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Radiocommunication Sector of ITU

Recommendation ITU-R BT.2016

(04/2012)

Error-correction, data framing, modulation and emission methods for terrestrial multimedia broadcasting for mobile reception using handheld receivers in VHF/UHF bands

BT Series

Broadcasting service (television)

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SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

Electronic Publication
Geneva, 2012

RECOMMENDATION ITU-R BT.2016*

Error-correction, data framing, modulation and emission methods for terrestrial multimedia broadcasting for mobile reception using handheld receivers in VHF/UHF bands

(2012)

Scope

This Recommendation defines error-correction, data framing, modulation and emission methods for terrestrial multimedia broadcasting for mobile reception using handheld receivers in the VHF/UHF bands.

The ITU Radiocommunication Assembly,

considering

a) that digital multimedia broadcasting systems have been implemented in many countries or are planned to be introduced, using the inherent capability of digital broadcasting systems;

b) that terrestrial emission systems for mobile reception using handheld receivers require specific technical characteristics due to peculiar propagation characteristics;

c) that the interoperability between multimedia and digital television and sound broadcasting systems may be desired;

d) that Recommendations ITU-R BT.1306 and ITU-R BT.1877 specify error-correction, data framing, modulation and emission methods for digital terrestrial television broadcasting;

e) that Recommendation ITU-R BS.1114 specifies error-correction, data framing, modulation and emission methods as well as higher-layer systems characteristics for digital terrestrial sound broadcasting;

f) that Recommendation ITU-R BT.1833 describes end user requirements and higher-layer systems characteristics for multimedia broadcasting systems for mobile reception using handheld receivers,

recommends

1 that administrations wishing to introduce terrestrial multimedia broadcasting for mobile reception using handheld receivers in the VHF/UHF bands should use one of the systems comprising error-correction, framing, modulation and emission methods outlined in Annex 1.

NOTE 1 − Tables 1 and 2 of Annex 1 can be used to evaluate the respective characteristics of the systems in selecting a specific system.

* NOTE – The meeting noted that this Recommendation may be updated at the next possible meeting with the conclusion of additional digital multimedia broadcasting systems.

Annex 1

Table 1 provides data about emission systems for terrestrial multimedia broadcasting for mobile reception using handheld receivers in the VHF/UHF bands. Supplemental information for the systems can be found in Appendices 1, 2 and 3.

Table 2 provides technical features of each system described in Table 1 that concern several aspects relevant to implementation and deployment.

TABLE 1

Parameters for emission systems

	Parameters	Multimedia System A	Multimedia System F	Multimedia System I
1	Channel bandwidths	1.712 MHz	1/14 × *n* of a) 6 MHz b) 7 MHz c) 8 MHz $n \geq 1$ (1)	a) 1.7 MHz b) 5 MHz c) 6 MHz d) 7 MHz e) 8 MHz
2	Used bandwidth	1.536 MHz	"Subcarrier spacing" (see item 5) + 1/14 × *n* × a) 6 MHz b) 7 MHz c) 8 MHz $n \geq 1$ (1)	a) 1.52 MHz b) 4.75 MHz c) 5.71 MHz d) 6.66 MHz e) 7.61 MHz
3	Number of segments	1	$n \geq 1$ (1)	
4	Number of subcarriers per segment	192 384 768 1 536	108 (Mode 1) 216 (Mode 2) 432 (Mode 3)	853 (1k mode) 1 705 (2k mode) 3 409 (4k mode) 6 817 (8k mode)
5	Subcarrier spacing	a) 8 kHz b) 4 kHz c) 2 kHz d) 1 kHz	a) 3.968 kHz (Mode 1)(2), 1.984 kHz (Mode 2), 0.992 kHz (Mode 3) b) 4.629 kHz (Mode 1), 2.314 kHz (Mode 2), 1.157 kHz (Mode 3) c) 5.291 kHz (Mode 1), 2.645 kHz (Mode 2), 1.322 kHz (Mode 3)	a) 1 786 kHz (1k) b) 5 580.322 Hz (1k) 2 790.179 Hz (2k) 1 395.089 Hz (4k) 697.545 Hz (8k) c) 6 696.42 Hz (1k), 3 348.21 Hz (2k), 1 674.11 Hz (4k), 837.05 Hz (8k) d) 7 812 Hz (1k), 3 906 Hz (2k), 1 953 Hz (4k), 976 Hz (8k) e) 8 929 Hz (1k), 4 464 Hz (2k), 2 232 Hz (4k), 1 116 Hz (8k)

TABLE 1 *(continued)*

	Parameters	Multimedia System A	Multimedia System F	Multimedia System I
6	Active symbol duration	a) 156 µs b) 312 µs c) 623 µs d) 1246 µs	a) 252 µs (Mode 1) [(2)], 504 µs (Mode 2), 1008 µs (Mode 3) b) 216 µs (Mode 1), 432 µs (Mode 2), 864 µs (Mode 3) c) 189 µs (Mode 1), 378 µs (Mode 2), 756 µs (Mode 3)	a) 560 µs (1k) b) 179.2 µs (1k), 358.40 µs (2k), 716.80 µs (4k), 1 433.60 µs (8k) c) 149.33 µs (1k), 298.67 µs (2k), 597.33 µs (4k), 1 194.67 µs (8k) d) 2 128 µs (1k), 256 µs (2k), 512 µs (4k), 1 024 µs (8k) e) 112 µs (1k), 224 µs (2k), 448 µs (4k), 896 µs (8k)
7	Guard interval duration or guard interval ratio	a) 31µs b) 62 µs c) 123 µs d) 246 µs	1/32, 1/16, 1/8, 1/4 of "active symbol duration" (see item 6)	1/32, 1/16, 1/8, 1/4 of active symbol duration
8	Transmission unit (frame) duration	96 ms 48 ms 24 ms	204 OFDM symbols (Symbol duration = guard interval duration + active symbol duration)	68 OFDM symbols. One super-frame consists of 4 frames
9	Time/frequency synchronization	Null symbol and Centre frequency and phase reference symbol	Pilot carriers	Pilot carriers
10	Modulation methods	T-DMB: COFDM-DQPSK AT-DMB: COFDM-DQPSK COFDM-BPSK over DQPSK COFDM-QPSK over DQPSK	DQPSK, QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM
11	Inner channel coding	T-DMB: Convolutional code (1/4 to 3/4) AT-DMB: Convolutional code + Turbo code (1/4 to 1/2)	Convolution code, Mother rate 1/2 with 64 states. Puncturing to rate 2/3, 3/4, 5/6, 7/8	Turbo Code from 3GPP2 with mother information block size of 12 282 bits. Rates obtained by puncturing: 1/5, 2/9, 1/4, 2/7, 1/3, 2/5, 1/2, 2/3

TABLE 1 *(end)*

	Parameters	Multimedia System A	Multimedia System F	Multimedia System I
12	Inner interleaving	Time interleaving and frequency interleaving	Frequency interleaving: Intra and inter segments interleaving Time interleaving: Symbol-wise convolutional interleaving 0, 380, 760, 1 520, 3 040 symbols (Mode 1) (2) 0, 190, 380, 760, 1 520 symbols (Mode 2) 0, 95, 190, 380, 760 symbols (Mode 3)	– Frequency interleaving – Time interleaving: Forney with 48 branches QPSK: 320/9 600 ms 16-QAM:160/4 800 ms
13	Outer channel coding	RS (204, 188, T=8) code for video service and scalable video service	RS (204, 188, T=8)	
14	Outer Interleaving	Convolutional interleaving for video service and scalable video service	Byte-wise convolutional interleaving, I=12	
15	Net data rates	• T-DMB: 0.576 to 1.728 Mbit/s • AT-DMB: 0.864 to 2.304 Mbit/s at BPSK over DQPSK • AT-DMB: 1.152 to 2.88 Mbit/s at QPSK over DQPSK	*n* × a) 0.281 to 1.787 Mbit/s b) 0.328 to 2.085 Mbit/s c) 0.374 to 2.383 Mbit/s	At MPEG-TS level and starting from the lower code rate with GI 1/4 to the higher rate with GI 1/32: a) 0.42 to 3.447 Mbit/s b) 1.332 to 10.772 Mbit/s c) 1.60 to 12.95 Mbit/s d) 1.868 to 15.103 Mbit/s e) 2.135 to 17.257 Mbit/s
Reference		Appendix 1	Appendix 2	Appendix 3

(1) The number of segments "*n*" is determined by the available bandwidth.

(2) Modes 1, 2, and 3 can be selected by the scale of the single frequency network (SFN) and the types of service reception such as fixed or mobile. Mode 1 can be used for single transmission operation, or for small single frequency network. This mode is suitable for mobile reception. Mode 3 can be used for large single frequency network. This mode is suitable for fixed reception. Mode 2 offers an additional trade-off between transmission area size and mobile reception capabilities. The mode should be selected by taking the applied radio frequency, the scale of SFN, and the type of service reception into consideration.

TABLE 2

Technical features of systems

		Multimedia System A	Multimedia System F	Multimedia System I
1	Multipath interference	Choice of 4 transmission modes, using OFDM modulation, offer flexible and appropriate protection against multipath interference in many situations	Choice of 4 guard intervals, choice of 3 Modes, and scattered pilots for reference symbol, using OFDM modulation, offer flexible and appropriate protection against multipath interference in many situations	Multipath interference is mitigated by selecting the appropriate guard interval duration (among 4) and Mode (1k, 2k, 4k or 8k)
2	Fading environments	Choice of 4 transmission modes, using OFDM modulation, offer flexible and appropriate protection in fading environments in many situations	Choice of 3 Modes, choice of time interleaving up to approximately 0.8 s and scattered pilots for reference symbol, using OFDM modulation, offer flexible and appropriate protection in fading environments in many situations	The combination of Turbo Code and flexible interleaver (up to 10 s) provides protection even in very challenging including blockage of duration comparable to the length of the interleaver
3	Single frequency networks	Typical SFN cell size is about 70 km (DQPSK, 1/2, guard interval 256 μs) depending on the frequency and transmission power	SFN is typically supported in 8k-FFT with selectable forward error correction (FEC) code rate and carrier modulation scheme. Long delay multipath signal caused by SFN is acceptable by long guard interval up to approximately 250 μs	SFN cell radius is mostly dependent on the configuration (SH-A or SH-B) and selection of the guard interval duration. Typical SFN distance is 30-35 km, extendable to 100 km
4	Simultaneous transmission of different quality levels (hierarchical transmission)	T-DMB: Not applicable AT-DMB: Different quality levels can be independently set to each layer Furthermore, up to four levels of different quality transmission is possible with adjusting constellation ratio	Different quality levels can be independently set to each basic composition of segments. Furthermore, up to three levels of different quality transmission is possible with 13-segment composition, and two levels of different quality transmission are possible with 3-segment composition	Hierarchical modulation is fully supported. Furthermore, a low-latency service can be embedded into a regular service using a feature of the interleaver

TABLE 2 *(end)*

		Multimedia System A	Multimedia System F	Multimedia System I
5	Spectrum efficiency (bit/s/Hz)	T-DMB: From 0.375 (DQPSK, convolutional code rate 1/4) to 1.125 (DQPSK, convolutional code rate 3/4) bit/s/Hz AT-DMB: From 0.5625 (BPSK over DQPSK, convolutional code rate 1/4, turbo code 1/4) to 1.5 (BPSK over DQPSK, convolutional code rate 3/4, turbo code rate 1/2) bit/s/Hz AT-DMB: From 0.75 (QPSK over DQPSK, convolutional code rate 1/4, turbo code rate 1/4) to 1.875 (QPSK over DQPSK, convolutional code rate 3/4, turbo code rate 1/2) bit/s/Hz	From 0.655 bit/s/Hz (QPSK 1/2) to 4.170 bit/s/Hz (64-QAM 7/8) Higher spectrum efficiency is provided by connected transmission because guardband is not required	– With GI 1/4: From 0.2806 bit/s/Hz with QPSK 1/5 to 1.8709 bit/s/Hz with 16QAM 2/3 – With GI 1/32: From 0.3402 bit/s/Hz with QPSK 1/5 to 2.2678 bit/s/Hz with 16QAM 2/3
6	Power consumption for handheld receivers	Low power consumption feature of DAB is applied Optimized narrow bandwidth allows low system clock frequency and simple FFT calculation. Supports sub-channel decoding for selected service	Narrow bandwidth and partial reception out of wideband signal enables low system clock frequency. Lower system clock in a receiver provides lower power consumption	Time slicing provides ~90% power saving compared to continuous reception in the DVB-SH receiver part

Appendix 1
to Annex 1

Multimedia system A (T-DMB and AT-DMB)

1 Overview and Summary of T-DMB

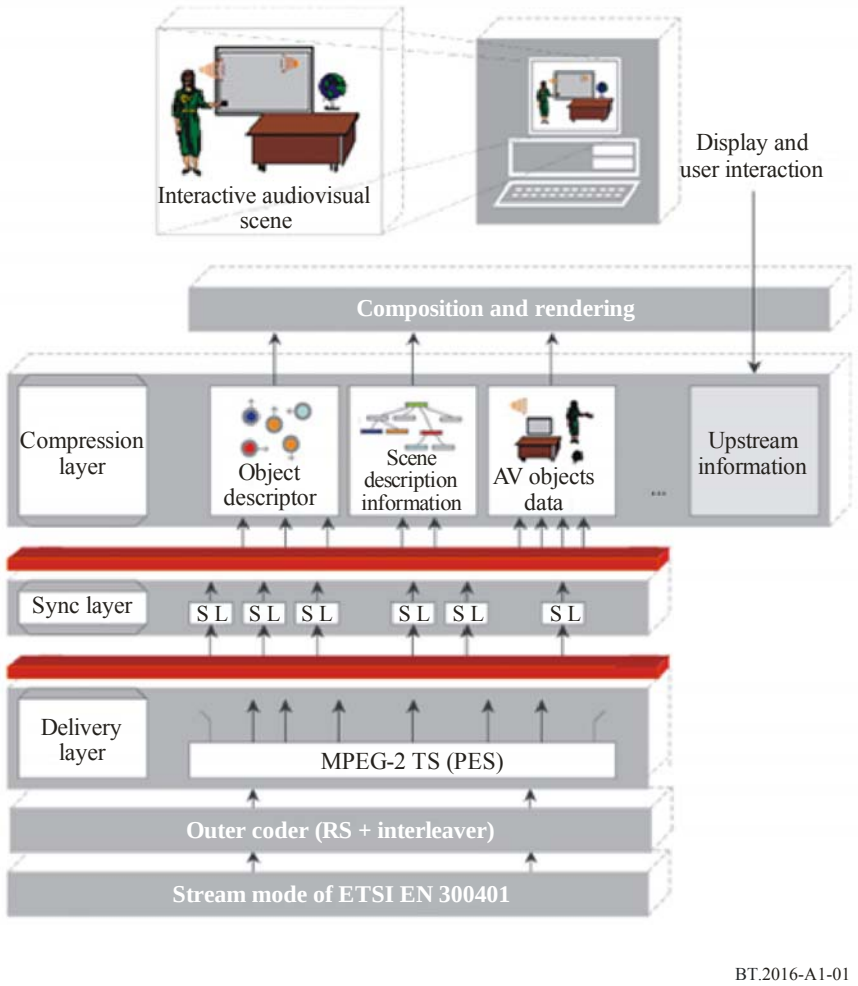
Terrestrial Digital Multimedia Broadcasting (T-DMB) is the enhanced system of digital system A defined in Recommendation ITU-R BS.1114, which enables multimedia service including video, audio, and interactive data for handheld receivers in a mobile environment.

For audio service, it uses MPEG-4 ER-BSAC or MPEG-4 HE AAC v2 + MPEG Surround in addition to MPEG-1/MPEG-2 Audio Layer II specified in digital system A. For video service ITU-T H.264 | MPEG-4 AVC standard is used for video, MPEG-4 ER-BSAC or MPEG-4 HE AAC v2 + MPEG Surround for the associated audio, and MPEG-4 BIFS and MPEG-4 SL for interactive data. Outer channel coding of Reed-Solomon code is applied to provide stable performance of video reception.

Conceptual T-DMB architecture for video service that transmits MPEG-4 content encapsulated using "MPEG-4 over MPEG-2 TS" specification is illustrated in Fig. A1-1.

FIGURE A1-1

Conceptual T-DMB architecture for video service



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Detailed mechanism on how to provide video service in a mobile environment is defined in ETSI TS 102 427 and ETSI TS 102 428 standards.

2 Overview and summary of AT-DMB

The second generation of T-DMB, which is called Advanced T-DMB or AT-DMB in short, increases channel capacity of T-DMB, Multimedia System A in Recommendation ITU-R BT.1833, up to twice at maximum the T-DMB System, is operable in T-DMB networks, since it is completely backward-compatible with T-DMB. The basic parameters of AT-DMB such as channel bandwidth, number of carriers, symbol duration, guard interval duration, etc. are the same as those of T-DMB.

For improvement of channel capacity, a hierarchical modulation is applied; BPSK or QPSK symbol is mapped over DQPSK symbol. Table A1-1 shows parameters of both T-DMB and AT-DMB. AT-DMB uses both Band III and L-Band spectrum in which T-DMB networks are in operation. It guarantees backward compatibility with T-DMB. Thus, using increased channel capacity of the AT-DMB system, it can provide either better quality or additional services other than the services provided by the T-DMB system. Detailed specification is described in the Standard "TTAK.KO-07.0070/R2" for modulation and error protection mechanism.

TABLE A1-1

Parameters comparison between AT-DMB and T-DMB systems

Parameters	T-DMB	AT-DMB
Standard	Recommendation ITU-R BS.1114 Digital System A	Recommendation ITU-R BS.1114 Digital System A, TTAK.KO-07.0070/R2
Channel code (code rate)	Convolutional code (1/4, 3/8, 1/2, 3/4)	Convolutional code, (1/4, 3/8, 1/2, 3/4) Turbo code (1/2, 2/5, 1/3, 1/4)
Modulation method (time interleaving depth)	DQPSK (384 ms)	DQPSK (384 ms), BPSK over DQPSK (768 ms), QPSK over DQPSK (384 ms)
Constellation ratio	N/A	1.5, 2.0, 2.5, 3.0, ∞*

* ∞ means that the hierarchical modulation is not applied.

AT-DMB can provide a scalable video service as well as all kinds of T-DMB services. The scalable video service fully guarantees backward compatibility with the video service of T-DMB. It can serve VGA quality video service to AT-DMB receivers, QVGA quality video service to T-DMB receivers. For audio of the scalable video service, it uses ISO/IEC 23003-1 for MPEG-4 ER-BSAC or MPEG-4 HE AAC v2 + MPEG Surround. For video of the scalable video service, it uses base line profile of Recommendation ITU-T H.264 | ISO/IEC 14496-10 Amendment 3 for MPEG-4 SVC.

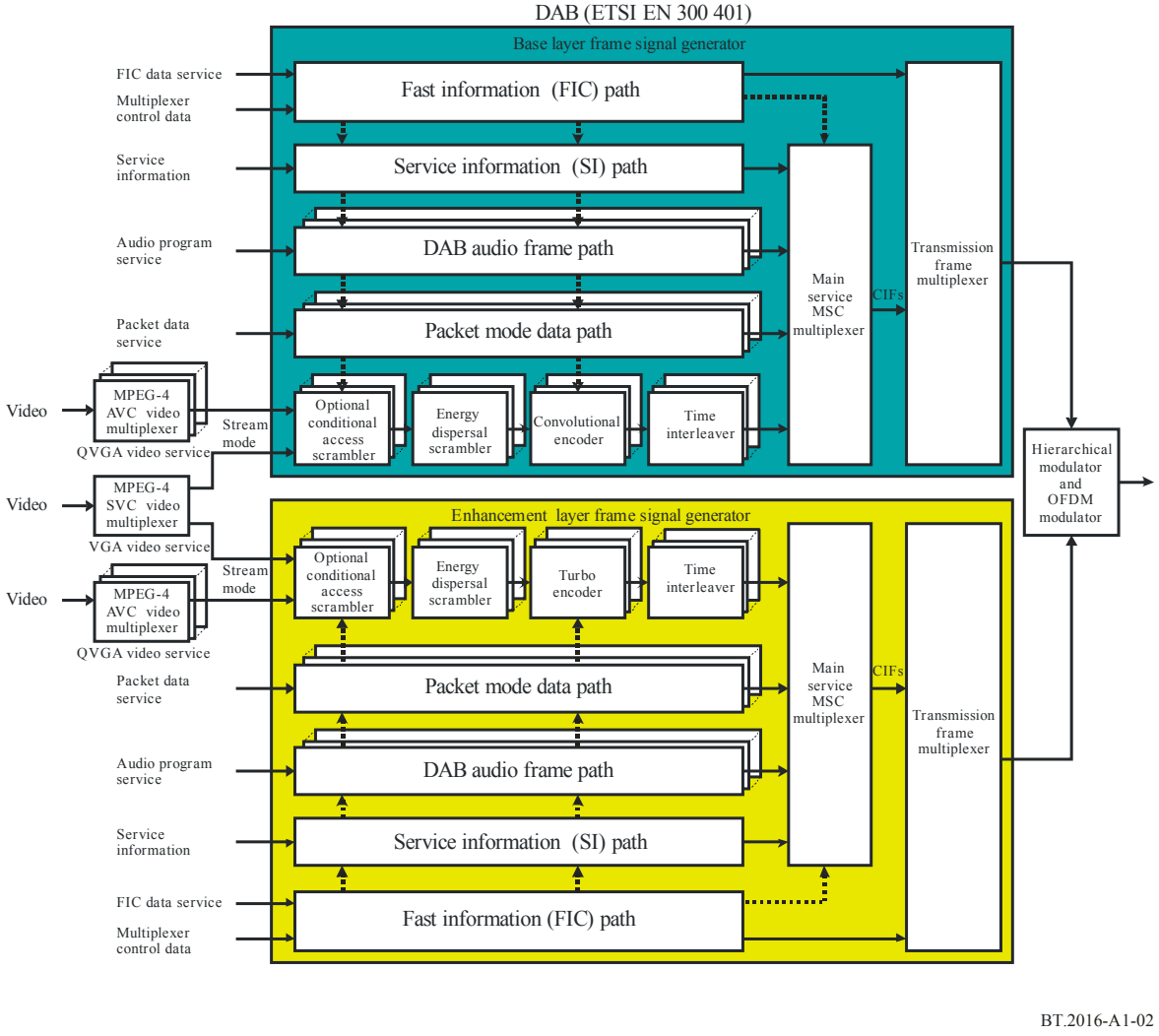
Refer to TTAK.KO-07.0070/R2 for hierarchical modulation scheme, error correction code, etc. of AT-DMB and TTAK.KO-07.0071 for AT-DMB scalable video service.

3 Transmission system architecture

There are two layers in AT-DMB system: one layer is a base layer for T-DMB receivers; the other layer is an enhancement layer that provides the additional service for AT-DMB receivers only. In order to improve channel error correction capability in the enhancement layer, turbo code is applied instead of convolutional code (CC) which is used for T-DMB receivers. Five constellation ratios of 1.5, 2.0, 2.5, 3.0 and ∞ are newly introduced to adjust reception performances and coverage areas of both AT-DMB and T-DMB services by controlling error correction capabilities in the base and the enhancement layers. Figure A1-2 shows the conceptual transmission system architecture of AT-DMB.

FIGURE A1-2

Conceptual transmission system architecture of AT-DMB



Bibliography

Normative references

[1] Recommendation ITU-R BS.1114 System A – System for terrestrial digital sound broadcasting to vehicular, portable and fixed receivers in the frequency range 30-3 000 MHz.

[2] ETSI EN 300 401: Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers.

[3] TTA, TTAK.KO-07.0070/R2: Specification of the Advanced Terrestrial Digital Multimedia Broadcasting (AT-DMB) to mobile, portable, and fixed receivers, 2011.

Informative references

[4] ETSI TR 101 497: Digital Audio Broadcasting (DAB); Rules of Operation for the Multimedia Object Transfer Protocol.

[5] ETSI TS 101 759: Digital Audio Broadcasting (DAB); Data Broadcasting – Transparent Data Channel (TDC).

[6] ETSI ES 201 735: Digital Audio Broadcasting (DAB); Internet Protocol (IP) Datagram Tunnelling.

[7] ETSI TS 101 499: Digital Audio Broadcasting (DAB); MOT Slide Show; User Application Specification.

[8] ETSI TS 101 498-1: Digital Audio Broadcasting (DAB); Broadcast Website; Part 1: User Application Specification.

[9] ETSI TS 101 498-2: Digital Audio Broadcasting (DAB); Broadcast Website; Part 2: Basic Profile Specification.

[10] ETSI EN 301 234: Digital Audio Broadcasting (DAB); Multimedia Object Transfer (MOT) Protocol.

[11] ETSI TS 102 371: Digital Audio Broadcasting (DAB); Transportation and Binary Encoding Specification for DAB Electronic Programme Guide (EPG).

[12] ETSI TS 102 818: Digital Audio Broadcasting (DAB); XML Specification for DAB Electronic Programme Guide (EPG).

[13] ETSI TS 102 427: Digital Audio Broadcasting (DAB); Data Broadcasting - MPEG-2 TS Streaming.

[14] ETSI TS 102 428: Digital Audio Broadcasting (DAB); DMB video service; User Application Specification.

[15] Report ITU-R BT.2049-3 – Broadcasting of multimedia and data applications for mobile reception.

[16] TTA, TTAK.KO-07.0071: Advanced Terrestrial Digital Multimedia Broadcasting (AT-DMB) Scalable Video Service.

Appendix 2
to Annex 1

Multimedia system F (ISDB-T multimedia broadcasting for mobile reception)

Multimedia System F is the enhanced ISDB-T/T_{SB}-based multimedia broadcasting system called "ISDB-T multimedia broadcasting for mobile reception". The system is based on the transmission technology of System C (also known as ISDB-T) in Recommendation ITU-R BT.1306 and Digital System F (also known as ISDB-T_{SB}) in Recommendation ITU-R BS.1114. Digital System F can be regarded as a narrow-band variation of ISDB-T. Figure A2-1 shows three basic compositions of ISDB-T multimedia broadcasting.

As featured by System C, Multimedia System F provides hierarchical transmission. This enables allocation of signals for mobile reception that requires greater robustness in the same channel as that for stationary reception. Use of "OFDM segments", units of OFDM carriers corresponding to 1/13 of a channel, is a key technique for this. One or more segments form a segment group. The transmission parameters of the modulation scheme of OFDM carriers, the coding rates of inner error correcting code, and the length of the time interleaving can be independently specified for each segment group. A segment group is the basic unit for delivering broadcast services, hence transmission parameters of the segments are common within the group.

The centre segment of ISDB-T and ISDB-T_{SB} is a special segment that is suitable for establishing a segment group having only one segment. When only the centre segment forms a segment group, the segment can be received independently.

The number of segments of Multimedia System F can be chosen in accordance with the application and available bandwidth. The spectrum is formed by combining 1-segment, 3-segment, and/or 13-segment blocks without a guardband. Figure A2-2 shows example combinations of the segment blocks. A receiver can partially demodulate a 1-, 3- or 13-segment part so that the hardware and software resources for ISDB-T or ISDB-T_{SB} receivers can be used to make receivers for the ISDB-T multimedia broadcasting for mobile reception.

FIGURE A2-1

Three basic compositions of ISDB-T multimedia broadcasting

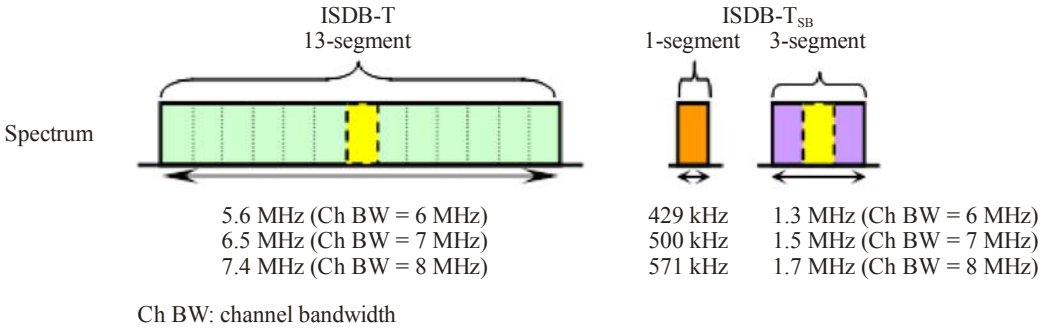


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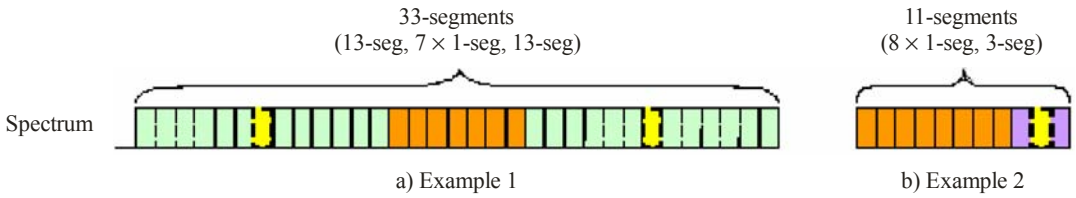
FIGURE A2-2

Example combinations of segment blocks of ISDB-T multimedia broadcasting



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

[3] ARIB STD-B46 – Transmission system for terrestrial mobile multimedia broadcasting based on connected segments transmission, *Association of Radio Industries and Businesses*.

Appendix 3
to Annex 1

Multimedia system I (DVB-SH)

Multimedia system "I" is an end-to-end broadcast system for delivery of any type of digital content and services using IP-based mechanisms optimized for devices with limitations on computational resources and battery. It consists of a unidirectional broadcast path that may be combined with a bidirectional mobile cellular (2G/3G/4G) interactivity path. The terrestrial component of multimedia system "I" (CGC) may be combined or integrated with a satellite component (SC) as illustrated in Fig. A3-1. The system specifications can be divided into the following categories:

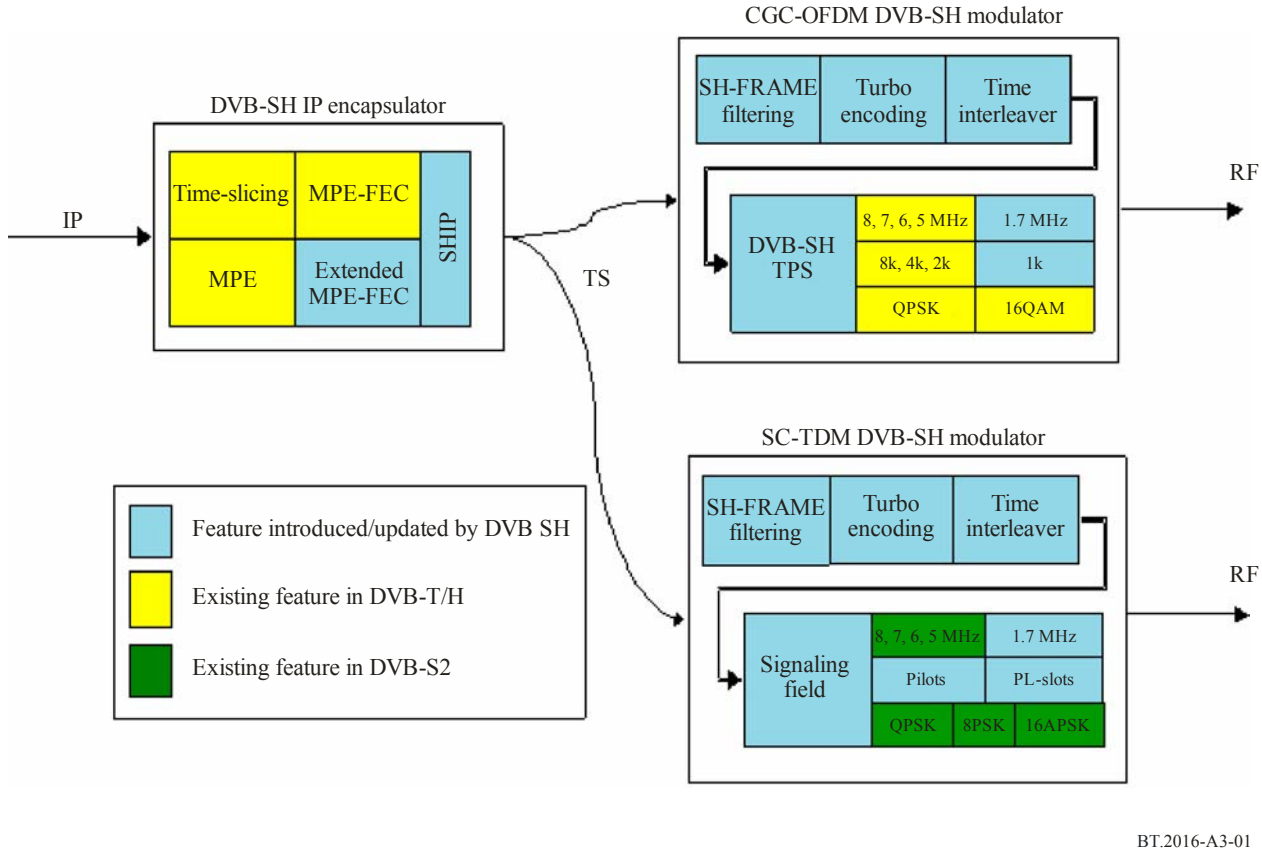
– General end-to-end system descriptions
– DVB-SH radio interfaces
– IP-based services delivery over DVB-SH service layer
– IP-based services delivery codecs and content formats.

DVB-SH is an enhancement of DVB-H, itself based on the widely accepted DVB-T digital broadcast standard for mobile broadcast reception. The umbrella specification for DVB-SH is ETSI TS 102 585.

DVB-SH systems use the forward error correction (FEC) scheme 3GPP2 Turbo code over 12 kbit/s blocks. In addition, DVB-SH systems use a highly flexible channel interleaver that offers time diversity from about one hundred milliseconds to several seconds depending on the targeted service level and corresponding capabilities (essentially memory size) of terminal class. The radio interface specification for DVB-SH is ETSI EN 302 583.

FIGURE A3-1

DVB SH-B architecture – Transmitter side



DVB-SH system signalling specifications in ETSI TS 102 470-2 defines the exact use of PSI/SI information in case of an IP-based services delivery.

For video services H.264/AVC and for audio HE AAC v2 codecs and respective RTP payload formats are used. Several types of data are supported including, e.g. binary data, text and still images.

RTP is the IETF protocol used for streaming services. Delivery of any kind of files in an IP-based services delivery system is supported by the IETF FLUTE protocol.

An electronic service guide has been specified to allow fast discovery and a selection of services for the end user.

Versatile service purchase and protection mechanisms have been defined for broadcast-only and interaction-capable handheld receivers.

Mechanisms have been defined for mobility over DVB-SH networks and between DVB-H and DVB-SH networks.

DVB-SH Implementation Guidelines including numerous results from laboratory and field trials are provided in ETSI TS 102 584.

Bibliography

General end-to-end system description

– ETSI TS 102 585: Digital video broadcasting (DVB); System specifications for satellite services to handheld devices (SH) below 3 GHz.

Radio interface

– ETSI EN 302 583: Digital video broadcasting (DVB); Framing structure, channel coding and modulation for satellite services to handheld devices (SH) below 3 GHz.

Link layer

– ETSI EN 301 192: Digital video broadcasting (DVB); DVB specification for data broadcasting.

– ETSI TS 102 772: Digital video broadcasting (DVB); Specification of multi-protocol encapsulation – inter-burst forward error correction (MPE-IFEC).

System level signalling

– ETSI TS 102 470-2: Digital video broadcasting (DVB); IP Datacast over DVB-SH: Programme specific information (PSI)/(Service Information (SI).

IP Datacast service layer

The electronic service Guide is specified in:

– ETSI TS 102 471: Digital video broadcasting (DVB); IP Datacast over DVB-H: Electronic service Guide (ESG).

– ETSI TS 102 592-2: IP Datacast over DVB-SH: Electronic service Guide (ESG) implementation Guidelines.

The content delivery protocols are specified in:

– ETSI TS 102 472: Digital video broadcasting (DVB); IP Datacast over DVB-H: Content delivery protocols.

– ETSI TS 102 591-2: Digital video broadcasting (DVB); IP Datacast: Content delivery protocols implementation Guidelines; Part 2: IP Datacast over DVB-SH.

Service purchase and protection mechanisms are specified in:

– ETSI TS 102 474: Digital video broadcasting (DVB); IP Datacast over DVB-H: Service purchase and protection.

Mechanisms for mobility are specified in:

– ETSI TS 102 611-2 IP Datacast over DVB-SH: Implementation Guidelines for mobility.

IP Datacast codecs and formats

– ETSI TS 102 005: Digital video broadcasting (DVB); Specification for the use of video and audio coding in DVB services delivered directly over IP.

Guidelines for deployment of DVB-SH

– ETSI TS 102 584: Digital video broadcasting (DVB); DVB-SH Implementation Guidelines.

OMA BCAST 1.1 specifications

OMA BCAST is a set of service layer specifications, applicable to various broadcast bearers, including the DVB-SH broadcast bearers.

– "BCAST Distribution system adaptation – IPDC over DVB-SH", open mobile alliance, Version 1.1.