Special Edition on ITS

Dedicated Short-range Communications for ITS—Trends in Research, Development and Standardization

Kikuo TACHIKAWA*

Abstract

In March, 2001, full-fledged operation of an “Electronic Toll Collection” (ETC) system was launched in the Chiba area of Japan. ETC is a system for processing automatic toll collection, using wireless communications between communication equipment installed in toll gates and other units on passing vehicles. This road-to-vehicle communications by means of wireless is called “Dedicated Short-Range Communications (DSRC), and plans are being made to applying it to areas of use besides ETC. ETC and other systems to which DSRC has been applied hold an important place in the growing field of “Intelligent Transport Systems” (ITS) and they are being adopted overseas as well as in Japan. DSRC is different from other mobile communications systems, and has the feature that, within a limited area, it can transmit large volumes of data accurately and reliably.

In this paper, we introduce the DSRC research and development work which our company has been putting efforts into, and discuss trends in standardization.

Trends in DSRC Research and Development

Developments related to DSRC have a long history, having begun in the 1980’s with the “Road / Automobile Communication System” (RACS). RACS was proposed by our company at a time when the basic concept of DSRC was not widely familiar. RACS included the concept, advanced at that time, that a variety of ITS applications could be implemented using a single wireless communication system. The results of the RACS research and development effort was superseded by research, development and actualization of the “Vehicle Information & Communication System” (VICS). In addition, from 1995 - 1996, government / private cooperative research on ETC was conducted and DSRC research and development was done, focusing on a few approaches. Our company participated in this research and development and we were later able to apply the results of the cooperative research in drafting DSRC standards for application to ETC.

Then, from 1998 to 2000, some further research and development projects on applications of DSRC were done in Japan. As typical examples the R & D projects of the New Energy and Industrial Technology Development Organization (NEDO) and of the Telecommunications Advancement Organization of Japan (TAO) in which our company and others participated can be cited.

The NEDO research and development was a project called “R & D on a platform for applying DSRC,” and R & D was conducted on expanding use of ETC on-board Equipments and on making DSRC more multi-purpose. “A platform for applying DSRC,” which was one of the themes, is a common foundation for efficiently developing and running a variety of ITS applications that use DSRC. With this platform, adding or changing application programs can be done easily. It provides a general-purpose interface between DSRC and the application program, and also software processing functions which can be made common to various kinds of applications. Figure 1 shows a conceptual drawing of the platform for applying DSRC.

To deal with the four subjects of handling large information volumes, high-speed processing, guaranteeing security, and application to low resource on-board equip-
ments, we developed sub-platforms ("middle ware") for each, and we were able to verify the effectiveness of this approach.

In the area of R & D related to applying DSRC to TAO, there was a project involving "R & D on techniques for expanding the applications of on-board wireless IC-cards and increasing speed." That project worked on developments related to entry/exit management at parking lots and assumed use of DSRC connected to the Internet. In addition, it addressed various problems not dealt with by standards for DSRC as applied to ETC, such as variable rate transmission, broadcasting, etc. One of those subjects, technology for an address management, assumed Internet use via DSRC in parking lots, etc., and had the objective of dynamically performing network address assignments and releases for the vehicles involved. In verification experiments, we addressed entry/exit management at parking lots and assumed utilization of DSRC connected to the Internet. Applying the results of the above-mentioned technical development work, we set a framework for achieving a more multi-purpose DSRC.

Trends in Standardization of DSRC

In parallel with research and development, progress has also been made toward standardization. Standardization of DSRC was first recognized as an issue, in its relation to ETC, and studies were done on an international scale. First, in 1992 in Europe, studies aimed at standardization of ITS were begun by Technical Committee TC278 of the Comité Européen de Normalisation (CEN), and DSRC was taken up as one of the subjects for standardization. Later, DSRC was considered by Technical Committee TC204 of the International Standards Organization (ISO) and in addition progress toward standardization was made by ITU-R/SG8 of the International Telecommunications Union.

Responding to these international activities, here in Japan studies were also done. In 1994, at the Telecommunication Technology Council (below, TTC), an advisory group to the Ministry of Posts and Telecommunications, studies were begun on a radio specification for use in ETC. In March, 1997 a report was issued by TTC and in September of the same year, the Ministry of Posts and Telecommunications finalized selection of an active system on the 5.8GHz band and issued the new regulations, and in addition, a standard for DSRC for use in ETC was established. Later demands for "multi-purposing" increased and in January, 2000 studies on making DSRC more multi-purpose were begun by TTC. The new requirements on DSRC were organized into nine applications, such as a DSRC system for parking lot management, etc., and based on these requirements, the necessary technical conditions were determined and a report was issued in October. Receiving this report, the Ministry of Public Management, Home Affairs, Posts and Telecommunications issued new regulations for DSRC, and it is planned that a new DSRC standard will be issued this fall.

Standardization of DSRC covers the protocol for road-vehicle communications which use as its base a three-layer structure—layers 1, 2, and 7. In 1997 - 1998, in Europe, a European preliminary standard, which included the 5.8GHz first layer, etc., was recognized. It is expected to become a European standard in 2001. In North America, a draft, using 915MHz, was recognized as a North American standard in 1998. At present, a 5.9GHz standard is being evaluated and it is expected to be adopted in 2001.

In May, 2000, at the general meeting of ITU-R, the frequency and wireless system for 5.8GHz DSRC was recommended, and this is a standard that combines the Japanese and European (CEN) approaches. Regarding ISO, at present their focus has shifted to standardizing the seventh layer and resource manager.

Specification of DSRC in Japan

Table 1 shows a part of the technical specification in a report of TTC issued in October, 2000. Compared to DSRC for ETC, its content, with higher data transmission rates, etc., became such as to promote private sector (commercial) use. In Japan, drafting of standards for the new DSRC is proceeding based on these conditions.

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency band</td>
<td>5.8GHz band</td>
</tr>
<tr>
<td>Carrier frequency interval</td>
<td>5MHz interval</td>
</tr>
<tr>
<td>Modulation method</td>
<td>ASK and QPSK</td>
</tr>
<tr>
<td>Modulation signal rate (data transfer rate)</td>
<td>1Mbps for ASK, 4Mbps for QPSK</td>
</tr>
<tr>
<td>Frequency interval between send and receive signals</td>
<td>40MHz</td>
</tr>
<tr>
<td>Antenna power</td>
<td>Roadside equipment: 300mW or less, but for propagation distances of 30m or less, 10mW or less Vehicle on-board devices: 10mW or less</td>
</tr>
</tbody>
</table>

Table 1: Outline of technical specification for DSRC

Conclusion

In 2001, introduction of ETC is proceeding on a nationwide scale in Japan, and it is planned that by the spring of 2003, 900 toll gates (about 70% of the toll gates for all the country’s toll roads) will have been converted to ETC. In addition, it is expected that large numbers of ETC on-board equipments will be in use.
In parallel, preparations for more multi-purpose DSRC, both technical and law-related, are steadily moving ahead. While using ETC as a foundation, by adding on other applications, convenience to the user can be greatly improved. It is expected that systems applying DSRC will be some of the first ITS systems adopted, and our company intends to continue its efforts in R & D related to this area and in the work being done on setting standards.