

1. Foreward

Integrated Services Digital Broadcasting – Terrestrial (ISDB-T), the digital terrestrial TV broadcasting (DTTB) system was originally developed in Japan, and the transmission system has been internationally standardized as System C in the Recommendation ITU-R BT.1306 “Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting”. The ISDB-T DTTB system has been adopted by 17 countries as of April 2015, as shown in Fig-1, including Japan and Brazil; and has either been already put into operation or is being prepared for implementation. In order to start DTTB services in these ISDB-T adopting countries, they are required to establish their own ISDB-T standards as well as the operational guidelines tuned to each of their countries’ conditions, while keeping the commonalities of the ISDB-T DTTB system.

We hereby introduce the activities of DiBEG (Digital Broadcasting Experts Group), established under ARIB, which has been supporting technical study for their own ISDB-T standardization at some of those newly ISDB-T adopting countries¹, in due consideration of various conditions unique with each of these countries.

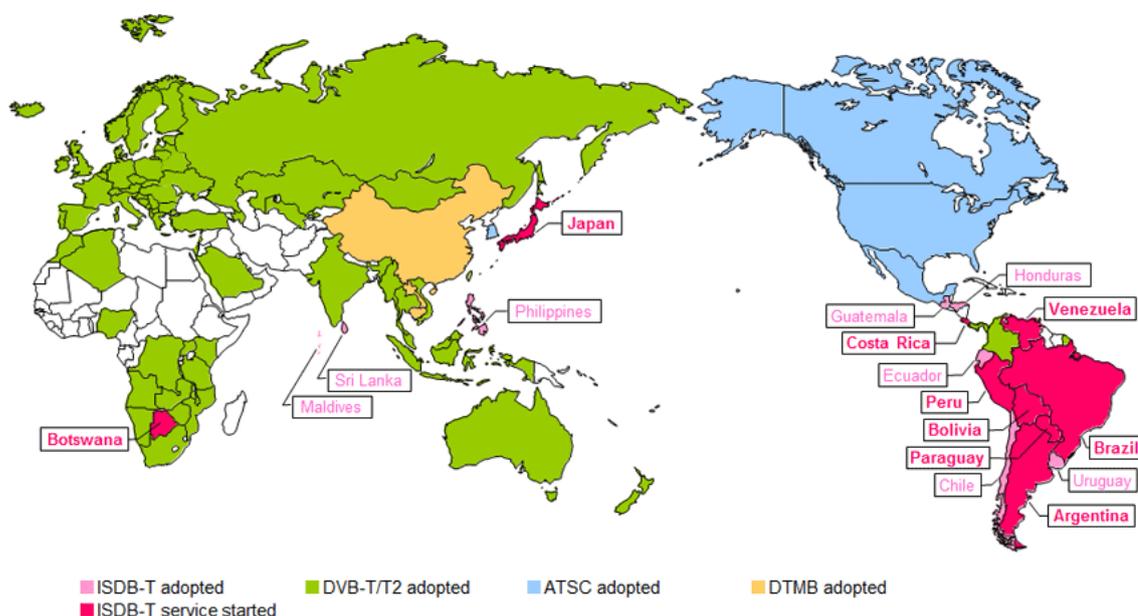


Fig-1 Permiation of Countries Adopting ISDB-T as DTTB System

¹ DiBEG has set up the Task Force for the Newly ISDB-T Adopting Countries in order to study and support the ISDB-T standardization unique to each of them, since Botswana’s adoption in February, 2013, followed by the Philippines, Sri Lanka and Maldives.

2. Considerations and the Background on the Standardization of ISDB-T Adopting Countries

To establish its own ISDB-T standards as well as the operational guidelines at each of the adopting countries, the standards have to be adjusted in consideration of the specific conditions of the said country, while keeping the commonalities of the ISDB-T DTTB system. The items to consider and the background for the ISDB-T standardization at each country are listed here-below;

2.1 Benefits of Digital Television and Considerations for the Migration

There are various benefits in the TV digitization by ISDB-T as listed below; and migrations from terrestrial analog television to digital are going on in many countries in the world right now.

- (i) Efficient use of frequency. By making use of highly efficient video and audio signal compression coding technologies, it enables multiple programs of standard definition television (SDTV), whose quality is equivalent to or better than the analog television, available in the same frequency bandwidth.
- (ii) Robustness against interference and noise. It can withstand multipath interference or fading, as well as urban impulse noise; which allows also lower output power signal transmission than that of analog TV broadcast.
- (iii) Effective utilization of frequency resource by SFN (Single Frequency Network). It allows SFN which constitutes a broadcast network with one frequency; leading to the efficient utilization of the frequency resources.

Transition to digital TV broadcast should be based on the existing analog TV broadcast standard; namely, the ISDB-T DTTB standards for one country should be based on the SDTV standards, channel allocation planning, channel bandwidth, etc. used for the existing analog TV broadcast.

Besides, in addition to the SDTV broadcasting service of the existing analog TV programs, the following new services are expected in migrating to digital television by ISDB-T;

- (iv) High Definition Television (HDTV). Thanks to the highly efficient video and audio signal compression coding technologies, HDTV broadcasting services are available with the same bandwidth as the existing analog TV services.
- (v) Data broadcasting. Transmission of various kinds of data in addition to the transmission of video and audio signals is available without changing the transmission system; allowing multimedia services available to TV viewers.
- (vi) Convergence between telecommunications and broadcast. Interactive broadcast service, combined between Internet and broadcast, is available.
- (vii) Wide variety of broadcast services, ranging from fixed, portable to mobile reception, are available in the same frequency band. By utilizing the functions of TMCC

signal (Transmission and Multiplexing Configuration Control), the transmission mode, modulation or data transmission rate can be selected, making it possible to provide various services for reception by not only conventional TV sets but also portable or hand-held receivers.

- (viii) Partial reception is available ("One-seg" service). By receiving only one segment in the center of the bandwidth by dividing the allocated frequency bandwidth, lower power consumption with the receiver is available; especially convenient for hand-held receivers. (See Item 3.1 (ii) below for the segmentation.)

Among these, as for data broadcasting, there are some standardized systems; then the technical standard accommodating each country's condition is to be adopted. Also, even when the same data broadcasting standard is adopted, some additional modifications such as character code for that specific country's language are required to be done.

2.2 Analog Television Broadcast Standards of Each Country and Evolution of Digital Video and Audio Compression Technologies

As the background of ISDB-T DTTB standards for each country, here are some explanations on the existing analog TV broadcast standards and the evolution of digital video and audio compression technologies as follows:

(1) Analog Television Standards of Each of the ISDB-T Adopting Countries

There are various analog television broadcast standards because the timing of starting the analog television broadcast (SDTV broadcast) varied at these countries. The differences are in the multiplexing system of color signals, sound multiplexing system, and in the waveform of sync signal or in the modulation system. As image scanning systems, there are two systems: 525 scanning lines/60 fields and 625 lines/50 fields.

One VHF or UHF physical channel is allocated to one analog television broadcast. While the frequency band allocations for television broadcast are defined by ITU (International Telecommunication Union), the actual frequencies and the channel bandwidths vary depending on the laws or the way implemented in each country; the physical frequency channels are assigned with the bandwidth of either 6MHz, 7MHz or 8MHz.

(2) Evolution of Digital Video and Audio Compression Technologies

The video and audio signals of digital TV signal are coded by digital compression technologies. The digital compression coding technologies have been advancing gradually, and also thanks to the advancement of semiconductor processing technologies, the practical decoder circuit capacity has been growing. Thus depending on the timing of launching digital TV broadcast at each country, the available digital compression coding technologies have been improving.

3. Configuration of ISDB-T DTTB System and International Standards

As in the Fig-2 below, the ISDB-T DTTB transmission system is comprised of Source Coding, Multiplexing and Channel Coding Blocks.

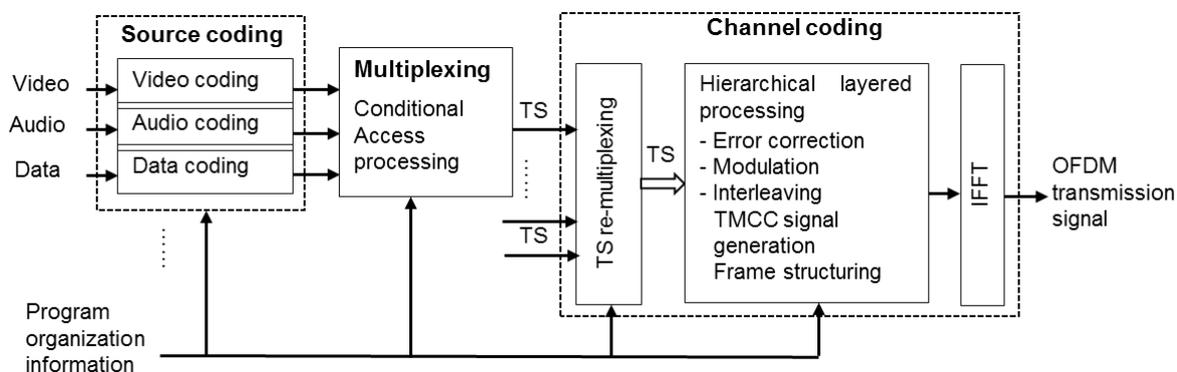


Fig-2 Block Diagram of ISDB-T DTTB transmission System

Most of the elements in these blocks have been established as international technical standards. And in Japan and Brazil, the detailed technical specifications have been standardized as domestic standard. In Japan these are defined as ARIB Standards (ARIB STDs); and in Brazil as ABNT (Associação Brasileira de Normas Técnicas) Standards. The Table-1 shows the ISDB-T DTTB system elements and the corresponding International Standards. It also shows ARIB Standards and ABNT Standards.

Table-1 Standards of ISDB-T Digital Terrestrial TV System

	International	ARIB	ABNT
Transmission	ITU-R BT.1306 System C	ARIB STD- B31	ABNT NBR 15601
Video Coding	MPEG-2 Video (ISO/IEC 13818-2, ITU-T H.262)	ARIB STD- B32 Part-1	ABNT NBR 15602-1
	MPEG-4 AVC (ISO/IEC 14496 -10, ITU-T H.264)		
Audio Coding	MPEG-2 AAC (ISO/IEC 13818-7)	ARIB STD- B32 Part-2	ABNT NBR 15602-2
	MPEG-4 AAC (ISO/IEC 14496 -3)		
Multiplexing	MPEG-2 Systems (ISO/IEC 13818-1, ITU-T H.222)	ARIB STD- B32 Part-3	ABNT NBR 15602-3
SI	MPEG-2 Systems (ISO/IEC 13818-1 ITU-T H.222)	ARIB STD- B10	ABNT NBR 15603
Receivers		ARIB STD- B21	ABNT NBR 15604
Data Broadcasting	ITU-R BT.1699	ARIB STD- B24	ABNT NBR 15606
Interactive Communications		ARIB STD- B24	ABNT NBR 15607
		ARIB STD- B21	

3.1 Transmission System of ISDB-T

The transmission system of ISDB-T is internationally standardized as System C of the Recommendation ITU-R BT.1306 “Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting”. Besides, the planning criteria is also standardized as the ITU-R Recommendation BT.1368 “Planning, including protection ratios, for digital terrestrial television services in the VHF/UHF bands”.

The main features of the transmission system of ISDB-T DTTB system are shown in (i) and (ii) below;

- (i) Adopting OFDM multi-carrier modulation system, which is highly robust to multi-path interference, and also it enables to establish SFN.
- (ii) Adopting segmented OFDM transmission system. The bandwidth of one channel is divided into 14 segments; 13 of them being used for maximum 3-layered hierarchical transmissions; which can assure a variety of signal transmissions such as for the simultaneous broadcast for both fixed reception and mobile reception. By adjusting the TMCC signal, the layered composition of segmented OFDM can be changed when necessary.

As described in the preceding Chapter 2.2, the frequency bandwidth of physical channels used for analog TV broadcasting varies in each country; 3 different frequency bandwidths of 6MHz, 7MHz and 8MHz in VHF/UHF bands. The ISDB-T countries such as Japan, the Philippines and the Latin American countries are using UHF band (while some of the countries such as Brazil are also using VHF), with the bandwidth of 6MHz. On the other hand, Botswana, Maldives and Sri Lanka are using UHF band with the bandwidth of 8MHz.

For the 8MHz bandwidth ISDB-T DTTB system, in order to utilize the 8MHz bandwidth effectively while maintaining the commonalities with the 6MHz system, the IFFT sampling frequency is changed to be higher by the ratio of bandwidth (of 8MHz/6MHz), without changing the number of OFDM carriers; and the bitrate available for transmission is larger by the ratio.

3.2 Source Coding and Multiplexing of ISDB-T

In digital TV broadcasting, in addition to the encoded video and audio signals, various information is also being broadcast as data; such as monomedia encoding of characters, graphics, still pictures; multimedia encoding which combines them spacio-temporally, and encoding of subtitle and superimpose. The encoding systems of these sources signals have been established as international or domestic standards.

➤ Multiplexing

The MPEG-2 Systems, international standard by ISO/IEC and ITU-T, is deployed for multiplexing.

➤ Encoding of Video and Audio

MPEG-2 Video coding or MPEG-4AVC coding, both international standards by ISO/IEC and ITU-T, are adopted for video coding. Likewise for audio coding, MPEG-2 AAC coding or MPEG-4 AAC coding, both international standards by ISO/IEC, is deployed.

➤ Data broadcasting

There are several data broadcasting systems. While Japan adopts BML (Broadcast Markup Language), Brazil adopts a different one called “Ginga”. The common parts of these two formats are identified as the Recommendation ITU-R BT.1699 “Harmonization of declarative content format for interactive TV applications”.

3.3 Emergency Warning Broadcast System

As one of the features of ISDB-T DTTB system, EWBS (Emergency Warning Broadcast System) must be pointed out. When there is an emergency alert such as tsunami, EWBS, by using the emergency alert signal generated by a broadcaster, will activate automatic start-up function of TV receivers in the stand-by mode, to advise TV viewers of such alert, in order to prevent or minimize the subsequent disaster. EWBS has been approved as “ISDB-T Harmonization Document Part 3: EWBS” by the ISDB-T International Forum where the ISDB-T adopting countries work together for technical harmonization among the member countries. The EWBS prescribed in the Harmonization Document has a mechanism which, in addition to the mechanism of the emergency alert broadcasting in Japan, transmits and indicates superimposed text message of such emergency information on the receiver screen.

4. Japanese and Brazilian Standards as the Bases for the Standards of ISDB-T Adopting Countries

The detailed technical specifications of ISDB-T have been established; in Japan as ARIB Standards, and in Brazil as ABNT Standards. To introduce the contents of the proposed specifications of ISDB-T standards tuned to each of the ISDB-T adopting countries, the common points and different points between the Japanese and the Brazilian standards are listed below;

Japan and Brazil have been using the same SDTV scanning lines of 525/60 fields, and the frequency bandwidth of 6MHz for analog TV system, System M. This makes it possible for both countries to use the common basic DTTB parameters.

Japan and Brazil both use the same parameters as the transmission system for ISDB-T DTTB system. Also in respect to multiplexing, both countries adopt the same MPEG-2 Systems standard.

As to the video coding, because both countries have adopted the most advanced and practical coding system at the time of the adoption, Japan adopted MPEG-2 Video; while Brazil adopted MPEG-4 AVC. While the MPEG-4 AVC is expected to have twice the

coding efficiency of MPEG-2 Video, the scale of the decoder complexity has to be almost twice that of MPEG-2 Video. By the time Brazil finalized its specifications, the MPEG-4 AVC had been available in the semiconductor market for consumer products, and the performances had been proved practical. For the audio coding, Japan adopted MPEG-2 AAC, and Brazil adopted MPEG-4 AAC; and thus there is a difference in the audio transport multiplexing stream. But they are both based on the same MPEG AAC coding scheme.

With respect to SI (Service Information), Brazil has arranged its SI based on the ARIB STD-B10 of Japan; and thus they are similar to each other. On the other hand about the character coding, Brazilian version has been modified in a way that, by using only 1 byte coding, all the alphanumeric and additional Latin characters can be indicated. Also about the subtitle, the character coding has been modified likewise that, with 1 byte coding, all the alphanumeric and Latin additional characters can be indicated.

As to the data broadcasting system, Japan adopts BML, and Brazil adopts “Ginga”; which are different from each other.

The Table-2 shows the outline of ISDB-T DTTB specifications of Japan and Brazil.

Table-2 Outline of ISDB-T DTTB specifications of Japan and Brazil

		Japan		Brazil	
Reference: Analog broadcasting		System-M			
	Scanning Lines	525 Lines			
	Field Frequency	60/1.001Hz			
	Channel Spacing	6MHz			
Transmission System		ISDB-T (Segmented OFDM)			
	Transmission Bandwidth	6MHz			
	Number of Segments.	13			
	Number of Carriers	1405/ 2809/ 5617 (Mode1/ 2/ 3)			
	Modulation Method	DQPSK, QPSK, 16QAM, 64QAM			
	Guard Interval	1/4, 1/8, 1/16, 1/32			
	Inner Coding	Convolutional 1/2, 2/3, 3/4, 5/6, 7/8			
	Outer Coding	RS (204, 188)			
	RF Channels	UHF 13-62		VHF 7-13, UHF 14-69	
Multiplexing		MPEG-2 System			
Audio Coding		MPEG-2 Video		MPEG-4 AVC/ H.264	
Video Resolution (* ; specified only in Japan)	Vertical	Horizontal	Scanning	Aspect Ratio	
	480	720	60I	4:3	
	480	720	60I	16:9	
	480	720	60P	16:9	
	720	1280	60P	16:9	
	1080*	1440*	60I*	16:9*	
	1080	1920	60I	16:9	
Audio Coding		MPEG-2 AAC		MPEG-4 AAC	

Container	ADTS	LATM/LOAS
Profile	AAC-LC	AAC-LC + SBR
Maximum Number of Channels	5.1 channels	
SI	Section System	
Subtitle and Superimpose	Synchronous/Asynchronous Independent PES	
Data Coding	BML	“Ginga”
Portable reception	One-seg service	
Video Coding	MPEG-4 AVC/ H.264	MPEG-4 AVC/ H.264
Audio Coding	MPEG-2 AAC-LC + SBR	MPEG-4 AAC-LC + SBR/PS

5. Proposal of ISDB-T Standards for Each ISDB-T Adopting Countries

As explained in the preceding chapter, the Brazilian ISDB-T DTTB standards, while maintaining the commonalities with the Japanese standards, have more efficient and practical video and audio coding methods than the Japanese as of this date. Therefore in preparing a proposal of its own ISDB-T standards for each adopting country, Brazilian standards have been adopted to be the basis except for the data broadcasting system. Namely, toward the Philippines, Botswana, Maldives and Sri Lanka, the Brazilian standards (ABNT standards) are the basis of the proposal, while the data broadcasting system is based on the Japanese standard BML (ARIB STD-B24). Also, in proposing the operational guidelines for the ISDB-T DTTB operation, likewise the standards, the Brazilian standards have been adopted as the basis, except for the data broadcasting (ARIB TR-B14).

As for EWBS, “ISDB-T Harmonization Document Part 3: EWBS” of the ISDB-T International Forum has been adopted to be referred to, and for receiver operational guideline, “ISDB-T Harmonization Document Part 1: Hardware” of the same Forum has been also adopted as the reference.

The base documents for the ISDB-T standards and operational guidelines for each of the newly adopting countries, are listed in the Table-3 below;

Table-3 The base documents for ISDB-T DTTB Standards and Operational Guidelines for newly adopting countries

		Base Standards	Base Operational Guidelines
1	Transmission	ABNT NBR 15601	ABNT NBR 15608-1
2	Video Coding	ABNT NBR 15602-1	ABNT NBR 15608-2
3	Audio Coding	ABNT NBR 15602-2	ABNT NBR 15608-2
4	Multiplexing	ABNT NBR 15602-3	ABNT NBR 15608-3
5	SI	ABNT NBR 15603	ABNT NBR 15608-3
6	Receivers	ABNT NBR 15604	ISDB-T International Harmonization Document Part 1: Hardware (*Note)
7	Copy Control	ABNT NBR 15605	- Same as left -

8	Data Broadcasting	ARIB STD-B24	ARIB TR-B14 Vol.3
9	Interactive Communications	ABNT NBR 15607	- Same as left -
10	EWBS	ISDB-T International Harmonization Document Part 3: EWBS	- Same as left -

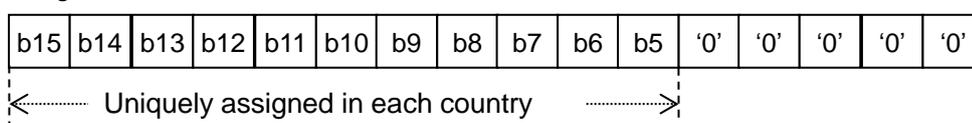
*Note: This Document has been approved by the ISDB-T International Forum as the harmonization document for the receiver’s operational guideline among the ISDB-T adopting countries, based on ABNT NBR 15604, ARIB STD-B21 and ARIB TR-B14.

5.1 Proposal of ISDB-T Standards for the Philippines

In proposing ISDB-T standards and operational guidelines for the Philippines, the following modifications have been additionally made to the base documents listed in the above Table-3;

- (i) The Philippines have been using the same analog broadcasting standards as those of Japan and Brazil, with the scanning lines of 525/60 fields of SDTV signal and the frequency bandwidth of 6MHz, System M; and thus there has not been any modification made to the transmission system. However, regarding the spurious emission, because it is desirable to comply with the international standards regulated by ITU rather than to be based on the Brazilian ABNT “Transmission System”, DiBEG has proposed the ITU RR (Radio Regulation) Appendix 3, Recommendation ITU-R BT.1206-1, and Recommendation ITU-R SM.329. Besides, since the Philippines would use only the UHF frequency, this point has been clearly described.
- (ii) There has not been any modification to the video coding.
- (iii) There has not been any modification to the audio coding and multiplexing.
- (iv) DiBEG has proposed the following modifications in respect to SI;
 - 1) Country Name and Country Code ("BRA"→"PHL")
 - 2) Language and Language Codes: ("por"→"eng", "tgl")
 - 3) Time Code: ("UTC-3"→"UTC+8")
 - 4) “Ginga” Descriptor for data broadcasting to be deleted
 - 5) DiBEG has proposed the following composition for original_network_id considering the convenience in applying the same kind method to service_id.

Original_network_id



In addition, network_id, service_id and affiliation_id should be uniquely assigned in the Philippines; which should be studied and arranged by the Philippines.

- (v) DiBEG has proposed ARIB STD-B24 for BML data broadcasting, subtitle and superimpose as being deployed in Japan, together with the following modifications; The ARIB STD-B24 prescribes the use of JIS and Shift-JIS character codes. But these are applied uniquely to the Japanese language only; and would better not be used. Likewise regarding UCS (Universal multi-octet coded character set), DiBEG has proposed that a character set unique to the Filipino language (Tagalog) to be added, instead of using the unique Japanese characters.
DiBEG has also proposed that the operational guidelines of ARIB TR-B14 should be modified in accordance with the language and character coding of the Philippines, with MPEG-4 AVC/MPEG-4 AAC applied, and with additional specifications of NVRAM for data broadcasting.
- (vi) As for the receiver specifications, DiBEG has proposed the modifications on the ABNT specifications regarding the data broadcasting by BML instead of GINGA and also the followings;
 - 1) Analog TV receiver specifications ("PAL-M"→" NTSC-M")
 - 2) Accommodation of Low IF of lower than 10MHz
 - 3) Remote Control Keys in accordance with data broadcasting
 - 4) The safety standards should derive from the Filipino domestic standards.
- (vii) There has not been any modification to the copy control function and the interactive communications function.
- (viii) DiBEG has had discussed with the Filipino authority in proposing the details regarding the area code settings for the EWBS operation.

5.2 ISDB-T Standards for Botswana, Maldives and Sri Lanka

The analog TV broadcasting in Botswana, Maldives and Sri Lanka is, different from that of Japan and Brazil, on PAL-I or PAL-B standard, with the SDTV signal of 625 scanning lines/50 fields; and the UHF band is to be used for digital TV broadcasting with 8MHz bandwidth. Thus it is necessary to make modifications from the existing ISDB-T DTTB standards shown in Table-3. Also as to the field frequency of HDTV signals, because 50 fields are to be utilized in consideration of the compatibility with SDTV, additional specifications to accommodate these conditions to the existing standards are required. Other remaining areas of the standards are basically the same as those which DiBEG has proposed to the Philippines. The details of proposed modifications are listed here-below;

- (i) DiBEG has adjusted the transmission system described in the ABNT specifications to be in compliance with the 8MHz system as standardized by ITU-R. In order to make effective use of 8MHz frequency bandwidth while keeping the commonality of channel coding specifications, the number of OFDM carriers has not been changed, yet by elevating the IFFT sampling frequency in proportion to the ratio of the transmission bandwidth (8MHz/6MHz).

To be more specific;

- 1) To enlarge the bandwidth by 8/6 (because it adopts 8MHz).
- 2) To make the IFFT sampling frequency faster by 8/6.
- 3) To shorten the symbol duration by 6/8.
- 4) To increase the transmission bitrate by 8/6.
- 5) To shorten the guard interval by 6/8.

Besides, DiBEG has suggested not to apply the 1/7 frequency offset to the operating channels. The spurious emission characteristics and the utilization of UHF band basically remain as proposed to the Philippines.

- (ii) In respect to the video coding, to accommodate the SDTV signal of 625 scanning lines/50 fields, DiBEG has proposed to include the video resolution of 720x576/50Hz Interlace and 720x576/50Hz Progressive. Also DiBEG has proposed the addition of 1920x1080/50Hz Interlace and 1920x1080/25Hz Progressive.

Regarding the items (iii) through (v), DiBEG has proposed the same additions and modifications as proposed to the Philippines, such as the addition of the character set unique to each country.

- (vi) On the subject of receiver specifications, in addition to what has been proposed to the Philippines, DiBEG has proposed the following modifications;

- 1) Addition of 720x576/50Hz Interlace, 720x576/50Hz Progressive, 1920x1080/50Hz Interlace, and 1920x1080/25Hz Progressive
- 2) Input terminal IEC 61169-2

Regarding the operational guidelines of the receiver, the "ISDB-T Harmonization Document Part 1: Hardware" is referred to. However, as the current Harmonization Document does not contain the specifications for the bandwidth of 8MHz, DiBEG has prepared a proposal to add the specifications for 8MHz; which will be presented at the next ISDB-T International Forum general meeting for the approval.

Regarding (vii) and (viii), DiBEG has proposed the same additions and modifications as proposed to the Philippines, such as the settings of the area codes for EWBS in each country.

6. Conclusion

ISDB-T DTTB system was firstly developed and deployed in Japan; the transmission system of which has been standardized internationally as Recommendation ITU-R BT.1306 ; and as of April of 2015 there are 17 ISDB-T adopting countries, including Japan and Brazil, either having already started commercial broadcasting or are preparing for commercial services. To start digital TV broadcasting in these countries, it is necessary to establish its own ISDB-T standards in each country, while maintaining the commonalities of ISDB-T system yet by tuning to the specific conditions of each country, in consideration of the situations of each of these countries.

This document describes the Japanese and Brazilian standards which should be the

bases for the ISDB-T standards of each of the ISDB-T adopting countries; and also explained the ISDB-T standards and operational guidelines, which DiBEG has proposed to the Philippines, Botswana, Maldives and Sri Lanka respectively.

In the Philippines the National Telecommunications Commission (NTC) announced the Implementing Rules and Regulations (IRR), containing the Filipino ISDB-T standards based on DiBEG proposals, in the end of 2014 and was effectuated as of January 1, 2015.

DiBEG will continue its technical support for those ISDB-T adopting countries, and will also promote ISDB-T DTTB system to those countries where the digital TV system has not yet been decided.