC**

**DSRC**

**Application Sub Layer (DSRC-ASL)**

Developed in ARIB, Japan (ARIB STD-T88) for easy deployment of multi application for the existing DSRC.

ASL utilizes multi functional service offered by DSRC Layer 7 for client/server type communication control.
Features of Application Sub Layer (ASL)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extends DSRC applications</td>
<td><em>without modification to the existing DSRC protocol stack</em></td>
</tr>
<tr>
<td>Realizes PPP (Point-to-Point Protocol)</td>
<td>for <em>Internet connection</em></td>
</tr>
<tr>
<td>Realizes network control protocol</td>
<td>for <em>Local Area Network (LAN)</em></td>
</tr>
<tr>
<td>Realizes local port control protocol</td>
<td>for <em>non-networks applications</em></td>
</tr>
</tbody>
</table>
To identify peer application of the originating application, access points are provided in DSRC-ASL.
Requirements for the next generation ITS radio communication

Allowable traveling speed (mobility)

Information supply-type (high-speed traveling)

Specific region entry charging

Image of a new portable telephone

Video/music distribution

Connection to Internet (IP)

On-demand information

Pedestrian support

Drive-through

Parking lot

Filling station

Convenience store

Logistic Management

Connection to Internet (IP)

Data transmission rate

100K 1M 10M [bps]

ARIB STD-T75 generally satisfies the requirements except for the very small area shown below.

- High data rate high-speed traveling

- Very high data rate semi-stationary
North American ITS radio communication system

Long communication range and high data rate at high vehicle speed.

MAXIMUM RANGE  1000 m (~ 3000 ft)
Bandwidth       75 MHz (5.850 - 5.925 GHz)
Modulation      QPSK OFDM (with 16QAM and 64QAM options)
Channels        7 channels (optional combinations of 10 and 20 MHz channels)
Data Rate       3, 4, 5, 6, 9, 12, 18, 24, and 27 Mbps with 10 MHz Channels
Packet Error Rate (PER) At speeds of 200 km/h, less than 10 % for message lengths of 64 bytes.

Reference: 5.9 GHz
DEDICATED SHORT RANGE COMMUNICATION (DSRC)
OVERVIEW
ARINC, incorporated

Maximum range: 1000m
Maximum speeds: 120mph

Reference: 5.9 GHz
DEDICATED SHORT RANGE COMMUNICATION (DSRC)
OVERVIEW
ARINC, incorporated

Human Machine Interface
RSU /w Antenna
Human Machine Interface
RSU messages loaded locally
In the CALM Architecture, **Network interface is originally supported.**
(CALM: Communication Air interface for Long and Medium range)
Standardization of ITS radio communication in ITU-R

1994, Question on ITS → Recommendations (Answers to the Question)


Objectives & Requirements

Rec. ITU-R M. 1310

1996

1997

1998

2000

2001

Functionalities

Rec. ITU-R M. 1451

Current Use of Spectrum

Traffic & Spectrum Requirements

Rec. ITU-R M. 1452

Rec. ITU-R M. 1453

Technologies

Short-range Radar

5.8GHz DSRC

Next generation ITS radio communication

Contribution are welcome!

ITU-R/SG8/WP8A/WG2: Standardization for ITS

Radio services
- Broadcast
- DSRC
- Short-range radar
- Short-range vehicle-to-vehicle
- Short-range continuous
- Wide area

Standards related to DSRC

ARIB Standards:
- **ARIB STD-T75**: Dedicated Short-Range Communication System
- **ARIB TR-T16**: Dedicated Short-Range Communication System. Test Items and Conditions for Mobile Station Compatibility Confirmation
- **ARIB STD-T88**: Application Sub Layer for DSRC Submitted to ITU-R WP8A meeting in Sep. 2004 and adopted as the revision of ITU-R M.1453-1

International standards:
- **ITU-R M.1453-1**: Transport information and control systems - Dedicated short range communications at 5.8 GHz
- **ISO FDIS 15628**: Intelligent transport systems - Dedicated Short-Range Communication (DSRC) - DSRC application layer