# On-Demand Media Shower System

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One of the development objectives of Intelligent Transport Systems (ITS) is the smart gateway. This paper will focus on smart gateways for information supply, evaluating the effectiveness of the services provided by ITS networks with a view towards the creation of on-demand shower systems that match the needs of mobile users. We shall look at the requirement for DSRC type systems which provide broadband characteristics coverage and ad-hoc capabilities, simultaneously, at low cost.

## Background

Here, at the beginning of the 21st century, Japan is a true "car society", with the number of motor vehicles in use exceeding 74 million, and a network of highways that are open to everyone. What is more, with the explosive growth of mobile phone use over recent years, Japan has also become a "network society", where a huge proportion of its citizens, some 52 million people, are mobile communications users with the Internet playing a part in their everyday lives. The "smart gateway" is one development objective of Intelligent Transport Systems (ITS)[1], in which various types of information relating to a wide variety of ITS applications are transmitted between the road side (smart way) and the vehicle side (smart car) and between respective vehicles, by means of a radio communications system. The key to the future expansion of smart gateways will be unearthing the new needs of mobile users, who have already acquired convenient movement means and communications means, and working out how to create products which match these needs.

The domestic portable telephone market stood at around 75 million users, including PHS, at the end of April 2002, which means that one in every two Japanese is a mobile phone user. What is more, as of the end of March 2002, the subscriber numbers for Internet connection services, using mobile phones, telephone circuits, CATV networks, and DSL, stood at around 52 million, 20 million, 1.45 million and 2.4 million, respectively, which shows that use of the Internet via mobile phones dramatically outstrips access via wired networks. The reason for this is the convenience of the mobile phone. A mobile user can make telephone calls, access the Internet, and communicate data, such as e-mails, whenever and wherever he or she wants.

On the other hand, regarding the Electronic Toll Collection (ETC) system, introduced in November 2001 in 685 different toll gates with the aim of eliminating traffic congestion on highways, the number of vehicles with on-board ETC terminals still remains approximately 280,000 by the end of April 2002. Possible ways of increasing the number of ETC subscribers include : (1) large reduction in the cost of purchasing on-board devices, and (2) increased congestion reducing effect by increasing ETC toll gates. More specifically, with respect to (1), adoption of a "pre-paid discount system" was due to start in July 2002, alongside the existing "time limit special discount system", and with respect to (2), 70% of the nationwide toll gates, some 900 in total, are scheduled for installation during the course of the year 2002.

However, are solutions ① and ② above really sufficient to generate significant increase in the number of ETC subscribers? Existing Vehicle Information and Communication Systems (VICS) use FM multiplex broadcasting, opto-radio beacons, and the like, to provide congestion information services on highways and general roads to drivers, via car navigation systems. Shipment of on-board VICS devices has already exceeded the 4.4 million mark, but it has taken 6 years for the ratio of cars fitted with VICS to reach 30%. One of the reasons that it has taken so long is that the users who need congestion information services are limited to city drivers concerned about chronic traffic jams.

This paper discusses an on-demand media shower system based on the smart gateway concept, which is orientated towards the needs of mobile users. In this discussion, we shall consider, firstly, the fact that by offering a single service, the number of relevant users is naturally limited and cannot be expected to increase, and secondly, the fact that these users are mobile users who are accustomed to the convenience of the mobile phone.

## ITS wireless network

### What is a smart gateway?

Smart gateways are ITS wireless networks which transmit various types of information corresponding to different ITS applications, between each other. The wireless communications systems that make up an ITS wireless network can be divided broadly into Road to Vehicle Communication (RVC) systems and Inter-Vehicle Communication (IVC) systems. A particular priority is the development of Dedicated Short Range

Communications (DSRC)-type RVC systems or IVC systems which take account of the communications environment on the roadway, in order to send various types of information simultaneously, at high speed.[2)]

**DSRC-type RVC system**

In April 2001, the Ministry of Public Management, Home Affairs, Posts and Telecommunications introduced a ministerial ordinance on DSRC-type RVC systems which use ETC-related radio communications technology to provide services, such as parking lot management, logistics management, and payment for drive through or service station shopping. Following this ordinance, in September 2001, the Association of Radio Industries and Businesses (ARIB) established private standards ARIB-STD T75 relating to this type of system. Using the 5.8 GHz radio band, these systems are able to provide two-way communications at a maximum rate of 4 Mbps, between roadside equipment and on-board equipment.

On the other hand, "hot spot" type Internet information supply services using 2.4 GHz-band wireless LANs (IEEE802.11b, etc.) are currently expanding in certain regions and locations in Japan. This spread of hot spot service areas is particularly welcomed, for example, by individual users who connect their own home computer to the Internet via a wireless router, or businessmen who take their work computer with them when they go out of the office on customer visits. DSRC-type RCV systems can be seen as one means of constructing hot spots in special environments, such as highways, and promoting broadband access to the Internet and dedicated ITS networks having highly communal features, by drivers and mobile users.

**ROF-RVC system**

As described previously, if systems provide only a single service, then the number of ITS wireless network users cannot be expected to increase. Consequently, it is desirable to provide multiple services in the DSRC-type RVC system. Specific examples of the multiple services that could be provided simultaneously with dedicated ITS services, such as VICS and ETC, include: public mobile communications services for Personal Digital Cellular (PDC) systems, Personal Handyphone Systems (PHS), next-generation public terrestrial mobile communications networks (International Mobile Telecommunication-2000: IMT-2000), and the like, satellite broadcasting services, and ITS general-purpose services, such as large-scale data downloading.

A ROF (Radio on Fibre) RVC system has been proposed as the basis for DSRC-type RVC systems of this kind. The ROF-RVC system uses ROF technology to transmit radio modulating signals directly onto a broadband fibre-optic transmission line.[3) 4)] The system uses radio waves in the 60 GHz milliwave band and the 5.8 GHz microwave band as communications media, which enables seamless supply of services from the wired network to the wireless network, via the broadband fibre-optic transmission line and the radio transmission line. It is desirable if the on-board equipment can receive a number of these radio services. Existing radio services all use mutually different radio frequency bands, but studies are under way into the possibility of merging these services, so that only one antenna is required in the on-vehicle radio terminal, and establishing a multi-service in the currently unused milliwave (60 GHz) frequency band.

**DSRC-type IVC system**

DSRC-type IVC systems are being investigated for possible application as radio communications systems for transmitting various information between respective on-vehicle devices.5) 6) The DSRC-type IVC system allows the creation of ad-hoc networks for two-way communication of vehicle control information and cruise-assist information, between one vehicle and another vehicle travelling nearby. Therefore, a vehicle group for sharing communications services is set up temporarily, enabling ITS applications, such as platooning, merge/diverge support, "Stop&Go", etc., to be used within the group. In addition, films, music, and other amusement information can be exchanged between the on-board devices.

The smart car concept is aimed at the development of the Advanced Safety Vehicle (ASV) which applies sensor fusion technology using information from sensors all over the vehicle to create a highly "intelligent" vehicle, which can guarantee a high level of safety. The DSRC-type IVC system initiative is linked to the development of the ASV.

## On-demand media shower system

**Role in AHS**

One of the concrete systems being developed on the basis of the smart gateway initiative is the Advanced Cruise-Assist Highway System (AHS) 7). The AHS assists the driver in making circumstantial judgements and supports the functions of the vehicle during travel, through

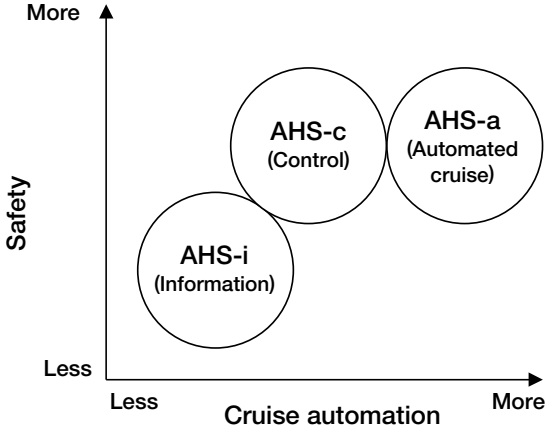


**Fig. 1 Improvements in cruise automation and safety through AHS**

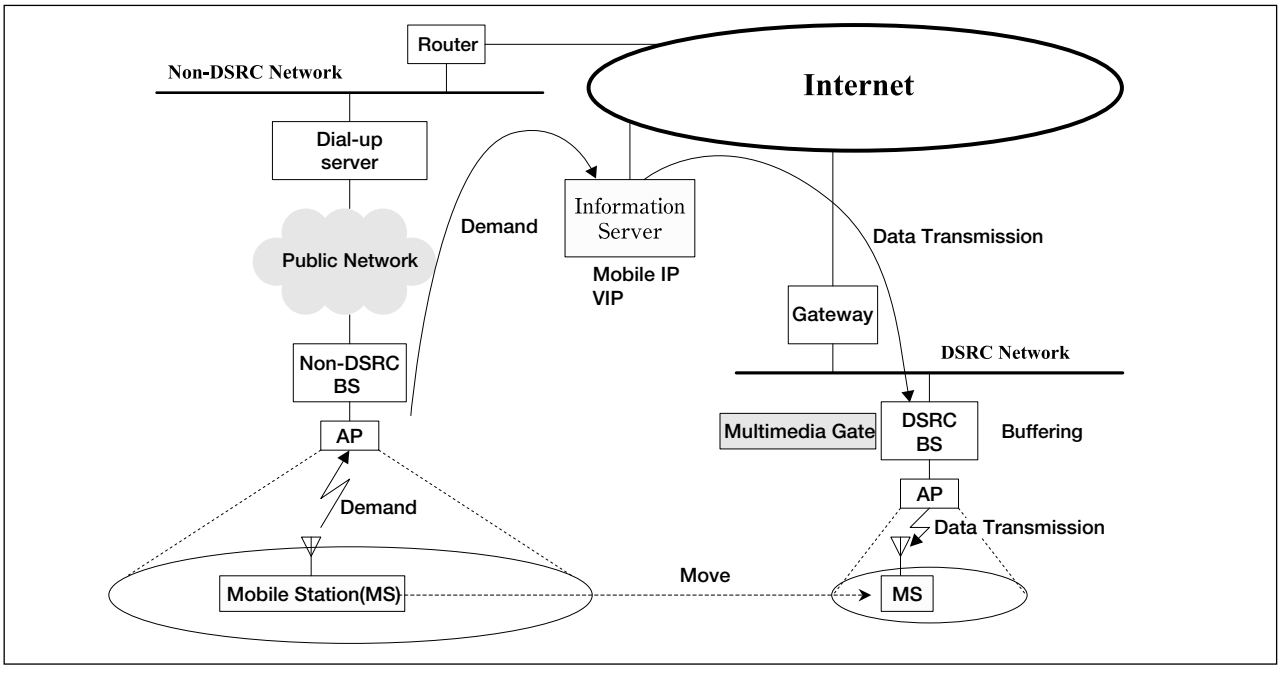


Fig. 2 On-demand media shower system

combined use of the highway infrastructure and information communications system. The AHS comprises three systems: Information supply (AHS-i), Control assistance (AHS-c), and Automated Cruise (AHS-a). Fig. 1 shows the relationship between the safety enhancement (horizontal axis) and the level of cruise automation (vertical axis) for each system. AHS-c and AHS-a, which supply cruise assistance to the driver, provide a greater guarantee of safety during driving.

### System configuration

An on-demand media shower system, which provides faster radio communications speed in the downlink circuit (from the roadside equipment to the on-board equipment) than the uplink circuit (from the on-board equipment to the roadside equipment), has been proposed for DSRC-type RVC systems or ROF-RVC systems8). Fig. 2 shows the configuration of an on-demand media shower system for AHS-i. In this set-up, the user is able to request information, via a conventional public mobile communications system, such as PDC, PHS, or the like, and download all the required information, in bulk, from a hot spot.

### Effects of services

Fig. 3 shows a comparison of the effects of the service on different features of the radio communications system. This is based on a study and assessment of the relationship between the market price, and convenience, area size and broadband, respectively. Fig. 3-a shows a comparison for convenience, Fig. 3-b relates to area size and Fig. 3-c relates to broadband. From Fig. 3-a, we can see that DSRC systems should be able to ensure convenience of use equivalent to that of a mobile phone, allowing all kinds of information to be communicated in two directions, anywhere, at any time. Fig. 3-b, on the other hand, indicates that whilst the service area radius covered by a single DSRC base station is larger than that of a current ETC system, it is roughly 1/10th that of a mobile phone. It is therefore crucial that the system can respond to the diversity of information by achieving the increased transmission rates indicated in Fig. 3-c.

### The role of ubiquitous networks

Research and development into ubiquitous networks is progressing with a target completion date of 2005.9)

The features of ubiquitous networks are as follows.

**(1) Multi-modal broadband network**

① Broadband characteristics
Permanent connection, 6 Mbps per person

② Multi-modal characteristics
Information transmission regardless of network mode (fixed/mobile, wired/wireless, communications/broadcasting).

**(2) Borderless connectability of information devices**
Internet connection possible in any use scenario

**(3) Seamless portability of contents**
Seamless transmission of rich contents, such as voice, animated pictures, etc., between many different types of information equipment.

The future development of ubiquitous networks appears likely to have a huge influence on ITS wireless networks. In particular, the provision of smart gateway services which combine both broadband and mobile features, will be a fundamental requirement.

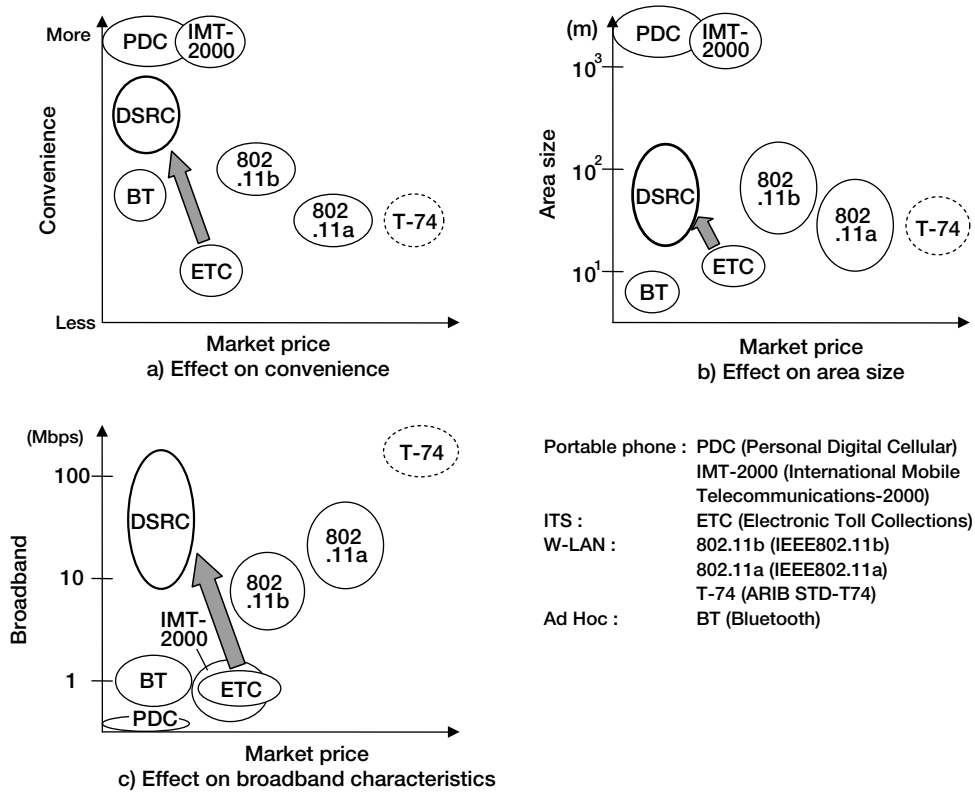


Fig. 3 Comparison of effects on various features of radio communications system

## Summary

This paper has investigated the requirements of DSRC systems with a special focus on items representing network characteristics, namely, service area size, broadband capability and ad-hoc features. In this, our perspective has been based on an assessment of the effectiveness of the services provided by ITS networks, with a view to the implementation of smart gateways which are matched to the needs of mobile users. Existing DSRC systems can provide both broadband and ad-hoc characteristics simultaneously, at low cost, but they are not sufficient to meet the needs of mobile users who wish to communicate from any location they choose. From the viewpoint of accelerating the promotion of these services in the future, the aim is to expand the communications area whilst seeking to reduce prices, and the advancement of integration between RVC systems and IVC systems, which are currently being researched and developed separately in the different independent research laboratories of Independent Administrative Institutions and private company's research centres, will provide an important step on the path towards building ubiquitous smart gateways. ◆◆

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