July 30, 2000

Comments on the ABERT/SET Final Report

Digital Broadcasting Experts Group (DiBEG)

The Digital Broadcasting Experts Group (DiBEG) was founded as a key force to drive the growth of digital broadcasting and the spread of the ISDB-T system in the world. Today, DiBEG has 35 members, including broadcasters, broadcast equipment manufacturers and consumer electronics manufacturers etc. The members are listed at the end. The ISDB-T system was developed by Association of Radio Industries and Businesses (ARIB), which consists of 308 members.

We express our deepest appreciation to the Brazil SET/ABERT group for their serious, fair, and open comparison testing of three digital terrestrial television broadcasting (DTTB) systems: ATSC (U.S.), DVB-T (Europe), and ISDB-T (Japan). Also, we congratulate ANATEL, for the transparent and open process ANATEL is conducting for the selection of the Brazilian digital TV standard. Many countries, which plan to start DTTB services in the near future, want to know how these systems perform under actual terrestrial transmission conditions. The results of Brazilian tests will provide them with useful information for selecting the most appropriate system for their situation.

When we were developing the Teletext system and the FM multiplex broadcasting system in the late 1970s, we found that the quality of terrestrial digital transmission was very poor compared to that of satellite digital transmission due to multipath interference, impulse noise, etc. Therefore we recognize that it is very difficult to develop terrestrial digital transmission paths, and we have a lot of information to overcome these problems

There is a strong need in Japan for terrestrial digital transmission to support such services as TV transmission to vehicles, because almost all sightseeing buses and some taxies have already installed TV receivers for passengers. In the future, probably all TV programs will be provided via fiber to the home (FTTH) or satellite. Because the VHF and UHF bands are the best for mobile reception, the DTTB using the bands will be ultimate broadcasting for vehicles.

Though we are a bit behind the U.S. and Europe in the introduction of DTTB because we have spent more time on developing a DTTB system suitable for mobile reception, we believe that the ISDB-T is the best system providing all the functions required for digital terrestrial broadcasting.

We started pilot DTTB services in 11 cities around Japan from 1998. Various kinds of service trials have been carried out in each city. By the way, we commence satellite digital HDTV broadcasting of seven channels using ISDB-SATELLITE system this December. Low-price ISDB-S receivers should be on the market by that time. ISDB-S shares common receivers with ISDB-T except for the RF part. There are more than ten receiver manufacturers in Japan, and some of them will have the ability to supply ISDB-T receiver LSI chips. Matsushita/Panasonic made an announcement about development of COFDM LSI for ISDB- T on July 14.

It is not surprising that ISDB-T showed the best results in the comparison tests carried out in Brazil, because similar results were obtained in the tests carried out in Singapore and Hong Kong. The tests performed on mobile reception in Brazil made the superiority of ISDB-T more evident. The system flexibility and the reliable mobile reception of ISDB-T make broadcasters more competent in the new wireless world. For an example, the ISDB-T having the BST-OFDM scheme can provide a sound-and-data service to mobile receivers by a robust modulation in parallel with a HDTV service to stationary receivers. In addition, because of the commonality of receivers, digital sound broadcasting services following DTTB can be easily implemented in a step-by-step manner.

The broadcasting business is quite different from the computer business. Once a broadcasting system has been selected and implemented, it is very difficult to change the system in short term. Therefore, all functions that will be required should be included in the initial specifications. We believe that ISDB-T satisfies most users for a long time. Flexibility of ISDB-T to be able to change the broadcasting system corresponding to the demand of individual broadcaster, is evaluated highly in the final report part two. We think that the features of ISDB-T are described very well in Chapter 5 “Analysis of flexibility “.

We appreciate you giving us the opportunity to comment on the test results.

Annexes

1. Features of ISDB-T
2. Topics of ISDB-T
3. The developments of Digital Terrestrial Broadcasting services in Japan

DiBEG Members

Steering committee:

- Advanced Digital Television Broadcasting Laboratory
- Asahi National Broadcasting Co., Ltd.
- Fuji Television Network Inc.
- Hitachi Ltd.
- Japan Broadcasting Corporation
- Matsushita Electric Industrial Co., Ltd.
- Mitsubishi Electric Corporation
- NEC Corporation
- Nippon Television Network
- Pioneer Electric Corporation
- Sanyo Electric Co., Ltd.
- Sharp Corporation
- Sony Corporation
- Television Tokyo Channel 12 .,Ltd.
- Tokyo Broadcasting Systems, Inc.
- Toshiba Corporation
- Victor Company of Japan

Others:

- HHAKUHODO Inc.
- Hitachi Cable, Ltd.
- Hitachi Denshi, Ltd.
- Ikegami Tsushinki Co., Ltd.
- KANSAI TELECASTING CORPORATION
- MAINICHI BROADCASTING SYSTEM.INC.
- Marubeni Corporation
- MASPRO DENKOH CORP.
- Matsushita Communication Industrial Co., Ltd.
- Mitsubishi Corporation
- NHK Integrated Technology, Inc.
- Nippon Telegraph and Telephone Corporation
- NISSAN MOTOR CO., LTD.
- Oki Electric Industry Co., Ltd.
- Satellite Communications Corporation
- SUMITOMO CORPORATION
- SUMITOMO ELECTRIC INDUSTRIES, LTD.
- THE FURUKAWA ELECTRIC CO., LTD.

July 28, 2000

Features of ISDB-T

Once a broadcasting system has been selected and implemented, it is impossible to change to another system. Therefore, all functions that may be required in the future should be included in the initial specifications.

As describes following, the ISDB-T system is the most suitable system for Brazil considering all factors.

From the technical point of view:

ISDB-T technology includes a wide range of transmission parameters, such as the transmission mode, carrier modulation scheme, coding rate of the inner error-correction code, and so forth. This system can provide hierarchical transmission and is more flexible than the DVB-T system.

ISDB-T has three transmission modes, 2k, 4k and 8k. The 8k-transmission mode is used for stationary reception, and the 2k-mode is used for mobile reception. The 4k-mode is suitable for both stationary and mobile reception. On the other hand, DVB-T has only 2k and 8k modes. If broadcasters would like to provide programs for both stationary and mobile receivers by DVB-T system, they have to broadcast their services using two radio channels. On the other hand, in the case of ISDB-T, for example, HDTV service for stationary reception and sound/data services for mobile reception can be simultaneously provided by arranging the different transmission parameters in appropriate segments using 4k-mode in ISDB-T system.

As in Japan, the channel bandwidth of analog television in Brazil is 6 MHz. All kinds of broadcasting equipment for the ISDB-T system can be provided in Brazil as well.

There is also an ISDB-T_N system in the ISDB family. The ISDB-T_N system is a narrow-band system used mainly for sound and data broadcasting for portable reception. ISDB-T_N has commonality with ISDB-T in its physical layer. The center segment in 6 MHz bandwidth channel can be received by ISDB-T_N receivers.

Interactive broadcasting capability will be important for future digital broadcasting services, even for mobile or portable reception. ISDB-T has interactive broadcasting capability in the specifications for data broadcasting.

ISDB-T uses MPEG2 AAC (Advanced Audio Coding), which is a very efficient audio coding method. The transmission efficiency of MPEG2 AAC is approximately twice that of MPEG2 BC, which is used by DVB-T.

It is not surprising that ISDB-T showed the best results in Brazil’s comparison tests, because similar test results were obtained in Singapore and Hong Kong. ISDB-T adopts time interleaving, which is a key technology for mobile reception and is also effective to cope with impulse noise degradation. DVB-T is originally designed for stationary reception, therefore it does not adopt time interleaving and the DQPSK modulation scheme.

From the implementation point of view:

We were the first in the world to develop HDTV. In Japan, HDTV has been broadcast for more than 10 years using a broadcasting satellite, reaching more than 840 thousands HDTV sets. The broadcasting time of HDTV programs is now about 17 hours a day. We thus have a lot of experience and knowledge of HDTV broadcasting techniques and can support Brazil in implementing HDTV. There are more than 10 manufacturers, including Panasonic, Toshiba, NEC, Sony, Mitsubishi, Victor, Pioneer, Sharp, Sanyo and Fujitsu, and they all support the ISDB-T system.

Large flat display panels for home use are a very important component to penetrate HDTV services. Large-scale plasma display panels (PDP) for HDTV service have already been developed. PDPs from Pioneer, NEC, Panasonic, Fujitsu, and Hitachi are on the market.

Digital terrestrial broadcasting based on DVB-T in Europe is SDTV multi-program broadcasting. Therefore, regarding HDTV broadcasting based on DVB-T, DVB-T TV sets which can decode and display HDTV broadcasting are not on the market. Any European countries do not have a plan to introduce HDTV services.

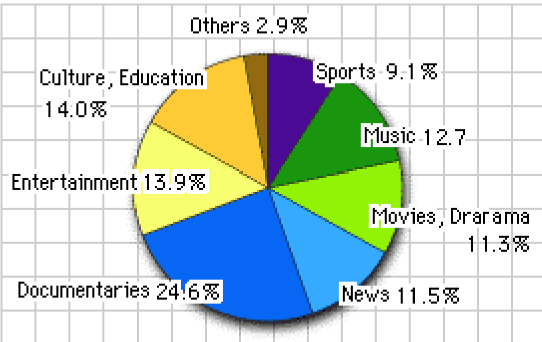
In Japan, digital broadcast-satellite (BS) services using ISDB-S will start in December 2000. The main services are HDTV and data broadcasting. Seven broadcasters will provide HDTV programs, and eight data-broadcasting providers will provide independent data broadcasting. Several TV sets and set top boxes (STBs) for ISDB-S are already on the market. All manufactures are making efforts to put their receivers on the market within the next half-year. A slogan is “10 millions receivers within 1,000 days”.

Moreover, Electronic Industries Association of Japan (EIAJ) predicts that 20 millions 6MHz ISDB-T receivers will be spread around 2005 and 60 millions by 2010. Japan is the biggest HDTV market in the world.

<u>HDTV Broadcasting Hours in Japan</u>

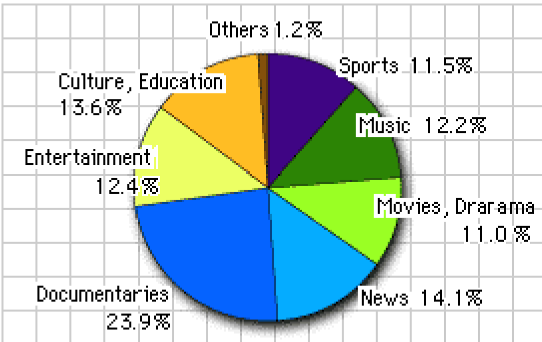
July, 2000

(Total broadcasting hours: 511.5h)



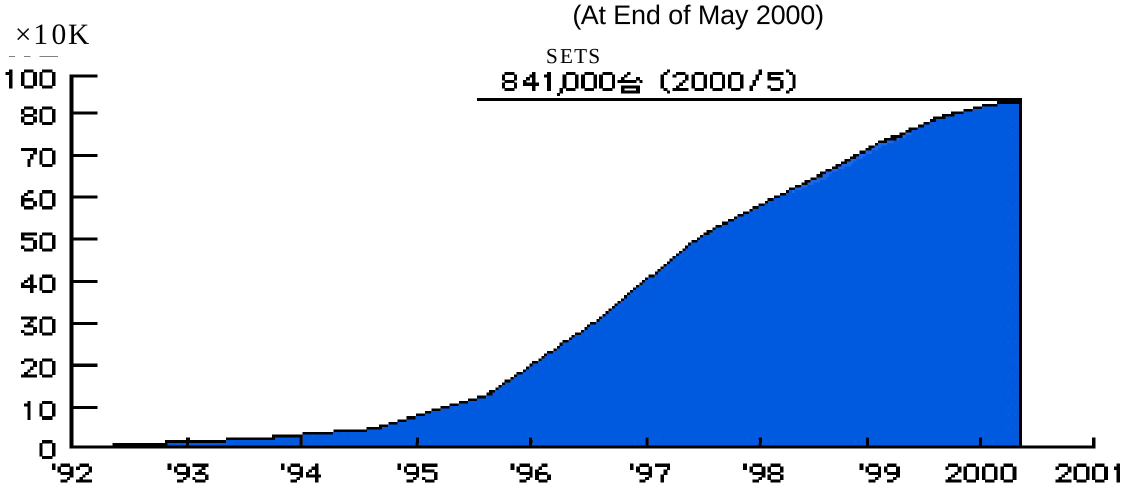
August, 2000

(Total broadcasting hours: 527.2h)



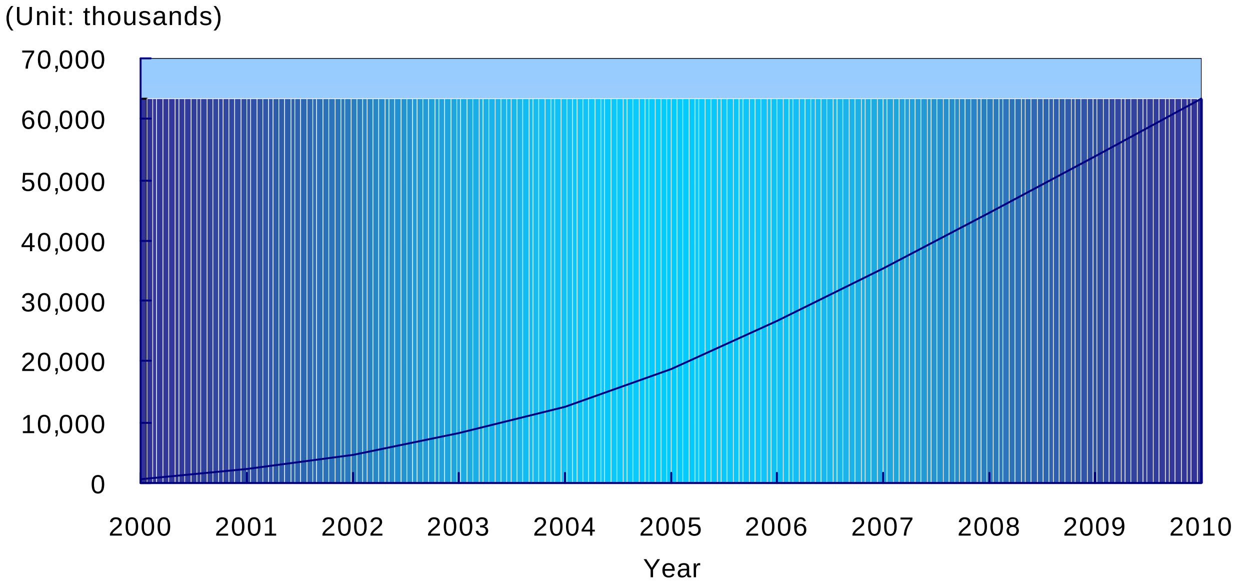
The total number of HDTV related receivers sold in Japan

(At End of May 2000)



Estimated Diffusion of ISDB-S/T Receivers

Source: Electronic Industries Association of Japan



ISDB-T receivers can use the same devices as ISDB-S receivers, except for the ISDB-T-oriented OFDM chip. Matsushita/Panasonic has already developed an ISDB-T decoder LSI chip. Other manufacturers have also begun developing this technology. There are more than ten receiver manufacturers in Japan, and all have the ability to supply ISDB-T decoder LSI chips.

Indeed the price of receivers depends on the number of receiver sold, but ISDB-S and ISDB-T receivers will be popularized in Japan. Therefore, manufacturers can provide ISDB-T receivers in reasonable price.

ISDB-T is designed to be compatible with ISDB-S (satellite). The common receiver will be also available soon. Regarding multimedia facilities, Digital Satellite Broadcasting using ISDB-S provides datacasting services and interactive services from this December. It is obvious that the same technologies and facilities will be easily implemented for ISDB-T.

July 28, 2000

TOPICS OF ISDB-T

The Integrated Services Digital Broadcasting - Terrestrial (ISDB-T) system was developed to provide flexibility, expandability, and commonality for multimedia broadcasting services using terrestrial networks. To confirm ISDB-T's feasibility in real broadcast environments, pilot broadcast stations have been set up in 11 major areas of Japan. Based on the results of field trials, the ISDB-T system was found to offer superior reception characteristics; and consequently, the ISDB-T system was adopted as the Japanese standard for digital terrestrial television broadcasting (DTTB) and digital terrestrial sound broadcasting (DTSB). This annex describes the ISDB-T's performance in field trials and some relating topics.

ISDB-T FACILITIES IN JAPAN

The Ministry of Posts and Telecommunications (MPT) launched several facilities to accelerate DTTB and DTSB services throughout Japan. The pilot broadcast stations were set up in 11 major areas in 1998 (Figure 1). The output powers of the main stations are over the kW range. Some stations have a number of relay stations used to verify SFN(Single Frequency Network). All the facilities are capable of providing HDTV, SDTV and data services with multimedia applications and interactive functions.

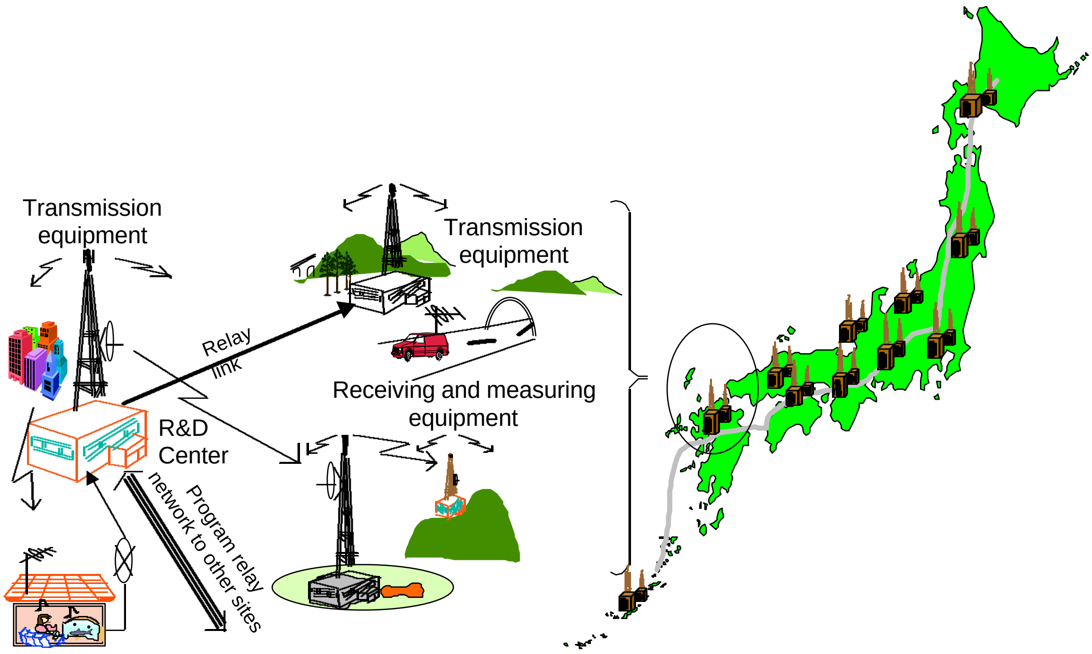


Figure 1 - ISDB-T facilities in Japan

MOBILE RECEPTION CHARACTERISTIC

The transmission condition and parameters used in the mobile reception trials in Tokyo area are listed in Table 1 and Table 2 respectively. The bit error rates and field strengths over the measured routes are shown in Figure 2. Total measured route distance was about 3000km.

TABLE 1 - Tokyo Tower transmission condition

Transmitter Frequency	485.15 MHz (center frequency)
Transmitter Power	100 W
Polarization	Linear-vertical
Antenna Height	261 m
E.R.P.	395 W

TABLE 2 - Mobile reception parameters

	Mobile Reception	
No.	M1	M2
Mode	2 (4k mode)	
Guard Interval Ratio	1/8 (63 µs)	
Number of Segments	13	
Carrier Modulations	DQPSK	DQPSK
Inner Code Rates	1/2	1/2
Time Interleaving	427.5 ms	0 ms
Information Rates	4.06 Mbps	4.06 Mbps

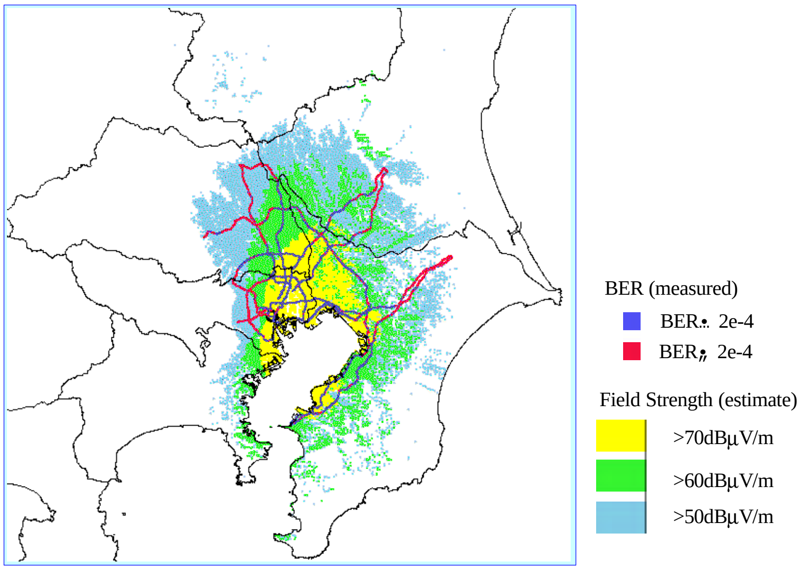


Figure 2 - Measure route in mobile reception

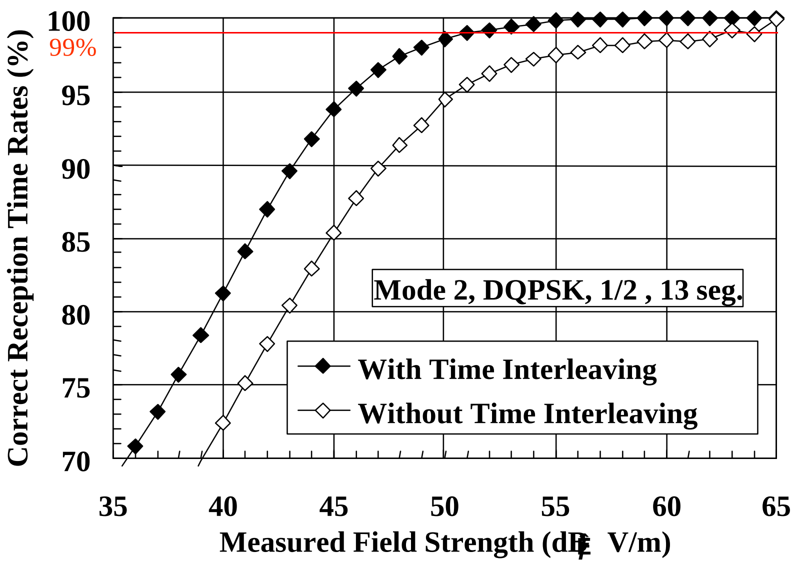


Figure 3 Correct reception rate in mobile reception

Figure 3 shows the time rates of correct reception. It shows that the required field strength for 99% -correct reception is about 50 dBuV/m in case of time interleaving for 427.5ms(M1). The figure compares the correct reception rates for transmission with (M1) and without (M2) time interleaving. If it does not adopt the time interleaving, the rate of 99% is hardly attained. Time interleaving is therefore very effective for mobile reception.

NARROW-BAND ISDB-T SYSTEM

Narrow-band ISDB-T system has two kinds of bandwidths: a single 429 kHz segment, and an extended version using three segments for terrestrial digital audio and data broadcasting. The system verification experiments carried out by the Association of Radio Industries and Businesses (ARIB).

The information bit rate of the system ranges from 280 kbps to 5.3 Mbps depending on the combination of transmission parameters. Table 3 shows two service examples using coding rate of covolutional code 1/2, which is the robustest coding rate of this system. In the case of carrier modulation scheme DQPSK, one stereo audio program, Electric Programming Guide (EPG), still pictures and files can be broadcasted within the bit rate of about 330 kbps. In the case of 16QAM, two stereo audio programs, EPG, motion picture and files can be broadcasted within the bit rate of about 660 kbps.

TABLE 3 - Service examples of narrow-band ISDB-T

Number of Segments	1-segment	
Guard interval ratio	1/16	
Inner code rate	1/2	
Carrier modulation	DQPSK	16QAM
Information bit rate	330.42 kbps	660.84 kbps
Stereo audio	144 kbps (1 program)	288 kbps (2 programs)
Character (include EPG)	16 kbps	16 kbps
Picture	64 kbps (still)	256 kbps (motion)
File (ex. newspaper)	32 kbps	32 kbps
Control	64 kbps	64 kbps
Total bit rate	320 kbps	656 kbps

In Tokyo area, the trials of mobile reception were carried out using the 1-segmente system. The transmission condition and parameters used in the trials are listed in Table 4 and Table 5 respectively. For the receiver antenna, a dipole antenna was installed on the roof of a vehicle. The height of the receiver antenna is 1.8 m. The receiving vehicle ran approximately 700km on main roads including expressway and main arterial road.

TABLE 4 - Outline of experimental transmitter

Transmission frequency	190 MHz
Antenna height	247.5 m
Polarization	Linear - Vertical
Transmitter power	100 W
Max. ERP	800 W

TABLE 5 - Transmission parameters of mobile reception trial for narrow-band ISDB-T system

Mode	Guard ratio	Time interleaving	Carrier modulation	Error correction
3	1/16	407ms	DQPSK	1/2+RS
3	1/16	407ms	16QAM	1/2+RS

Figure 4 shows the correct reception time rates on the measurement course. For example, to obtain a correct reception time rate of 99%, it was found that the DQPSK modulation requires a field strength of 38 dBµV/m and the 16QAM requires a field strength of 44 dBµV/m. From the results, it was found that DQPSK was approximately 6dB more robust than 16QAM in mobile reception environment.

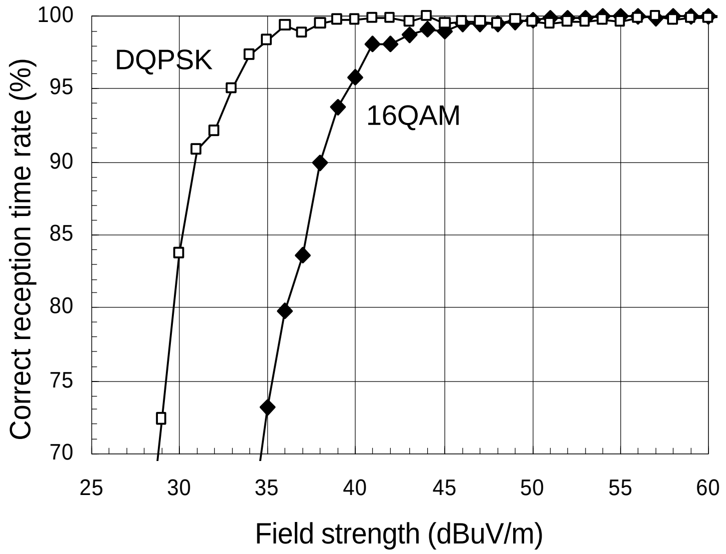


Figure 4 - Correct reception time rates for each field strength of wide-area mobile reception trial

DEMONSTRATION OF MULTIMEDIA SERVICES

In the Tokyo pilot project, application tests that involved the transmission of video, sound, and data, using signals that were close to those of actual services, were conducted. In these test, function verifications for the reception of data transmitted in conjunction with TV programs were carried out. These verifications focused on the transmission and reception of independent data services (i.e., news and weather forecasts) and program-linked data services.

Figure 5 - Multimedia Services Tests

HOME SERVER FOR DIGITAL BROADCASTING

Home server research and development continues to produce more advanced digital broadcasting services. A prototype home server can playback any one program while recording other digital HDTV programs and verified the operation of the home sever. This accomplishment was based on video hard disks. New functions were incorporated into the home server, such as the "Top function" that enables complete viewing from the beginning of a program already in progress, and "Pause function" that can suspend a program on the air for later viewing. This home server was developed for watching a set of scenes automatically rearranged from recorded programs using program index information. This function allows the viewer to watch highlights of a long news program or portions of a sports program in which the viewer's favorite athlete is participating. Easy recording reservation was made possible through the use of EPGs (Electronic Program Guides) distributed by digital broadcasting.

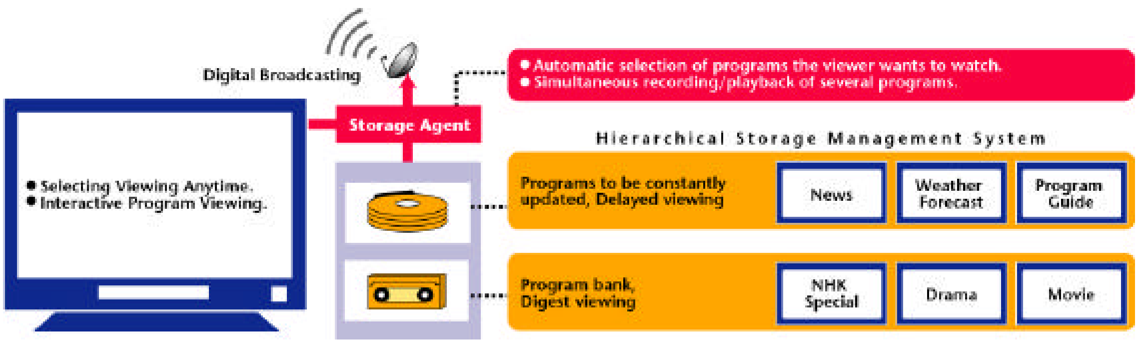


Figure 6 - An example of home server system

SFN BROADCASTING RADIO WAVE RELAYS

In order to realize a digital terrestrial SFN via a broadcasting relay system, it needs to overcome the distortions caused by coupling between transmitting and receiving antennas at relay station. As a countermeasure, a coupling canceler was developed. It was confirmed that the cancellation algorithm was capable of the desired performance under the following conditions: the existence of three coupling waves, the power of these waves being nearly equal to that of the master broadcasting wave. Combining this canceler with a planar reception antenna with improved side lobe characteristics, a field trial has been conducted using the ISDB-T facilities in some regions.

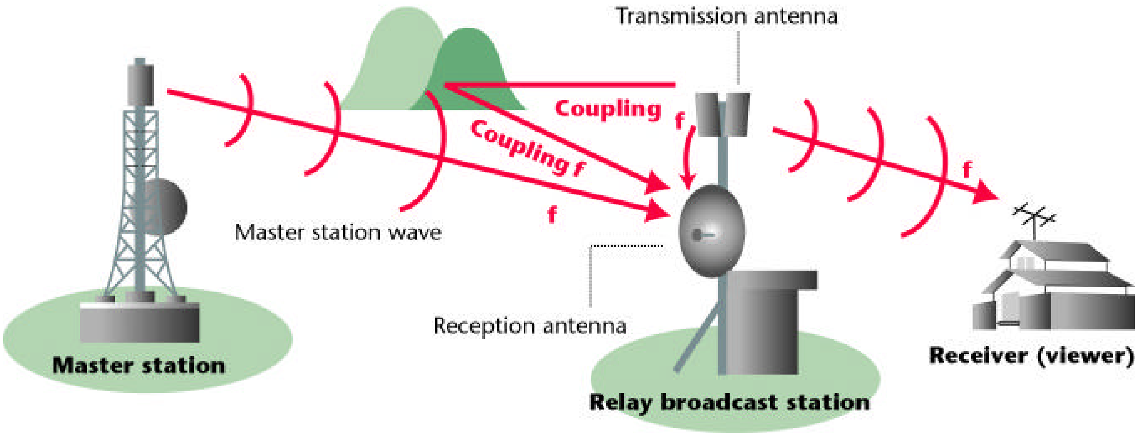


Figure 7 - Relay station on SFN

July 28, 2000

The Developments of Digital Terrestrial Broadcasting services in Japan

With the goal of making digital terrestrial broadcasting the most widely used broadcasting medium in Japan, MPT has worked hard to make the necessary regulations, as well as to finalize such matters as the choice of digital broadcasting system and a channel allotment plan.

1. Decision of the System

In order to investigate the technical feasibility of several digital-broadcasting systems, the Association of Radio Industries and Businesses (ARIB) and other relevant organizations jointly conducted a series of indoor experiments and outdoor tests on basic transmission methods from January 1997 to September 1998. Based on the test results, Telecommunications Technology Council decided upon a digital terrestrial television broadcasting system in May 1999, and upon a digital terrestrial sound broadcasting system in November 1999.

As regards digital terrestrial television broadcasting, Radio Regulatory Council enacted the regulations in November 1999. As for digital terrestrial sound broadcasting, the Council will establish the regulations in 2000.

2. Channel Allotment Plan

MPT drafted a nationwide channel allotment plan for digital terrestrial broadcasting in December 1998, taking into consideration the results of research into radio wave propagation characteristics that began in 1997 in major cities throughout the country.

In April 2000, Private Broadcaster, NHK (Japan Broadcasting Corporation) and MPT decided National Channel Plan of Main Terrestrial Digital television Stations.

3. Digital Terrestrial Broadcasting Pilot Experiments

In November 1998, MPT began conducting joint experiments with the “Tokyo Pilot,” which consists of broadcasting companies, telecommunications carriers, manufacturers and others. This series of experiments, staged in the Kanto region, is intended to evaluate and verify the functionality of the provisional digital broadcasting systems in a real setting, as well as to check the functions and operation of digital broadcasting terminals.

The “Tokyo Pilot” has also conducted experiments independently. In phase one of these, from November 1998, they carried out a range of image transmission experiments on such areas as multi channel broadcasting, HDTV broadcasting and program reception with mobile terminals.

In phase two of the experiments, which began in April 1999, the committee conducted tests on such new services as data broadcasting, 3-D television and storage-type broadcasting and phase two was completed in May 2000.

4. Open Facilities for R&D on Digital Terrestrial Broadcasting

MPT began a project to build facilities for research and development in 10 locations across Japan, which are leased to the researchers, spending the budget of 46 billion yen (about 400 million US dollar) from 1998 fiscal year budget.

Through the project, MPT aims to promote the earliest possible achievement of nationwide digital broadcasting, as well as to effectively help develop new technologies and services that are unique to various regions.

The project, under the management of the Telecommunications Advancement Organization of Japan, links the 10 locations via broadcasting re-lays, using relay equipment housed in the facilities. For about five years from fiscal 1999, the facilities are made freely available to any researcher, with the aim of promoting a variety of projects that will utilize the characteristics of digital terrestrial broadcasting technologies.

These stations are leased to the consortium composed of local broadcasters and industry, and used for experiments of digital television broadcasting services. Especially, new multimedia applications using data broadcasting and interactive functions are designed. Some examples are multimedia mobile application, seamless connection to cable, connection to information highway network.

Fig. Outline of Open Facilities for R&D on Digital Terrestrial Broadcasting