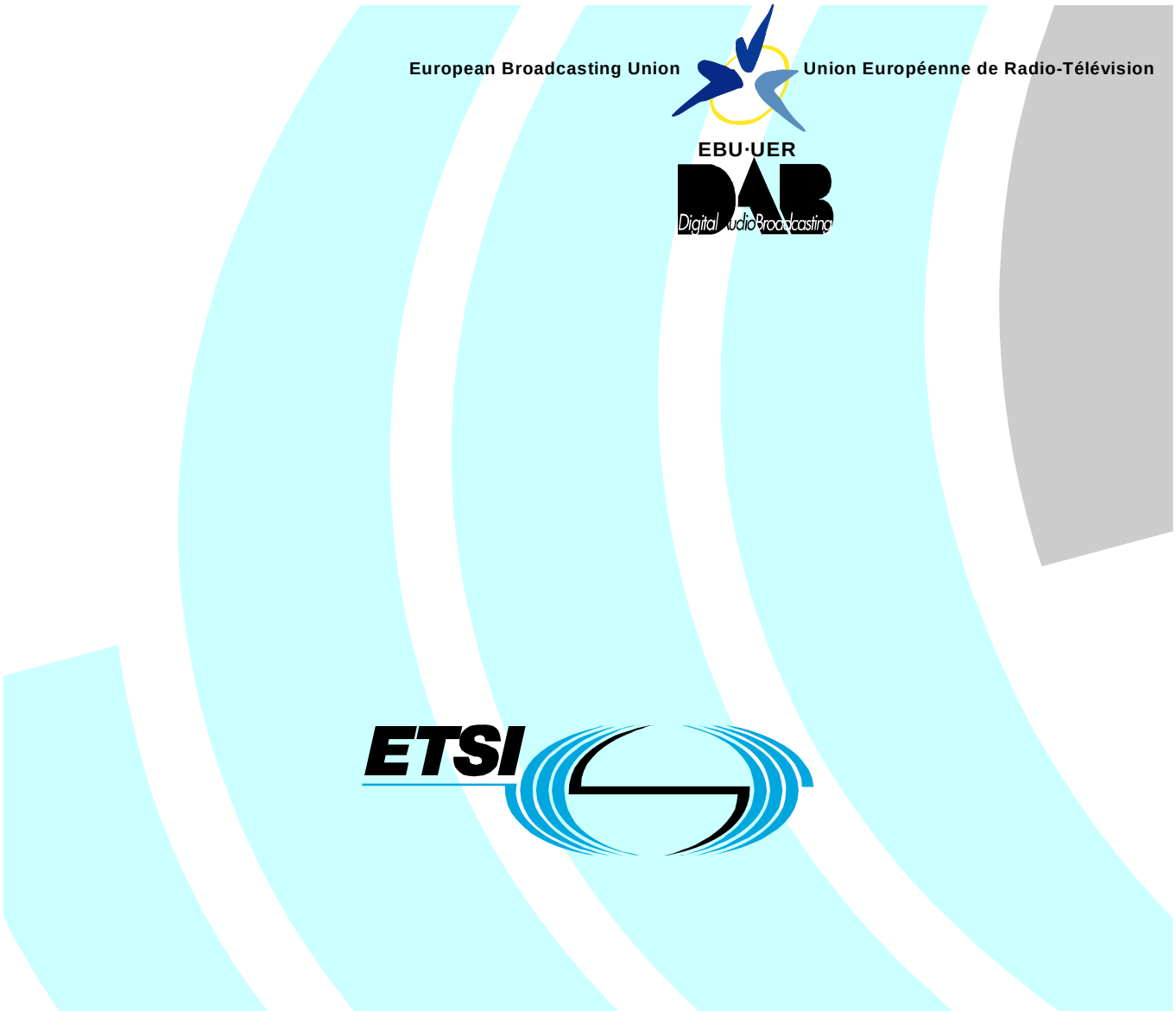
ETSI TS 102 428 V1.2.1 (2009-04)

Technical Specification

Digital Audio Broadcasting (DAB); DMB video service; User application specification



Reference
RTS/JTC-DAB-61

Keywords
broadcasting, digital, DAB, video

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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Foreword

This Technical Specification (TS) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE 1: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

European Broadcasting Union
CH-1218 GRAND SACONNEX (Geneva)
Switzerland
Tel: +41 22 717 21 11
Fax: +41 22 717 24 81

The Eureka Project 147 was established in 1987, with funding from the European Commission, to develop a system for the broadcasting of audio and data to fixed, portable or mobile receivers. Their work resulted in the publication of European Standard, EN 300 401 [1], for DAB (see note) which now has worldwide acceptance. The members of the Eureka Project 147 are drawn from broadcasting organizations and telecommunication providers together with companies from the professional and consumer electronics industry.

NOTE 2: DAB is a registered trademark owned by one of the Eureka Project 147 partners.

1 Scope

The present document specifies the user application for DMB video services carried via DAB. It also includes profile definitions for the application.

The user application is delivered using the MSC stream data mode (EN 300 401 [1]) including additional error protection (TS 102 427 [2]).

The present document defines the components of the DMB video services; the content compression, the synchronization mechanism and multiplexing mechanism. The components of the DMB service are the video object, the audio object, and the auxiliary media objects. All the objects are packetized and synchronized using MPEG-4 SL (ISO/IEC 14496-1 [4]). The present document also specifies the mechanism for the multiplexing of the multimedia data using MPEG-2 TS (ISO/IEC 14496-1 [4]). For efficiency, some appropriate restrictions to MPEG-4 SL and MPEG-2 TS are specified.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
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  - for informative references.

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2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

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

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

[3] ISO/IEC 13818-1: "Information technology - Generic coding of moving pictures and associated audio information: Systems".

[4] ISO/IEC 14496-1: "Information technology - Coding of audio-visual objects - Part 1: Systems".

[5] ISO/IEC 14496-3: "Information technology - Coding of audio-visual objects - Part 3: Audio".

[6] ISO/IEC 14496-10: "Information technology - Coding of audio-visual objects - Part 10: Advanced Video Coding".

[7] ETSI TS 101 756: "Digital Audio Broadcasting (DAB); Registered tables".

[8] ISO/IEC 10918-1: "Information technology - Digital compression and coding of continuous-tone still images: Requirements and guidelines".

[9] ITU-T Recommendation H.264: "Advanced video coding for generic audiovisual services".

[10] ISO/IEC 23003-1: "Information technology - MPEG audio technologies - Part 1: MPEG Surround".

[11] ETSI TS 102 563: "Digital Audio Broadcasting (DAB); Transport of Advanced Audio Coding (AAC) audio".

[12] ISO/IEC 15948: "Information technology - Computer graphics and image processing - Portable Network Graphics (PNG): Functional specification".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area**.** For non-specific references, the latest version of the referenced document (including any amendments) applies.

Not applicable.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

audio object: data encoded by the audio compression algorithm used for DMB video service

auxiliary media object: data encoded by an auxiliary media compression algorithm used for DMB video service (e.g. JPEG or PNG images)

DMB video multiplexer: Transport Stream (TS) multiplexer that combines all ESs that belong to the DMB video service

DMB video service: service composed of audio, video and auxiliary media objects

elementary stream: consecutive flow of compressed mono-media data, i.e. one of the coded audio, coded video or other coded bitstream

interactive service: service in which the users can select, respond to or control the broadcast content

radio service: DMB video service composed of (at least) one audio object, (at least) one auxiliary media object and one optional video object

NOTE: All receiving devices allow access to radio services.

random access: capability of receiving a service from an arbitrary point in its timeline rather than being confined to progressively receiving it from its beginning

Synchronization (Sync) layer: Sync Layer (SL), as defined in ISO/IEC 14496-1 [4], provides a combined transmission of timing and synchronization information with Elementary Streams (ESs)

television service: DMB video service composed of one video object, (at least) one audio object associated with the video object and optional auxiliary media objects

NOTE: Only receiving devices with video decoding capability allow access to television services.

Transport Stream (TS) multiplexer: device that combines all the ESs that belong to a single program into a Transport Stream (TS) defined in ISO/IEC 13818-1 [3] for the delivery through a single transmission path

video object: data encoded by the video compression algorithm used for the DMB video service

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

BIFS	BInary Format for Scene
CTS	Composition Time Stamp
DAB	Digital Audio Broadcasting
DMB	Digital Multimedia Broadcasting
DRC	Dynamic Range Control
DTS	Decoding Time Stamp
ES	Elementary Stream
ID	IDentifier
IOD	Initial Object Descriptor
IPI	Intellectual Property Identification
IPMP	Intellectual Property Management and Protection
OCR	Object Clock Reference
OD	Object Descriptor
PAD	Programme Associated Data
PAT	Program Association Table
PCR	Program Clock Reference
PES	Packetized Elementary Stream
PID	Program IDentifier
PMT	Program Map Table
PSI	Program Specific Information
PTS	Presentation Time Stamp
RS	Reed-Solomon
SL	Synchronization Layer
TS	Transport Stream
URL	Universal Resource Locator

4 Architecture

The DMB video service user application described in the present document is delivered through the MSC stream data mode (EN 300 401[1]). In order to maintain extremely low bit error rates, the service uses the additional error protection mechanism described in TS 102 427 [2]. The DMB video service is composed of three layers; content compression layer, synchronization layer, and transport layer. In the content compression layer, DMB specifies a specific compression method for the video content, a specific compression method for the audio content and a specific scene description for interactive content. To synchronize the audio and video content, both temporally and spatially, MPEG-4 SL is employed in the synchronization layer. In the transport layer, MPEG-2 TS with some appropriate restrictions is employed for the multiplexing of the compressed audio and video content.

This clause defines the system architecture for the DMB video service user application. This architecture is illustrated in figure 1.

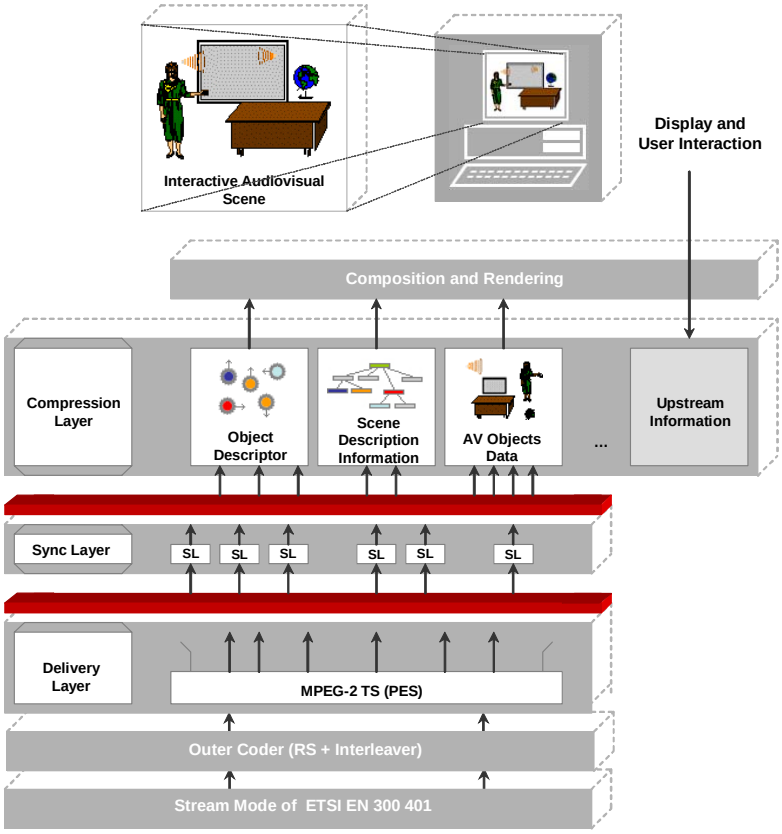


Figure 1: Conceptual architecture for the DMB video service

4.1 DMB video service transmission architecture

The conceptual transmission architecture for the DMB video service is shown in figure 2.

- The video, audio and the auxiliary media information which makes up a DMB video service, are multiplexed into an MPEG-2 TS and further outer error correction is added (TS 102 427 [2]). The DMB video multiplexer is described in clause 4.2.
- The multiplexed (and outer-coded) stream is transmitted by the MSC stream mode data channel of DAB defined in EN 300 401 [1].

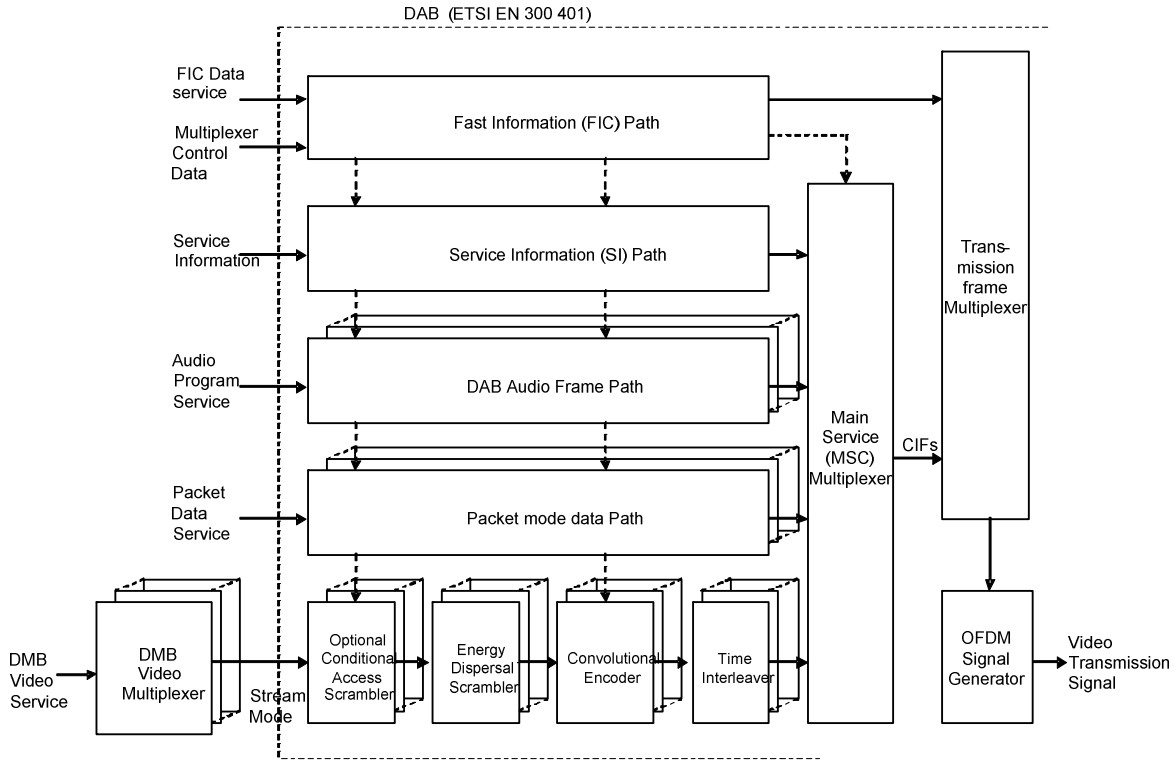


Figure 2: Conceptual transmission architecture for the DMB video services

4.2 DMB video multiplexer architecture

The conceptual architecture of the DMB video multiplexer for a DMB video service is shown in figure 3.

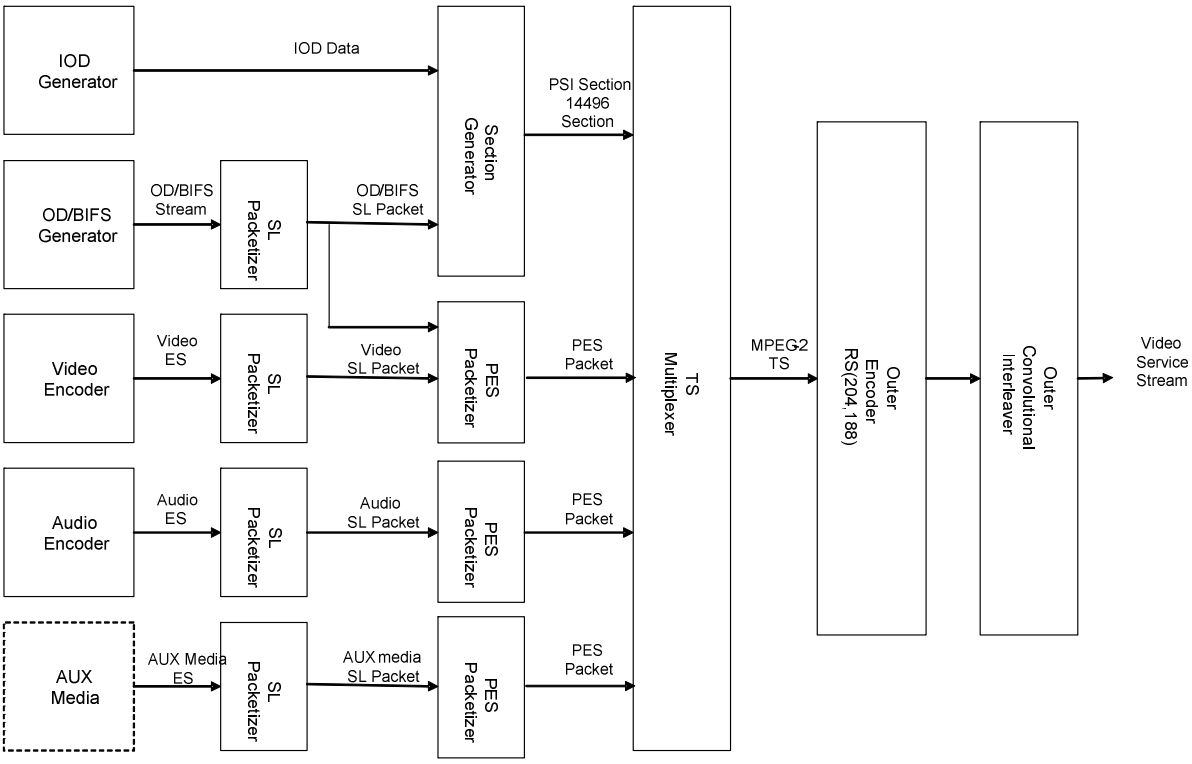


Figure 3: Conceptual architecture of the DMB video multiplexer

- The IOD generator creates IODs that comply with the ISO/IEC 14496-1 [4].

- The OD/BIFS generator creates OD/BIFS streams that comply with the ISO/IEC 14496-1 [4] according to the DMB video service profiles defined in clause 5.1.
- The audio encoder generates an encoded bitstream compliant with the audio specification defined in one of the DMB video service profiles defined in clause 8, by performing data compression processing of the input audio signal (see clause 5.3).
- The video encoder generates an encoded bitstream compliant with the video specification defined in one of the DMB video service profiles defined in clause 8, by performing data compression processing of the input video signal (see clause 5.4).
- Each SL packetizer generates a SL packet stream, compliant with ISO/IEC 14496-1 [4] system standard for each input media stream (see clause 5.2).
- The section generator creates sections compliant with ISO/IEC 13818-1 [3] for the input IOD/OD/BIFS (see annex A).
- Each PES packetizer generates a PES packet stream compliant with ISO/IEC 13818-1 [3] for each SL packet stream (see clause 6.2).
- The TS multiplexer combines the input sections and PES packet streams into a single MPEG-2 transport stream complying with ISO/IEC 13818-1 [3] (see clause 6.1).
- The outer encoder generates Reed-Solomon (RS) codes for error correction to each packet in the MPEG-2 TS multiplexed data stream (see TS 102 427 [2]).
- The outer-coded data stream is interleaved by the outer interleaver, which is a convolutional interleaver (see TS 102 427 [2]), and is output into the DAB sub-channel as a MSC stream data service component.

5 Contents description

5.1 Composition of content

The tools defined in the "Core" Profile of ISO/IEC 14496-1 [4] are used for the description of objects in the DMB video services (see table 1). The IPMP tool is not used.

The following restrictions are imposed on the MPEG-4 descriptors that are used in the DMB video service.

The following descriptors shall always be used:

- OD.
- IOD.
- ES Descriptor.
- Decoder Config Descriptor.
- SL Config Descriptor.

The following descriptors shall **not** be used:

- IPI Descriptor Pointer.
- IPMP Descriptor Pointer.
- IPMP Descriptor.

The scene description tools used in DMB video service shall comply with the "Core2D@Level1" Scene Graph Profile and with the "Core2D@Level1" Graphics Profile of ISO/IEC 14496-1 [4]. Appropriate signalling in the InitialObjectDescriptor is described in table 1.

Table 1: OD and BIFS profiles in the InitialObjectDescriptor

InitialObjectDescriptor	Value
ODProfileLevelIndication	0x01
sceneProfileLevelIndication	0x0C
graphicsProfileLevelIndication	0x04

Any InitialObjectDescriptor that does not conform to table 1 shall be ignored.

The character codes used for "Text" nodes are the basic characters used in DAB (EN 300 401 [1]).

The stream type and the object type of the contents in the DMB video service shall be determined by the streamType and objectTypeIndication values of DecoderConfigDescriptor. The stream type and the object type values are listed in ISO/IEC 14496-1 [4].

The permitted values of object types for the DMB video service are listed in table 2.

Table 2: ObjectTypeIndication values

Values	ObjectTypeIndication Description
0x02	Systems ISO/IEC 14496-1 [4]
0x21	Visual ISO/IEC 14496-10 [6]
0x40	Audio ISO/IEC 14496-3 [5]
0x6C	Visual ISO/IEC 10918-1 [8]
0x6D	Visual ISO/IEC 15948 [12]
0xC0 to 0xFE	User private

The permitted values of stream types for the DMB video service are listed in table 3.

Table 3: Permitted stream types

StreamType value	Stream Type
0x01	ObjectDescriptorStream
0x02	ClockReferenceStream
0x03	SceneDescriptionStream
0x04	VisualStream
0x05	AudioStream
0x20 to 0x3F	User private

A DMB scene description shall never require a receiver to render more than one video object and more than one audio object at a given time.

Examples of IOD, OD and BIFS descriptions in the case of a single audio object and a single audio object with a single video object are provided in annex A.

An informative content access procedure within receiving terminals playing a DMB video service is given in annex B.

5.2 Packetization of content

Content shall be packetized as Sync Layer (SL) packets as defined in ISO/IEC 14496-1 [4]. The following rules are applied to SL packet headers:

- The "useAccessUnitStartFlag" field has no restriction on its value.
- The "useAccessUnitEndFlag" field has no restriction on its value, but shall always be used with the "useAccessUnitStartFlag" field.
- The "useRandomAccessPointFlag" field has its value restricted to "0".

NOTE 1: Random access is supported through use of the "random_access_indicator" field within the TS packet.

- The "hasRandomAccessUnitsOnlyFlag" field has its value restricted to "0".
- The "usePaddingFlag" field has its value restricted to "0".

NOTE 2: Padding is employed in PES packets.

- The "useTimeStampsFlag" field has its value restricted to "1".
- The "useIdleFlag" field has its value restricted to "1".
- The "durationFlag" field has no restriction on its value.
- The "timeScale" field shall always be used if the "durationFlag" field has the value of "1".
- The "accessUnitDuration" field shall always be used if the "durationFlag" field has the value of "1".
- The "compositionUnitDuration" field shall always be used if the "durationFlag" field has the value of "1".
- The "timeStampResolution" field shall be set to 90,000 Hz.
- The "OCRResolution" field shall be set to 90,000 Hz.
- The "timeStampLength" field shall be less than or equal to 33 bits.
- The "OCRLength" field shall be less than or equal to 33 bits.
- The "AU_Length" field has its value restricted to "0".
- The "instantBitrateLength" field has no restriction on its value.

NOTE 3: This field shall be used if an OCR is encoded within an SL packet header since the "instantBitrate" field shall also be encoded in the case.

- The "degradationPriorityLength" field has its value restricted to "0".
- The "AU_seqNumLength" field has its value restricted to "0".
- The "packetSeqNumLength" field has its value restricted to "0".

The recovery and usage of timing information shall comply with the following:

- Clauses 2.11.3.3, 2.11.3.4 and 2.11.3.6 in ISO/IEC 13818-1 [3].
- The OCR defined in ISO/IEC 14496-1 [4] shall synchronize all the objects necessary for the description of a scene.

5.3 Audio Object

In the DMB video service user application, the audio object type that needs to be supported by the audio decoder shall be determined by the objectTypeIndication value of its DecoderConfigDescriptor (see table 2). The detailed specifications for the audio decoding are defined in clause 8. When several audio objects are defined, the stream selection can be operated at the object level through specific MPEG-4 ES_Descriptor (e.g. using a LanguageDescriptor descriptor) or at the scene level through user interaction (e.g. using a Switch BIFS node). By default, the first audio stream in the PMT shall be rendered.

5.4 Video Object

In the DMB video service user application, the video object type that needs to be supported by the video decoder shall be determined by the objectTypeIndication value of its DecoderConfigDescriptor (see table 2). The detailed specifications for the video decoding are defined in clause 8.

5.5 Auxiliary Media Objects

In the DMB video service user application, the auxiliary media object type that needs to be supported by the auxiliary media decoder shall be determined by the objectTypeIndication value (see table 2) of its DecoderConfigDescriptor. Auxiliary media objects are auxiliary contents for the scene description that are transported and synchronized with interactive services.

6 Transport stream specification

The MPEG-2 transport stream layer multiplexes video, audio, and auxiliary media to form a single program. It does not support the conditional access scheme defined in ISO/IEC 13818-1 [3] because CAT is not used in the PSI. It uses PCR for system clock recovery. The ISO/IEC 14496-1 [4] MPEG-4 system layer provides synchronization among ESs using OCR, CTS and DTS together with the PCR described above. In addition, it provides linkage among ESs that constitutes a DMB video service and uses scene description information for the composition of a DMB video service. It uses the SL packetization, but does not utilize FlexMux multiplexing.

6.1 Transport stream packet specification

A TS packet shall have the structure shown in table 4. Mandatory restrictions are detailed where applicable.

Table 4: Structure of a TS packet

Syntax	Number of bits	Restrictions
Transport_packet(){		
sync_byte	**8**	
transport_error_indicator	**1**	
payload_unit_start_indicator	**1**	
transport_priority	**1**	
PID	**13**	
transport_scrambling_control	**2**	**"00"**
adaptation_field_control	**2**	
continuity_counter	**4**	
if(adaptation_field_control = = '10' || adaptation_field_control = = '11'){		
adaptation_field()		
}		
if(adaptation_field_control = = '01' || adaptation_field_control = = '11') {		
for (i=0; i<N; i++){		
Data_byte	**8**	
}		
}		
}		

The adaptation field within a TS packet shall have the structure shown in table 5. Manditory restrictions are detailed where applicable.

Table 5: Structure of the adaptation field of a TS packet

Syntax	Number of bits	Restrictions
adaptation_field() {		
adaptation_field_length	**8**	
if (adaptation_field_length>0) {		
Discontinuity_indicator	**1**	
random_access_indicator	**1**	
elementary_stream_priority_indicator	**1**	
PCR_flag	**1**	
OPCR_flag	**1**	**"0"**
splicing_point_flag	**1**	
transport_private_data_flag	**1**	
adaptation_field_extension_flag	**1**	**"0"**
if (PCR_flag = = '1') {		
program_clock_reference_base	**33**	
Reserved	**6**	
program_clock_reference_extension	**9**	
}		
if (OPCR_flag = = '1') {		**not used**
}		
if (splicing_point_flag = = '1') {		
splice_countdown	**8**	
}		
if (transport_private_data_flag = = '1') {		
transport_private_data_length	**8**	
for (i=0; i<transport_private_data_length; i++) {		
Private_data_byte	**8**	
}		
}		
if (adaptation_field_extension_flag = = '1') {		**not used**
}		
for (i=0; i<N; i++) {		
stuffing_byte	**8**	
}		
}		
}		

6.2 PES packet specification

A PES packet shall have the structure shown in table 6. Mandatory restrictions are detailed where applicable.

Table 6: Structure of a PES packet

Syntax	Number of bits	Restrictions
PES_packet() {		
packet_start_code_prefix	**24**	
stream_id	**8**	**0xFA**
PES_packet_length	**16**	
if (stream_id !=program_stream_map		(condition
&& stream_id !=padding_stream		always true)
&& stream_id !=private_stream_2		
&& stream_id !=ECM		
&& stream_id !=EMM		
&& stream_id !=program_stream_directory		
&& stream_id !=DSMCC_stream		
&& stream_id !=ITU-T Rec. H.222.1 type E stream) {		
'10'	**2**	
PES_scrambling_control	**2**	**"00"**
PES_priority	**1**	
data_alignment_indicator	**1**	
Copyright	**1**	
original_or_copy	**1**	
PTS_DTS_flags	**2**	**"10" or "00"**
ESCR_flag	**1**	**"0"**
ES_rate_flag	**1**	**"0"**
DSM_trick_mode_flag	**1**	**"0"**
additional_copy_info_flag	**1**	**"0"**
PES_CRC_flag	**1**	**"0"**
PES_extension_flag	**1**	**"0"**
PES_header_data_length	**8**	
if (PTS_DTS_flags = = '10') { (see note)		
'0010'	**4**	
PTS [32..30]	**3**	
marker_bit	**1**	
PTS [29..15]	**15**	
marker_bit	**1**	
PTS [14..0]	**15**	
marker_bit	**1**	
}		
if (PES_extension_flag = = '1') {		**not used**
}		
for (i=0; i<N1; i++) {		
stuffing_byte	**8**	
}		
for (i=0; i<N2; i++) {		
PES_packet_data_byte	**8**	
}		
}		
}		
NOTE: The PTS field is included in a PES header only when the encapsulated SL packet header includes an OCR. Otherwise, the PTS field is not used.		

In DMB video services, the following rules are applied at the transmitting side in order to allow random access at the receiving side.

- A PAT (Program Association Table) shall describe only one program, and its transmission period shall be no greater than 500 ms.
- A PMT (Program Map Table) shall have the structure shown in table 7 and adhere to the following rules:
  - A group of descriptors with Restriction "A" in table 7 shall include an IOD_descriptor.
  - A group of descriptors with Restriction "B" in table 7 shall include an SL_descriptor for an ES_ID.

- The transmission period of a PMT shall be no greater than 500 ms.

Table 7: Structure of a PMT

Syntax	Number of bits	Restrictions
TS_program_map_section() {		
table_id	**8**	
section_syntax_indicator	**1**	
'0'	**1**	
Reserved	**2**	
section_length	**12**	
program_number	**16**	
Reserved	**2**	
version_number	**5**	
current_next_indicator	**1**	
section_number	**8**	
last_section_number	**8**	
Reserved	**3**	
PCR_PID	**13**	
Reserved	**4**	
program_info_length	**12**	
for (i=0; i<N; i++) {		
descriptor()		A
}		
for (i=0; i<N1; i++) {		
stream_type	**8**	"0x12" or "0x13"
Reserved	**3**	
elementary_PID	**13**	
Reserved	**4**	
ES_info_length	**12**	
for (i=0; i<N2; i++) {		
descriptor()		B
}		
}		
CRC_32	**32**	
}		

- The transmission period for the base scene description information (replace scene command) and the base object description information (audio/video) shall be no greater than 500 ms.
- The transmission period of a PCR within a transport stream shall be no greater than 100 ms.
- The transmission period of an OCR in the ISO/IEC 14496-1 [4] SL layer shall be no greater than 700 ms.
- The transmission period of a CTS in the ISO/IEC 14496-1 [4] SL layer shall be no greater than 700 ms.

7 User Application signalling

7.1 Profile signalling

The use of the DMB video service within a DAB data channel shall be indicated by the use of FIG0/13 (see EN 300 401 [1]) with a UserApplicationType value for "DMB" (see TS 101 756 [7]). The User Application data field shall carry a one byte field - the VideoServiceObjectProfileId - indicating the specific profiles of audio and video object decoder that should be used to decode the audio and video elementary streams of the DMB video service. Receivers shall ignore any User Application data following the VideoServiceObjectProfileId field.

The profiles defined for the VideoServiceObjectProfileId field are given in table 8.

Table 8: Video service profiles

VideoServiceObjectProfileId	Description
0x00	Reserved
0x01	Profile 1
0x02	Profile 2
0x03 to 0xff	Reserved

Radio services may carry Programme Associated Data (PAD) (see clause 9). If the PAD contains User Applications then these shall be signalled by extending the FIG 0/13 User Application information field to include additional User Application fields, including the X-PAD data field, for each User Application carried in the PAD. The Number of User Applications field shall indicate the number of PAD User Applications + 1. The User Application 1 field shall indicate the DMB service, with subsequent User Application fields indicating the PAD User Applications.

7.2 Television service signalling

Television services only require that both the audio object and the video object are presented to the user, although displaying the auxiliary media objects, when present, will significantly enhance the service. Television services shall be signalled as data services; the P/D flag in the FIG type 0 header shall be set to 1 (32-bit SId).

7.3 Radio service signalling

Radio services only require that the audio object is presented to the user, although displaying the video object, when present, and the auxiliary media objects will significantly enhance the service. Radio services shall be signalled as programme services; the P/D flag in the FIG type 0 header shall be set to 0 (16-bit SId).

8 DMB video service profiles

8.1 Profile 1

Profile 1 is signalled with VideoServiceObjectProfileId = 0x01.

- audio object: MPEG-4 ER-BSAC.
- video object: ITU-T Recommendation H.264 [9] | MPEG-4 AVC.

8.1.1 Audio object

Audio object specification conforms to the standard relevant to the ER BSAC Audio Object Type with ObjectType ID 22 defined in ISO/IEC 14496-3 [5].

Audio object bitstream has the following restrictions.

- In AudioSpecificConfig():
  - epConfig: restricted to 0.
- In GASpecificConfig():
  - frameLengthFlag: restricted to 0.
  - DependOnCoreCoder: restricted to 0.
- In bsac_header():
  - sba_mode: restricted to 0 so that the error resilience tool is not supported.

- In general_header():
  - ltp_data_present: restricted to 0.
- The restrictions in table 9 shall be applied.

Table 9: Restrictions on audio objects

Item	Value
Sampling rate	24 kHz; 44,1 kHz; 48 kHz
Number of channels	1, 2
Number of objects	1
Maximum bitrate	128 kbps

8.1.2 Video Object

Video objects are based on ITU-T Recommendation H.264 [9] | ISO/IEC 14496-10 [6]. Video bitstreams shall comply with each of the items below.

8.1.2.1 Profile and levels supported

- Profile:
  - Video bitstreams shall comply with the "Baseline Profile" (ITU-T Recommendation H.264 [9] | ISO/IEC 14496-10 [6], clause A.2.1).
  - "Arbitrary slice order" shall not be allowed.
  - In the syntax of "Picture Parameter Sets", the "num_slice_groups_minus1" field has its value restricted to "0".
  - In the syntax of "Picture Parameter Sets", the "redundant_pic_cnt_present_flag" field has its value restricted to "0".
  - In the syntax of "Sequence Parameter Sets", the "pic_order_cnt_type" field has its value restricted to "2".
  - In the syntax of "Sequence Parameter Sets", the "num_ref_frames" field has its value restricted to "3".
- Level:
  - Level 1,3 in table A-1 of ITU-T Recommendation H.264 [9] | AVC annex A shall be used with the following further restrictions.
  - Resolutions supported: the formats listed in table 9.
  - Vertical MV component range (MaxVmvR) shall be [-64,+63,75].
  - Maximum frame rate for each of the resolutions supported shall be 30 fps.
  - MaxDPB shall be 445,5 Kbytes at maximum.

Table 10: Resolutions supported

Format	PicWidthInMbs	FrameHeightInMbs	PicSizeInMbs
QCIF	11	9	99
QVGA	20	15	300
WDF	24	14	336
CIF	22	18	396

8.1.2.2 Specification related to the transport of a video stream

To enable random access at the receiving side, IDR pictures shall be encoded within a video stream at least once every 2 seconds.

The "Parameter Set" shall be delivered through DecoderSpecificInfo or included in the video stream itself.

MPEG-4 SL packet encapsulation related to the video stream shall comply with clause I of ISO/IEC 14496-1 [4].

8.2 Profile 2

Profile 2 is signalled with VideoServiceObjectProfileId = 0x02.

- audio object: MPEG-4 HE-AAC v2. The 1024 transform shall be used.
- video object : ITU-T Recommendation H.264 [9] | MPEG-4 AVC.

8.2.1 Audio object

The audio object specification conforms to:

- HE AAC v2 profile as specified in [5]. This profile contains the audio object types 2 (AAC LC), 5 (SBR) and 29 (PS).
- MPEG Surround Baseline profile as specified in [10]. This profile contains the audio object type 30 (MPS).

8.2.1.1 List of Tools/Functionalities

AAC-LC offers waveform coding over a large bitrate range. In combination with SBR full audio bandwidth is available at all bitrates. PS allows the stereo image of an audio signal to be coded at very low bitrates, enabling the reproduction of a stereo signal from a transmitted mono signal given a small amount of side information. MPS allows mono/stereo compatible multichannel encoding.

8.2.1.2 Comparison with existing profiles and object types

The AAC-LC object type is part of the AAC profile, and AAC-LC and SBR constitutes the HE-AAC profile. These are hierarchical profiles, meaning that the HE-AAC profile decoder of a certain level can handle all AAC profile streams of the corresponding level. The HE-AAC v2 profile is hierarchical w.r.t. the AAC profile and the HE-AAC profile, hence backwards compatibility is ensured so that the HE-AAC v2 profile decoder of a certain level can handle all HE-AAC profile streams of the corresponding level.

8.2.1.3 Supported levels

For DMB profile 2, only the 1 024 transform is permitted. The audio decoder shall support at least MPEG-4 HE AAC v2 level 2.

The audio output of the audio decoder can be restricted to 1 audio channel only.

The restrictions in table 11 shall be applied.

Table 11: Restrictions on audio objects within an audio object bitstream

Item	Value
Output sampling rate of audio decoder	24 kHz; 32 kHz; 48 kHz
Sampling rate of AAC core	If SBR is used, the sampling rate of the AAC core must be half the output sampling rate. If SBR is not used, the sampling rate of the AAC core must be equal to the output sampling rate.
Number of channels of the HE AAC v2 bitstream payload	1, 2
Number of objects	1
Maximum bitrate (net)	192 kbps

MPEG Surround can be used to provide surround sound to receivers with headphones (using binaural decoding) and to receivers with surround setup (e.g. 5.1 setup); see clause 8.2.1.4.

8.2.1.4 MPEG Surround

MPEG Surround is standardized in ISO/IEC 23003-1 [10]. A DMB service may use MPEG Surround on an optional basis.

Information regarding the use of MPEG surround in the DAB family (overview, requirements for MPEG Surround encoders and decoders) is provided in TS 102 563 [11], clause 5.3.

8.2.1.4.1 Operational aspects of broadcasting

It is not mandated that MPEG Surround is used for the whole lifetime of the service component.

When MPEG Surround is used, all audio access units shall contain an extension payload of type EXT_SAC_DATA and the SpatialSpecificConfig() shall be broadcast at least every 500 ms.

EXT_SAC_DATA payloads shall be broadcast only when MPEG Surround is used.

When MPEG Surround is enabled or its configuration is changed, the first audio access unit of the new configuration shall contain the SpatialSpecificConfig() to allow seamless continuation of audio playback.

Changes of the MPEG Surround configuration shall not happen more frequently than each 500 ms.

NOTE: It is assumed that an MPEG Surround configuration is valid for the entirety of a programme item.

8.2.1.4.2 Receiver implementation aspects

A receiver that is capable of decoding MPEG Surround shall probe each audio access unit for the existence of an extension payload of type EXT_SAC_DATA. If an EXT_SAC_DATA extension payload was found, it shall be prepared to decode MPEG Surround.

If EXT_SAC_DATA extension payloads are received, an MPEG Surround capable receiver shall not delay playback for more than 500 ms. If it has not received a SpatialSpecificConfig() by then, it shall start decoding and playback of the HE AAC v2 payload, but shall continuously check for the availability of a SpatialSpecificConfig() and then reconfigure itself for the decoding of MPEG Surround.

It is not mandated that an MPEG Surround payload is transmitted for the whole lifetime of the service component and hence a receiver shall support a change of the MPEG Surround configuration. Depending on the implementation, this may result in a receiver that can reconfigure the audio output or a receiver that always produces multichannel sound output. In the latter case, the MPEG Surround enhanced matrix mode can be used to generate the multichannel output if no MPEG Surround payload is transmitted.

If a receiver is currently decoding MPEG Surround and an audio access unit with no EXT_SAC_DATA extension payload is received, then the receiver shall assume that MPEG Surround is no longer used and appropriately reconfigure itself.

A receiver shall assume that each reconfiguration is valid at least for the equivalent of 500 ms output audio data, hence it shall not reconfigure itself more than two times per second.

The receiver must be able to detect and correctly handle changes in the SpatialSpecificConfig().

8.2.2 Video Object

Video objects are based on ITU-T Recommendation H.264 [9] | ISO/IEC 14496-10 [6] as defined in clause 8.1.2.

9 Programme Associated Data (PAD)

The full range of functions provided by PAD carried in Layer II audio frames (EN 300 401 [1]) are provided for radio services. PAD is not available for television services. The PAD is coded in exactly the same way as for Layer II audio (see EN 300 401 [1] clause 7.4) using the F-PAD and X-PAD. The only exception is that the Dynamic Range Control mechanism provided by F-PAD is not used, see clause 9.3. The timing relationship between PAD and audio frames is looser than for Layer II audio.

The inclusion of PAD is optional for the service provider.

9.1 Coding of the PAD field

Figure 4 shows the coding of the PAD field.

Figure 4: Coding of the PAD field

If no information is available for the X-PAD field and no information is sent in the F-PAD field, then the PAD field is empty and shall not be added to the PAT table.

If information is available for the X-PAD field but no information is sent in the F-PAD field, then both bytes of the F-PAD field shall be set to zero.

If no information is available for the X-PAD field but information is sent in the F-PAD field, then the X-PAD field is empty.

The PAD field cannot be associated with a particular audio frame.

All bytes of the PAD field have the same error protection. The maximum size of the X-PAD field is 160 bytes.

9.2 Inclusion of PAD

The PAD field is transported in the "transport private data" field of any TS packet header. The first byte of the "transport private data" field shall carry an identifier to determine the payload of the transported private data. The permitted values are listed in table 12. The following bytes shall contain the PAD field.

Table 12: Permitted identifiers for transport private data

Identifier	Payload
0	PAD
1 to 255	reserved

The "transport private data length" field in the TS packet header shall indicate the length of the PAD field + 1. Only complete PAD fields may be carried; they shall not be split between TS packet headers.

The F-PAD channel carries a 2-bit field, "X-PAD Ind", which indicates one of three possibilities for the length of the X-PAD field:

- No X-PAD: only the F-PAD field is available. No X-PAD field is present. No signalling field is present. The length of the PAD field shall be two bytes.
- Short X-PAD: in this case the length of the X-PAD field is four bytes.
- Variable size X-PAD: in this case the length of the X-PAD field may vary. The length of the X-PAD field in the current PAD field can be derived by subtracting the length of the F-PAD field (2 bytes) from the length of the complete PAD field.

9.3 Coding of F-PAD and X-PAD

The coding of F-PAD and X-PAD shall be as specified in EN 300 401 [1], clause 7.4 with the following exception:

- In contrast to MPEG Audio Layer II, Dynamic Range Control (DRC) data shall not be carried in F-PAD. If dynamic range control is used, the DRC data shall be encoded utilizing MPEG-4 specific means: DRC data is stored in dynamic_range_info(), being contained in an extension_payload(), which in return is contained in a fill_element(), the latter being a syntactic element of MPEG-4 audio that can be multiplexed within a raw_data_block().

9.4 PAD extraction

PAD data (if present) is always located in the "private transport data" field of TS packets; therefore if the "private transport data flag" field of a TS packet is set to one and the first byte of the "private transport data" field of the TS packet is set to 0x00, then PAD data is available.

If the "private transport data flag" field of a TS packet is set to zero, then the PAD decoder shall react as if the F-PAD field had been received with both bytes set to zero and no X-PAD data is available.

The "private transport data length" field of a TS packet containing PAD explicitly indicates the length of the PAD information. The PAD decoder uses this length information to determine the size of the PAD field and also the size of the X-PAD field (if present). The size of the X-PAD field (if present) is two bytes less than the size of the PAD field.

Once the X-PAD field is extracted, decoding is the same as for X-PAD in MPEG audio layer II. The length of the X-PAD shall also be deduced from the contents information carried within the X-PAD field. If this length does not match the length of the X-PAD field derived from the length information within the "private transport data length" field of the TS packet, then the decoder shall discard the X-PAD field.

Annex A (informative): An example of the IOD/OD/BIFS

In annex A, examples of minimum IOD/OD/BIFS is described in the case of a single audio object, a single audio object with a single video object and a single video object with multiple audio objects all within a broadcast stream.

Annex A describes the binary syntax and field values of IOD/OD/BIFS by using the example values of ES_ID, OD_ID, and URL as shown in the following table A.1.

Table A.1: Example values of ES_ID, OD_ID, and URL

	ES_ID	OD_ID	URL
OD stream	1	0	0
BIFS stream	2		
Audio object	101	10	10
Video object	201	20	20

A.1 IOD (binary syntax and field values)

# of bits	Field Name	Value
InitialObjectDescriptor		
8	InitialObjectDescriptor tag	0x02
16	descriptor size	---
10	ObjectDescriptorID	0
1	URL_Flag	0
1	includeInlineProfilesFlag	0
4	Reserved	15
8	ODProfileLevelIndication	0x01
8	sceneProfileLevelIndication	0x0C
8	audioProfileLevelIndication	0x23
8	visualProfileLevelIndication	
8	graphicsProfileLevelIndication	0x04
ES_Descriptor(OD)		
8	ES_Descriptor tag	0x03
8	descriptor size	---
16	ES_ID	1
1	streamDependenceFlag	0
1	URL_Flag	0
1	OCRstreamFlag	0
5	streamPriority	0
DecoderConfigDescriptor(OD)		
8	DecoderConfigDescriptor tag	0x04
8	descriptor size	---
8	objectTypeIndication	1
6	streamType	1
1	Upstream	0
1	Reserved	1
24	bufferSizeDB	250
32	maxBitrate	0
32	avgBitrate	0

# of bits	Field Name	Value
SLConfigDescriptor(OD)		
8	SLConfigDescriptor tag	0x06
8	descriptor size	---
8	Predefined	0
1	useAccessUnitStartFlag	1
1	useAccessUnitEndFlag	1
1	useRandomAccessPointFlag	0
1	hasRandomAccessUnitsOnlyFlag	0
1	usePaddingFlag	0
1	useTimeStampsFlag	1
1	useIdleFlag	1
1	durationFlag	0
32	timeStampResolution	90000
32	OCRResolution	90000
8	timeStampLength	33
8	OCRLength	33
8	AU_Length	0
8	instantBitrateLength	---
4	degradationPriorityLength	0
5	AU_seqNumLength	0
5	Packet_SeqNumLength	0
2	Reserved	3(0b11)
ES_Descriptor(BIFS)		
8	ES_Descriptor tag	0x03
8	descriptor size	---
16	ES_ID	2
1	streamDependenceFlag	0
1	URL_Flag	0
1	OCRstreamFlag	0
5	streamPriority	0
DecoderConfigDescriptor(BIFS)		
8	DecoderConfigDescriptor tag	0x04
8	descriptor size	---
8	objectTypeIndication	2
6	streamType	3
1	Upstream	0
1	Reserved	1
24	bufferSizeDB	22
32	maxBitrate	0
32	avgBitrate	0
SLConfigDescriptor(BIFS)		
8	SLConfigDescriptor tag	0x06
8	descriptor size	---
8	Predefined	0
1	useAccessUnitStartFlag	1
1	useAccessUnitEndFlag	1
1	useRandomAccessPointFlag	0
1	hasRandomAccessUnitsOnlyFlag	0
1	usePaddingFlag	0
1	useTimeStampsFlag	1
1	useIdleFlag	1
1	durationFlag	0
32	timeStampResolution	90000
32	OCRResolution	90000
8	timeStampLength	33
8	OCRLength	33
8	AU_Length	0
8	instantBitrateLength	---
4	degradationPriorityLength	0
5	AU_seqNumLength	0
5	Packet_SeqNumLength	0
2	Reserved	3(0b11)

A.2 OD (binary syntax and values)

A.2.1 The case of a single audio object in a broadcast stream

# of bits	Field Name	Value
ObjectDescriptorUpdate		
8	ObjectDescriptorUpdate tag	0x01
8	descriptor size	---
ObjectDescriptor(audio)		
8	ObjectDescriptor tag	0x01
8	descriptor size	---
10	ObjectDescriptorID	10
1	URL_Flag	0
5	Reserved	31
ES_Descriptor(audio)		
8	ES_Descriptor tag	0x03
8	descriptor size	---
16	ES_ID	101
1	streamDependenceFlag	0
1	URL_Flag	0
1	OCRstreamFlag	0
5	streamPriority	5
DecoderConfigDescriptor(audio)		
8	DecoderConfigDescriptor tag	0x04
8	descriptor size	---
8	objectTypeIndication	0x40
6	streamType	5
1	Upstream	0
1	Reserved	1
24	bufferSizeDB	---
32	maxBitrate	---
32	avgBitrate	---
DecoderSpecificInfo(audio)		
8	DecoderSpecificInfo tag	0x05
8	descriptor size	---
8*	DecoderSpecificInfo data	---
SLConfigDescriptor(audio)		
8	SLConfigDescriptor tag	0x06
8	descriptor size	---
8	Predefined	0
1	useAccessUnitStartFlag	1
1	useAccessUnitEndFlag	1
1	useRandomAccessPointFlag	0
1	hasRandomAccessUnitsOnlyFlag	0
1	usePaddingFlag	0
1	useTimeStampsFlag	1
1	useIdleFlag	1
1	durationFlag	0
32	timeStampResolution	90000
32	OCRResolution	90000
8	timeStampLength	33
8	OCRLength	33
8	AU_Length	0
8	instantBitrateLength	---
4	degradationPriorityLength	0
5	AU_seqNumLength	0
5	Packet_SeqNumLength	0
2	Reserved	3(0b11)

A.2.2 The case of a single audio object and a single video object in a broadcast stream

# of bits	Field Name	Value
ObjectDescriptorUpdate		
8	ObjectDescriptorUpdate tag	0x01
8	descriptor size	---
ObjectDescriptor(video)		
8	ObjectDescriptor tag	0x01
8	descriptor size	---
10	ObjectDescriptorID	20
1	URL_Flag	0
5	Reserved	31
ES_Descriptor(video)		
8	ES_Descriptor tag	0x03
8	descriptor size	---
16	ES_ID	201
1	streamDependenceFlag	0
1	URL_Flag	0
1	OCRstreamFlag	1
5	streamPriority	4
16	OCR_ES_ID	101
DecoderConfigDescriptor(video)		
8	DecoderConfigDescriptor tag	0x04
8	descriptor size	---
8	objectTypeIndication	0x21
6	streamType	4
1	Upstream	0
1	Reserved	1
24	bufferSizeDB	---
32	maxBitrate	---
32	avgBitrate	---
DecoderSpecificInfo(video)		
8	DecoderSpecificInfo tag	0x05
8	descriptor size	---
8*	DecoderSpecificInfo data	---
SLConfigDescriptor(video)		
8	SLConfigDescriptor tag	0x06
8	descriptor size	---
8	Predefined	0
1	useAccessUnitStartFlag	1
1	useAccessUnitEndFlag	1
1	useRandomAccessPointFlag	0
1	hasRandomAccessUnitsOnlyFlag	0
1	usePaddingFlag	0
1	useTimeStampsFlag	1
1	useIdleFlag	1
1	durationFlag	0
32	timeStampResolution	90000
32	OCRResolution	90000
8	timeStampLength	33
8	OCRLength	33
8	AU_Length	0
8	instantBitrateLength	---
4	degradationPriorityLength	0
5	AU_seqNumLength	0
5	Packet_SeqNumLength	0
2	Reserved	3(0b11)
ObjectDescriptor(audio)		
8	ObjectDescriptor tag	0x01
8	descriptor size	---
10	ObjectDescriptorID	10
1	URL_Flag	0
5	Reserved	31

# of bits	Field Name	Value
ES_Descriptor(audio)		
8	ES_Descriptor tag	0x03
8	descriptor size	---
16	ES_ID	101
1	streamDependenceFlag	0
1	URL_Flag	0
1	OCRstreamFlag	0
5	streamPriority	5
DecoderConfigDescriptor(audio)		
8	DecoderConfigDescriptor tag	0x04
8	descriptor size	---
8	objectTypeIndication	0x40
6	streamType	5
1	Upstream	0
1	Reserved	1
24	bufferSizeDB	---
32	maxBitrate	---
32	avgBitrate	---
DecoderSpecificInfo(audio)		
8	DecoderSpecificInfo tag	0x05
8	descriptor size	---
8*	DecoderSpecificInfo data	---
SLConfigDescriptor(audio)		
8	SLConfigDescriptor tag	0x06
8	descriptor size	---
8	Predefined	0
1	useAccessUnitStartFlag	1
1	useAccessUnitEndFlag	1
1	useRandomAccessPointFlag	0
1	hasRandomAccessUnitsOnlyFlag	0
1	usePaddingFlag	0
1	useTimeStampsFlag	1
1	useIdleFlag	1
1	durationFlag	0
32	timeStampResolution	90000
32	OCRResolution	90000
8	timeStampLength	33
8	OCRLength	33
8	AU_Length	0
8	instantBitrateLength	---
4	degradationPriorityLength	0
5	AU_seqNumLength	0
5	Packet_SeqNumLength	0
2	Reserved	3(0b11)

A.3 BIFS

A.3.1 The case of a single audio object within a broadcast stream

A.3.1.1 Syntax

```
OrderedGroup {
    children [
        Sound2D {source AudioSource {url 10}}
    ]
}
```

A.3.1.2 Coded data

```
C0 10 12 81   30 2A 05 7C
```

A.3.2 The case of a single audio object and a single video object within a broadcast stream

A.3.2.1 Syntax

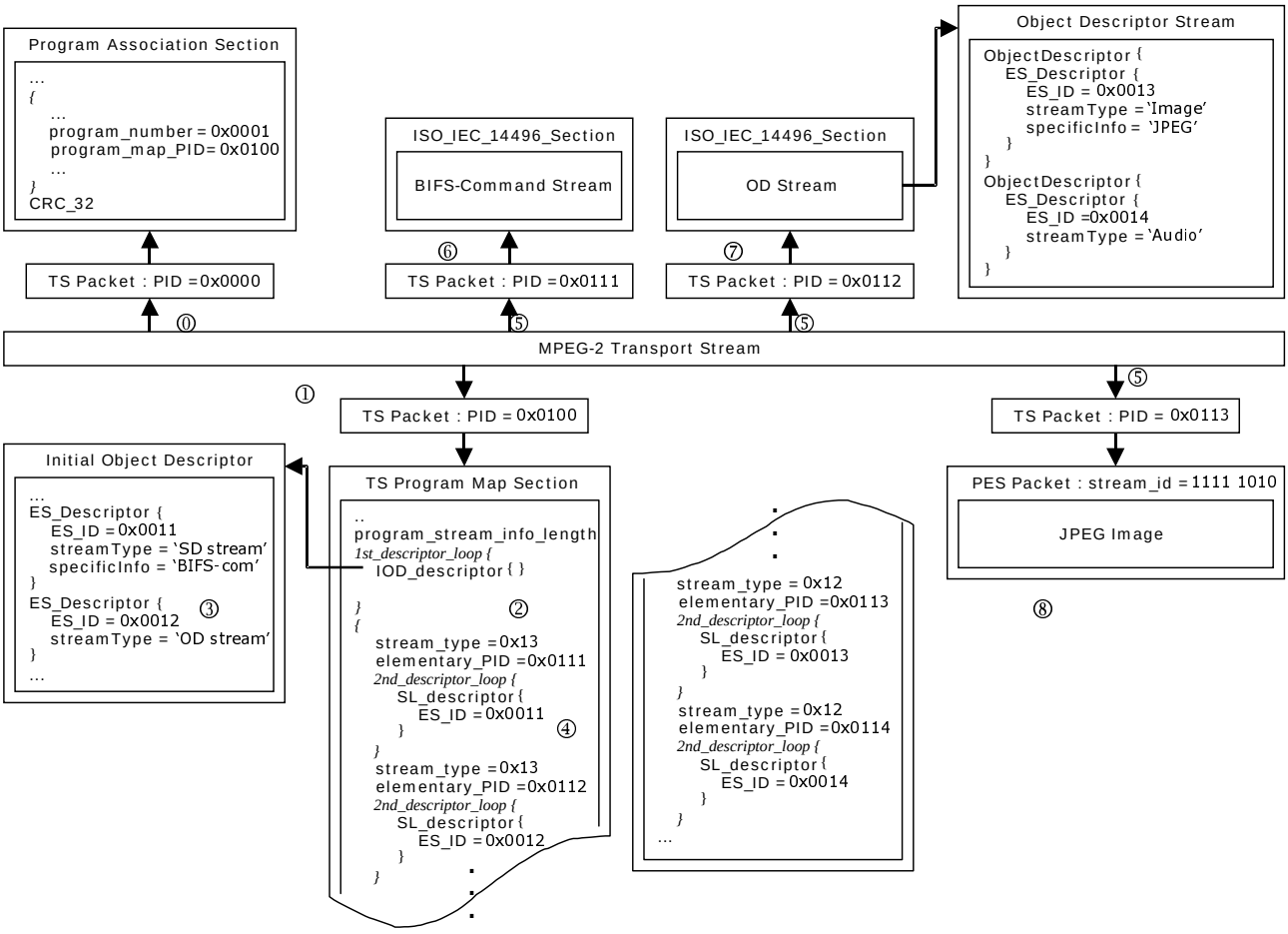
```
OrderedGroup {
    children [
        Sound2D {source AudioSource {url 10}}
        Shape {
            geometry Bitmap {}
            appearance Appearance {texture MovieTexture {url 20}}
        }
    ]
}
```

A.3.2.2 Coded data

```
C0 10 12 81   30 2A 05 72   61 04 88 50   45 05 3F 00
```

Annex B (informative): Content Access Procedure

The procedure by which content is accessed is explained using the example shown in figure B.1.



⓪ From an MPEG-2 TS, obtain the PAT from the TS packets with PID 0x0000. Identify program numbers and their corresponding PMT PID. In case of DMB video services, only one program is defined in the PAT.

① Search for the PMT in the TS using the PMT PID obtained from the PAT.

② Within the PMT, find the IOD_descriptor that includes the IOD.

③ Within the IOD, find the ES_Descriptors related to the scene description and object description.

④ From the ES_Descriptor information found in ③, obtain the ES_IDs and then search for the elementary stream information corresponding to the ES_IDs through the descriptor loop in the PMT.

⑤ From the elementary stream information found in ④, obtain the PID pair corresponding to the ES_IDs. Find packets corresponding to each of these in the TS.

⑥,⑦ By using the ObjectDescriptorID contained in the scene description information, obtain the corresponding ObjectDescriptor contained in the object descriptor stream. By using the relationship between the ES_ID contained in the ObjectDescriptor and the PID that can be found in a way similar to ⑤, compose the scene.

⑧ Obtain the auxiliary media using the scene description information.

Figure B.1: MPEG-2 TS example that includes ISO/IEC 14496 [4] contents

History

Document history		
V1.1.1	June 2005	Publication
V1.2.1	April 2009	Publication