DEVELOPMENT OF COMMON COMMUNICATION PLATFORM FOR VARIOUS SERVICES USING ETC TECHNOLOGY

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ABSTRACT

As the primary technology, 5.8GHz active system Dedicated Short Range Communication (DSRC) is the key to the deployment of ITS. This technology, which allows massive volume of data for high-speed interactive communication, is authorized by International Telecommunication Union Radio-communication Sector (ITU-R) as the international standard. In Japan, the Electronic Toll Collection System (ETC) has been deployed nation-wide in a uniform manner through this technology. The paper reports the outcome of our research efforts on a common platform which provides a basis for an array of service operations, including ETC to be implemented efficiently and in line with user’s convenience.
TECHNICAL PAPERS

FOREWORD
Recently, vehicles are equipped with information technology (IT) devices through the development of IT. The total accumulated number of in-car navigation units exceeded 14,540,000 as of the end of March, 2004. Among these, 9,110,000 units have been equipped with the Vehicle Information and Communication System (VICS). Further, the number of on-board equipment for ETC in the market has exceeded 2,700,000 units. This current trend is translated into a sign for a new lifestyle where people regard vehicle not merely as a means of ‘transportation’ but as ‘mobile informative space’.

For ETC which was introduced for the purpose of dispersing traffic jam and improving user service, 5.8GHz active system DSRC as Road-to-Vehicle radio communication technology has been used. This radio communication technology features allow massive volumes of data for high-speed interactive communication, and was authorized by International Telecommunication Union (ITU) as the international standard in May 2000. This technology became available for multipurpose services through revision of the Japanese ministerial ordinance related with the radio law in April 2001.

Fig1. Various service image
As a result, the multipurpose use of this technology was launched, including parking control for IN/OUT at department stores or apartment, information services at service areas/parking areas (SA/PA) and Michi-no-Eki (Roadside rest area), and downloading service of updated navigation map, music and video at convenience stores and other places, which are offered by both public and private vendors. (Fig 1)

NEEDS FOR COMMON PLATFORM BUILDING

COMMON PLATFORM
For efficiently providing these services to road users and for facilitating convenient use, a single unit of this on-board system must have the capacity to offer any services to be required, where a key to the efficient processing of various applications is ‘a common platform’, which allows a single on-board unit to offer diversified services by both public and private vendors. The effort to build the common platform will lead to a premise to put various services on DSRC in real use at an early stage.

The format for information dissemination is divided into two types. One is an IP (Internet Protocol) service family, which expects that information will be transferred to a vehicle operated at a low speed or while at halt. The other type, non-IP service family, uses a simplified coding format for road-to-vehicle communication, where both sides recognize the data transfer definitions for the coding to communicate each other.

ASL
The core of the common platform is the Application Sub Layer, which intervenes between DSRC protocols and applications. ASL processes various types of protocol efficiently and activates various applications. The ASL is composed of a ‘extended link control protocol’ and a ‘network control protocol.’

The ‘extended link control protocol’ controls the communication link to complement such DSRC communication functions as a client/server type communication control and bulk forward control. The ‘network control protocol’ is a control protocol group to

Fig 2 construction of ASL (Within the a bold frame)
forward data to each type of the linked application. A control protocol, a component of the ‘network control protocol’ includes not only ‘PPP control protocol’ and ‘LAN control protocol’, both linking PPP or Ethernet with TCP/IP, but also a ‘local port control protocol’ to link individual applications.

Application identifiers, access point identifiers, local port numbers and port numbers which are added to the communication data allow the communication link of applications between roadside units and on-board units. (Fig 2)

These versatile links are not necessary for a single dedicated on-board unit as in the present ETC. However, they are absolutely essential for using information from various applications. National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport has set forth an ASL proposal for building common platform and validity experiments on various service uses. For defining ASL, opinions were called for through Internet and the public opinions were widely adopted to achieve a transparency and fairness in definition.

EXPERIMENT OUTLINE
For building the common platform at an early stage, the effect is tested on the platform in communicating with a vehicle at low-speed operation or halt while at higher-speed operation.

EXPERIMENT ON IP SERVICE FAMILY FOR A HALTED VEHICLE
Ministry of Land, Infrastructure and Transport conducted an experiment, with the Japanese highway public corporation and Smartway Partner conference. The Experiment, IP family information service via Internet, was conducted to halted vehicles in the Moriya service area (SA) along the outbound of Joban Expressways for five days from January 29th to February 2nd, 2003. The objective of the experiment was to verify the linkage of the common platform which was built, as well as to distribute the questionnaires to the general road users who experienced the cruise assist service with dynamic image and others and to collect the
filled-out papers.

**MECHANISM OF INFORMATION TRANSFER**

Figure 3 illustrates a view of experiment in the Moriya SA. The information transfer device is composed of a roadside antenna, roadside unit, information server, and external Internet link. In the experiment, the 5.8GHz DSRC roadside antenna placed in the service area over four halted vehicles using an on-board unit that joined common platform. The interactivity transform between roadside antenna and on-board units carries massive volume of data (maximum transmit speed 4 Mbps) to a monitoring display screen, via the roadside unit, information server and the external Internet link. A driver manually operates the on-board unit to access information requested on demand.

**CONTENT OF SERVICE PROVIDED IN EXPERIMENT**

The services provided in the experiment are public ones by road administrators, and private ones by vendors. The public service focused on operational vehicle assistance such as ‘safe driving support’, ‘smooth driving support’ and ‘improved user service.’ As a result, public services for ‘Detailed information on lane regulation’ and ‘Detailed service area information on route ahead’, was offered. Further, the information on road conditions using dynamic image, such as ‘Real-Time weather conditions at passes’, was offered to appeal high-speed massive volume data transfer. The information on interactive restaurant seat reservations such as ‘Seat reservations of restaurants in service areas’ was offered to appeal solid two-way communications. (Fig 4)

![Example of the services provided by road administrators](image-url)
And private services such as ‘internet connection’ and ‘E-mail’, ‘IP phone’, and ‘Tourist information of the periphery’ were provided. Using the advantage of the character of 5.8GHzDSRC, high-speed massive volume data transfer, the service for confirming the condition of home during travel through ‘Live image from remote camera’ was provided. (Fig 5)

**EXPERIMENT RESULT**

Over 300 people of the general road users have experienced the service provided at the experiment site during a period from January 30th to February 2nd, 2003. Prior to questionnaire answering, staff outlined the Experiment system and demonstrated the system operations. Approximately 80% of respondents are men and by distinction of age, 30’s was most interested in the system. Many of them are familiar with using

![Diagrams of services provided by vendors](image1)

**Fig5. Example of the services provided by vendors**

![Diagrams of user questionnaires](image2)

**Fig6. The Result of User Questionnaires**
Massive volume of data was transferred to a vehicle in operation at 100km/h. The 5.8GHz DSRC roadside antenna.

Fig 7. A view of the experiment on non-IP service family transfer to a vehicle in operation.

EXPERIMENT ON NON-IP SERVICE FAMILY TRANSFER TO A VEHICLE IN OPERATION

In March 2004, a series of experiment on non-IP service family to a vehicle in operation was implemented at the test course of National Institute for Land and Infrastructure Management. In this experiment, the 5.8 GHz DSRC was relayed from a roadside antenna to a vehicle in operation with an on-board unit.

MECHANISM OF INFORMATION TRANSFER

The experiment system is composed of a roadside antenna for 5.8GHz DSRC, an information server, and on-board units with the common platform. The experiment vehicle was operated along the communication zone set at 20m in a running direction of a vehicle, and a large volume of data was relayed from the roadside antenna to examine the condition of data reception on-board.

Fig 7. A view of the experiment on non-IP service
**EXPERIMENT RESULT**

Data was transferred to a vehicle in operation at 100km/h and reception conditions were examined. There were no problems with transferring 100 KB of data. In the experiment, the effect of common platform was verified. (Table 1)

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<tr>
<td>operation at 100[Km/h]</td>
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Table 1. Judge of data reception in operating vehicle.

**CONCLUSION**

Through a series of experiments for this time, the effect of the common platform for the IP service family via Internet connections to a halted vehicle was explicitly identified for both public and private services. The incremental needs of drivers for these services were also identified. Further, the effect of the common platform regarding the non-IP service family to a running vehicle was verified.

Toward the future, the study will be aggressively conducted in order to realize practical applications as services by the public sector. The institute will be positively involved in local and international promotion activities toward the realization of providing various services at an early stage. Many people from all over the world will gather to attend the ITS World Congress in Nagoya and Expo 2005 in Aichi, Japan. This will be a good opportunity to demonstrate diversified information services offered both from the Japanese public sector and private vendors.