INFRASTRUCTURE

Field study on DIGITALIZATION OF TERRESTRIAL TELEVISION IN JAPAN

Report

Telecommunication Development Sector

Field study on digitalization of terrestrial television in Japan

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1 Executive summary

The digital terrestrial television service started in Tokyo, Nagoya and Osaka in December 2003. Since then, many relay transmitting stations have been built. While the coverage of digital terrestrial television was being expanded, public announcements regarding the digital transition, and promotion of the replacement of existing analogue television sets with digital television sets were carried out within the "All Japan" framework. As a result, analogue switch-off (ASO) was successfully completed in July 2011. It was decided that the Satellite Safety Net (SN), for those households that had not been able to replace their TV sets by the time of ASO, would be terminated in March 2015. Currently the final measures are being taken in order to ensure that everyone in Japan can enjoy the benefits of digital terrestrial broadcasting.

It was not an easy task to complete the ASO of 50 million households across the country, and Japan's achievement in this regard has become an example of successful ASO. All parties involved in ASO are proud of the achievement of implementing the deployment of digital terrestrial broadcasting while maintaining the existing analogue television services within the limited and congested spectrum available in Japan.

Japan's Digital Terrestrial Television System, ISDB-T, has an excellent feature that enables single frequency network (SFN), so that spectrum for digital television was reduced from 62 channels of VHF and UHF, to 40 within the UHF band. The vacated frequency ranges have been newly assigned to new services and mobile communications, such as LTE mobile phones, ITS and multimedia broadcasting, while TV white space is becoming available for radio microphone applications.

The aim of this report is to share the Japan experience of ASO, in the hope that this will provide a useful reference for administrations, broadcasters and other stakeholders in other countries when considering and proceeding towards their own ASO.

2 Digitalization of terrestrial television broadcasting in Japan

After 58 years of service, analogue terrestrial television had brought the development and maturation of television culture in Japan to a high level. However, the introduction of digital television marked the beginning of a new era. In the last 20 years, television has become more of a personal media, with the widespread adoption of PC and mobile phones. Furthermore, the integration of broadcasting and broadband Internet access has changed the television-viewing environment.

This report looks at the efforts made towards the completion of digitalization by 'Team Japan' (including government, broadcasters, and other key players) within a timeframe of just ten years.

3 Start of digitalization

In October 1998, The Advisory Committee on Digital Terrestrial Broadcasting, which was organized under the Ministry of Posts and Telecommunications, published a report entitled 'Formation of the new terrestrial digital broadcasting'. The report explained: the reasons for and necessity of digitalization, the benefits to the viewers, the form that it was anticipated that digital TV receivers would take, the support that would be provided by the government to viewers, and the regulatory measures that would need to be adopted.

- It was proposed that the service would start before the end of 2006 in 3 metropolitan areas: Tokyo, Osaka, and Nagoya.
- 6 MHz bandwidth for each channel should be assigned to HDTV broadcasting.
- It was suggested that it would be desirable to switch off the analogue terrestrial television signal by 2010.

Also, it was agreed that the basic channel allocation plans should be developed by December 1998 and completed by the autumn of 1999.

In order to complete the digitalization of terrestrial television in Japan, it was also agreed that:

- digitalization should be positioned as a national project;
- decisions should be made regarding the digital television system and frequency planning; and
- suitable services for new types of television and development of new television receivers would be urgently required.

Due to the limited spectrum availability in Japan and the rising penetration of cable television reception, it was decided that a step-by-step approach would need to be adopted to ensure a smooth migration to the new digital television environment.

4 Analogue switch-off set for 24 July 2011

According to the amended Radio Law enacted in 24 July 2001, analogue television broadcasting was to be terminated within ten years. Given this stipulation, broadcasters would need to terminate their analogue service by 24 July 2011. The ten-year countdown had thus started towards analogue switch-off.

On the face of it, ten years might seem long enough for the migration to digital television, however, considering the need to start digital terrestrial television service in the three major cities of Tokyo, Osaka and Nagoya in 2003, and in other urban areas in 2006, this timetable did not in fact allow much time to complete the migration in other parts of the country. Moreover, the construction of transmitting stations across the country, as well as ensuring adoption of digital television receivers, had to get underway well before the termination of the analogue service. Therefore, the “digital-analogue simulcast scheme” was introduced in order to accomplish the smooth migration to digital television.

Frequency for television broadcasting in Japan is fifty times more congested than in the United States. Even compared to the United Kingdom, the spectrum is as twice as congested in Japan. In order to secure enough frequency for both analogue and digital at the same time, NHK and 127 commercial broadcasters carried out analogue switch-off. For the new spectrum of digital television, traditional analogue frequency had to be reassigned in this short period of time.

5 Overview of ISDB-T

The Telecommunications Technology Council approved a working document towards a draft transmission system for digital terrestrial television on 24 September 1997. Then, on 24 May 1999, a draft system was adopted based on this working document and on the results of the field experiments by the Telecommunications Technology Council and the Association of Radio Industries and Businesses (ARIB). The final system was formulated in 24 May, 1999 after large-scale experiments. To regulate actual operation, the *Operational Guidelines for Digital Terrestrial Television Broadcasting* in (ARIB TR-B14) was published.

The following are the technical requirements for digital terrestrial television in Japan:

- availability of HDTV service;
- availability of Multi-channel SDTV service;
- availability of mobile service;
- contribution to effective spectrum utilization (SFN technology);
- flexible use of spectrum by segmentation structure;
- compatibility with satellite broadcasting service in terms of baseband signals;
- compatibility with terrestrial digital sound broadcasting;
- adoption of international standards.

Overview of the system:

- Name: ISDB-T (Integrated Services Digital Broadcasting - Terrestrial)
- Modulation:
  - segmentation multi-carrier OFDM;
  - DQPSK, QPSK, 16QAM and 64QAM selectable at segment level for fixed and mobile reception;
  - bandwidth: 5.6 MHz with maximum of 23.234 Mbit/s;
  - TMCC (Transmission and Multiplexing Configuration Control) available;
- Multiplex system: MPEG-2 Systems;
- Video coding: MPEG-2 Video;
- Audio coding: MPEG-2 AAC Audio.

Table 1 – Operation parameters

No. of segments	Reception	Parameters	Bit-rate	
12	Fix	64QAM Inner Code Rate: 3/4 GI: 126 µs	16.8 Mbit/s	• HD Video 14 Mbit/s • Audio 0.5 Mbit/s • Data 1.5 Mbit/s • EPG 0.6 Mbit/s • ES 0.2 Mbit/s
1	Portable	QPSK Inner Cod Rate: 2/3 GI: 126 µs	416 kbit/s	• Video 224 kbit/s • Audio 55 kbit/s • Data 80 kbit/s • EPG 20 kbit/s • Caption 5 kbit/s • Others 32 kbit/s

Table 2 – Transmission parameters for ISDB-T in Japan

	Mode 1		Mode 2		Mode 3	
No. of Segments	1	13	1	13	1	13
Bandwidth	428.57kHz	5.575MHz	428.57kHz	5.573MHz	428.57kHz	5.572MHz
Modulation	OFDM					
Carrier Modulation	QPSK、DQPSK、16QAM、64QAM					
Carrier Spacing	3.968kHz		1.9841kHz		0.99206kHz	
No. of Carriers	108	1405	216	2809	432	5617
Segment Bandwidth	6MHz/14=428.57…kHz					
Effective Symbol Rate	252µs		504µs		1.008ms	
GI	63(1/4), 31.5(1/8) µs 15.75(1/16), 7.875(1/32) µs		126(1/4), 63(1/8) µs 31.5(1/16),15.75(1/32) µs		252(1/4), 126(1/8) µs 63(1/16), 31.5(1/32) µs	
Inner Code Rate	1/2, 2/3, 3/4, 5/6, 7/8					
Outer Code Rate	Reed Solomon (204, 188)					

Table 3 – Transmission rate (13 segments)

Carrier Modulation	Code Rate	Num of TSP (Mode 1/2/3)	Capacity (Mbit/s)			
			GI 1/4	GI 1/8	GI 1/16	GI 1/32
DQPSK QPSK	1/2	156/312/624	3.651	4.056	4.295	4.425
	2/3	208/416/832	4.868	5.409	5.727	5.900
	3/4	234/468/936	5.476	6.085	6.443	6.638
	5/6	260/520/1040	6.085	6.761	7.159	7.376
	7/8	273/546/1092	6.389	7.099	7.571	7.744
16QAM	1/2	312/624/1248	7.302	8.113	8.590	8.851
	2/3	416/832/1664	9.736	10.818	11.454	11.801
	3/4	468/936/1872	10.953	12.170	12.886	13.276
	5/6	520/1040/2080	12.170	13.522	14.318	14.752
	7/8	546/1092/2184	12.779	14.198	15.034	15.489
64QAM	1/2	468/936/1872	10.953	12.170	12.886	13.276
	2/3	624/1248/2469	14.604	16.227	17.181	17.702
	3/4	702/1404/2808	16.430	18.255	19.329	19.915
	5/6	780/1560/3120	18.255	20.284	21.477	22.128
	7/8	819/1638/3276	19.168	21.298	22.551	23.234

* 1/13 for each segment
* Grey background shading denotes current operation parameters

6 Channel plan under the 'All Japan' framework

The channel plan for nationwide digital terrestrial broadcasting nationwide had first been established as the Ministry of Posts and Telecommunications draft in 1998. This was the first draft of the channel plan for master stations and about 550 large-scale relay stations. In 1999, a joint study group to advance the channel plan based on the Ministry of Posts and Telecommunications draft (including representatives of the Ministry of Internal Affairs and Communications, NHK, and commercial TV stations) was launched.

The first challenge was with regard to SFN. A conventional network based on the analogue television model would not work in all instances because of the need for microwave relay in some cases (for time synchronization between the transmitting stations). Generally, construction of a microwave point-to-point network costs more, and the licensing procedure for these microwave stations raised concerns regarding possible delay in construction of the digital television network. Therefore, it was decided that a multi-frequency network (MFN) could also be introduced on a case-by-case basis. With the use of MFN, the original channel plan, which only used channels 14 to 33 in UHF, would have to be revised. In light of this decision, and in order to achieve the transition in the short period of time available, a new channel plan was developed that allowed for the use of the whole UHF television band.

In July 2007, the Joint Council to Promote Terrestrial Digital Broadcasting took over from the joint study body that had been formed by MIC, NHK and commercial broadcasters, and regional councils were also organized in each region. This nationwide structure accelerated both the channel plan development and detailed consideration of the planning of the digital television network.

7 Small-scale station channel plan and roadmap

In addition to 550 large-scale stations, more relay stations needed to be built in order to realize the required wide coverage. In December 2004, the Small-scale Channel Investigation and Channel Promotion TG was established in order to ensure coverage for the whole country, including mountainous area. The main task of the TG was to analyze the coverage area of the 550 large-scale stations, the number of small area relay stations (gap fillers) required, and the available frequencies for those stations.

The results of the TG's investigations indicated that an additional 1 500 digital small-scale stations were required. Combined with the 550 large-scale key stations, in total 2 100 new stations were required. By way of comparison, NHK had provided analogue broadcasting through 3 400 relay stations covering all of Japan. The relatively small number of new stations (2 100) given above reflects digital television relay station resistance to "ghosting," as well as the results of measures taken to minimize the number of new stations needed by digitalizing the existing equipment that was already being used as community antennas in poor-reception areas.

The above deployment plan of 2 100 new stations was tabulated, together with a timeline and a zoning plan, resulting in the formulation of the relay station roadmap. The first version was issued in April 2006, and the roadmap was updated as necessary until December 2010. The roadmap represented a commitment to the construction of new relay stations all over Japan.

8 Analogue television frequency conversion

In August 2001, the Association of Radio Industries and Businesses (ARIB) was designated as the organization that would be responsible for conducting the analogue television frequency conversion. To support implementation of analogue television frequency conversion, reception support centres were established at the target areas of analogue television frequency conversion, so as to inform viewers of the necessary reception measures, receive and process applications for subsidies, and provide consultation to individual customers.

The construction of new digital relay stations continued in parallel with the analogue television frequency conversion, with particular attention being paid to preventing frequency interference, which requires the consideration of triple interference structures after analogue television frequency conversion, namely analogue-analogue wave interference, digital-analogue wave interference, and digital-digital wave interference, when formulating plans. In light of the above, the National Council vigorously investigated the relevant measures and expenditures, and in August 2002 reported that the project would have a budget of 180 billion yen, covering 801 target stations and 4 260 000 target households. Based on this estimation, the Japanese government decided to proceed with analogue television frequency conversion.

While regional Councils to Promote Terrestrial Digital Broadcasting provided practical support, broadcasters implemented the measures necessary for transmission, such as changing channel specifications at relay stations. Once a given region had completed the measures necessary for transmission, this was followed by the measures necessary for reception.

The measures necessary for reception included ensuring sufficient provision of information to viewers in the target areas in advance, as well as responding properly to inquiries after the frequency conversion. Later, however, it was discovered that many people phoned the centre only after their TV set started showing no picture after the frequency conversion. This experience was noted, as a reference for the future measures to be taken at the coming termination of analogue broadcasting.

It took almost five years, until March 2007, to complete the analogue television frequency conversion. Despite there being so many complicated factors to deal with, the conversion was successfully completed without significant confusion that could adversely affect the schedule for the transition to full-scale digital broadcasting.

9 Construction of digital terrestrial television network

To launch digital terrestrial television broadcasting, a master station must first be established within the target area to transmit digital radio waves. In Japan, digital broadcasting was started in Tokyo, Nagoya, and Osaka in 2003. This was rapidly followed by an extension of the area served to include all prefectural capitals in Japan by December 2006. In terms of construction management, the ideal situation would have been to spread the construction work out evenly over the implementation schedule. However, due to having only a limited amount of time available before the scheduled completion date, most of the work ended up being carried out towards the end of the implementation period, in the latter half of 2006. Especially in Western Japan, it was a race against time, because the region had so many frequencies in operation. Construction of digital master stations could be started only after finishing the analogue television frequency conversion.

In the event, digital terrestrial television broadcasting from the master stations all over Japan commenced successfully at the end of 2006 as scheduled. The next task was to build a large number of new digital relay stations. Regarding the construction schedule, a commitment had already been made to viewers in the form of the roadmap, and this commitment had to be honoured.

Although the overall number of new digital stations that needed to be established was smaller than the number of existing analogue stations, the actual period available for construction was limited to only four years between 2007 and 2010. The timetable required NHK to build more than 720 relay stations in the peak year of 2010. That is to say, NHK needed to open two new stations every day for a year, without any delays. During the peak period of analogue broadcasting expansion, NHK had built a maximum of 239 stations a year. It can thus be seen that the construction schedule was unprecedentedly challenging.

Notwithstanding the above, by December 2010, having overcome many difficulties, NHK had successfully completed the deployment of 2 100 new relay stations. Although this task was a NHK responsibility, the project could not have been accomplished without extensive support from all parties concerned.

10 Reception environment and promotion of receivers

While the new station construction described above is a basic responsibility for broadcasters, analogue broadcasting could not be terminated through this station-building work alone. To migrate to full-scale digital broadcasting, the development of the reception-side environment (as well as the widespread adoption of digital receiver equipment) was indispensable. In principle, these matters should be addressed by individual viewers, and owners or controllers of shared facilities. However, as a broadcaster, it was important for NHK to provide technical support, as well as disseminating information over the air as much as possible, in order to help ensure a smooth transition to digital broadcasting.

Reception environment varies according to the individual household, housing complex, building shadow community antenna, or remote area community antenna, and therefore the development issues that needed to be faced were highly complex. With its accumulated know-how in the area of reception consultation, NHK provided technical surveys and created ”reception prescriptions,” in addition to the provision of subsidies to assist in the modification of those facilities that were eligible for national government subsidies.

Regarding promotion of digital receivers, the most effective way for broadcasters to promote digital receiver adoption is to inform people through their broadcasts. However, this may result in an individual, uncoordinated approach to digital receiver adoption, which may be less effective. For this reason, NHK and other commercial broadcasters cooperated on the publicizing of relevant information. The approach started with the broadcasting of in-depth explanations of the merits of digital broadcasting and the significance of the transition from analogue broadcasting to digital broadcasting. At a later stage, the approach shifted to reminding analogue broadcasting viewers of the termination schedule of the analogue broadcasting service, by using an analogue superimposed message and repeating the termination announcement. At the time of the actual termination of analogue broadcasting, full-time superimposed messages as well as letter box size messages were aired. All these messages may have seemed like a nuisance to the viewers of analogue broadcasting at the time, but this was necessary in order to avoid confusion at the time of termination of analogue service.

At the same time, the efforts by the national government, focusing on the introduction of eco-points and subsidies to help economically-vulnerable people to purchase tuners, also contributed to the widespread adoption of digital receivers. (Refer to Chapter 14 for details.)

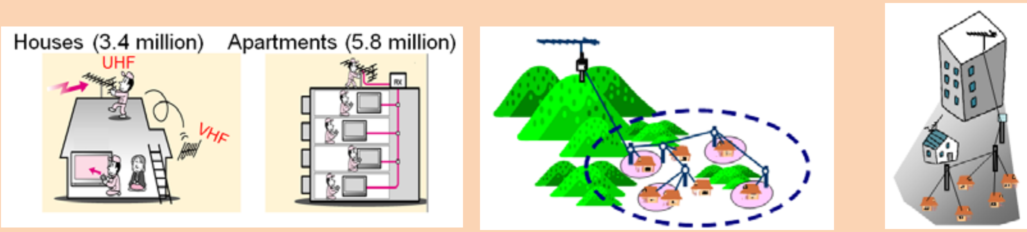
Digital receivers in households

To secure a better reception environment, establish a desirable reception system, and formulate appropriate promotion and migration strategies for digital broadcasting, NHK carried out a series of surveys on reception conditions. The survey conducted in July 2011 revealed that 99.1 per cent of households already owned digital terrestrial television broadcasting receivers. On 24 July 2011, with the exception of Iwate, Miyagi, and Fukushima prefectures, full-scale digital terrestrial television broadcasting started in Japan. On 31 March 2013, the same services started in the above three prefectures as well.

11 Three major obstacles faced in regard to analogue switch-off

There were three major difficulties faced in relation to the reception infrastructure for digital terrestrial television.

Figure 1: Three major obstacles towards analogue switch-off



Source: ITU

11.1 Conversion from VHF to UHF

In most regions in Japan, analogue broadcasting was originally implemented using both the VHF and UHF bands, but in some areas, including Tokyo, which has the largest population, the main analogue TV stations used only the VHF band. It was therefore necessary for many households in Tokyo and its suburbs to replace VHF antennas with UHF antennas. This included 3.4 million detached houses and 5.8 million households in apartments or condominiums, for a total of 9.2 million households.

11.2 Community reception in rural areas

In rural areas where over-the-air signals could not be received directly, community reception antennas had been built for analogue broadcasting. These antennas were located in places where signals from transmitting stations could be received. This part of the infrastructure, affecting approximately 0.8 million households, also needed to be converted to digital.

11.3 Interference caused by building shadows

There are many locations that require community reception systems because buildings create shadows blocking radio waves. The owners of these buildings were required to conduct technical surveys and share the costs of digitizing these systems. This process affected approximately 8 million households. Both the government and NHK provided financial and technical support to help resolve these issues.

12 Notification through Analogue TV Broadcasting

One of the most effective methods of generating publicity for the analogue-to-digital transition was having broadcasters make changes to analogue TV images in the stages shown in the table below. These changes made it easy for viewers to distinguish between analogue and digital TV services, and telephone numbers on the screen made it easy for them to contact the relevant call centre.

Figure 2: Notifications through analogue TV broadcasting

Stage | **Sample picture** | **Description**

1st stage
July 2008

Characters meaning "analogue" were superimposed on the top right of the picture.

2nd stage
July 2010

As an addition to the 1st stage, blanks serving as "letterboxes" were added to the top and bottom of the picture.

3rd stage
October 2010

As an addition to the 2nd stage, short messages to promote the digital transition were superimposed in the letterbox on the bottom of the picture.

4th stage
1 July 2011

As an addition to the 3rd stage, a message showing the countdown to the termination of analogue TV was superimposed on the picture.

5th stage
Noon, 24 July 2011

All broadcasters broadcast their final message announcing that analogue broadcasting would terminate when analogue transmitting was terminated.

6th stage
After 24 July 2011

Analogue transmitting was terminated.

Source: ITU

13 Inquiries to the call centres

To be able to respond appropriately to inquiries from viewers regarding the transition from analogue terrestrial broadcasting to digital terrestrial broadcasting, and to support their preparations in terms of the adoption of digital receivers, individual antennas, and community antenna facilities, MIC opened the digital terrestrial television broadcasting call centres.

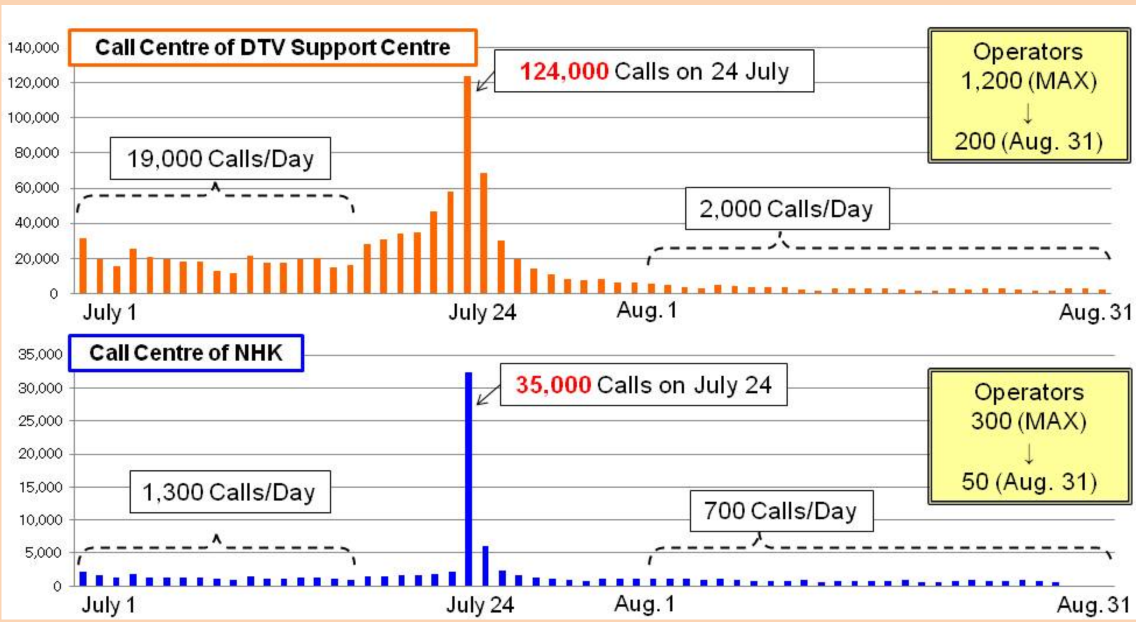
To respond to telephone inquiries at the expected peak period at the time of termination of analogue terrestrial broadcasting, NHK also enhanced the capacity of their call centres all over Japan around 23 July 2011, and in Iwate, Miyagi, and Fukushima prefectures in 31 March 2012, which resulted in a successful transition to digital terrestrial broadcasting without any serious trouble.

Table 4 – Call centre readiness at the time of termination of analogue broadcasting

	24 July 2011	31 March 2012
NHK ASO CC	300 operators	30 operators
NHK reception consultation CC	44 operators	20 operators
MIC DTTB C	1 225 operators	70 operators
NHK Crews for door-to-door reception consultation	600 crews	15 crews
Households	4 740 000 households	2 110 000 households

On 24 July the number of operators at sales call centres was increased to a peak level of 400. On both days, the capacities at local stations were increased.

Figure 3: Numbers of inquiries to DTV call centres

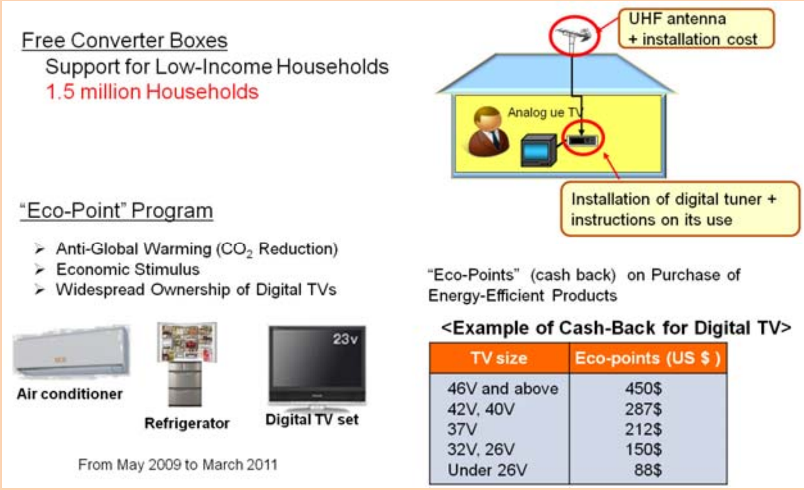


Source: NHK

14 Financial assistance

The Japan Government also provided assistance for purchasing digital television receivers. A digital tuner and antenna were delivered free-of-charge to 1.5 million low-income households. Also, an incentive programme involving "eco-points" was introduced to reward customers for purchasing eco-friendly products, including digital TVs. Eco-points could be exchanged for a coupon, so effectively this was a kind of rebate or cash-back programme. The amount of eco-points depended on the size of the TV and the energy efficiency of the individual products. For example, purchase of a TV larger than 46 inches resulted in points equivalent to USD 450.

Figure 4: Eco-points



Source: ITU

15 Actions in relation to new poor reception areas

Through the process of establishing the digital broadcasting network, a new issue emerged: the need to implement actions in relation to new poor reception areas. The above areas had no problem in receiving VHF analogue broadcasting before, but now experienced difficulty in receiving UHF digital broadcasting, due to the difference in the nature of the waves. The radio reception of such areas needed to be improved by providing digital relay gap filler stations, community antennas, or high-performance antennas. However, due to difficulties in finding available digital frequency before the termination of analogue terrestrial broadcasting, and problems with finding the best location for radio wave reception in mountainous areas, it became apparent that the countermeasures would not be available before July 2011. Many such areas had no alternative solutions such as CATV services or community antennas. Therefore, the only solution available was to provide satellite broadcasting on a temporary basis (the so-called Satellite Safety Net), which was in operation for five years up to March 2015. The intention was that, by the end of the period of implementation of the above temporary measures, permanent measures using terrestrial systems (land wave, community antenna, or CATV services) would have been established.

16 Satellite Safety Net

This was a temporary, supplemental measure adopted by the government until such time as the development of an adequate digital reception environment could be completed, in order to provide digital broadcasting programmes to viewers living in areas where there was no feasible means of developing a digital reception environment by the time of termination of analogue terrestrial broadcasting. More specifically, the measure consisted of two activities:

(1) retransmission of a total of seven channels (NHK general, NHK educational, and five commercial broadcasters) by using BS digital 17 channel, and

(2) providing support for viewers (except non-households and designated areas) who did not have BS digital receivers to acquire BS tuners and antenna.

The satellite service to poor reception areas was sponsored by government and broadcasters, and operated by the Association for Promotion of Digital Broadcasting (Dpa). The target areas were listed in the List of Poor Reception Areas Subject to Satellite Service (White List).

16.1 Outline of the Satellite Safety Net

The outline of the services set in accordance with the requirements of the Joint Council to Promote Terrestrial Digital Broadcasting was as follows.

- Seven channels (NHK general, NHK educational, and five commercial broadcasters) were simultaneously retransmitted by using the BS 17 channel.
- Picture quality was standard definition, available with closed-caption. Electronic programme guide (EPG) was available with programme titles only. No data broadcasting, no superimposed text, and no emergency alarm broadcasting were available.
- Simultaneous retransmission was continued from March 2010 to 31 March 2015. Support for viewers' acquisition of receiving equipment was continued from the issuing of the White List until the termination of analogue terrestrial broadcasting.
- The retransmitted programme was scrambled.
- Viewers were not charged a fee or required to pay any form of compensation (this applied also to the support for viewers' acquisition of receiving equipment).

The acceptance of applications for the Satellite Safety Net (Application at the Reception Centre for the Support for Receiving Equipment as a Temporary Satellite Measure and Use of Satellite Broadcasting for Poor Reception Area) was terminated on 31 March 2012 in 44 prefectures and on 30 November 2012 in Iwate, Miyagi, and Fukushima prefectures. Exceptional application, however, is still acceptable for some cases, such as moving into a White List area, or temporary use during a disaster situation.

16.2 Role of NHK in solving the problem of poor reception areas

The Satellite Safety Net was a temporary measure during the transition from analogue broadcasting to digital broadcasting, and its application was limited to the former analogue broadcasting areas. NHK, however, took this opportunity to also eliminate the absolute non-reception areas, so that regardless of the previous analogue broadcasting situation, applicants in the poor reception areas were given the opportunity to view the NHK digital terrestrial broadcasting programmes through the Satellite Safety Net.

16.3 Number of Subscribing Households of the Satellite Safety Net (as of 31 March 2013)

Table 5: Satellite Safety Net subscribing households

	Subscribing households (accumulated)	Actual subscribing households	Terminated subscription
White List areas and other poor reception areas	118 814 households	62 203 households	56 611 households
Temporary use	7 559 households	497 households	7 062 households

16.4 Approach to one-segment broadcasting after the termination of satellite safety net

- As of 31 December 2013, about 33 000 households needed a permanent measure to solve poor reception by the time of termination of satellite broadcasting for the poor reception areas (Satellite Safety Net) on 31 March 2015. About 1 600 households among the above were too scattered to install community antenna or too remote to maintain relaying facilities.

- Therefore, the Joint Council to Promote Terrestrial Digital Broadcasting decided to adopt one-segment broadcasting, which had low picture quality but was receivable at low electric field, as a permanent measure (One-Segment Measure) for these 1 600 households, because broadcasting was absolutely necessary to provide regional information in view of disaster response requirements.
- In principle, implementation was to be carried out before the end of the 2013 financial year. Regional councils explained the One-Segment Measure to local municipalities and communities, and started door-to-door visits to the target households to confirm their decision from July 2013 onwards.

17 Digital television support centre (Digi-Suppo)

Recognizing the need for everyone to have a sufficient understanding of how to address the transition to digital terrestrial broadcasting and how to prepare to develop the necessary reception environment, MIC established the first 11 MIC Digital Television Support Centres (Digi-Suppo) (as well as a headquarters) throughout Japan on 1 October 2008, to provide detailed advice and information regarding the actions necessary to address the transition to digital terrestrial broadcasting in light of local conditions. Subsequently, on 1 February 2009, the number of Digi-Suppo was extended to cover all prefectural capitals, and at its height extended to 52 centres (including Digi-Suppo Suzu and the headquarters). After the termination of analogue terrestrial broadcasting, the number of centres in Japan was decreased to ten; these ten centres would continue to support the permanent measures for poor reception areas that had been temporarily using the Satellite Safety Net. NHK provided maximum support to the Digi-Suppo by sending more than 100 staff members to each centre (as of 31 December 2013, 34 staff members including 22 full-time active employees) and providing the know-how on reception consultation at each centre.

The full-scale operation of Digi-Suppo was started by the Association for Promotion of Digital Broadcasting, commencing in 2009. The organization promoted full-scale transition to digital broadcasting from 24 July 2011, by delivering community-based activities such as supporting aged people and handicapped people. After the termination of analogue broadcasting, the organization was mainly engaged in reception improvement related to repacking, surveying and supporting poor digital reception areas.

17.1 Receiving-side actions in relation to newly found poor reception areas

Digi-Suppo provided permanent measures on the receiving side, such as installation of community antenna and high-performance antenna, or transition to cable TV services, based on the action plan formulated by the regional council. More specifically,

- Provision of technical support necessary for receiver-side actions such as general designing and receiving location surveys.
- Subsidy to finance the expenses for the measures taken according to the plan to eliminate poor reception areas (such as installation of high-performance antennas, transition to cable TV services, and creation of community antenna facilities).
- Continued cultivation efforts by repeatedly reminding people directly through the subscribers of the Satellite Safety Net, in cooperation with the Satellite Safety Net Office.

17.2 Actions against digital interference and repacking frequency

Digi-Suppo provided solutions for digital interference due to phasing and foreign waves by improved repacking of frequency and receiver-side actions.

- Surveys of the digital broadcasting reception environment as influenced by landscape, long-term on-site surveys (phasing interference), and digital interference in the areas suggested by computer simulation.

- Modification of community antennas, measures on receiver antennas, and rescanning of receivers in association with transmission changes in improved repacking. (Refer to Chapter 18 for the details of repacking.)
- Provision of assistance in filter installation, measures on high-performance antennas, and transition to cable TV services in connection with measures against digital interference on the receiver side.
- Handling of related subsidies

17.3 Reception consultation and door-to-door surveys

Digi-Suppo provided consultations in relation to individual and professional inquiries received through the Digital Terrestrial Television Broadcasting Call Centre, regional bureaux of telecommunications, and local municipalities. It also provided consultations in regard to the problems associated with poor reception at the regional level.

17.4 Subsidy to community antenna to counter interference, and digitalization of housing complexes

To complete the digitalization process within a limited timescale, the organization subsidized a part of the related repair expenditure. The following operations were terminated at the end of analogue broadcasting:

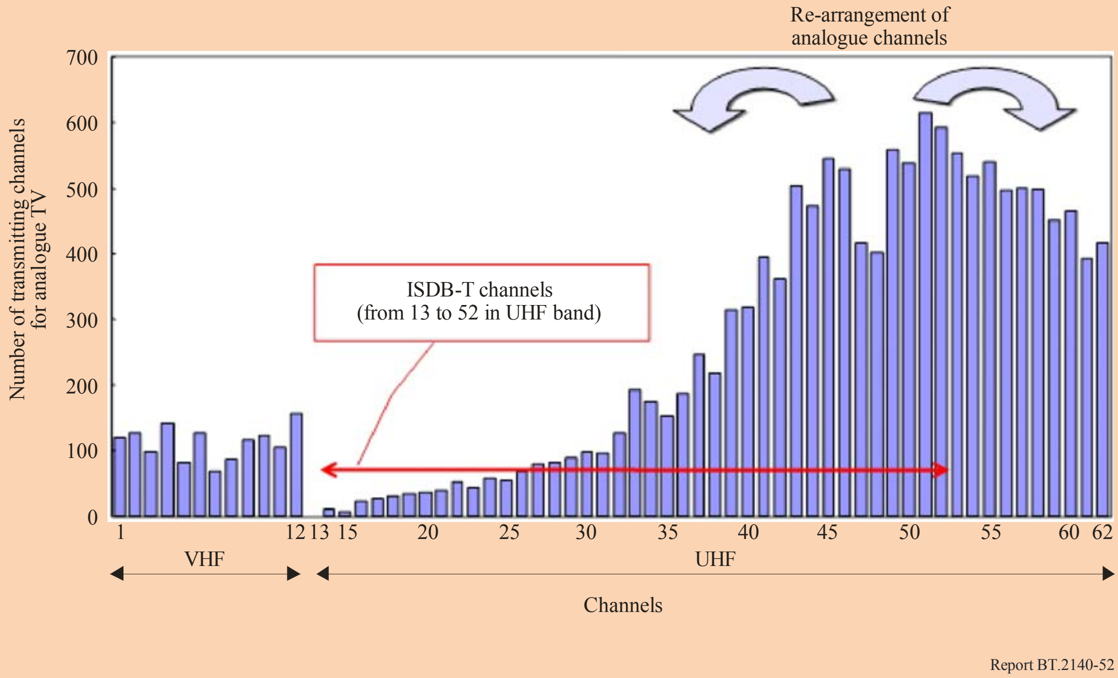
- legal consultation and mediation regarding buildings located near a community antenna;
- provision of consultation and mediation by professional legal advisers in cases where a dispute occurred among concerned parties regarding the installation of community antenna as a measure to solve poor reception;
- investigation and analysis regarding the transition to digital terrestrial television broadcasting;
- twice-a-year sampling survey covering the whole of Japan to check viewers' understanding of digital terrestrial television broadcasting;
- detailed explanation and door-to-door visits;
- provision of correct information, active encouragement to shift to digital broadcasting, and provision of technical support through community meetings and door-to-door visits to aged people and handicapped people.

18 Repacking for rearrangement and improvement

Changing the transmission channels of digital terrestrial broadcasting was called channel repacking, of which there were two types: rearrangement and improvement.

Rearrangement repacking was performed to reassign channels 53 to 62 to channels under 52 within one year after the termination of analogue broadcasting. Improvement repacking was performed to mitigate the problem of digital interference created by frequency congestion.

Figure 5: Rearrangements of digital broadcasting frequencies



Source: ITU

18.1 Rearrangement repacking

Due to frequency congestion during the overlapping period of analogue and digital broadcasting, digital terrestrial television broadcasting used the UHF band (channels 13 to 62). To use frequency resources efficiently in the future, digital broadcasting needed to vacate channels 53-62 and use only channels 13 to 52 after 25 July 2012. Accordingly, the relay stations using channels 52 to 62 needed to be reassigned to channels under 52 within one year from the termination of analogue broadcasting in July 2011 (between 25 July 2011 and 24 July 2012).

Due to the devastation caused by the Great East Japan Earthquake and Tsunami on 11 March 2011, and subsequent difficulties in developing the reception environment of digital terrestrial television broadcasting by 24 July 2011, Iwate, Miyagi, and Fukushima Prefectures were exempted from the above schedule. In light of this situation, a special provision to extend the termination of analogue broadcasting one year up to 24 July 2012, *Act on Special Provisions for Radio Act Regarding Digital Terrestrial Television Broadcasting in Consequence of the Great East Japan Earthquake and Tsunami,* was enacted on 15 July 2011, with a partial change to the expiration of analogue broadcasting frequencies. Accordingly, it was decided that (1) the period of use of analogue terrestrial broadcasting frequencies for Iwate, Miyagi, and Fukushima Prefectures would be extended up until 31 March 2012, and (2) the period of use of channels 52 to 62 of digital terrestrial broadcasting frequency, which were needed for repacking, was extended from 24 July 2012 to 31 March 2013 for Iwate and Miyagi Prefectures.

The above rearranging repacking was completed on 18 January 2013.

Table 6: Relay stations subject to rearrangement repacking (January 2013)

	All broadcasters	NHK
Number of affected stations	65 stations	42 stations
Number of affected channels	130 channels	61 channels
Number of affected households	540 000 households	440 000 households

18.2 Improvement repacking

Regarding reception failure due to digital interference, each regional council identified the affected areas and formulated its own action plan (Action Plan to Address Poor Reception Area for Digital Terrestrial Television Broadcasting). Changing transmission channel to eliminate interference was called improvement repacking. In 2013, such repacking was planned at Seihi-Oshima Station (Nagasaki) on January 13 and at Rebun Station (Hokkaido) in October. In the improvement repacking, the elimination of not only domestic radio waves, but also neighbouring country radio waves, was included.

Table 7: Relay stations subject to improvement repacking (January 2013)

	All broadcasters	NHK
Number of affected stations	39 stations	31 stations
Number of affected channels	127 channels	50 channels
Number of affected households	1 090 000 households	950 000 households

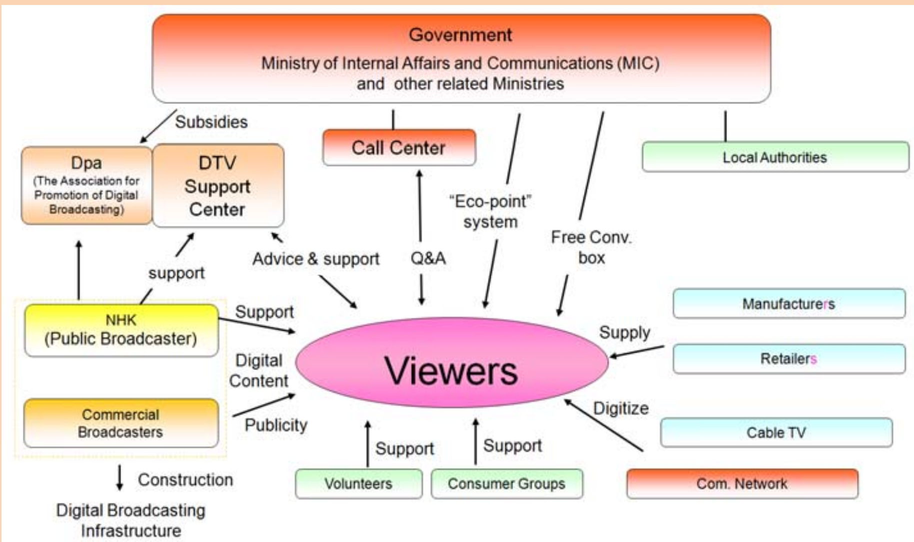
Principal operators

Measures on the transmitting station side (i.e. changing transmitting channels at the relay station and receiving channels at the downstream station) were implemented by broadcasters, with financial assistance from government. Measures on the receiver side (i.e. channel scan (resetting) of individual subscriber digital receiver or the community antenna in the area) were implemented by government (Digi-Suppo).

19 Keys to the Success of ASO

Various stakeholders in Japan worked on different aspects of the transition to digital for the benefit of viewers. The stakeholders participated actively, and cooperated closely, to support the transition, as a result of which the transition was completed without incident. About 4 000 people (including volunteers) worked with 360 staff members of the DTV support centres, and an additional 4 000 operators were on the line at the call centres on 24 July. Broadcasters took responsibility not only for building transmitting stations but also for publicizing the digital transition. Manufacturers, retailers, and Cable TV companies, played a very important role in promoting digital TV as well. The Japanese government and NHK drew up several plans to solve difficulties, and provided both financial and technical support.

Figure 6: Stakeholders of Transition to DTTB in Japan



Source: ITU

20 Conclusion

Digital terrestrial television broadcasting (full-scale technical research on which started in the 1990s) is now entering the final stage of adoption.

With digital television broadcasting, household television sets are tending to become larger and thinner, providing viewers with high-quality images and sound through the medium of high-definition television. At the same time, one-segment broadcasting allows viewers to access networks anytime, anywhere, in addition to interactive programmes, through connection to the Internet.

The ISDB-T digital terrestrial television broadcasting system developed by Japan is already being adopted in other parts of the world, mainly in Asian and South American countries. In addition, the ISDB-Tmm system, a mobile multi-media broadcasting system that is closely related to ISDB-T, has started services in the VHF band. Japan's experience, however, will not be limited to be applied to other Administrations adopted other DTTB systems. Japan hopes that this report will provide a useful reference for administrations, broadcasters and other stakeholders in other countries when considering and proceeding towards their own ASO.

Appendix 1: DTTB network construction technique for ISDB-T[1]

1 SFN network design

1.1 Introduction

DTTB networks can be constructed using various signal distribution methods to distribute the signal to the relay stations. Microwave links, referred to as station-to-transmitter link (STL), transmitter-to-transmitter link (TTL), or broadcast wave (off-air) relay, are mainly used for this purpose. The relay system is an important factor that determines the characteristics of the transmitter facilities and the quality of the transmission signal. When deciding on the relay system, the technical considerations that must be taken into account include the need to maintain the long-term reliability and stability of network operation and broadcasting reception in the service area. After the necessary assessment of the transmission signal quality, a suitable relay system is chosen, taking into account the cost of building the facilities and of long-term maintenance.

When considering a relay system, first the quality of the relay network is estimated based on the signal quality of the upper node station and on the field strength of interference calculated by the simulation and the propagation characteristics calculated on the basis of past measurement results.

Next, the field measurement results of the incoming waves, such as the desired signal, interference, and multipath signals, are considered and reflected in the simulation results. Since the measurement investigation can facilitate comprehension of individual propagation situations such as interference due to mountain reflection, such investigation is indispensable when deciding on a relay system.

To maintain entire DTTB networks at a given quality level, the whole relay system should be decided on using common criteria.

This Annex outlines how to determine a relay system between a relay station and its upper node station, along with single frequency network (SFN) delay time adjustment design.

In this Appendix, unless specified otherwise, the following ISDB-T transmission parameters[2] are used:

Table A1.1: Transmission parameters of ISDB-T

Transmission parameter	Value
Mode	3
Modulation method	64-QAM
Inner channel code	3/4
Guard interval duration	1/8 (126 μs)
Inner interleaving	2

2 Selection of signal distribution system

2.1 Overview of signal distribution system considerations

There are four major methods for distributing a signal from the studio or upper node station to the transmitting station. Broadcast wave relay system and microwave, satellite and optical fibre links are commonly used for the construction of a DTTB network. Developing channel plans is essential, and these plans should be developed prior to choosing the method for sending signals to relay stations. Taking into account the delay adjustment for an SFN and the propagation characteristics of the broadcast wave relay

[1] For further information, see Report ITU-R BT.2294. Construction technique of DTTB relay station network for ISDB-T.

[2] For further information, see Recommendation ITU-R BT.1306 Error correction, data framing, modulation, and emission methods for digital terrestrial television broadcasting.

between stations, the most appropriate and cost effective means should be chosen. If the microwave link or TTL is chosen, the channel plan for the microwave link should also be arranged.

To determine the relay system at the relay stations, simulations and field tests should be conducted, and the results (properly reflecting the quality of the link) should be considered.

2.1.1 Broadcast wave relay system

A broadcast wave relay system is usually the most cost-effective method of constructing a relay station network. A relay station receives the DTTB signal from its upper node and retransmits the signal to its service area. Since this system uses the signal of its upper node station, the network is relatively small, due to the distance between the stations in the network.

2.1.2 Microwave link

Links from the studio to the transmitting station and from the transmitting station to another transmitting station are called Studio to Transmitter Link (STL), and Transmitter to Transmitter Link (TTL), respectively. A microwave link is used when signal quality needs to be maintained or when delay time adjustment is required.

2.1.3 Satellite link

A satellite link can be the most efficient way to distribute signals via satellites from the studio to the transmitting stations in various locations. This system's construction stage costs less, but the satellite operation costs, such as transponder usage cost, may be higher than for other systems.

When wide areas need to be covered, satellite links make the distribution more cost-effective than microwave or optical fibre networks. Besides the fact that it is possible to reach many stations with a single signal, satellite is, in many cases, the only way to feed relay stations that are far from the head-end. Sun transit of the satellite, on the other hand, raises the reception noise level and may cause interruption of service. Also, variation in satellite position may disturb the SFN conditions between transmitting stations. These phenomena should be taken into account.

2.1.4 Optical fibre link

Optical fibre links can be used as the medium for distributing digital TV signals, or can operate together with microwave links on a main/stand-by basis, maintaining signal quality and permitting delay time adjustment on an SFN as well. It should be borne in mind that route switching may change the transmitting timing of the station, which affects the SFN conditions.

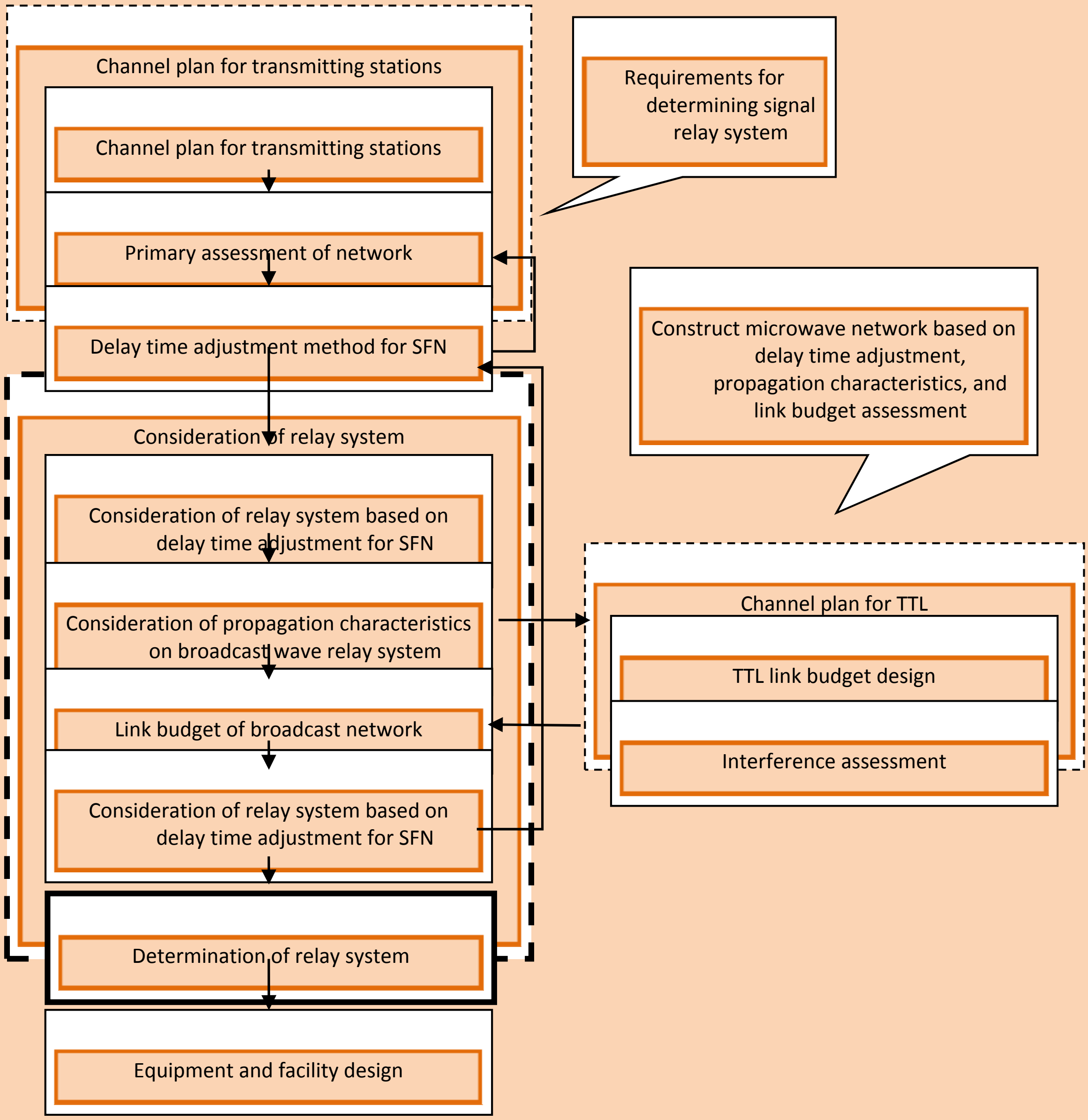
2.2 Requirements for selecting the relay system

2.2.1 Channel plan for transmitting stations

The channel plan should determine the transmission specifications of the relay stations. Transmission specifications include the transmission power, the directivity of the transmission antenna, and the height of the antenna needed to satisfy the service area. Then, the transmission channel can be chosen by considering the interference with other stations, taking into account the above transmission conditions.

In the ISDB-T network, SFN construction would be feasible, even though the protection ratio between stations with the same signal could not be satisfied. Therefore, the delay time adjustment and the network topology are also considered in the selection of the relay system.

Figure A1.1: Flowchart of selection of relay system

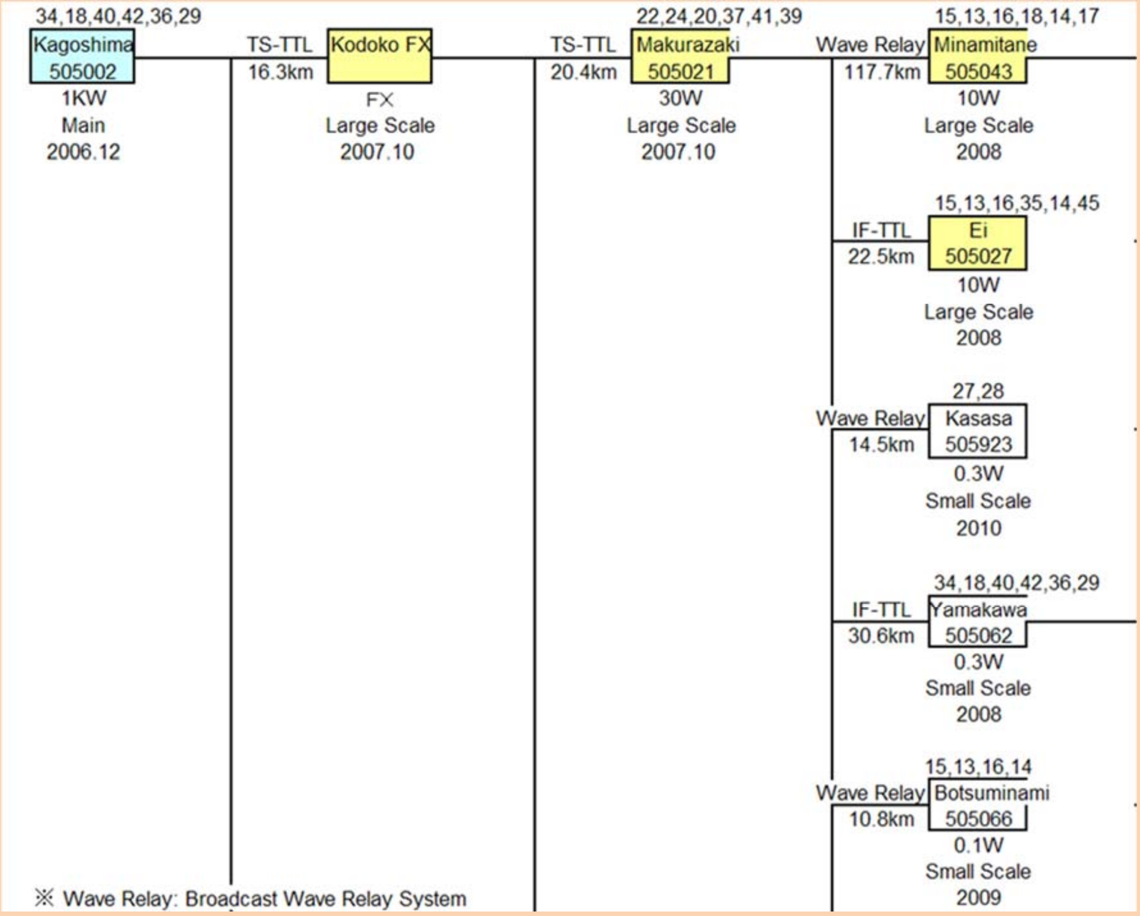


Source ITU

2.2.2 Primary assessment of broadcasting network construction

A network identical to the existing analogue television network is the first step when considering the construction of the broadcasting network. Figure A1.2 shows an example of a part of the network structure in Kagoshima prefecture, on the island of Kyushu in southern Japan.

Figure A1.2: Example of broadcasting network structure in Kagoshima



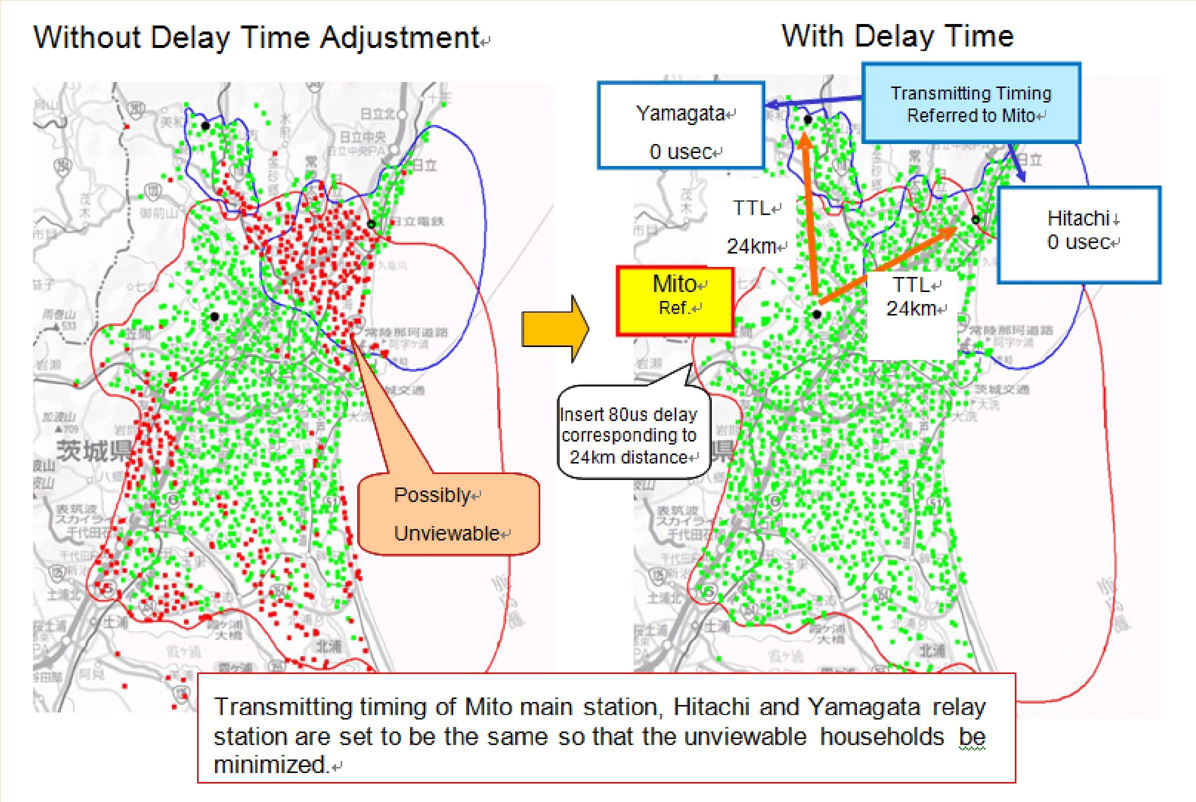
Source: ITU

2.2.3 Delay time adjustment design for SFN

The SFN is a network constructed with an identical signal on the same frequency transmitted from a different location. To ensure precision in the SFN transmission frequency, Inverse Fast Fourier Transform (IFFT) sampling frequency precision and transmitting waveforms are required. Also, all the signals in the service area should reach the reception point within a certain period of time, called the guard interval (GI). A signal arriving at the reception point after the GI is treated as an interfering signal. If the signal over the GI is strong enough, then the signal will not be decoded properly. To avoid this situation, the transmitting timing is adjusted; this is called delay time adjustment of SFN.

Figure A1.3 shows an example of the delay time adjustment of an SFN in the Mito area, near Tokyo. The delay time depends upon the transmitting location, the field strength at the reception points, and the type and direction of reception antennas. It is important to minimize the number of households that cannot receive the signal properly, by means of a computer simulation. The transmission delay time to minimize the number of households that cannot receive the signal is called the SFN delay time adjustment design. Delay time adjustment is required each time the transmitting timing changes, and is implemented by adding equalizers to the transmitter.

Figure A1.3: Example of SFN delay time design at Mito Station



Source:ITU

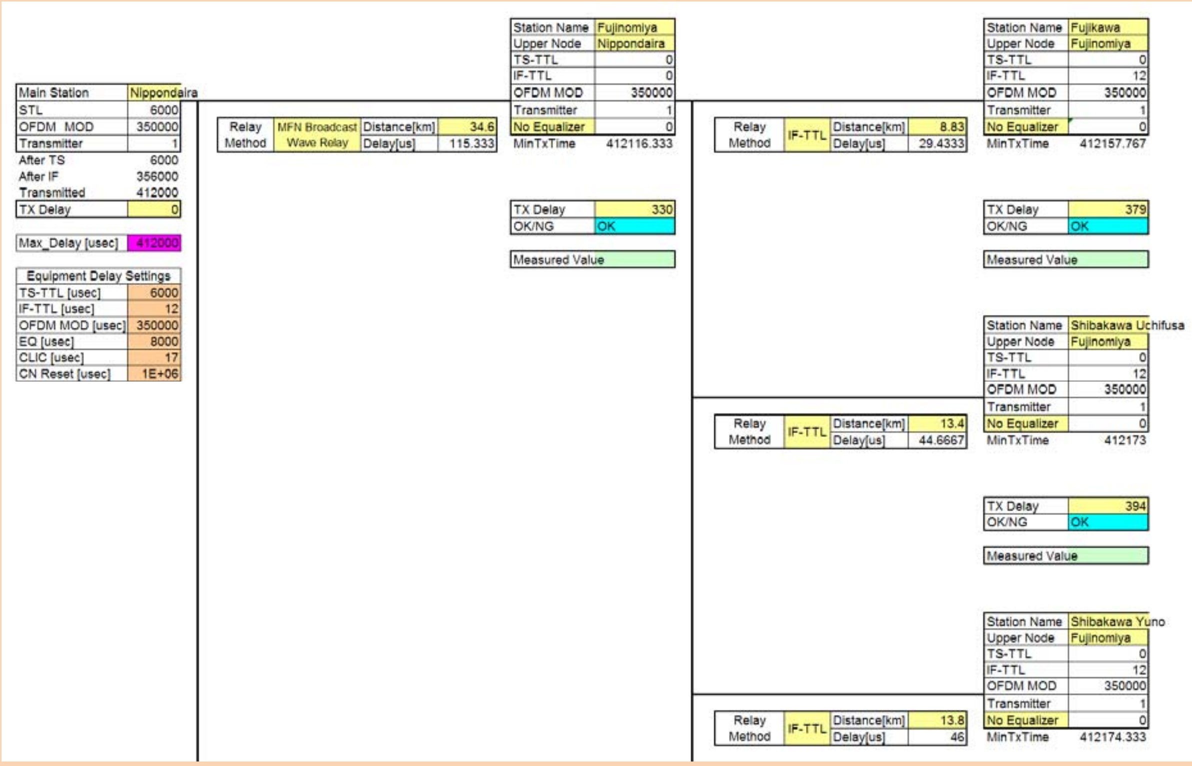
2.3 Consideration of relay system

The broadcast wave relay system, which receives the UHF DTTB signal from the upper node station, is the preferred choice because it is considered to be the most cost-effective. However, other systems could be considered if the broadcast wave relay method is not feasible (due to the SFN design or the quality of the UHF receiving signal not being sufficient).

2.3.1 Consideration of relay system based on delay time adjustment for SFN

In the SFN delay time adjustment design, all types of delay time, including the delay caused by the transmitting equipment (such as equalizers), must be considered. For the assessment of the delay time adjustment, a delay time check sheet could be used. Figure A1.4 is an example of the sheet for Shizuoka Prefecture.

Figure A1.4: Example of time delay check sheet for Shizuoka Prefecture



Source: ITU

The transmission delay time of each relay station is shown as the time relative to the maximum allowable delay time. One example of the maximum allowable delay time used successfully in Japan is 412 ms, and this time is used in the following section. Usually, the main station is set as 0 µs as a reference. The feasibility of the network structure can be checked by entering all the necessary data in the sheet.

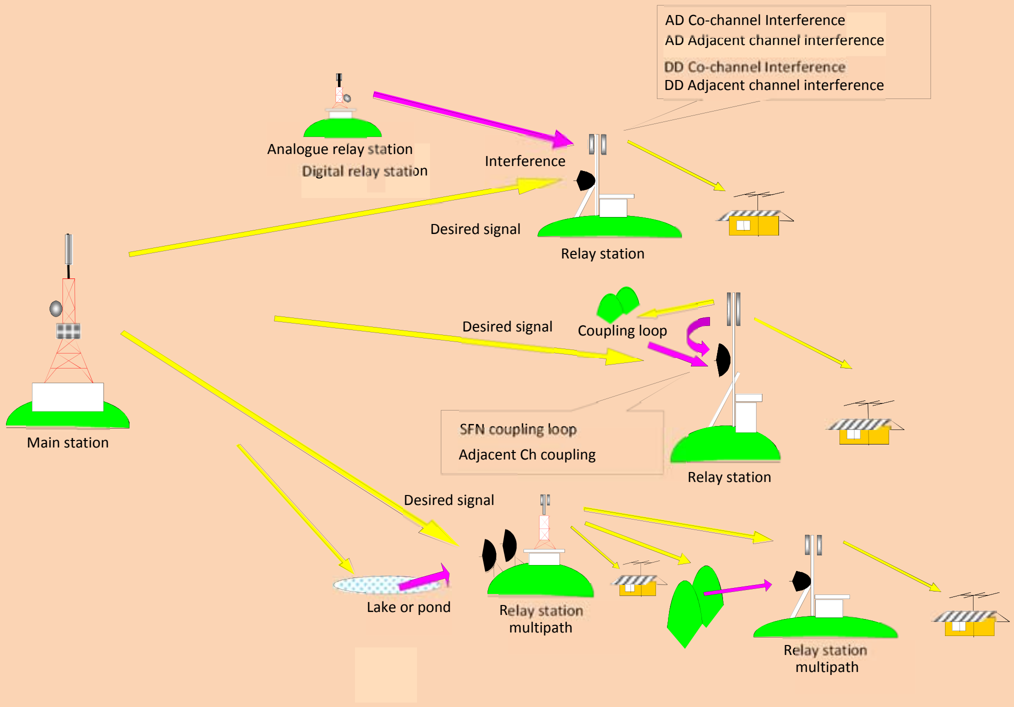
Because the transmitting timing might be changed as the result of considering the relay system by adding equalizers to the transmitter, it is necessary to check that the delay time is properly designed in the network, after all the delay time adjustments have been conducted.

2.3.2 Consideration of propagation characteristics of broadcast wave relay

Propagation characteristics between a certain relay station and its upper node station include signal degradation by fading, multipath, and other forms of interference from other signals. Figure A1.5 shows a simple diagram of the propagation characteristics. The assessment and evaluation of propagation characteristics between the stations should be carried out based on data obtained from the propagation simulation and the results of field measurements.

In accordance with the propagation characteristics between the stations, an equalizer may be selected. If the propagation characteristics do not meet the operational requirements of the equalizer, another relay system such as TTL should be selected. The selection should also take into account the link budget of the network under consideration.

Figure A1.5: Typical propagation characteristics of broadcast wave relay



Source: ITU

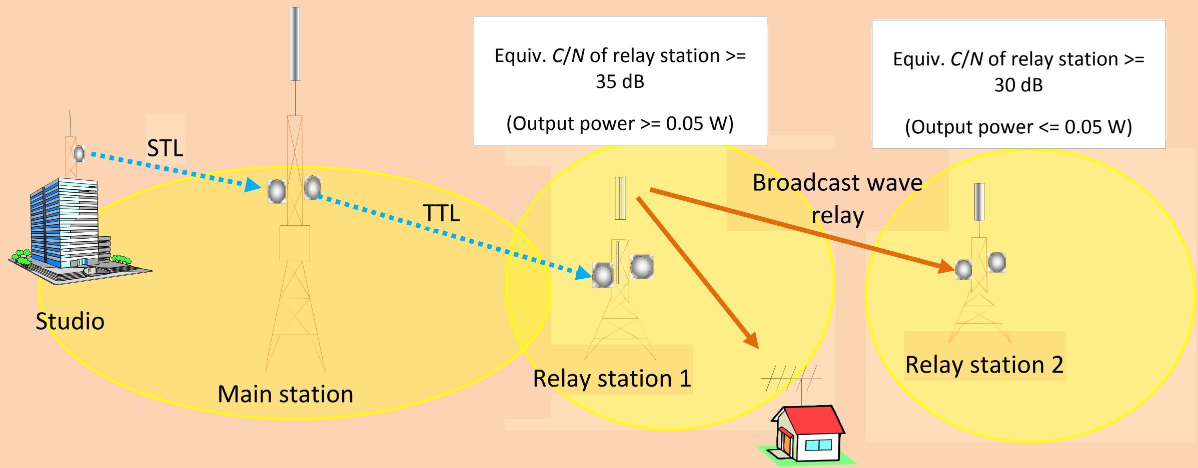
2.3.3 Link budget of broadcasting network

In this section, the entire network from the uppermost main station to the end node relay stations is discussed. The link budget should consider the various signal degradation factors in the network, and the quality of the signal of each transmitting station should be calculated. The quality of the signal is expressed in the form of the equivalent carrier-to-noise ratio (*C*/*N*). The equivalent *C*/*N* of the transmitted signals of all transmitting stations is needed to satisfy the reference value. Figure 2.6 shows a diagram of a broadcasting network.

A DTTB programme is transmitted from the studio to the main station through the microwave link called the station-to-transmitter link (STL), and then the signals are transmitted to relay stations either by the broadcast wave relay or by transmitter-to-transmitter link (TTL). The quality of the transmitted signal of each transmitting station should meet the specified criteria (taking into account the scale of the transmitting station).

The equivalent *C*/*N* of the transmitted signal can be calculated using the design sheet. The sheet can be used to calculate the equivalent *C*/*N* by entering the type of relay system, the distance from the upper node station, and the signal strength of the other interferences at a certain relay station. If the TTL is selected, the regulatory measures for the microwave link should also be taken into account in the design of the link.

Figure A1.6: Diagram of a broadcasting network



Source: ITU

2.3.4 Channel plan for microwave links

If, based on the results of the delay time adjustment, the assessment of propagation characteristics and the link budget it is determined that the TTL is required in a certain network, the network should be added to the TTL channel plan list. To decide whether to use a channel, the link budget and interference assessment should be conducted for the channel plan.

For efficient channel planning of the microwave links, channel grouping can be applied in the individual regions, with the same channel being used repeatedly.

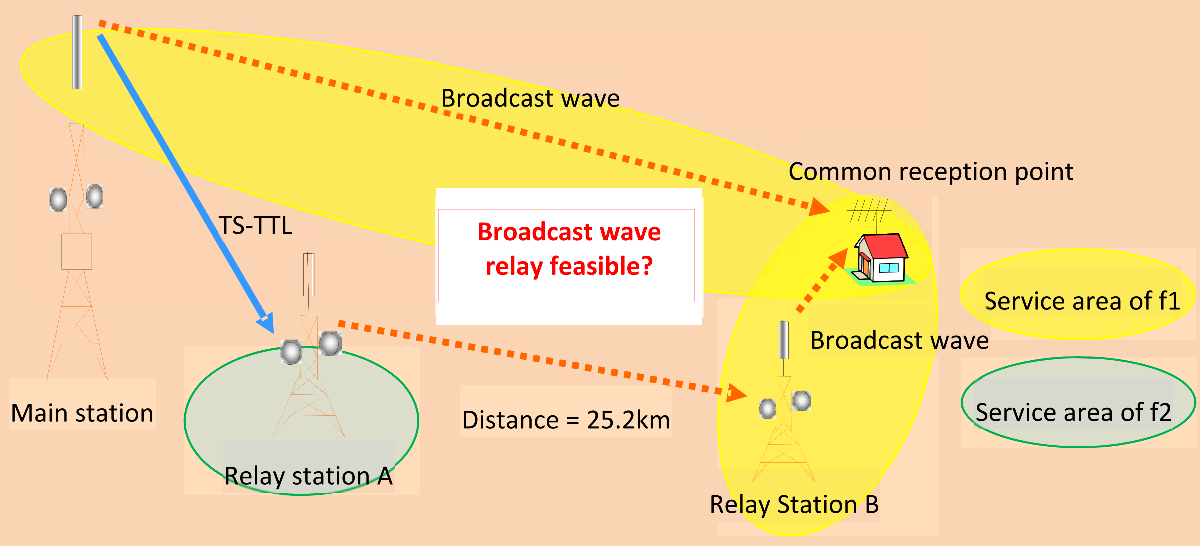
3 SFN delay time adjustment and relay system

SFN delay time adjustment is an important factor in the prevention of SFN interference. Section 2.3.1 states that all the delay time in the broadcasting network should be taken into consideration in order to realize SFN delay time adjustment. This section describes the method for taking this into consideration.

3.1 SFN delay time adjustment

Figure A1.7 shows an overview of SFN delay time adjustment. The main station and relay station B, which transmits on the same channel in f1, comprise the SFN. The delay time difference between signals from these stations at the common reception point should be within the guard interval.

Figure A1.7: Overview of SFN network



Source: ITU

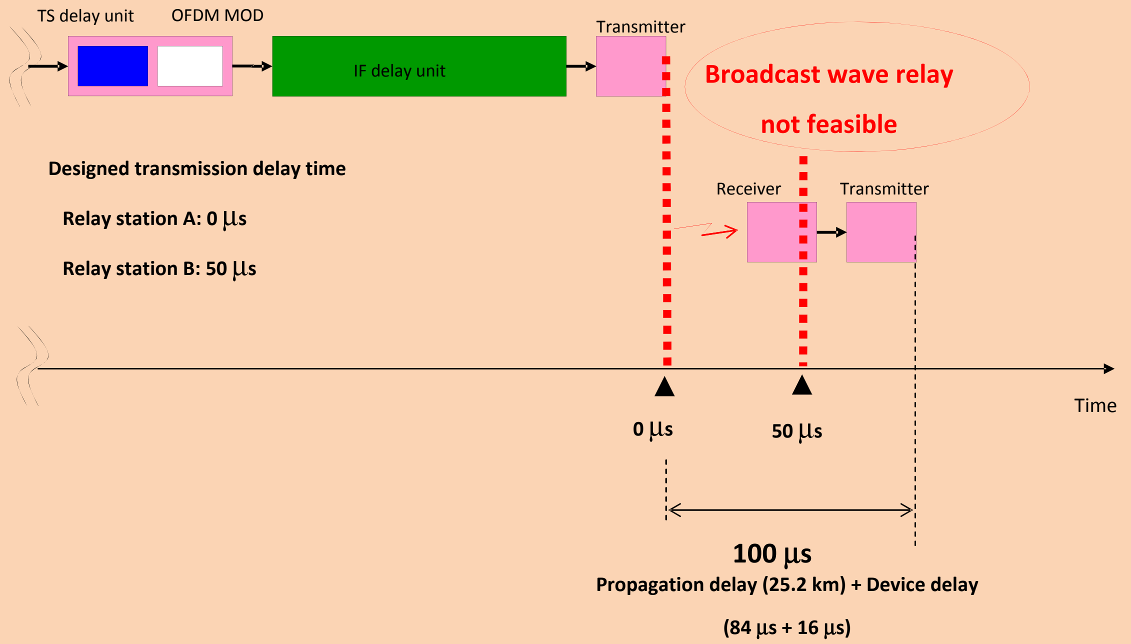
If the relay system from relay station A to relay station B is the broadcast wave relay, then the transmitting timing of relay station B delays the transmitting timing of relay station A for the total distance between the stations (25.2 km, 84 µs) and for the process time of the transmitting equipment in relay station B. Because the transmission delay time of relay station B is designed earlier than the transmitting timing (which is determined by the broadcasting network composition), other relay systems such as TTL may be chosen.

3.1.1 Case where transmitting timing exceeds designed transmission delay time

In Figure A1.8, the transmission delay times of relay station B and relay station A are set to 50 µs and 0 µs, respectively.

In this case, as shown in Figure A1.8, since the sum of the propagation delay and the device delay at relay station B is 100 µs, the transmitting timing exceeds the designed transmission delay time, so broadcast wave relay could not be chosen. In such a case, the transmission delay time will need to be reconsidered, or else a different relay system may be required.

Figure A1.8: Case where transmitting timing exceeds designed transmission delay time



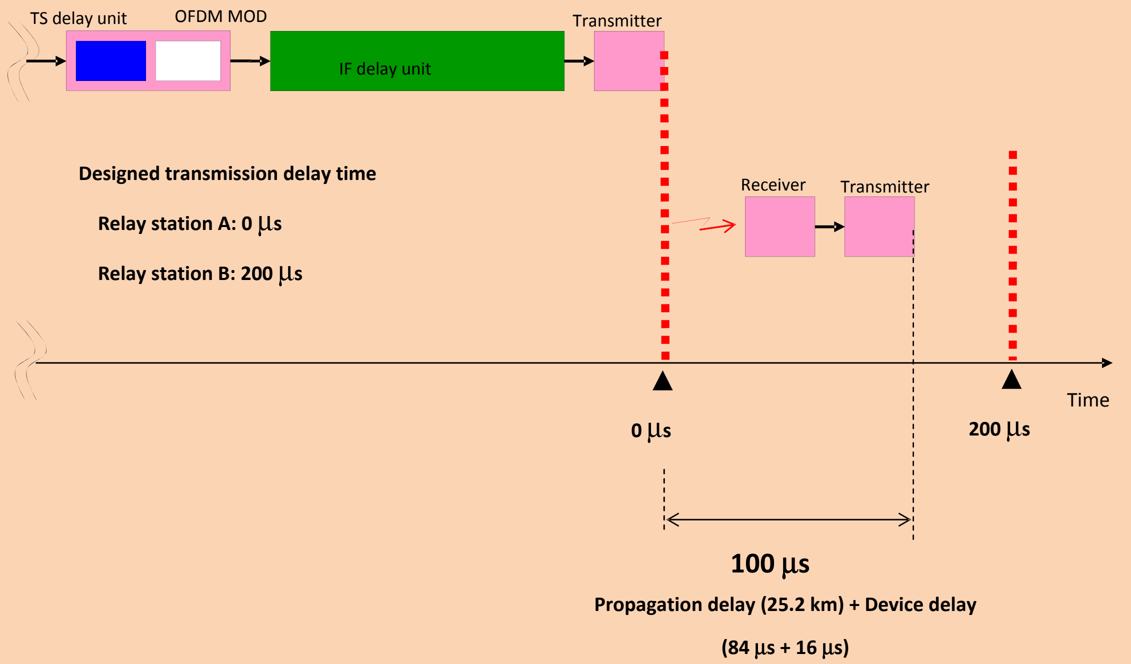
Source: ITU

3.1.2 Case where transmitting timing is within designed transmission delay time

In Figure A1.7, the transmission delay times of relay station B and relay station A are set to 200 µs and 0 µs, respectively.

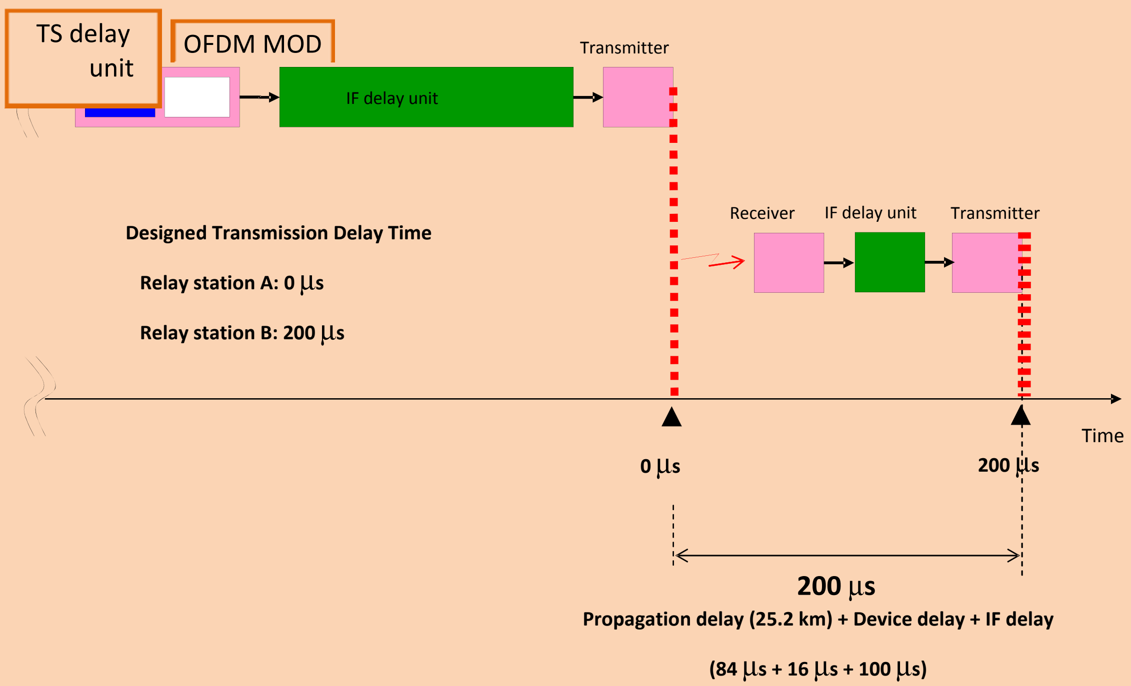
In this case, as shown in Figure A1.9 (a), since the sum of the propagation delay and the device delay in relay station B is 100 µs, the transmitting timing is within the designed transmission delay time, and so broadcast wave relay can be chosen. In such a case, as shown in Figure A1.9(b), the transmitting timing should be adjusted to the designed transmission delay time with the IF delay unit.

Figure A1.9 (a): Case where transmitting timing is within designed transmission delay time



Source: ITU

Figure A1.9 (b): Case where transmitting timing is set to 200 µs with IF delay unit



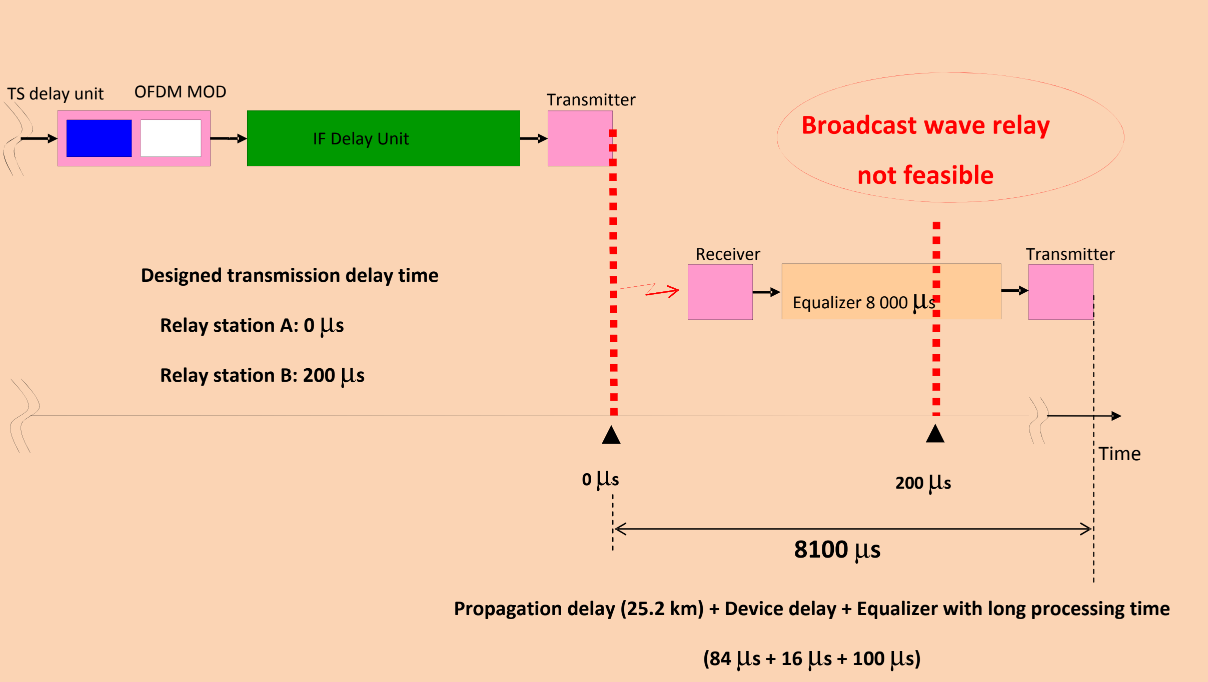
Source: ITU

3.1.3 Case of use of equalizer with long processing time

In Figure A1.7, the transmission delay times of relay station B and relay station A are set to 200 µs and 0 µs, respectively.

In this case, as shown in Figure A1.10, if an equalizer with a long processing time is used, the sum of the propagation delay and the device delay in relay station B is 8 100 µs. Therefore, the transmitting timing exceeds the designed transmission delay time, and broadcast wave relay could not be chosen. In such a case, the transmission delay time will need to be reconsidered, or else a different relay system may be required.

Figure A1.10: Case of use of equalizer with long processing time



Source: ITU

3.2 Criterion for delay time adjustment

The SFN delay time adjustment should be set for each form of media. The transmitting timing of each station is adjusted to the designed transmission delay time with the IF delay unit. When the transmission delay time satisfies the following conditions, the broadcast wave relay system (including the IF-TTL relay system that receives the broadcast wave) can be chosen.

Designed transmission delay time ≥ total delay time to the relay station

It is possible to adjust the delay time for TTL, except for the IF-TTL relay which receives the broadcast wave by the maximum delay time adjustment method shown in § 3.2.1.

3.2.1 Maximum delay time adjustment method

To determine the optimum delay time, the following four conditions should be met:

1. suspending transmission at the upper node station is not required to adjust the delay time of a lower node station;
2. the cost of developing the network is minimized;
3. the delay time adjustment of every transmitting station is not complicated;
4. even after the transmitting station is launched, fine adjustment of the delay time is feasible.

To satisfy the four conditions, the maximum delay time adjustment method was proposed and successfully implemented in the network of the Japanese public broadcaster.

Figure A1.11 shows the concept of the maximum delay time adjustment method.

In this method, the delay time from the re-multiplexer (re-mux) in the studio to the transmitting equipment in the main station is set at 412 ms.

There are three reasons for setting it at 412 ms:

1. The transmitting time of the one-span TS-TTL system is 6 ms (including propagation time)

   Even in rural areas, 10-span TS-TTL systems are enough for the entire network.

   (6 ms $\times$ 10-span = 60 ms)

2. The processing time of the OFDM modulator is 350 ms.

   (All OFDM modulators must satisfy this processing time)

3. The transmitting time of the one-span IF-TTL system is 0.2 ms (including propagation time).

   Even in rural areas, 10-span IF-TTL systems are enough for the entire network.

   (0.2 ms $\times$ 10-span = 2 ms)

   60 ms + 350 ms + 2 ms = 412 ms

Even where the relay station is a very long distance from the TV studio, it is still possible to connect from the re-mux equipment in the TV studio to the relay station's transmitter by 412 ms.

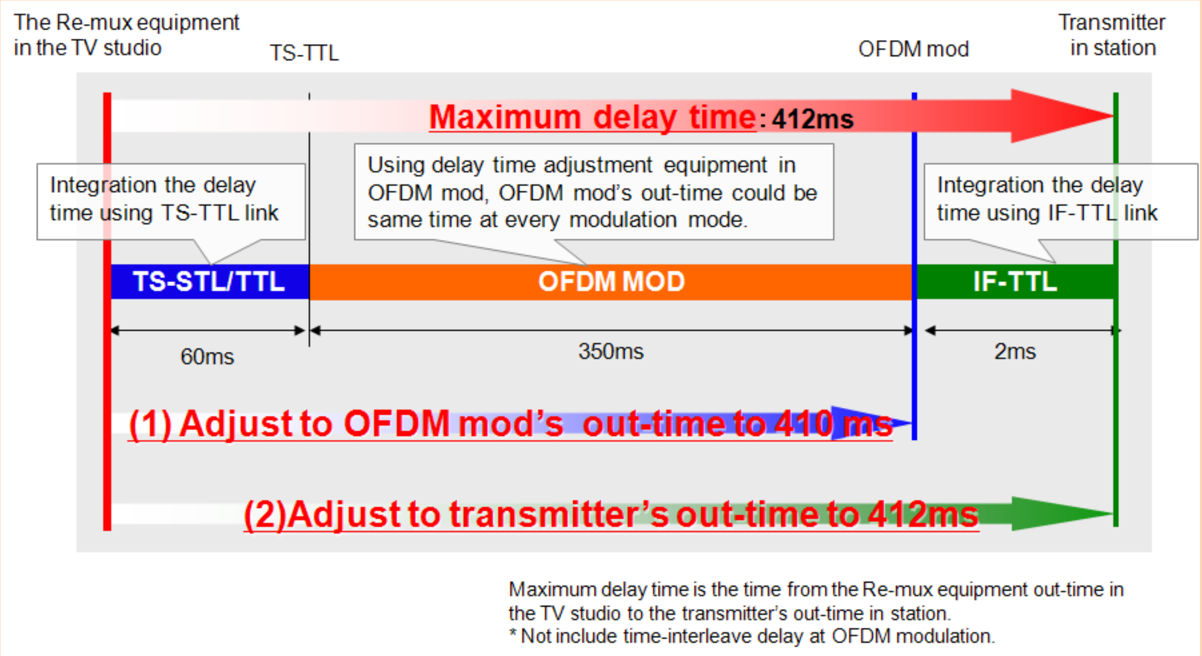
The maximum delay time adjustment method is based on the concept that the delay from re-mux equipment in the TV studio to all the transmitters' output should be the same (412 ms), and the delay from the re-mux equipment in the TV studio to all the OFDM modulators' output should also be the same (410 ms).

Figure A1.12 (a) shows a case of the delay time adjustment at TS-TTL, and Figure A1.12(b) shows a case of the delay time adjustment at IF-TTL.

In both cases, the delay time can be adjusted independently and easily. No interruption of the service at the upper node station is required.

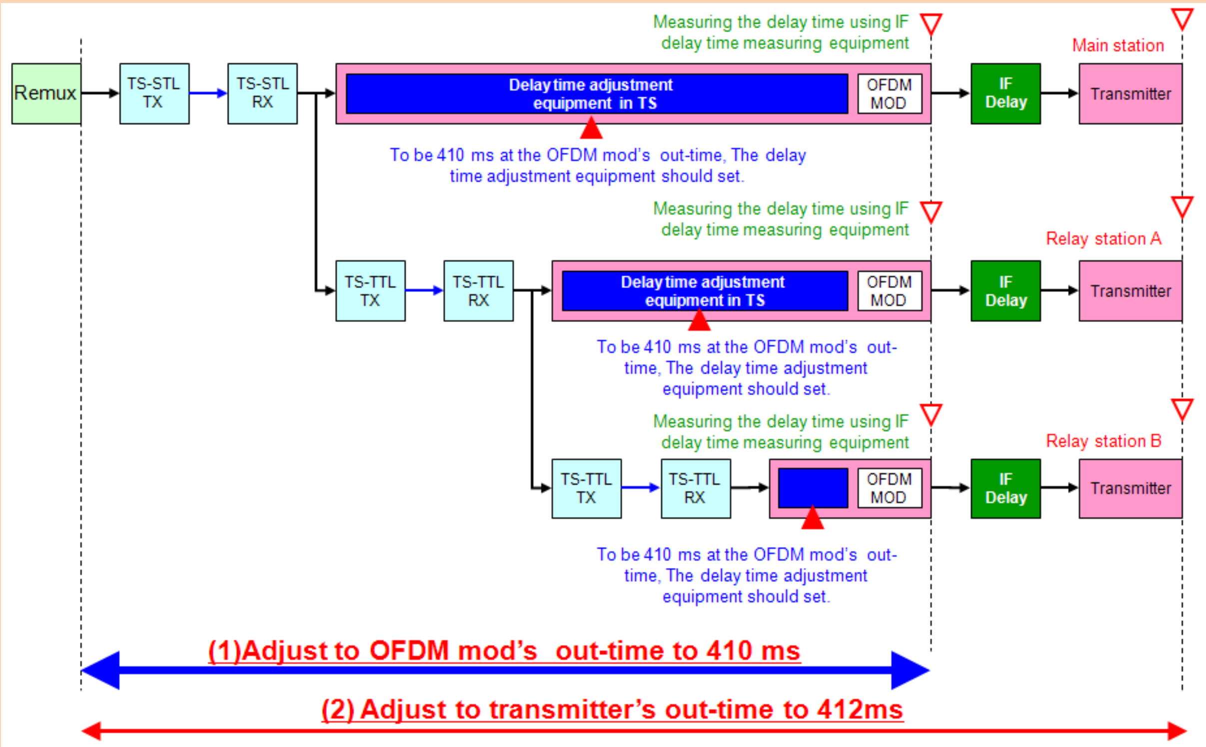
Additionally, even after the transmitting station is launched, fine adjustment of the delay time can be made with the IF delay unit.

Figure A1.11: Concept of maximum delay time adjustment method



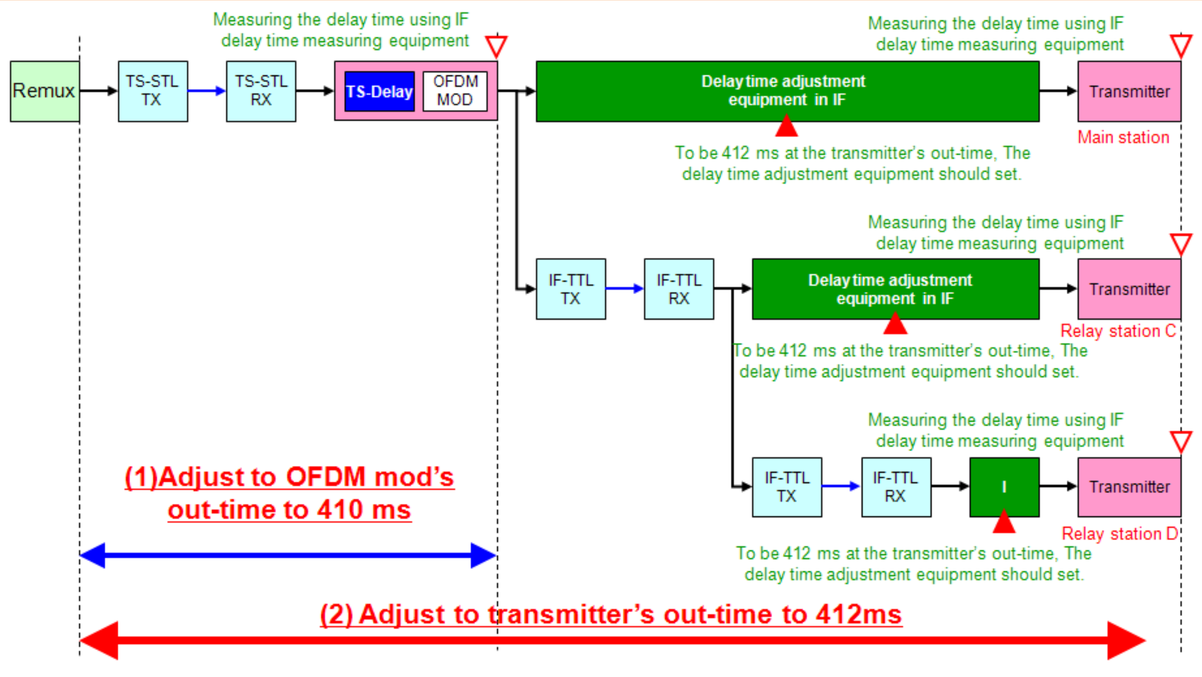
Source: ITU

Figure A1.12 (a): Case of the delay time adjustment at TS-TTL network



Source: ITU

Figure A1.12 (b): Case of delay time adjustment in IF-TTL network

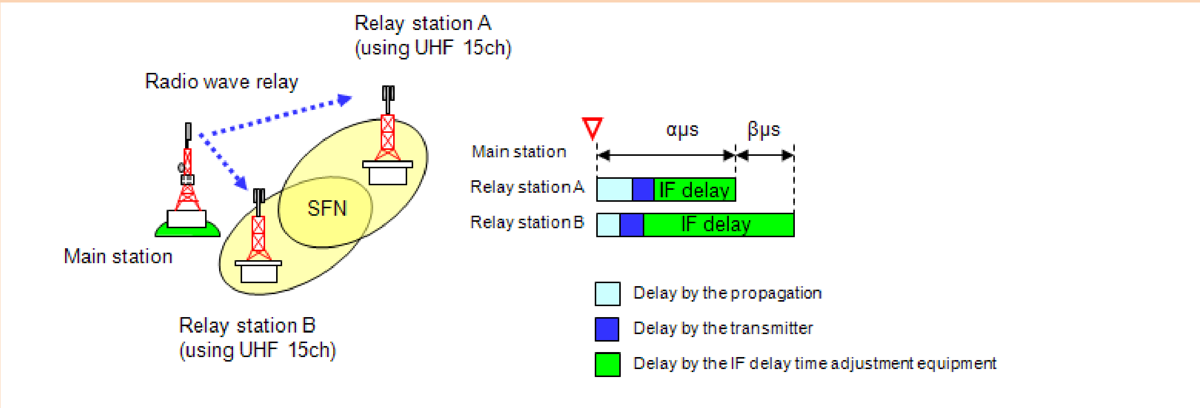


Source: ITU

3.2.2 Delay time adjustment at broadcast wave relay system

In the broadcast wave relay system, the relative transmitting timing between relay stations using the same channel is considered. Figure A1.13 shows the concept of the delay time adjustment at the broadcast wave relay system. The objective is to set the reception timing at the location where two signals can be received to be within the guard interval.

Figure A1.13: Concept of delay time adjustment at broadcast wave relay

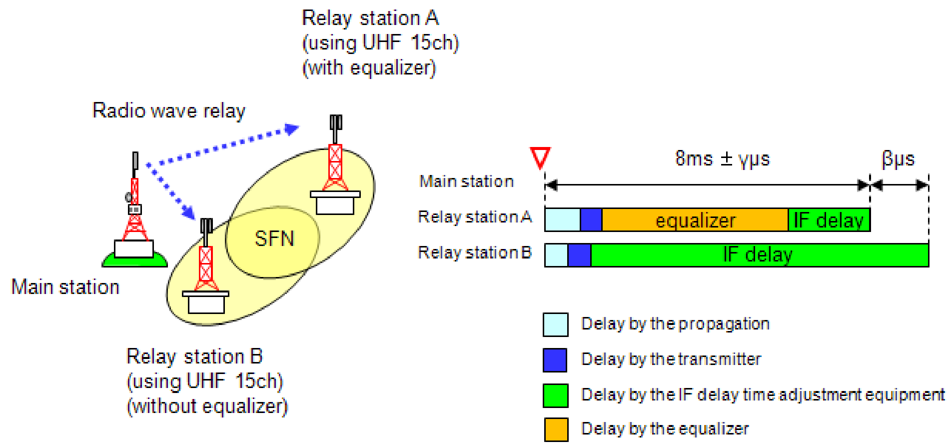


Relay station A is needed to adjust delay time with main station at α usec by using IF delay time adjustment equipment.
Relay station B is needed to adjust delay time with Relay station A.

Source: ITU

If an equalizer with a long processing time is used at relay station A, then relay station A has to adjust the total delay time to 8 ms, which is relative to the main station, by introducing the IF delay unit. If fine adjustment is needed, ± γ µs is added. Relay station B needs to adjust the delay time with relay station A in order for the two signals to be received within the guard interval, which is 126 µs. Figure A1.14 shows the concept of the delay time adjustment at the broadcast wave relay system with an equalizer.

Figure A1.14: Concept of delay time adjustment at broadcast wave relay with an equalizer



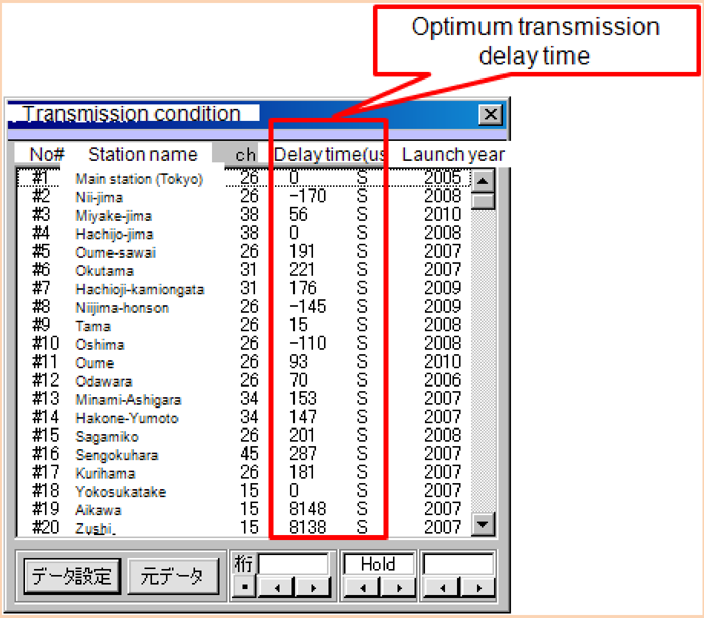
Relay station A is needed to adjust delay time with main station at 8 msec by using IF delay time adjustment equipment.
(If the fine adjustment is needed, ± γ µsec is added)
Relay station B is needed to adjust delay time with Relay station A.

Source: ITU

3.3 SFN delay time adjustment

The SFN delay time can be designed by means of simulation. The simulation calculates the number of households affected by the SFN interference in the network under varying conditions, including transmitting timing. The simulation result shows the optimum transmission delay time whereby the number of households affected by the SFN interference is minimized. Figure A1.15 shows an example of a simulation result for the optimum transmission delay time at all stations in the network. The delay time of the main station is set to 0 µs, and the optimum transmission delay time of each station is shown in the window.

Figure A1.15: Example of simulation result of optimum transmission delay time



No#	Station name	ch	Delay time(us		Launch year
#1	Main station (Tokyo)	26	0	S	2005
#2	Nii-jima	26	-170	S	2008
#3	Miyake-jima	38	56	S	2010
#4	Hachijo-jima	38	0	S	2008
#5	Oume-sawai	26	191	S	2007
#6	Okutama	31	221	S	2007
#7	Hachioji-kamiongata	31	176	S	2009
#8	Niijima-honson	26	-145	S	2009
#9	Tama	26	15	S	2008
#10	Oshima	26	-110	S	2008
#11	Oume	26	93	S	2010
#12	Odawara	26	70	S	2006
#13	Minami-Ashigara	34	153	S	2007
#14	Hakone-Yumoto	34	147	S	2007
#15	Sagamiko	26	201	S	2008
#16	Sengokuhara	45	287	S	2007
#17	Kurihama	26	181	S	2007
#18	Yokosukatake	15	0	S	2007
#19	Aikawa	15	8148	S	2007
#20	Zushi	15	8138	S	2007

Source: ITU

Appendix 2: Deployment of NHK transmitting stations

Table A2.1 Deployment of NHK stations

FY	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013 Expected	Sub-total
Main Station※1	3	4	14	24	6							51
Large - scale Key Station		6	11	58	171	171	45	17	1	2	1	483
Small-scale					47	270	561	706	30	37	24	1,675
Total※2	3	10	25	82	224	441	606	723	31	39	25	2,209

※1 Including six in Hokkaido and 1 in Kitakyushu.

※2 Excluding three in Hokkaido and one in Kitakyushu.

Appendix 3: Bibliography

ITU-R Recommendations

- BT.1306 'Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting'
- BT.1368 'Planning criteria, including protection ratios, for digital terrestrial television services in the VHF/UHF bands'
- BT.1871 'User requirements for wireless microphones'
- F.1777 'System characteristics of television outside broadcast, electronic news gathering and electronic field production in the fixed service for use in sharing studies'

ITU-R Reports

- BT.2140 'Transition from analogue to digital terrestrial broadcasting'
- BT.2209 'Calculation model for SFN reception and reference receiver characteristics of ISDB-T system'
- BT.2294 'Construction technique of DTTB relay station network for ISDB-T'
- BT.2069 'Tuning ranges and operational characteristics of terrestrial electronic news gathering (ENG), television outside broadcast (TVOB) and electronic field production (EFP) systems'

Links

- MIC (Ministry of Internal Affairs and Communications): www.mic.go.jp/
- ARIB (Association of Radio Industries and Businesses) : www.arib.or.jp
- DiBEG (Digital Broadcasting Experts Group): www.dibeg.org/
- NHK (Japan Broadcasting Corporation): www.nhk.or.jp/nhkworld/

Appendix 4: Challenges and solutions in migration to DTTB

Challenges and Solutions in migration to DTTB

NHK
Japan Broadcasting Corporation

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- About NHK
- Overview of Analogue Switch-off in Japan
- Key Measures Related to:
  - Transmission
  - Reception
  - Notifications
- On 24 July 2011

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Japan Broadcasting Corporation (NHK)



- Japan’s sole public broadcaster
- Operating 2 terrestrial TV channels, 2 satellite TV channels, 3 Radio channels, plus International TV and Radio services
- Reaching all Households (about 52 Million) in Japan
- 54 Stations across Japan, 30 Bureaus Worldwide
- The Sole Designated Public Corporation for News Media Activity under the Basic Disaster Countermeasures Act

3

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Objectives of Full Digitalization

High Quality Broadcasting Services

- HDTV
- Mobile TV Service (One-Seg)
- Data Broadcasting
- 5.1-Channel Surround Audio
- Closed Captioning

Closed Captions

Effective Frequency Use

Analogue TV Bandwidth: 370 MHz
↓
Digital TV Bandwidth: 240 MHz

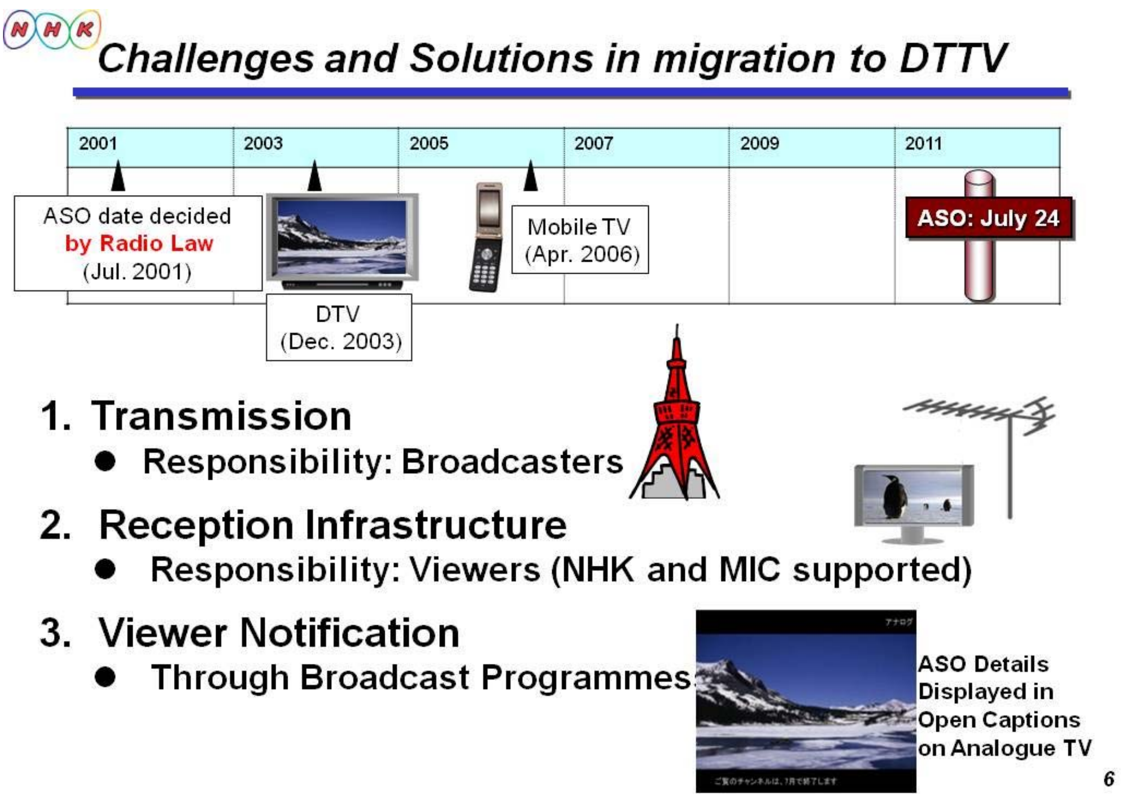
130 MHz Released for New Services

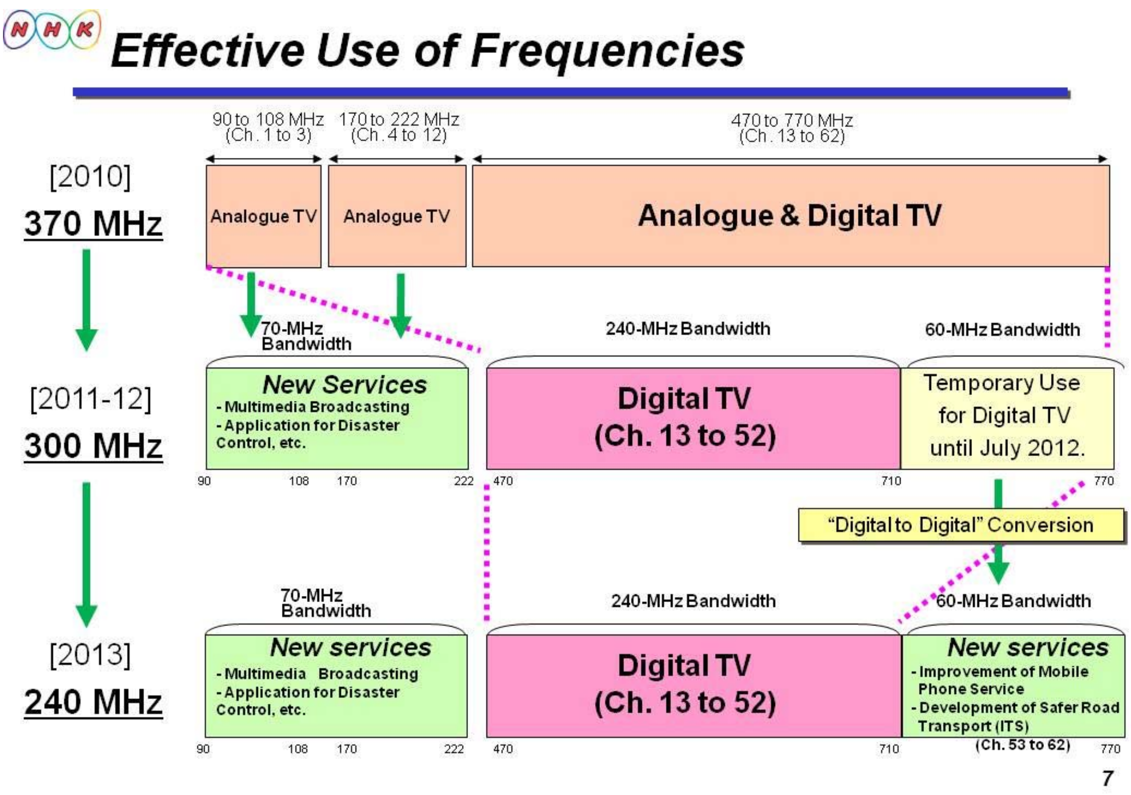
- Multimedia Broadcasting
- Disaster Control Apps.
- Mobile Phones
- Intelligent Transport (ITS)

Positive Impact On Other Industries

- TV Manufacturers
- Retailers
Electronic Commerce
- Content;
(Digital Content Commerce; Archives)
- Internet and Mobile
(Connection with TV)
- Local Government
(Broadband Infrastructure)

5


Challenges and Solutions in migration to DTTV
2001
2003
2005
2007
2009
2011
ASO date decided
by Radio Law
(Jul. 2001)
DTV
(Dec. 2003)
Mobile TV
(Apr. 2006)
ASO: July 24
1. Transmission
● Responsibility: Broadcasters
2. Reception Infrastructure
● Responsibility: Viewers (NHK and MIC supported)
3. Viewer Notification
● Through Broadcast Programmes
ASO Details
Displayed in
Open Captions
on Analogue TV
6


Effective Use of Frequencies
90 to 108 MHz
(Ch. 1 to 3)
170 to 222 MHz
(Ch. 4 to 12)
470 to 770 MHz
(Ch. 13 to 62)
[2010]
370 MHz
Analogue TV
Analogue TV
Analogue & Digital TV
70-MHz
Bandwidth
240-MHz Bandwidth
60-MHz Bandwidth
[2011-12]
300 MHz
New Services
- Multimedia Broadcasting
- Application for Disaster
Control, etc.
Digital TV
(Ch. 13 to 52)
Temporary Use
for Digital TV
until July 2012.
90
108
170
222
470
710
770
"Digital to Digital" Conversion
70-MHz
Bandwidth
240-MHz Bandwidth
60-MHz Bandwidth
[2013]
240 MHz
New services
- Multimedia Broadcasting
- Application for Disaster
Control, etc.
Digital TV
(Ch. 13 to 52)
New services
- Improvement of Mobile
Phone Service
- Development of Safer Road
Transport (ITS)
(Ch. 53 to 62)
90
108
170
222
470
710
770
7

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  - Reception
  - Notifications
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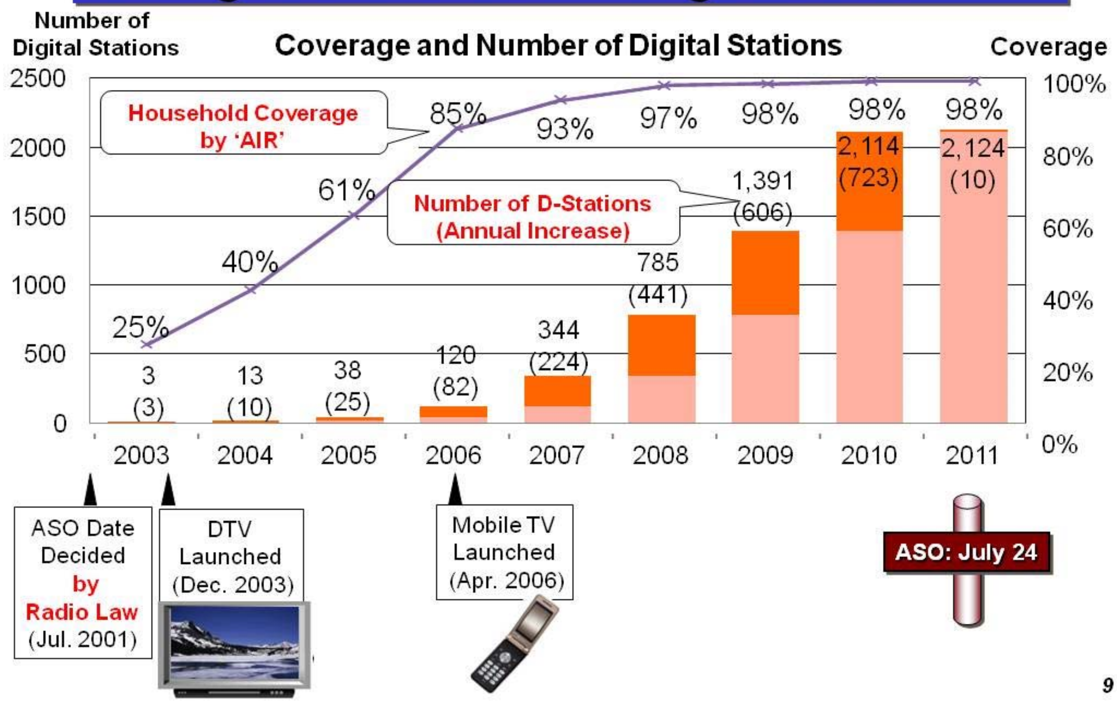
Challenges and Solutions in migration to DTTV



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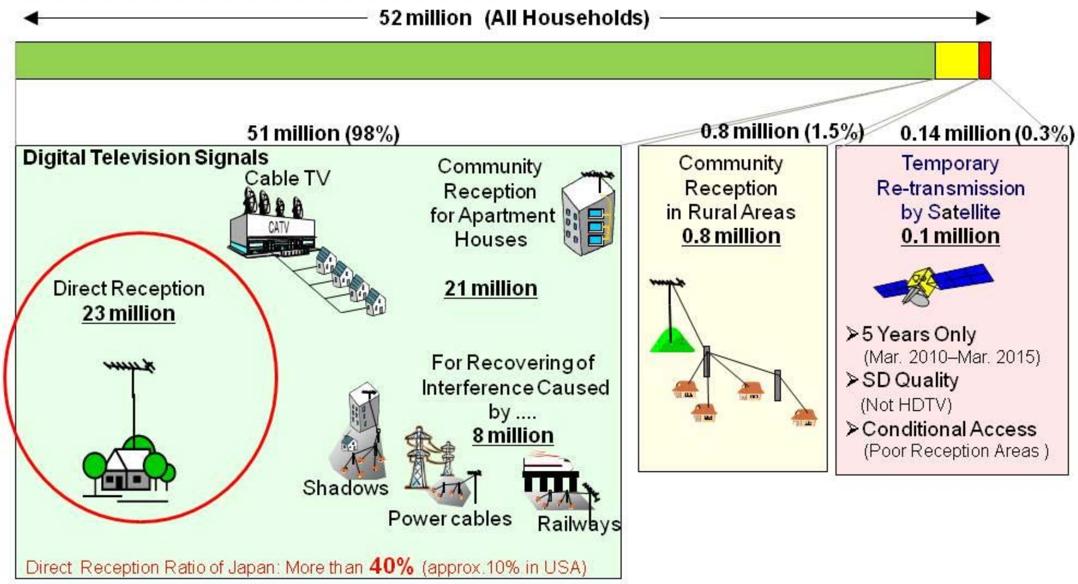
Digital TV Coverage



Digital TV Coverage Reached 100% by 2010.

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  - **Reception**
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Viewers' Preparation Towards Digitalization

DTV Support Centres
(Established by Ministry of Internal affairs and Communications)

Overview: Established by Government Nationwide
Help Viewers for Digital TV Reception

How: Notification and Announcement from the DTV Centers

Main Players:
Local governments, Retailers, and Broadcasters

More Than 100 NHK Engineers Dispatched as Team-Leaders at "DTV Support Centre"

12

DTV Support Centres

(1) Explanatory Meetings for Elderly People
(2) Visits to **Elderly People**;
(More than 2 Million Households)

(3) Radio Measurement Vehicle

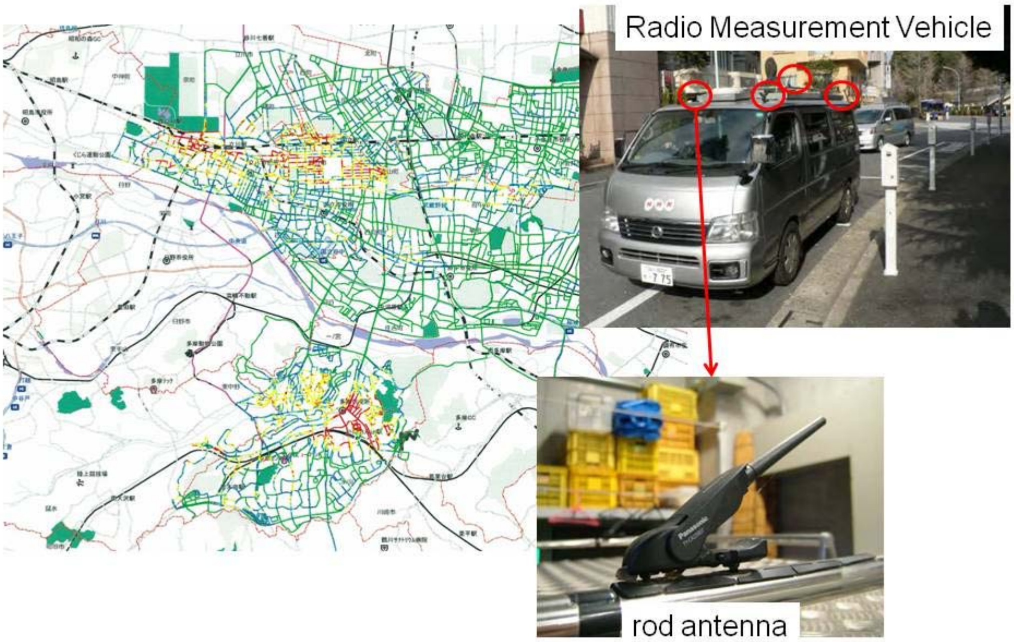
(publication)

"Quick Radio Measurement"
Blue Roads = GOOD RECEPTION

(4) Call Centres (Max 1,200 Operators)

13

Quick Radio Measurement



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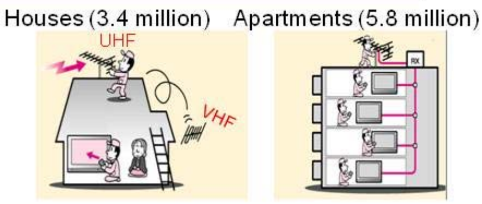
Three Major Difficulties of Reception Infrastructure



1. Change VHF Antennas to UHF

Changing Antennas for VHF to UHF required in the Area where Analogue TV Service was on VHF
(Approx. 9.2 million households)

2. Rural Area Reception

Community Reception Antennas are Needed for Rural Area
(Approx. 0.8 million households)

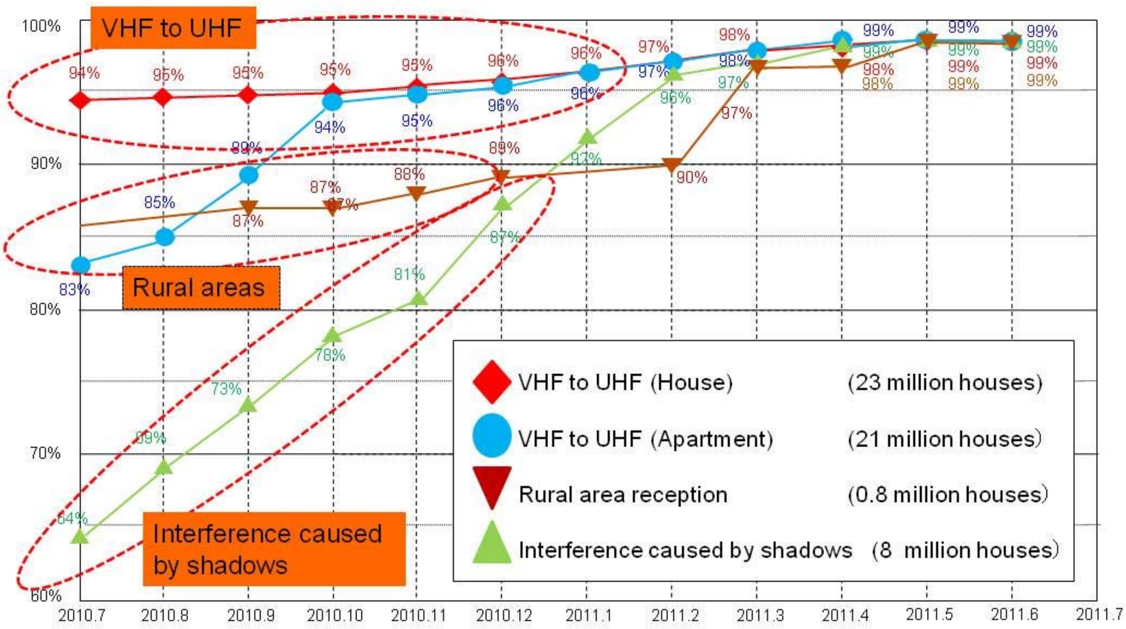
3. Interference Caused by Building Shadows

Technical Surveys and Agreement for Cost Sharing Required
(Approx. 8 million households)

Both Government and NHK Worked Closely for Solutions in Financially and Technically

15

Status of Reception Infrastructure



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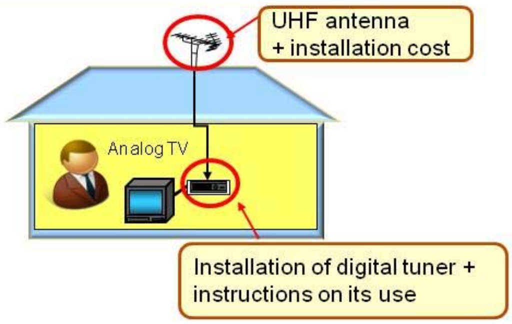
Financial Assistance for Purchasing TV Receivers

Free Converter Boxes

Support for Low-Income Households

1.5 million Households



"Eco-Point" Program

- Anti-Global Warming (CO_2 Reduction)
- Economic Stimulus
- Widespread Ownership of Digital TVs

Air conditioner Refrigerator Digital TV set

From May 2009 to March 2011

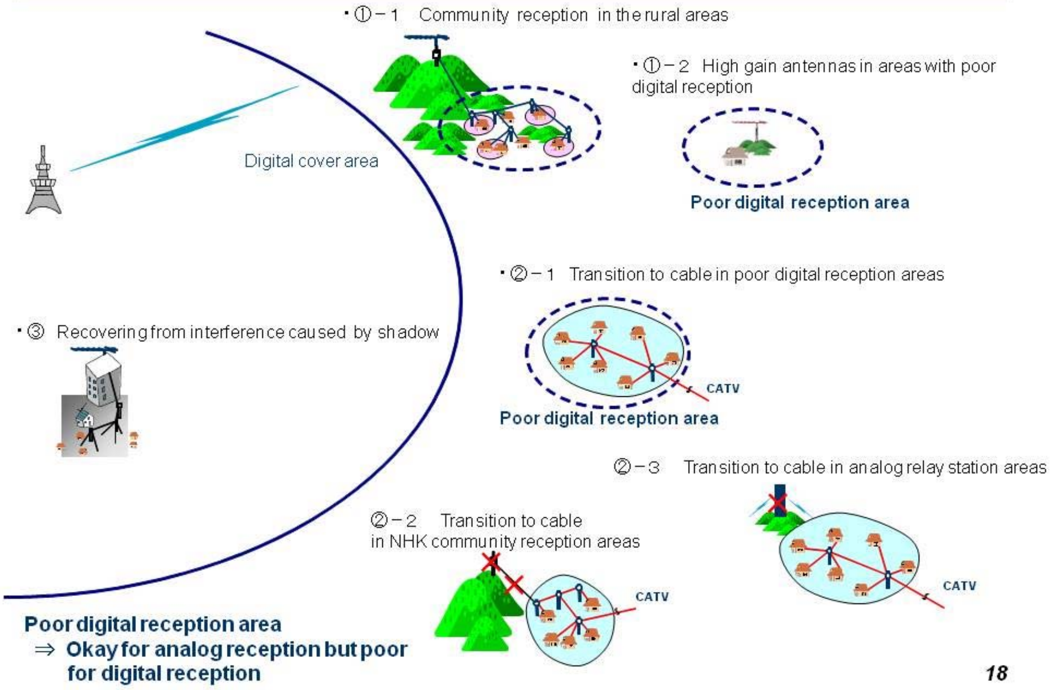
"Eco-Points" (cash back) on Purchase of Energy-Efficient Products

<Example of Cash-Back for Digital TV>

TV size	Eco-points (US $)
46V and above	450$
42V, 40V	287$
37V	212$
32V, 26V	150$
Under 26V	88$

17

Support for Reception Infrastructure



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Financial Support Facts

①－1 Community reception in rural areas (digitalize and new construction)	5,500 community receivers
①－2 High gain antenna in poor digital reception area	33,000 houses
②－1 Transition to cable in poor digital reception area	40,000 houses
②－2 Transition to cable in NHK community reception area	1,500 community receivers
②－3 Transition to cable in analog relay station area	230 stations
③ Recovering from interference caused by shadow	4,000 receivers

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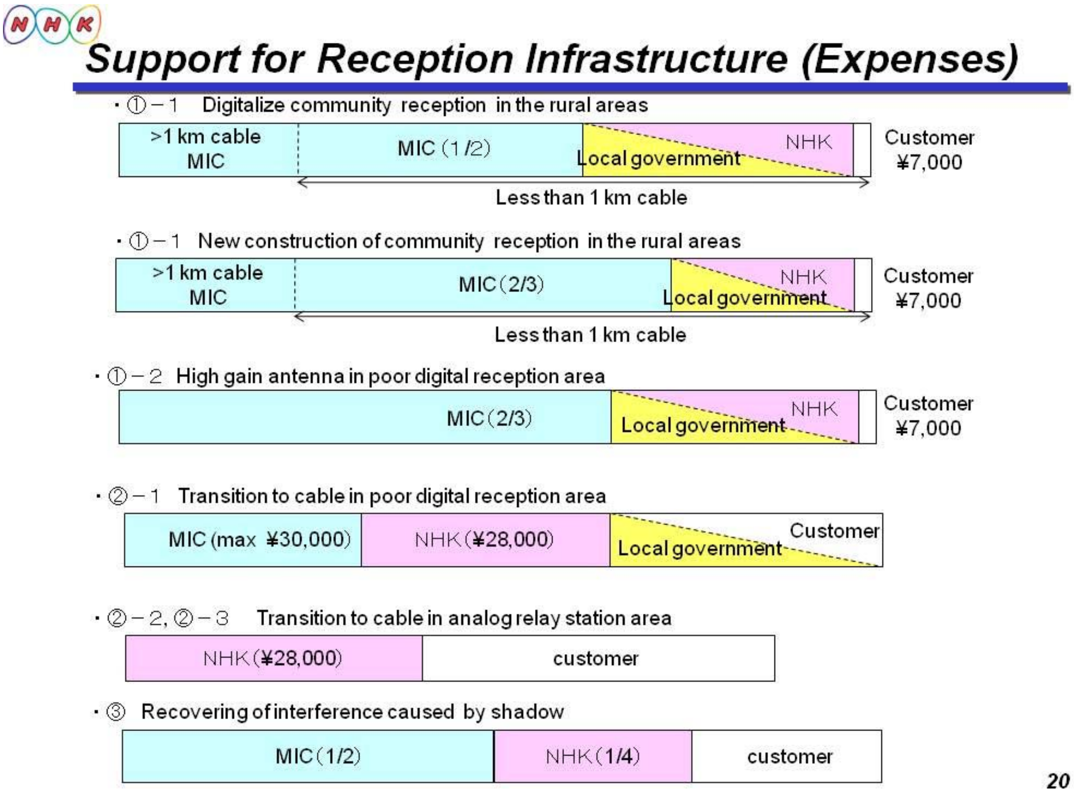
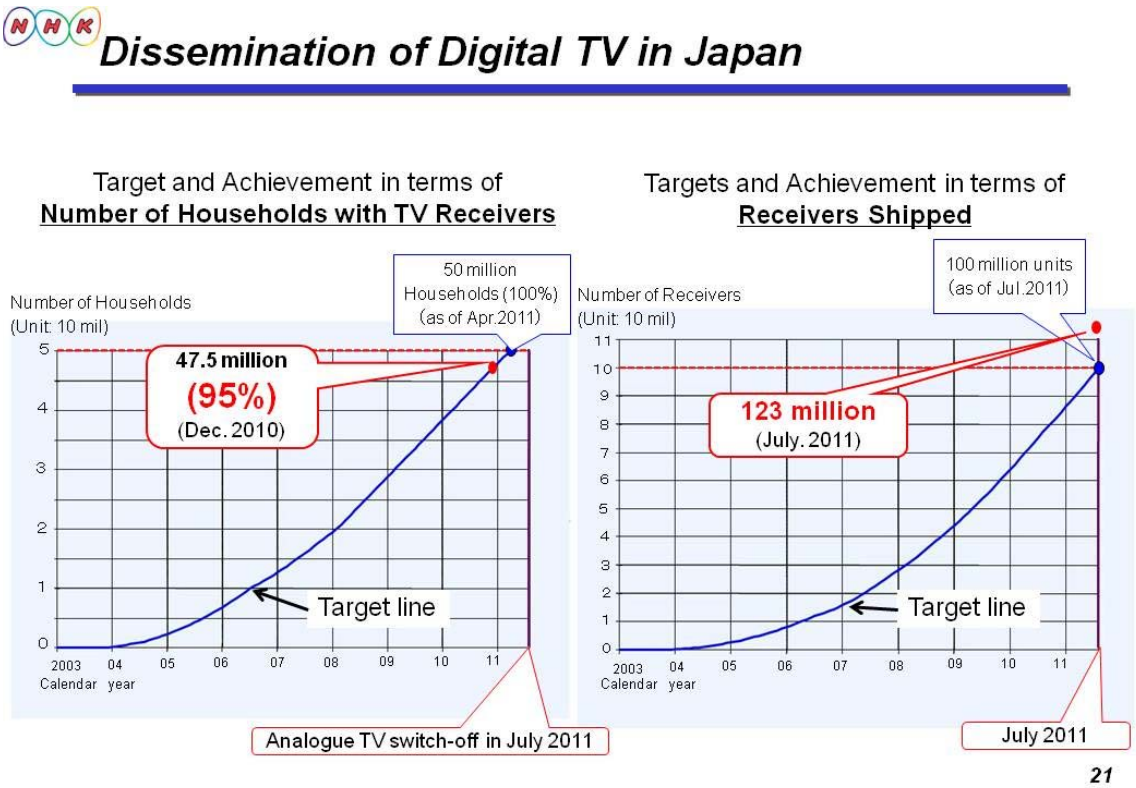

Support for Reception Infrastructure (Expenses)
・①－1 Digitalize community reception in the rural areas
>1 km cable
MIC
MIC（1/2)
Local government
NHK
Customer
¥7,000
Less than 1 km cable
・①－1 New construction of community reception in the rural areas
>1 km cable
MIC
MIC（2/3)
Local government
NHK
Customer
¥7,000
Less than 1 km cable
・①－2 High gain antenna in poor digital reception area
MIC（2/3)
Local government
NHK
Customer
¥7,000
・②－1 Transition to cable in poor digital reception area
MIC (max ¥30,000)
NHK（¥28,000)
Local government
Customer
・②－2, ②－3 Transition to cable in analog relay station area
NHK（¥28,000)
customer
・③ Recovering of interference caused by shadow
MIC（1/2)
NHK（1/4)
customer
20


Dissemination of Digital TV in Japan
Target and Achievement in terms of
Number of Households with TV Receivers
Number of Households
(Unit: 10 mil)
50 million
Households (100%)
(as of Apr.2011)
47.5 million
(95%)
(Dec. 2010)
Target line
2003 04 05 06 07 08 09 10 11
Calendar year
Analogue TV switch-off in July 2011
Targets and Achievement in terms of
Receivers Shipped
Number of Receivers
(Unit: 10 mil)
100 million units
(as of Jul.2011)
123 million
(July. 2011)
Target line
2003 04 05 06 07 08 09 10 11
Calendar year
July 2011
21

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Termination of Analog TV, Step-by-Step

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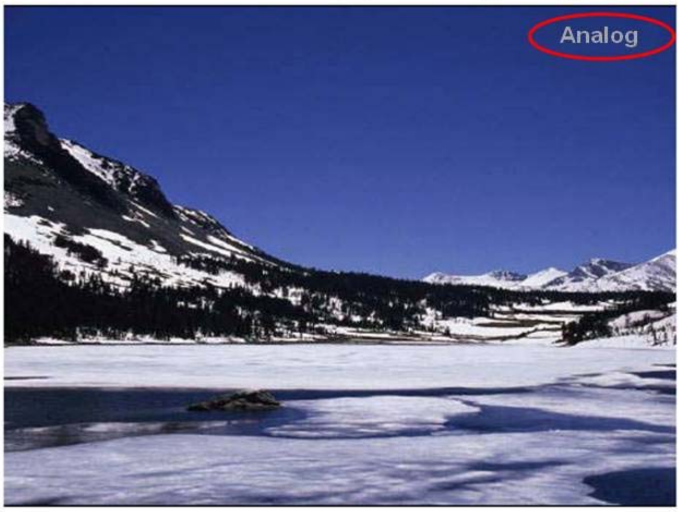
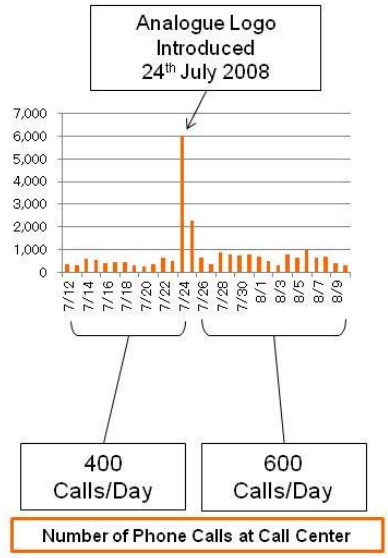
Termination of Analogue TV, Step-by-Step: 1st Stage

■ 3 Years before ASO, "Analog" Logo Placed on ANALOG Screen



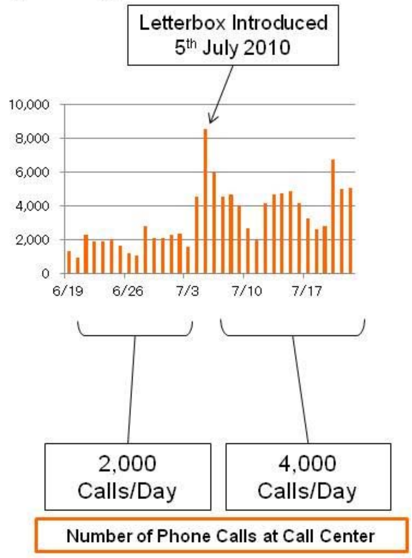


24th July 2008

24

Termination of Analogue TV, Step-by-Step: 2nd Stage

■ 1 Year before ASO, Letterbox Format Image Began



5th July 2010

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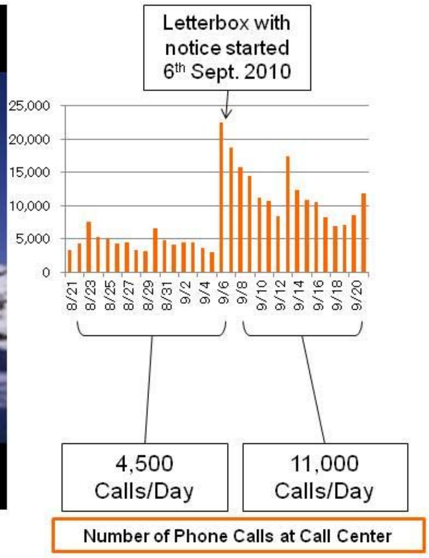
NHK

Termination of Analogue TV, Step-by-Step: 3rd Stage

- 10 months before, notice was added to the letterbox



6th Sept. 2010

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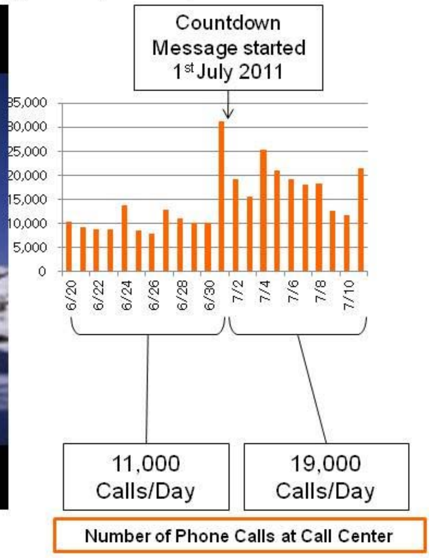
NHK

Termination of Analogue TV, Step-by-Step: 4th Stage

- 24 days before ASO, Countdown Message Superimposed



1st July 2011

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Termination of Analogue TV, Step-by-Step: 4th Stage

- From 0:00 to 12:00 on 24 July

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Final Notice at 12:00 on July 24

- From 12:00 to 23:59 on July 24

This analog broadcast will be terminated on July 24, 2011.
Please make arrangements for digital TV reception.

<Inquiries>

Please contact:
AAAA TV support centre
Tel: XXXX-XXX-XXX
DTV support centre
Tel: 0570-07-0101
9am-9pm (9am-6pm Weekends/Holidays)

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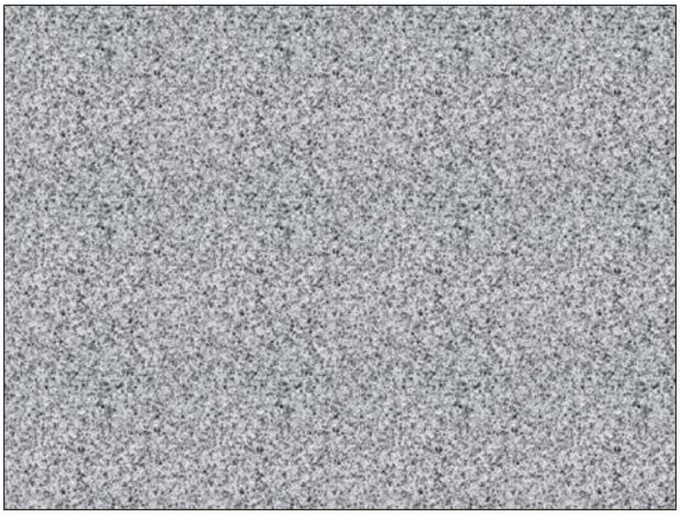
Termination of Analogue Transmitters at 23:59 on 24 July

- at 23:59 on 24 July



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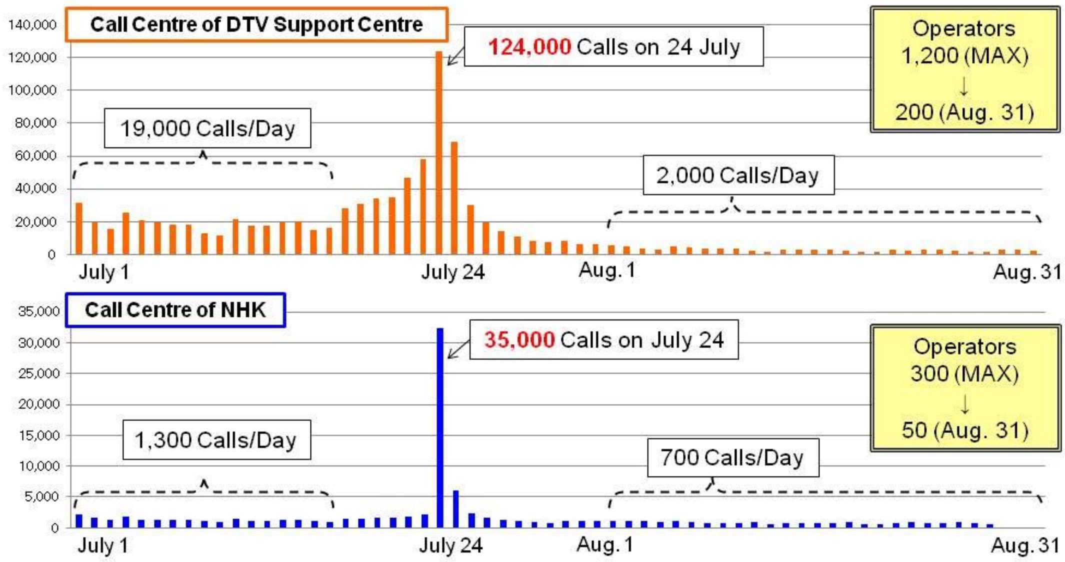
Phone Calls (July 2011 – August 2011)

Calls Dropped After July 24 Drastically.

Successful Completion of Analogue Switch-Off in Japan



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NHK News on That Day

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Solution of Poor Reception by Temporarily Satellite Use

To resolve poor digital terrestrial reception in some areas, digital terrestrial broadcast programmes are re-transmitted via broadcast satellite, called a "BS safety-net".

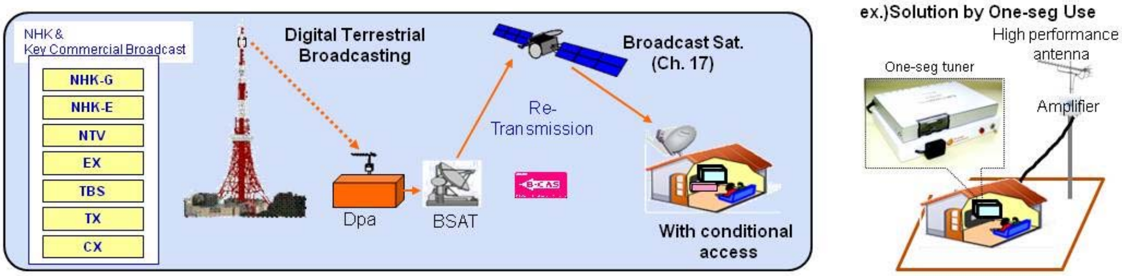
Program: Digital Terrestrial Broadcast Programs
NHK (General & Educational) and Network Commercial Broadcasts
(with Conditional Access for Poor Reception Households Only)

Services: Standard quality picture (SD), Closed captions, Electronic Program Guide

Channel: Satellite Broadcasting Channel (channel 17)

Operation Period: Mar. 2010 – Mar. 2015 (5 years only)

Japanese government and Broadcasters are offering technical and financial support (ex: Installation of one-seg tuners or high performance antennas at viewers' houses)



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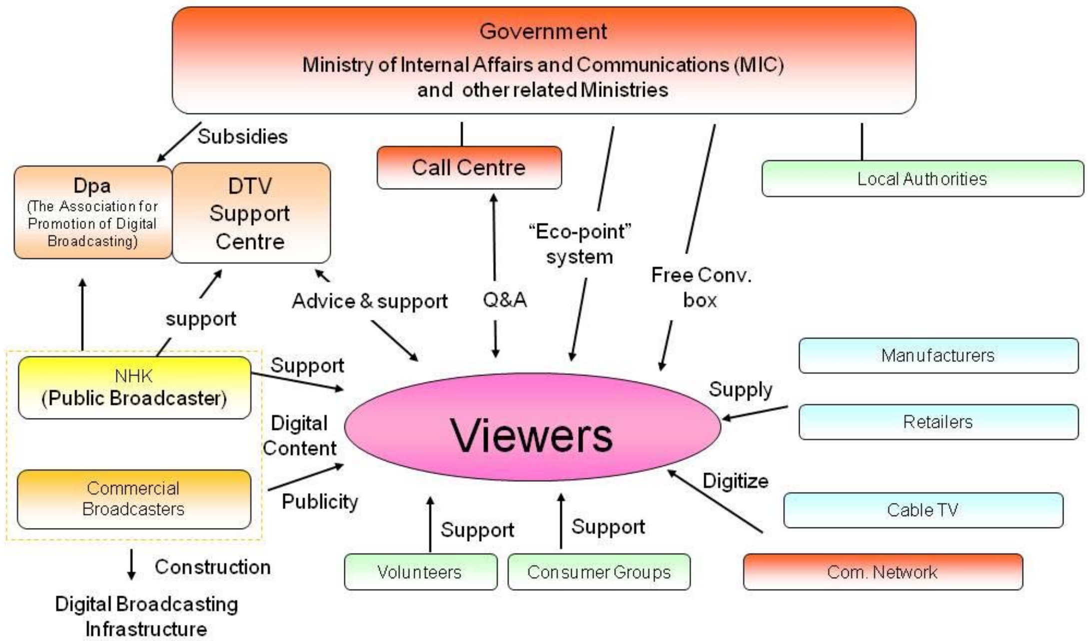
Contributors to Successful Accomplishment



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Acronyms

ASO:	Analogue switch-off
ARIB:	Association of Radio Industries and Businesses
DiBEG:	Digital Broadcasting Experts Group
ISDB-T:	Integrated Service Digital Broadcasting-Terrestrial
ITS:	Intelligent Transport Systems
MIC:	Ministry of Internal Affairs and Communications
NHK:	Nippon Hoso Kyokai, Japan Broadcasting Corporation
SN:	Safety Net

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