# Digital Broadcasting Systems for ITS

## — Seamless Service Through Use of Elliptic-orbit Satellites —

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*OVERVIEW: The conversion of broadcasting to the digital format is progressing, and digital broadcasting by means of satellite and terrestrial signals is being implemented. Broadcasting has up to now been focused on services delivered to the home, but seamless services aimed at mobile terminals, mainly automobiles, are expected to be developed in near future. Broadcasting is a medium that makes it possible to distribute information to a large number of end users at one time. Digital broadcasting allows clear reception even by mobile terminals so that car passengers and drivers can enjoy comfortable and pleasant driving. Hitachi, Ltd. has been developing a digital broadcasting system that employs elliptic-orbit satellites, a terrestrial digital broadcasting system, and a terminal for receiving the broadcasts of those systems.*

## INTRODUCTION

CONVENTIONAL broadcasting, such as AM-FM radio broadcasting and analog terrestrial TV broadcasting, has now spread widely to homes everywhere. Radio is also used in nearly all automobiles. The use of TV in automobiles has also been increasing rapidly in recent years, with the increasing popularity of car navigation systems. This kind of broadcasting was originally based on reception in the home. In mobile reception, the reception conditions vary with the changing environment of a moving receiver, so it is virtually impossible to always receive a clear video or audio.

What digital broadcasting for mobile terminals promises is “satellite digital audio broadcasting” and “terrestrial digital broadcasting.” These broadcasting media make clear reception of video, audio and data possible while on the move as well as in the home.

Here, we describe how Hitachi, Ltd. is tackling the issue of digital broadcasting.

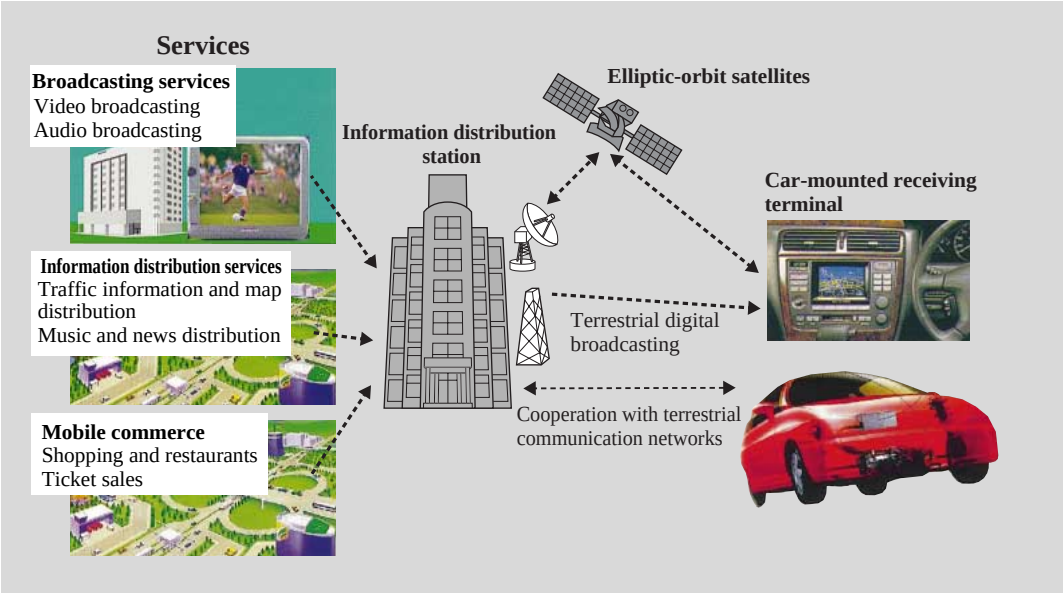


*Fig. 1— Digital Broadcasting System for Mobile Terminals.*
*Clear reception while moving can be achieved by using a broadcasting system that is suited for mobile terminals.*

## ELLIPTIC-ORBIT SATELLITE SYSTEM

### System Overview

Hitachi, Ltd. has taken up the challenge of developing a system that employs elliptic-orbit satellites as a digital broadcasting and communication system that includes "satellite digital audio broadcasting."

An example of the satellite orbit configuration of the elliptic-orbit satellite system is shown in Fig. 2. This system consists of three satellites, each of which is placed in a petal-shaped elliptical orbital plane with the earth at one of the elliptical focal point of each elliptical orbit. The three satellites operate in shifts of 8 hours each so as to provide all of Japan with continuous broadcasting and communication services from a high elevation angle.

### System Features

The special features of this satellite system are listed below (see Fig. 3).

(1) Because direct reception from the satellite is possible, the effects of signal blockage by buildings, mountains and so on are reduced. There is therefore less need for the installation of terrestrial repeaters than with geostationary satellite orbit systems and it is possible to realize uniform services over the entire country, including mountainous regions as well as the metropolitan areas.

(2) Because direct transmission to satellites is possible, bi-directional communication networks are easily constructed.

(3) The radio wave propagation path is simplified, so there are fewer multiple reflected waves and fading is reduced.

(4) The antenna beam pattern can be set to the skyward direction, increasing the antenna gain and reducing its size.

(5) These good radio wave propagation characteristics allow the introduction of highly efficient modulation schemes, increasing the transmission efficiency of the satellite link.

This satellite system can thus offer excellent features that have not been available with geostationary satellite orbit or terrestrial radio waves, and we believe it can also be used effectively for communication in times of emergency, including crisis management and safety monitoring, with application to the ITS (intelligent transport systems) as a start.

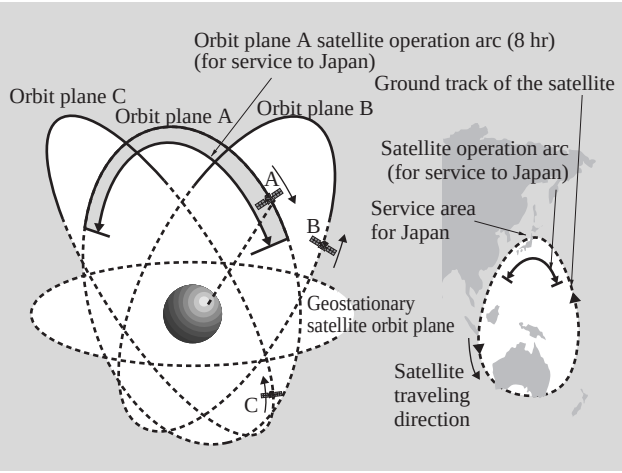


*Fig. 2—Example of Elliptic-orbit Satellite System Orbit Configuration.*
*The elliptic-orbit satellite system uses three satellites, each in a different orbit that is synchronized with the earth's rotation. Continuous direct broadcasting and communication services are provided to all of Japan by transmitting from the one satellite that is positioned at the zenith (the part of each orbit indicated by the solid lines in the above figure).*

## TERRESTRIAL DIGITAL BROADCASTING

### Overview and Features

Concerning the conversion of terrestrial radio wave broadcasting to the digital format, in 1999, the Telecommunications Technology Council of the Ministry of Posts and Telecommunications set forth the specifications of the system for Japan in "Technical Conditions for the Terrestrial Digital Television Broadcasting System"[1] and "Technical Conditions for the Terrestrial Digital Audio Broadcasting System."[2]

The special features of terrestrial digital TV broadcasting[3] are as listed below.

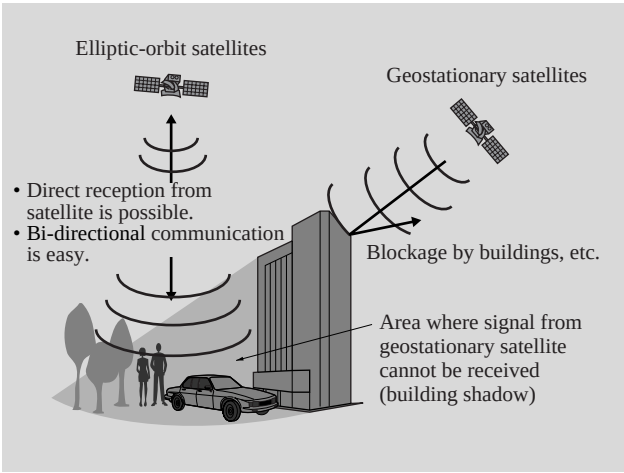


*Fig. 3—Satellite System and Features.*
*Direct reception from elliptic-orbit satellites is easy, because the satellites are positioned near the zenith and so signal blockage by buildings, mountains, etc. is reduced.*

(1) Single-channel high-definition TV broadcasting and multi-channel standard TV broadcasting are possible (see Fig. 4).
(2) The effects of ghosting are less than with the analog system and even mobile terminals can receive the signals with little degradation of quality.
(3) There is compatibility with other digital broadcasting media and multimedia broadcasting can be handled as well.

The special features of terrestrial digital audio broadcasting are listed below.
(1) In addition to CD (compact disc)-quality high-fidelity stereo audio broadcasting, various types of broadcasting to provide content such as data, still images and so on are possible.
(2) There is less influence from noise than with analog systems, so that reception by mobile terminals is also possible.
(3) Compatibility with other digital broadcasting media is guaranteed.

As described above, both systems aim for better quality of reception for mobile terminals compared to conventional analog broadcasting. Furthermore, use as an ITS is made possible by making use of data broadcasting.

### Mobile Terminal Receiver

Of the R&D facilities of terrestrial digital broadcasting system for cooperative usage,[4] installed by Telecommunications Advancement Organization of Japan in 10 sites throughout Japan in 1998, Hitachi, Ltd. provided all of the facilities for the Tohoku and Tokai sites and the data broadcasting facilities for the Fukuoka and Okinawa sites.

Currently, broadcasting companies, appliance manufacturers, and other parties are using the R&D facilities of the various regions to conduct digital broadcasting experiments. Hitachi, Ltd. is involved in experiments centering around applications for traveling vehicles that are being conducted together with the Honda R&D Co., Ltd. in the Tohoku sites (Fig. 5), from which good results are being obtained.

## IN-VEHICLE RECEIVING TERMINAL SYSTEM

### In-vehicle Services That Use Digital Broadcasting

With digital broadcasting, data broadcasting that centers around audio broadcasting is possible in addition to the conventional MPEG2 (Moving Picture Expert Group 2) based video broadcasting. For example, we are currently pushing forward with a variety of multimedia broadcasting services for the elliptic-orbit satellite system. Those services employ MPEG2 Audio (AAC: Advanced Audio Coding) and combine text and images in multi-channel CD-quality high-fidelity stereo audio broadcasting. High compression rate MPEG4 video can also be used.

The elliptic-orbit satellite system and terrestrial digital broadcasting allow broadcasting to mobile

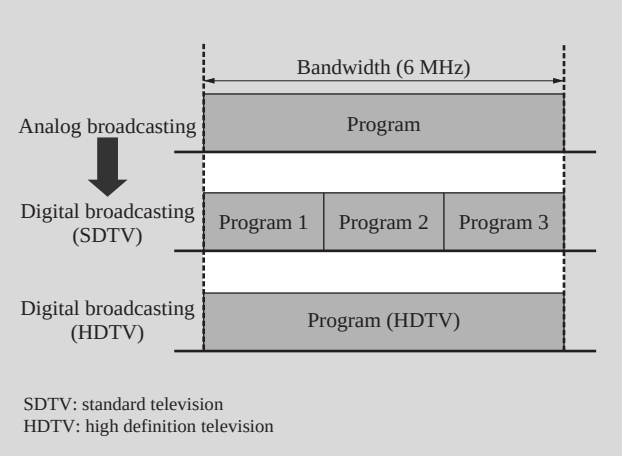


*Fig. 4—Terrestrial Digital TV Broadcasting Program Structure. With terrestrial digital TV broadcasting, multi-channel broadcasting (3 channels at standard TV broadcasting quality), or one channel of high-definition TV broadcasting within the bandwidth of current analog TV broadcasting (6 MHz) is possible.*

*Fig. 5—Mobile Terminal Reception Experiment. Experiments on reception while the vehicle is traveling are being conducted with a terrestrial TV broadcasting receiver (center), evaluation equipment, a car navigation terminal (upper right) and other such devices installed in the vehicle.*

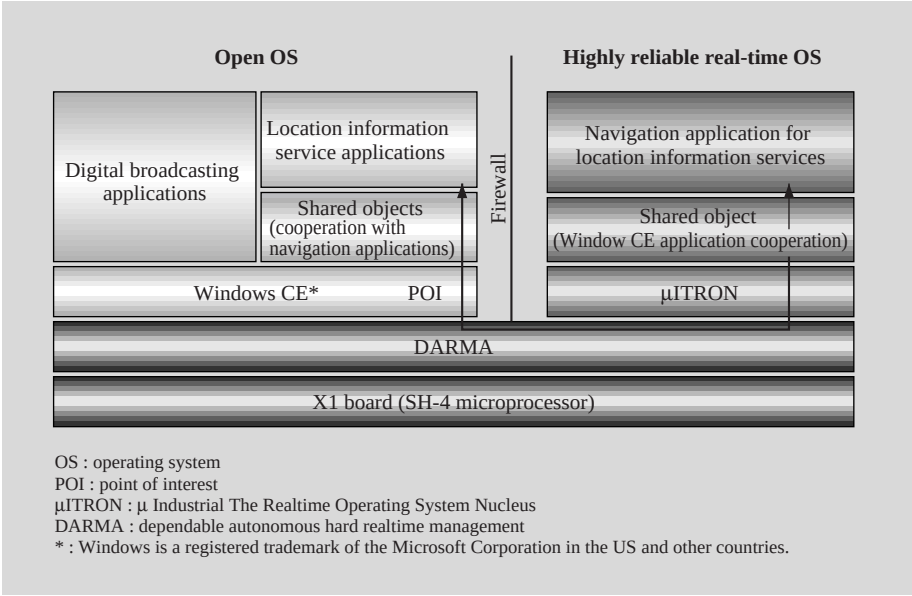


*Fig. 6— Software Configuration of the Receiver.*
*DARMA technology makes it possible to freely construct in-vehicle information service applications that run on an open OS and cooperate with navigation and other functions.*

terminals, opening up the possibility of realizing new in-vehicle services. Examples of such services include the distribution of information, such as audio, video, and news or traffic information and maps, as well as mobile commerce, such as shopping, restaurants, and ticket sales.

## Receiver Terminal Architecture

Towards implementing the in-vehicle services described above, Hitachi, Ltd. has developed a prototype receiving terminal[5] based on the CIS (car information system) next-generation vehicle platform. In this receiving terminal, location information distribution applications, which process traffic information or location information for restaurants, etc. described in XML (extensible markup language), a world standard information description language, and multimedia applications, which extend audio or video media, run on an open OS and cooperate with the navigation function through shared objects (Fig. 6). Moreover, this receiving terminal can be used with either the elliptic-orbit satellite system or the terrestrial digital broadcasting by simply changing the RF (radio frequency) module, which is dependent on the broadcasting signal.

## Location Information Display

With this receiving terminal, real-time location information distributed by digital broadcasting can be displayed by the car navigation system. For example, real-time information such as whether gasoline stations are open or closed or parking is available can be provided to the user through a link to the navigation system display screen. Moreover, it is possible to obtain further information such as telephone numbers by selecting the location information on the screen. With data broadcasting, a function for filtering the huge amount of distributed data according to location so as to obtain only the required data can also be provided.

## MPEG Software Decoder

The receiving terminal is equipped with an MPEG decoder for reproduction of real-time digital audio data and video broadcasting. Thus, the MPEG playback and the navigation processing on the real-time OS are performed in parallel, and the results can be superimposed on the same display screen (Fig. 7).

*Fig. 7—Prototype Receiving Terminal Displaying a Moving Picture.*
*The terminal is equipped with a location information display and MPEG software decoder, realizing cooperation with the navigation system.*

Also, these multimedia functions are implemented in software, so the system is highly portable.

## CONCLUSIONS

We have described the work of Hitachi, Ltd. in digital broadcasting.

In future work, the development of new services that have never been seen before is expected through the fusion of broadcasting and telecommunication. By applying the results of terrestrial digital broadcasting and receiving terminal development to the elliptic-orbit satellite system, we aim to provide seamless services unrestricted by time or place.

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