ABSTRACT
The commencement of various services is expected with 5.8GHz DSRC (dedicated short-range communication), which has been used for rapidly spreading ETC (electronic toll collection systems). In August 2004, Smartway Project Advisory Committee offered an opinion which included the guideline for full-scale adoption of ITS by 2007. This paper reports on the outcome of the study on targeted capacities of a roadside unit and an OBU (On-Board Unit), which will provide the advanced road services including fee payment service in public parking areas, internet connection service at rest areas, and information service on road.

CURRENT SERVICE WITH DSRC
The growth of automotive transportation in Japan has created frequent traffic accidents, traffic congestion, and adverse effects on the environment due to exhaust gases, noise, and other factors. To resolve these problems, Japan has been actively promoting the development and application of ITS, which consist of systems that use advanced information and tele-communication technologies to link humans, roads, and vehicles. ETC services first launched in 2001, and these services have spread rapidly. Seven million vehicles or more are equipped with ETC OBUs as of June 1, 2005, representing approximately 40% of all toll settlements. Now the number of ETC users is growing without a hitch. As a result, an effect on alleviating congestion at toll gate is already beginning to appear. 5.8GHz DSRC, a communication method for ETC, allows massive volume of data for road-to-vehicle communication. Multi-purpose use other than ETC was allowed by the revision of the Ministry Ordinance related with the Radio Wave Law in April, 2001.
The needs for various services with 5.8GHz DSRC have increased in general public, and both public entities and private companies are moving ahead with provision of services such as providing traffic information and others through Internet, downloading map data, music delivery, hotel reservation, fee payment in parking lots and drive-through shop, etc.

Figure 1- Increase in the number of ETC on-board unit

Figure 2- Various services with DSRC
ESTABLISHING A COMMON INFRASTRUCTURE

To effectively provide various services and secure convenience for service users, it is important to be able to use various services with a single OBU. If OBU and infrastructure are individually developed for every service, there is a possibility of damaging to user's convenience and increasing cost for establishing infrastructure. Therefore, it is necessary to promote an open platform, or infrastructure that can be used in common by many business operators including public and private businesses. National Institute for Land and Infrastructure Management is conducting R&D on capacity of both roadside system and OBU to realize this open platform.

ADVANCED ROAD SERVICES

ITS in the Second Stage

In August 2004, Smartway Project Advisory Committee offered an opinion, ‘ITS Enter the Second Stage. Smart Mobility for All’, which included the guideline for full-scale adoption of ITS by 2007. There is a wide range of user services based on ITS, but the following are the basic services. The utilization and combination of these basic services will lead to the realization of ITS services for safety and safe driving, affluence and the environment, comfort and convenience.

1) Vehicular information transmission services, in which information from vehicles is transmitted to the roadside or a center, and this information is used and combined in order to provide services. Example: Bus location services.

2) Fee payment services, in which various types of cashless payments are made in vehicle. Example: Cashless payment of parking fees.

Figure 3- Realization of open platform
3) Information and warning services, in which drivers are provided with warnings to support their driving or timely information. Example: Enhanced VICS services.

4) Information provision services, in which various types of road traffic information or information on roadside facilities are provided on demand, or Internet services are provided via the on-board unit.

**Figure 4- Basic ITS services**

Further, any combination of these basic services is expected to create three services toward the advanced road service by 2007. These services are shown below. These three services will be steadily realized mainly in public services, with provision of commercial services taken into account.

**Fee payment service in a public parking area**

This service offers cashless fee payment in a public parking area. The information of an IC card is sent from OBU to roadside system through radio communications at the entrance/exit gate of the parking area. This method allows entrance/exit management and cashless payment at the parking area. This service is considered it will include discount on the fee, combination with other systems, and service for the disabled.
Internet connection service at rest area

This service offers road information and others to vehicles parking at service areas and parking areas on expressways or at rest areas on ordinary roads. A user can get the information on road traffic and sightseeing spots and the vicinity, by manipulating an OBU being connected with roadside intranet or Internet to send his or her requests. It is expected that user’s convenience is improved and the local community is activated with increasing chances for attaining information.
Information service on road

This service offers road traffic information, with 5.8GHz DSRC, which has been provided by VICS.

This service allows the provision of information on wider area than ever and the provision of information with voices and images by utilizing 5.8GHz DSRC with a capacity of massive volume of communication. Further, it allows the provision of information on more routes than ever by collecting the information on driving records of vehicles and the information of vehicle sensor both being compiled in OBU and using this information. Among the information being provided, guidance and warning information are supposed to be given more priority than other information.

An objective vehicle is supposed to be running on a expressway. And the service is planned to be available for a vehicle running approximately at 100km/h.

![Figure 7- Information service on road](image)

Configuration of systems providing advanced road services

The advanced road service is to be offered by the system that consists of an ITS OBU, roadside system and vehicle-roadside communication. ITS OBU further consists of three components of "vehicle-roadside communication capacity", "basic API (Application Program Interface)" and "car navigation capacity". On the other hand, the roadside system consists of "vehicle-roadside communication capacity", "basic API" and "individual applications". The basic API is a capacity for roadside system and OBU for common use of services.
Configuration of OBU

ITS OBU provides information for a driver, and receives driver’s requests. It is difficult to install individual application in advance for any service providers and service contents. Therefore, basic API for data processing and communications should be installed, and actual service operation should be implemented with the combination of basic APIs.
The basic API includes the following functions:

1. Function of reply to directions, which give a reply from OBU to a roadside system in response to given instructions
2. Function of memory access, which allows roadside system to read/write memory of OBU
3. Function of ID communication, which allows roadside system to identify OBU and enables OBU to reply
4. Function of card access, which transmits/receives transaction data from/to IC card
5. Function of ‘push’ type information delivery, which allows roadside system to provide various information to OBU
6. Function of security, which provides “reciprocal identification”, “data authorization”, and “encoding”.

Further, "Car navigation capacity" should be equipped with "Display/WEB capacity" to function as a connecting point between an OBU and a driver and "Up-link capacity" to collect information from ECU (Electronic Control Unit) and others for up-linking it.

**Configuration of Roadside system**

Roadside system comprises "Vehicle-roadside communication capacity", "Basic API" and "Individual application" to provide services to an OBU under the linkage with outer systems. According to services provided, roadside system is equipped with capacities shown below which are actually necessary.

![Figure 10- Configuration of roadside system](image)

Capacities of outer systems in Fig. 10 are as described below.
"Capacities for creating, editing and compiling information" is a general term for the capacity to create the information for providing to OBUs, edit this information and compile it or else. For example, for Internet connecting service at rest area, Web servers or others on Intranet is assumed.
"Probe data processing capacity" is a general term for capacities such as to create additional information from the information received from OBUs and to provide the information...
received from OBUs and the information newly created to other systems. "Payment processing capacity" is a capacity to process parking fee for an appropriate individual based on the information received from the vehicle with an OBU to use the parking area. For example, the data base of credit card companies is assumed. "Parking area managing capacity" is a general term for the capacity to calculate parking fee based on the information on parking time and discount, to judge if a vehicle is allowed to enter based on the information on confirming the settlement of payment or monthly payment contract, and to control open/close of entrance/exit gate. For example, existing management system is considered, which has been used for controlling entrance/exit gates since before roadside system was established. "Charge displaying capacity" is a capacity to provide the information such as on parking fee, parking time and guidance of the parking area to an OBU.

CONCLUSION

Ministry of Land Infrastructure and Transport is implementing various efforts, responding to the opinion by the Smartway Project Advisory Committee, which include formulating standards and specifications by 2005, promoting infrastructure building and the fabrication of OBU by 2006, and eventually some targeted service commencements by 2007 toward the full-scale adoption of ITS.

Figure 11- Image of ITS society in the future