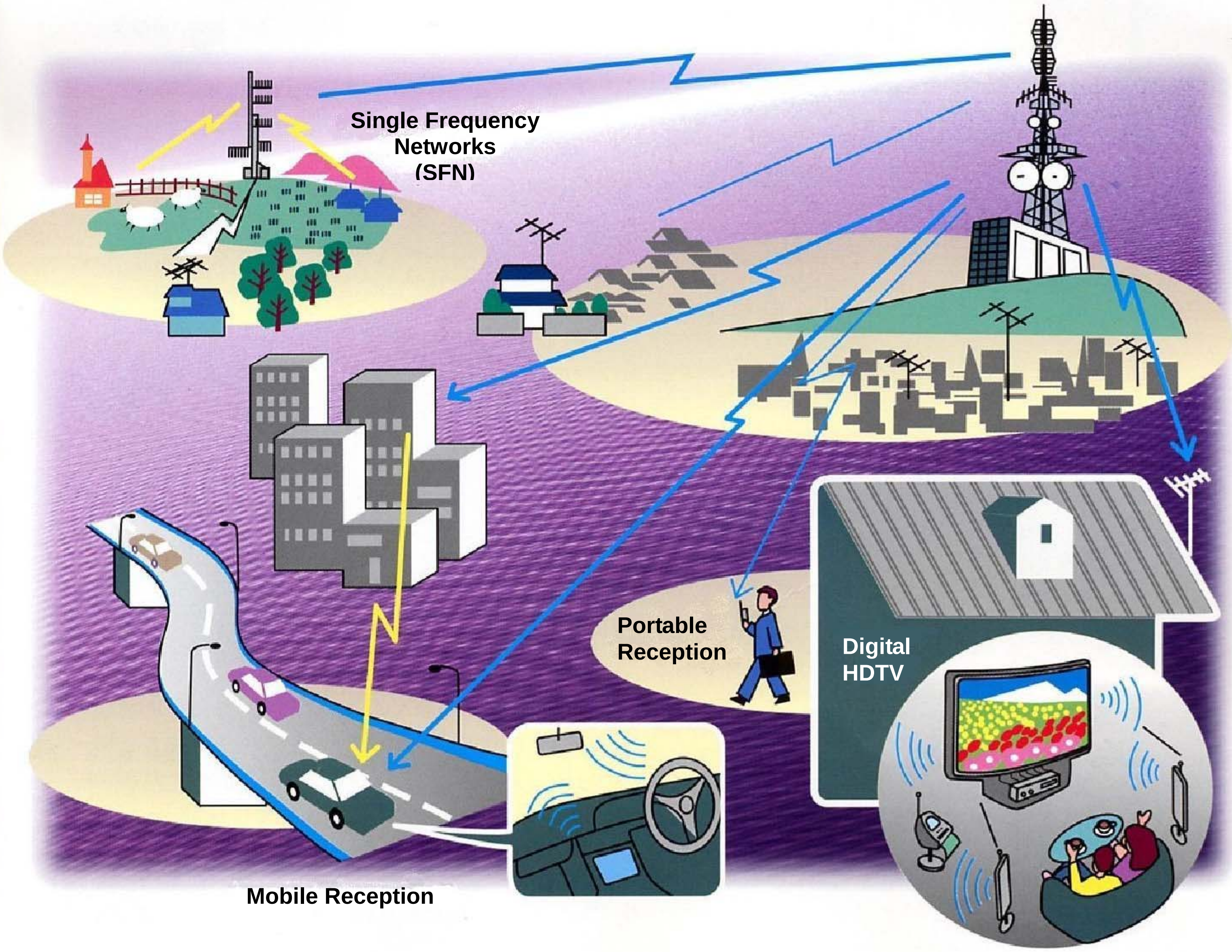
Digital Terrestrial Television Broadcasting

ISDB-T

Integrated Services Digital Broadcasting-Terrestrial



Presented by

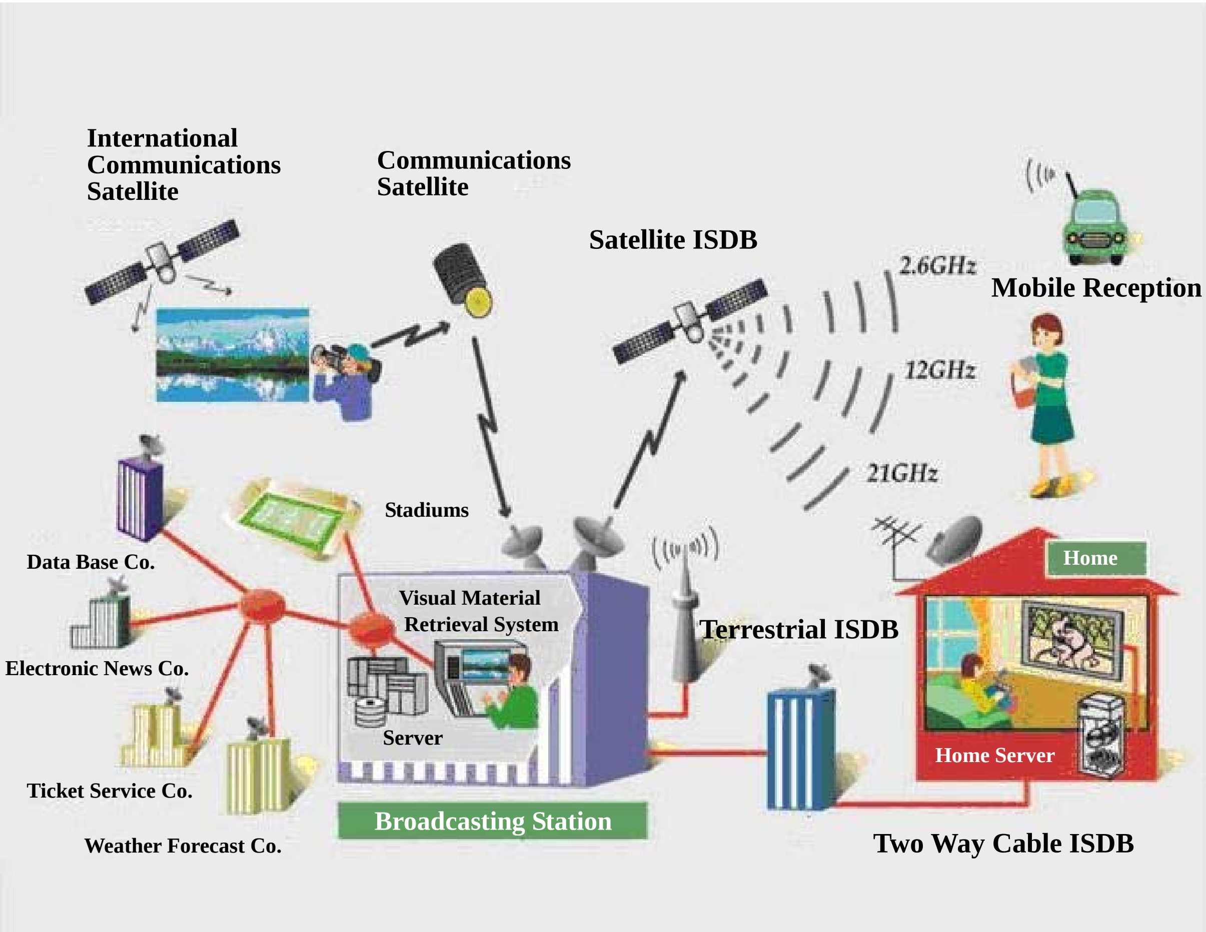
DiBEG

Digital Broadcasting Experts Group

DiBEG (Digital Broadcasting Experts Group) was founded on September 1997 to promote ISDB-T Digital Terrestrial Television Broadcasting System all over the world.
To achieve its main task, DiBEG promotes exchange of technical information and international cooperation to facilitate common understanding in the world and smooth exchange of programs in digital era.
DiBEG members are basically the main broadcasters and the manufacturers working on the broadcasting business, besides associations related to the broadcasting industry in Japan.

Digitalization of Broadcasting

The era of total digital broadcasting, from program production to digital receivers has definitely arrived as a result of advances in image compression technology, higher integration and improved performance in LSI devices, and the rapid progress in digital technologies including the development of digital transmission systems.
Figure outlines the sequence by which broadcast signals are transmitted. This sequence begins with the relay of video signal by a camera on the scene or in studio and continues through program production, editing, storage, network operations, transmission, and reception. In recent years, broadcast studios have introduced advanced digital technologies and functionalities that allow processing of broadcast signals in the studio and over relay networks.



Compared with conventional analog systems, digital broadcasting is distinguished by the following features.

(a) Robust versus noise

In analog broadcasting, a weakening of the received signal means degraded picture quality in the form of noise on the television screen. A digital signal needs only to identify itself as a “1” or “0” making digital broadcasting more robust to noise compared with analog broadcasting.

(b) Large band compression of video and audio signals

ITU-R recommends the same compression technique for both video and audio signals, namely, MPEG-2. In the digital compression of video signals, however, the manner in which a disturbance appears depends on the characteristics of the picture. Recent MPEG-2 image compression techniques have achieved compression ratios of 1/20 for standard TV and 1/60 for HDTV. Research on MPEG-2 continues with the aim of further improving compression ratios while maintaining an adequate level of picture quality.

(c) Error correction techniques not possible with analog signals

Basically speaking, noise cannot be removed in analog broadcasts. In digital broadcasts, however, it is possible to correct bit errors caused by disturbances on the transmission path by using error correction techniques. Here, only bit errors that are too large to be corrected will actually be labeled as “errors.” While extra parity bits that must be transmitted for the sake of error correction may be viewed as disadvantageous from the viewpoint of transmission power, the obtained correction effect essentially outweighs the advantage of not sending these bits. Error correction has become an indispensable technology for digital systems.

(d) Identical method of handling video, audio, data, and control signals

Digital signals consist of signals of “0” and “1” bits that are transmitted in groups called packets within which the type of digital signal is indicated. As result, all signal types can be handled in the same way. This characteristic makes it easier to add new services.

(e) High-performance data broadcasting

In data broadcasting provided by conventional analog channels, such as Teletext broadcasting that uses the vertical blanking period of the TV signal, the transmission capacity is quite small, at about 11 kbps per scanning line (1H). Satellite and terrestrial digital broadcasting, on the other hand, are capable of delivering advanced data broadcasting services having transmission rates of several Mbit/s. Considering, moreover, that telephone lines or LAN (local area network) can be effectively used as uplinks, many digital data broadcasting applications can be envisioned, such as receiving immediate responses from viewers and providing easy access to the Internet.

(f) Easy to scramble signals

In contrast to the difficulty of scrambling an analog broadcasting signal, scrambling a digital signal can be easily achieved so that only subscribers can receive the content of a broadcast by descrambling the received original digital signal.

(g) Low transmission power

Because digital signals are robust to noise as mentioned in item (a) above, transmitter power can be lowered. Although actual transmission power depends on bit rate and send/receive conditions, it can generally be said that digital terrestrial television broadcasting can reach a particular service area for a transmission power of about 1/10 that of an equivalent analog television broadcasting.

(h) Simplified channel planning

Because low power transmission is possible, there is little affect on adjacent channels or on identical channels in different areas. Channel planning is therefore easier and more channels overall can be used.

(i) Modulation systems robust against ghosts and fading

Ghosts, which is a form of interference caused by buildings, are a major problem in digital terrestrial broadcasting. Assuming that the maximum bit rate is desired for a limited frequency bandwidth, it is impossible to deal with ghosts by using the conventional single carrier modulation system. Instead, multi-carrier orthogonal frequency division multiplexing (OFDM) can be used to eliminate ghosts. OFDM can also be applied to the mobile reception environment in general.

(j) Applicable to LSI technology

LSI devices are achieving higher levels of integration and higher speeds each year. Since most tasks performed by digital broadcast receivers consist of digital signal processing, smaller and cheaper receivers can be expected.

(l) Sudden drop in service quality just beyond service area

In analog broadcasting, moving away from the transmitting antenna means more noise on the television screen and gradual deterioration of the picture as receive power weakens. In digital broadcasting, on the other hand, the use of error correction techniques results in a steep curve for the relationship between received power and bit error rate on the receiver side. As a consequence, insufficient received power less than minimum level results in complete loss of reception as opposed to a gradual deterioration in picture quality.

(m) New frequencies needed for digital broadcasting

At present, a large range of frequencies are being used for analog terrestrial television broadcasting in Japan and few frequencies are available for digital terrestrial broadcasting. For digital terrestrial broadcasting, it is therefore necessary to move some of the frequencies currently being used for analog broadcasting to other frequencies and to allocate new frequencies for digital broadcasting. It has been decided to reserve low frequencies in the UHF band for digital broadcasting in Japan.

(n) Users must purchase new receivers

Since conventional analog receivers cannot, of course, be used for receiving digital broadcasting, users have to purchase receivers especially designed for digital broadcasting.

(o) Facility investment required by broadcast stations

Broadcasters have to invest in various types of equipment including video/audio encoding devices, program-production equipment for data broadcasting, operating equipment, and transmission equipment.

Digital TV in Japan

History in Brief

The digital broadcasting system was discussed in Japan by the Telecommunications Technology Council (TTC) of Ministry of Post and Telecommunications – MPT, and detailed technical matters have been discussed at the Association of Radio Industries and Businesses (ARIB).

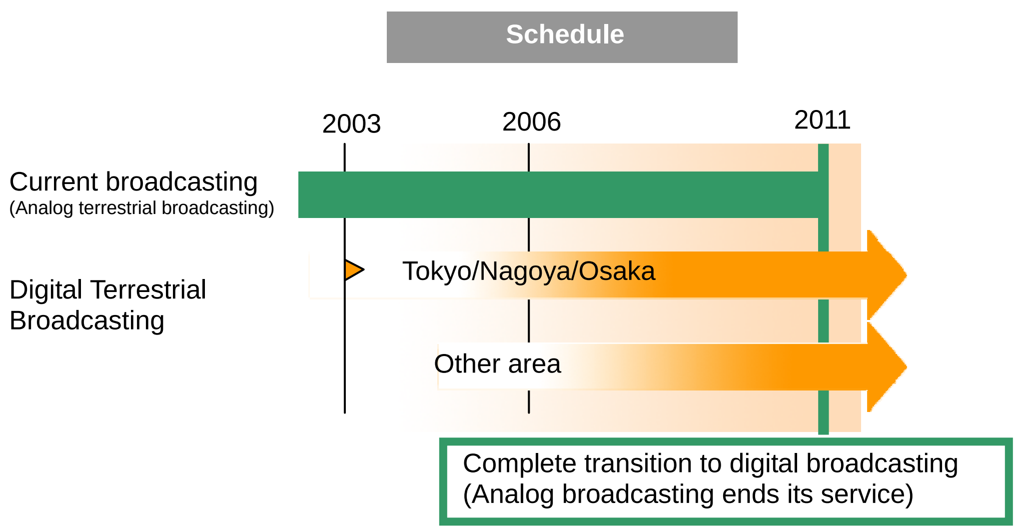
ISDB (Integrated Services Digital Broadcasting) is an emerging digital broadcasting concept. With ISDB, everything is handled digitally. The three kinds of systems, ISDB-S (Satellite), ISDB-T (Terrestrial) and ISDB-C (Cable) were developed in Japan to provide flexibility, expandability and commonality for the multimedia broadcasting services using each network.

Based on the results of field trials, an ISDB-T system was found to offer superior reception characteristics; and consequently, the ISDB-T system was adopted in Japan as the digital terrestrial television broadcasting (DTTB) system and digital terrestrial sound broadcasting (DTSB) system in 1999.

Time schedule for digital terrestrial television

Figure shown below presents the time schedule for Digital Broadcasting in Japan.

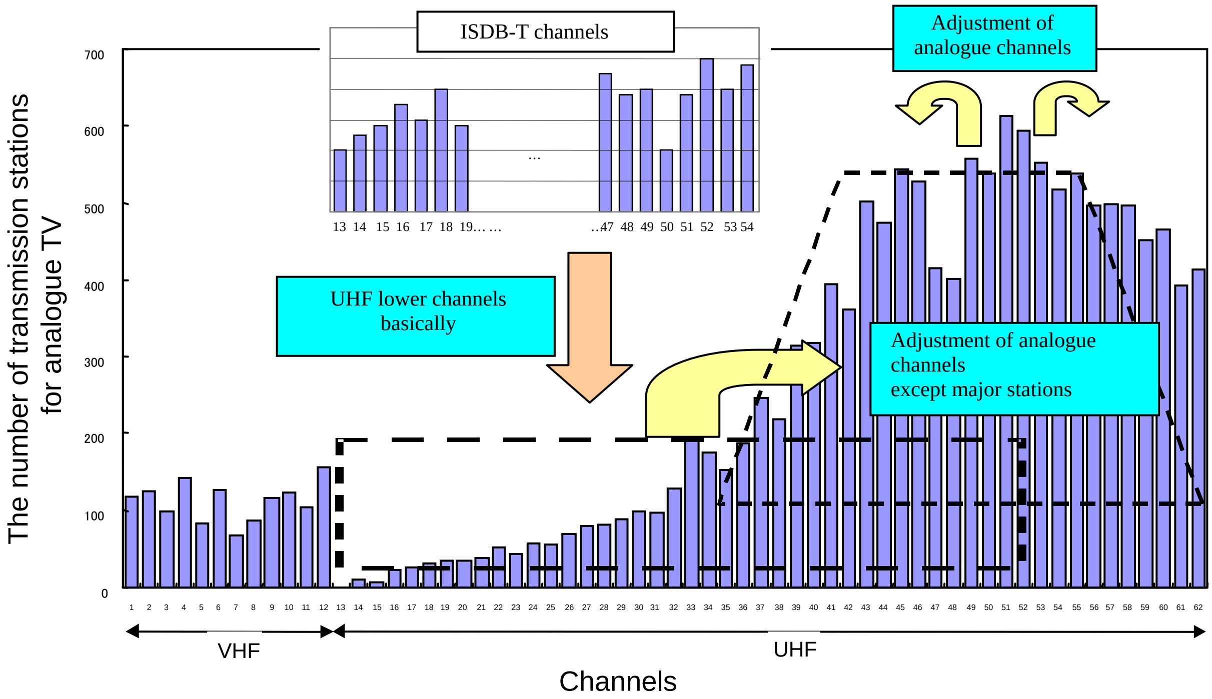
Digital terrestrial broadcasting was launched in December 2003 in Tokyo, Osaka and Nagoya metropolitan areas. And digital terrestrial broadcasting has started at the main cities in all other prefectures by the end of 2006. The service areas become wider step by step. Analog terrestrial television broadcasting will be terminated in 2011.



Frequency Situation

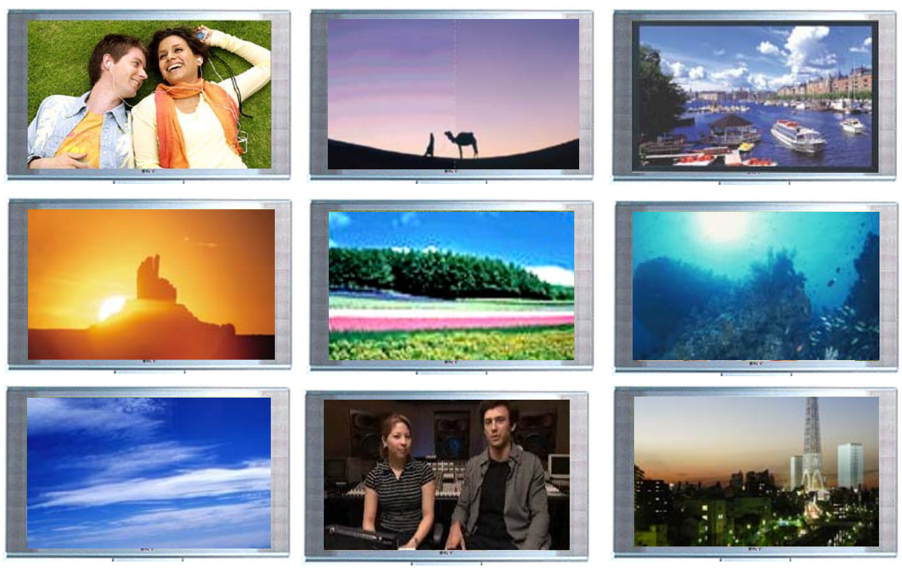
Analog terrestrial broadcasting utilizes MFN (Multi-Frequency Network), a transmission scheme that uses a different transmitting frequency in each service area. MFN requires the use of many transmitting stations to reach a national audience due to radio wave interference in each area covered by multiple radio signals. Approximately 15,000 transmitting stations for analog terrestrial television broadcasting were established throughout Japan. So there is not enough frequencies for digital television broadcasting.

The Japanese Government is undertaking a huge program which will cost around 180 billion Yen (applox. 1.8 billion US $) to move a quantity of analog television stations to the upper part of the spectrum in order to make free space of frequencies for digital television.



TV channels in Tokyo

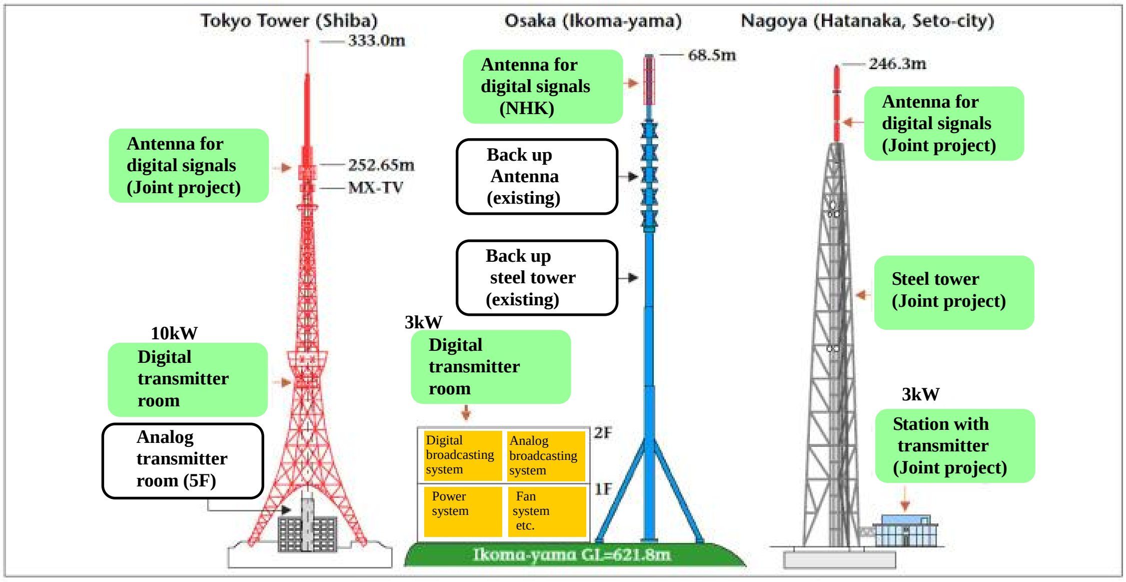
Nine digital TV channels was launched from Tokyo tower.



Nine ISDB-T channels in Tokyo area

Transmission Antennas

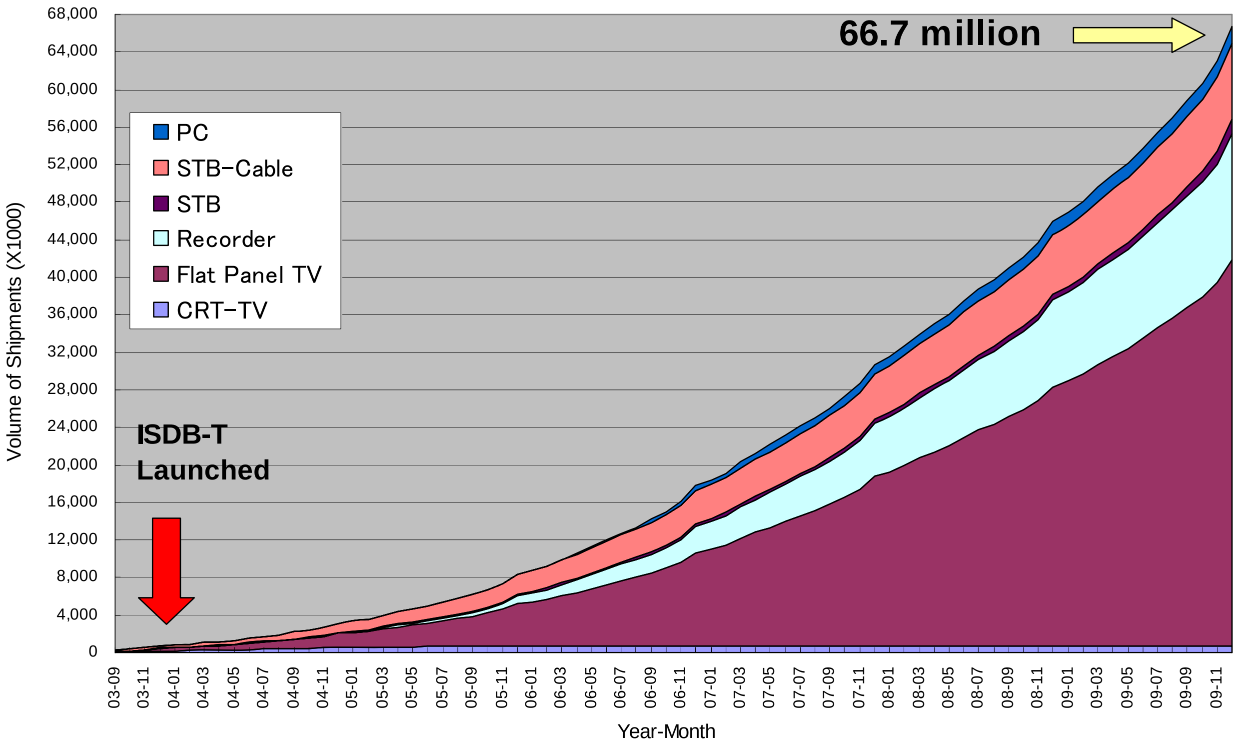
In the Tokyo area, broadcasters have placed new antennas at a height of 250 m on Tokyo Tower. A transmitter room was built under the tower's large observatory. In the Nagoya area, a new facility with a 246-m steel tower and a broadcasting station has opened in Seto city. In the Osaka area, broadcasters installed antennas on their own towers. An overview of these facilities is shown in Figure.



Tokyo/Nagoya/Osaka Digital transmitting facility overview

Shipments of ISDB-T receivers in Japan

Although digital terrestrial broadcasting has started Dec. 2003, over 66 million ISDB-T receivers have been shipped since the launch of the service. (50 million families in Japan)



Technical Characteristics of ISDB-T

ISDB-T takes into consideration compliance between television and sound broadcasting. ISDB-T with full segments serves digital terrestrial television broadcasting and ISDB-Tsb using one or three segments serves digital terrestrial sound broadcasting.

ISDB-T is also capable of providing data broadcasting consisting of text, diagrams, still pictures, and video image for handheld devices, in addition to high quality pictures and stereo sound. In contrast with digital satellite broadcasting, it is able to feature detailed local interest information. Furthermore, it has a great potential to diffuse mobile multimedia terminals, such as car radios and the pocket-sized receivers.

The following requirements were considered on the development of ISDB-T.

It should:
- be capable of providing a variety of video, sound, and data services,
- be sufficiently robust to any multipath and fading interference encountered during portable or mobile reception,
- have separate receivers dedicated to television, sound, and data, as well as fully integrated receivers,
- be flexible enough to accommodate different service configurations and ensure flexible use of transmission capacity,
- be extendible enough to ensure that future needs can be met,
- accommodate single frequency networks (SFN),
- use vacant frequencies effectively, and
- be compatible with existing analogue services and other digital services.

To comply with all the specified requirements ISDB-T took use of a series of unique tools like OFDM modulation system associated with band segmentation, which gives the system great flexibility and the possibility of hierarchical transmission, time interleaving which contributes to reach the necessary robustness for mobile and portable reception besides giving the system powerful robustness against impulsive noise and TMCC (Transmission and Multiplex Configuration Control) which allows dynamic change of transmission parameters in order to set the system for optimized performance depending on the type of broadcasting (HDTV, mobile reception, etc).

Those unique characteristics make ISDB-T able to provide a wide range of applications like the ones presented on next chapter.

Applications on ISDB-T

In this chapter some examples of applications on ISDB-T are shown.

HDTV program

Multi SDTV programs

EPG (Electronic Program Guide)

Data broadcasting

Internet access

All ISDB-T television receivers can access to the Internet.

HDTV Mobile reception

HDTV program broadcasted through ISDB-T system can be received even in mobile reception. Several car receivers are on the market.

One-Seg service : TV service for handheld/portable receivers

One-Seg TV service for cellular phones or portable TV receivers was launched in April 2006 in Japan. Such a terminal with a communications link will also be able to receive network-linked data broadcasting. For this kind of reception, we are studying new network-linked data broadcast services that combine data broadcasting and information that has been obtained through a communications network.

Human-friendly broadcasting services

Digital broadcasting has a variety of forms, from textual data and diagrams to regular video and audio data. It is intended to exploit this diversity to provide human-friendly broadcasting services that would be accessible to everyone, including the elderly and people with physical impairments.

Outline of ISDB-T transmission scheme, and related ARIB standards, ITU-R recommendations

Item			Contents	ARIB standards	ITU-R recommendations
Video coding			MPEG-2 Video (ISO/IEC 13818-2)	STD-B32	BT.1208
Audio coding			MPEG-2 AAC (ISO/IEC 13818-7)	STD-B32	BS.1115
Data broadcasting			BML (XHTML), ECMA Script	STD-B24	BT.1699
Multiplex			MPEG-2 Systems (ISO/IEC 13818-1)	STD-B10, STD-B32	BT.1300, BT.1209
Conditional access			Multi 2	STD-B25	—
Transmission			ISDB-T transmission	STD-B31	BT.1306 System C
	Channel Bandwidth		6MHz, 7MHz, 8MHz		
	Modulation		Segmented OFDM (13 segment / ch)		
	Mode, guard		Mode : 1, 2, 3 Guard Interval ratio : 1/4, 1/8, 1/16, 1/32		
	Carrier Modulation		QPSK,16QAM,64QAM, DQPSK		
	Error correction	Inner	Convolutional code (Coding rate : 1/2, 2/3, 3/4, 5/6, 7/8)		
		Outer	(204,188) Reed-Solomon code		
	Interleave		Frequency and time interleave Time interleave : 0 - 0.5 sec		
	Information bit rate (depends on parameters)		6MHz : 3.7 – 23.2 Mbit/s 7MHz : 4.3 – 27.1 Mbit/s 8MHz : 4.9 – 31.0 Mbit/s		
Receiver			ISDB-T receiver	STD-B21	—
Operational guideline			ISDB-T broadcasting operation	TR-B14	—

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