RECOMMENDATION ITU-R BT.1300-2

Service multiplex, transport, and identification methods for digital terrestrial television broadcasting

(Question ITU-R 31/6)

(1997-2000-2004)

The ITU Radiocommunication Assembly,

considering

a)   that digital terrestrial television broadcasting (DTTB) will be introduced in the VHF/UHF bands by many administrations;

b)   that the simultaneous transmission of video, sound, data and control signals is required in a DTTB service;

c)   that practical implementation of digital terrestrial broadcasting systems may require certain constraints and/or extensions to the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) Standard 13818-1 transport specification;

d)   that a common Transport Stream syntax has been established in ISO/IEC Standard 13818-1 (Moving Picture Experts Group (MPEG-2) Systems);

e)   that a common Transport Stream syntax is recommended by Recommendations ITU-R BT.1207 and ITU-R BT.1209 based upon ISO/IEC Standard 13818-1;

f)   that the MPEG-2 defines two methods of transport, the Program Stream and Transport Stream method, and that Transport Stream syntax is optimized for use in environments where transmission errors are likely;

g)   that the exchange of programming from various sources will continue to be necessary, placing special demands on the transport layer,

recommends

1   that DTTB systems should comply with ISO/IEC Standard 13818-1 multiplexed streams and Transport Stream syntax as given in Recommendations ITU-R BT.1207 and ITU-R BT.1209, using one of the service transport methods described in Annex 1;

2   that digital terrestrial television systems should be designed to comply with the method for harmonization of service multiplex methods summarized in Annex 2.

NOTE 1 – New DTTB systems or functions may require the addition of new standard methods to the appropriate Annex.

"Service multiplex and transport" refers to the means of dividing the digital data stream into "packets" of information, the means of uniquely identifying each packet or packet type, and the appropriate methods of multiplexing video data stream packets, audio data stream packets, and ancillary data stream packets into a single data stream consisting of a sequence of 188-byte Transport Stream packets.

Annex 1 describes service transport methods and Annex 2 describes service multiplex methods.

Annex 1

Service transport methods

1   Introduction

The service transport method shall conform with the MPEG-2 Transport Stream syntax described in ISO/IEC Standard 13818-1 (MPEG-2 Systems). Permissible constraints and extensions for existing systems have been standardized and are given in § 2 of this Annex.

In developing the transport mechanism, interoperability among digital media, such as terrestrial broadcasting, cable distribution, satellite distribution, recording media, and computer interfaces, is a prime consideration. ITU-R recommends that digital television systems employ the MPEG-2 Transport Stream syntax for the packetization and multiplexing of video, audio, and data signals for digital broadcasting systems. The MPEG-2 Transport Stream syntax was developed for applications where channel bandwidth or recording media capacity is limited and the requirement for an efficient transport mechanism is paramount. It was designed also to facilitate interoperability with the asynchronous transfer mode (ATM) transport mechanism.

2   Service transport method

2.1   System overview

The specifications for service multiplex and transport systems characteristics of System A, System B and System C are referenced in Appendices 1, 2 and 3, respectively.

The transport format and protocol for System A, System B and System C are compatible subsets of the MPEG-2 Systems specification defined in ISO/IEC Standard 13818-1. All three systems are based on a fixed-length packet transport stream approach that has been defined and optimized for digital television delivery applications.

In these system standards certain extensions and constraints with respect to MPEG-2 Systems are specified. The following sections outline these.

2.2   Specification

The syntax and semantics of the specification of the System A, System B and System C standards conform to ISO/IEC Standard 13818-1 subject to the constraints and conditions specified here. The coding constraints that apply to the use of the MPEG-2 Systems specification in System A, System B and System C are as follows.

2.2.1 MPEG-2 Systems standard

2.2.1.1 Video Transport Standard (T-STD)

The video T-STD is specified in § 2.4.2 of ISO/IEC Standard 13818-1 and follows the constraints for the level encoded in the video elementary stream.

2.2.1.2 Audio T-STD

The audio T-STD for System A is specified in § 3.6 of Annex A of [ATSC, 1995a] (see Appendix 1).

The audio T-STD for System B and System C is specified in § 2.4.2 of ISO/IEC Standard 13818-1. The buffer model for ISO/IEC 13818-7 is described in Annex Q of ISO/IEC Standard 13818-1.

2.2.2 Registration descriptor

System A uses the registration descriptor described in § 2.6.8 of ISO/IEC Standard 13818-1 to identify the contents of programs and elementary streams to decoding equipment.

In System B and System C, the use of the registration descriptor is in accordance with § 2.6.8 of ISO/IEC Standard 13818-1.

2.2.2.1 Program format identifier

Programs which conform to the System A specification will be identified by the 32-bit format identifier within a registration descriptor carried in the program (service) descriptor loop in the section of the Program Map Table (PMT) detailed in § 2.4.4.8 of ISO/IEC Standard 13818-1. The format identifier will be coded according to § 2.6.8 of ISO/IEC Standard 13818-1, and shall have a value of 0x4741 3934 ("GA94" in ASCII).

2.2.2.2 Audio elementary stream format identifier

Audio elementary streams which conform to the System A specification will be identified by the 32-bit format identifier within a registration descriptor carried in the elementary stream descriptor loop in the section of the Program Map Table (PMT) detailed in § 2.4.4.8 of ISO/IEC Standard 13818-1. The identifier format will be coded according to § 2.6.8 of ISO/IEC Standard 13818-1, and shall have a value of 0x4143 2D33 ("AC-3" in ASCII).

2.2.3 Program-related constraints

No program-related constraints on the Packet Identifier (PID) allocation are required in System A, System B or System C.

2.2.4 Constraints on Program Specific Information (PSI)

In System A, the program constituents for all programs are described in the PSI as specified in ISO/IEC Standard 13818-1 and in the Program and System Information Protocol (PSIP) [ATSC, 1997]. The following constraints apply to the PSI information:

– Only one program is described in a PSI transport bit stream corresponding to a particular PMT_PID value. A transport bit stream containing a program_map_table shall not be used to transmit any other kind of PSI table (identified by a different table_id).

−   The maximum spacing between occurrences of a program_map_table containing television program information shall be 400 ms.

−   The program numbers are associated with the corresponding PMT_PIDs in the Program Association Table (PAT) (PID 0x0000). The maximum spacing between occurrences of section 0 of the program_association_table is 100 ms.

−   The video elementary stream section shall contain the data stream alignment descriptor described in § 2.6.10 of ISO/IEC Standard 13818-1. The alignment_type field shown in Table 2-47 of ISO/IEC Standard 13818-1 shall be 0x02.

−   Adaptation headers shall not occur in Transport Stream packets of the PMT_PID for purposes other than for signalling with the discontinuity_indicator that the version_number (§ 2.4.4.5 of ISO/IEC Standard 13818-1) may be discontinuous.

−   Adaptation headers shall not occur in Transport Stream packets of the PAT (PID 0x0000) for purposes other than for signalling with the discontinuity_indicator that the version_number (§ 2.4.4.5 of ISO/IEC Standard 13818-1) may be discontinuous.

In System B, the program constituents for all programs are described in the PSI as specified in ISO/IEC Standard 13818-1 and in the Service Information (SI) as specified in Appendix 2 [ETSI, 1996a]. The following constraints apply to the PSI information:

−   Each section of the PAT and the PMT should be transmitted at least once every 100 ms.

−   The Network Information Table (NIT) is defined in compliance with ISO/IEC Standard 13818-1, and the data format is further defined in Appendix 2 [ETSI, 1996a]. The NIT is carried in Transport Stream packets with a PID value of 0x0010. Each section of the NIT shall be transmitted at least once every 10 s. The minimum time interval between the arrival of the last byte of a section to the first byte of the next transmitted section with the same table_id and table_id_extension shall be 25 ms.

In System C, the program constituents for all programs are described in the PSI as specified in ISO/IEC Standard 13818-1 and in the Service Information (SI) as specified in Appendix 3 [ARIB, 2003a]. The following constraints apply to the PSI information:

−   Each section of the PAT and the PMT is preferably to be transmitted at least once every 100 ms.

−   The Network Information Table (NIT) is defined in compliance with ISO/IEC Standard 13818-1, and the data format is further defined in Appendix 3 [ARIB, 2003a]. The NIT is carried in Transport Stream packets with a PID value of 0x0010. Each section of the NIT is preferably to be transmitted at least once every 10 s. TS packets of Service Information with the same PID, are transmitted within the range of 4 kilobytes ±100% (0 to 8 kilobytes) in 32 ms each.

2.2.5   Packetized Elementary Stream (PES) constraints

PES syntax and semantics shall be used to encapsulate the audio and video elementary stream information. The PES syntax is used to convey the Presentation Time-Stamp (PTS) and Decoding

Time-Stamp (DTS) information required for decoding audio and video information with synchronism. This section describes the coding constraints for this system layer.

Within the PES packet header, the following restrictions apply:

For System A:

– PES_scrambling_control shall be coded as '00'.

– ESCR_flag shall be coded as '0'.

– ES_rate_flag shall be coded as '0'.

– PES_CRC_flag shall be coded as '0'.

For System B:

– The following trick mode fields shall not be transmitted in a broadcast bitstream: trick_mode_control, field_id, intra_slice_refresh, frequency_truncation, field_rep_cntrl.

For System C, specific constraints are not specified but may apply if necessary.

Within the PES packet extension in System A, the following restrictions apply:

– PES_private_data_flag shall be coded as '0'.

– pack_header_field_flag shall be coded as '0'.

– program_packet_sequence_counter_flag shall be coded as '0'.

– P-STD_buffer_flag shall be coded as '0'.

2.2.5.1 Video PES constraints

The following constraints are specified in System A.

Each PES packet shall begin with a video access unit, as defined in § 2.1.1 of ISO/IEC Standard 13818-1, which is aligned with the PES packet header. The first byte of a PES packet payload shall be the first byte of a video access unit. Each PES header shall contain a PTS. Additionally, it shall contain a DTS as appropriate. For terrestrial broadcast, the PES packet shall not contain more than one coded video frame, and shall be void of video picture data only when transmitted in conjunction with the discontinuity_indicator to signal that the continuity_counter may be discontinuous.

Within the PES packet header, the following restrictions apply:

– The PES_packet_length shall be coded as '0x0000'.

– data_alignment_indicator shall be coded as '1'.

Video PES constraints of System C are specified in Appendix 3 [ARIB, 2003d].

2.2.5.2 Audio PES constraints

The following constraints are specified in System A.

The audio decoder may be capable of simultaneously decoding more than one elementary stream containing different program elements, and then combining the program elements into a complete program. In this case, the audio decoder may sequentially decode audio frames (or audio blocks) from each elementary stream and do the combining (mixing together) on a frame or (block) basis. In order to have the audio from the two elementary streams reproduced in exact sample

synchronism, it is necessary for the original audio elementary stream encoders to have encoded the two audio program elements frame synchronously; i.e., if audio program 1 has sample 0 of frame *n* at time *t*0, then audio program 2 should also have frame *n* beginning with its sample 0 at the identical time *t*0. If the encoding is done frame synchronously, then matching audio frames should have identical values of PTS.

If PES packets from two audio services that are to be decoded simultaneously contain identical values of PTS then the corresponding encoded audio frames contained in the PES packets should be presented to the audio decoder for simultaneous synchronous decoding. If the PTS values do not match (indicating that the audio encoding was not frame synchronous) then the audio frames which are closest in time may be presented to the audio decoder for simultaneous decoding. In this case the two services may be reproduced out of sync by as much as 1/2 of a frame time (which is often satisfactory, e.g., a voice-over does not require precise timing).

The value of stream_id for System A audio shall be 1011 1101 (private_stream_1).

Audio PES constraints of System C are specified in Appendix 3 [ARIB, 2003d].

2.2.6   Services and features

2.2.6.1   System/Service Information

In addition to the PSI defined in ISO/IEC Standard 13818-1 which gives information for the multiplex in which they are contained, the System A Program and System Information Protocol (PSIP), the System B Service (or System) Information (SI) and the System C Service Information (SI) allow for identification of services or events for the user and may also provide information on services carried by different multiplexes and even other networks. PSIP/SI data complements the PSI tables specified in ISO/IEC Standard 13818-1 by providing data to aid automatic tuning of decoders, and information intended for display to the user. PSIP/SI is carried by means of descriptors that are included in PSI information tables or in tables that conform to the private section syntax defined in ISO/IEC Standard 13818-1.

The System A PSIP shall be generated as specified in Appendix 1 [ATSC, 1997].

The System B SI is specified in Appendix 2 [ETSI, 1996a] and guidelines for its use are given in Appendix 2 [ETSI, 1996b].

The System C SI and guidelines for its use are specified in Appendix 3 [ARIB, 2003a].

2.2.6.2   Program guide

In System A, the data to support an interactive program guide shall be transmitted in the transport stream. The program guide data stream shall be transported in PID 0x1FFB. This PID shall be reserved exclusively for the PSIP data. The PSIP data shall be formatted according to the structure and syntax described in "Program and System Information Protocol for Terrestrial Broadcast and Cable" in Appendix 1 [ATSC, 1997]. The program guide database allows a receiver to build an on-screen display of program information and contains control information to facilitate navigation.

In System A, the PSIP elementary streams identified by Transport Stream packets with PID 0x1FFB, as well as PSIP-defined PIDs for event information tables and extended text tables, shall adhere to an STD model that may be described by an MPEG smoothing buffer descriptor (§ 2.6.30 in ISO/IEC Standard 13818-1) with the following constraints:

–   sb_leak_rate shall be 625 (indicating a leak rate of 250 000 bit/s).

–   sb_size shall be 1 024 (indicating a smoothing buffer size of 1 024 bytes).

Note that the smoothing buffer descriptor is referred to here to describe the STD model for the PSIP data, and does not imply that a smoothing buffer descriptor for the PSIP data is to be included in the PMT.

System B SI or System C SI data may also be used as the basis of an Electronic Programme Guide; presentation methods are outside of the scope of the specification.

2.2.6.2.1   System Information PID and Service Information PIDs

In System A, certain system information is transmitted in the Transport Stream. The PSIP data stream shall be transported in PID 0x1FFB. This PID shall be reserved exclusively for the PSIP information. The PSIP information shall be formatted according to the structure and syntax described in "Program and System Information Protocol for Terrestrial Broadcast and Cable" in Appendix 1 [ATSC, 1997]. Constraints applying to specific transmission media are given in that standard.

System B Service Information defines eight tables that are carried in PIDs 0x10 through 0x14, inclusive. The NIT, whose internal structure is not defined in ISO/IEC Standard 13818-1 and which is defined in detail by Appendix 2 [ETSI, 1996a], is assigned the PID value 0x10. The PIDs 0x15 through 0x1F inclusive are reserved for future use by System B.

System C SI defines eight tables that are carried in PIDs 0x10 through 0x14, inclusive. The NIT, whose internal structure is not defined in ISO/IEC Standard 13818-1 and which is defined in detail by Appendix 3 [ARIB, 2003a], is assigned the PID value 0x10. The PIDs 0x15 through 0x2F inclusive are used or reserved for future use by System C.

2.2.6.2.2   System/Service Information STD model

In System A, the PSIP elementary streams identified by Transport Stream packets with PID 0x1FFB, as well as PSIP-defined PIDs for Event Information Tables and Extended Text Tables, shall adhere to an STD model that may be described by an MPEG smoothing buffer descriptor (§ 2.6.30 in ISO/IEC Standard 13818-1) with the following constraints:

–   sb_leak_rate shall be 625 (indicating a leak rate of 250 000 bit/s).

–   sb_size shall be 1 024 (indicating a smoothing buffer size of 1 024 bytes).

Note that the smoothing buffer descriptor is referred to here to describe the STD model for the PSIP data, and does not imply that a smoothing buffer descriptor for the PSIP data is to be included in the PMT.

In System B, the Service Information data shall obey the following constraint. The minimum time interval between the arrival of the last byte of a section to the first byte of the next transmitted

section with the same PID, table_id and table_id_extension and with the same or different section_number shall be 25 ms.

In System C, TS packets of Service Information with the same PID, are transmitted within the range of 4 kilobytes ± 100% (0 to 8 kilobytes) in 32 ms each.

2.2.6.3   Specification of private data services

Private data provides a means of adding new ancillary services to the basic digital television service specified in the System A, System B and System C standards. Private data may be inserted on various layers as specified in ISO/IEC Standards 13818-1 and 13818-2 and provides means for further compatible extension of services.

In System A, private data is supported in two bit stream locations.

–   Private data may be transmitted within the adaptation header of Transport Stream packets (§ 2.4.3.4 and 2.4.3.5 of ISO/IEC Standard 13818-1).

–   Private data may be transmitted as a separate transport stream with its own PID. The contents may be identified as being System A private by using the private_data_indicator_descriptor (§ 2.6.29 of ISO/IEC Standard 13818-1) within the PMT.

In either case, it is necessary that the standards which specify the characteristics of such private_streams be consistent with the System A Digital Television Standard. Standards for private_streams shall precisely specify the semantics of the transmitted syntax as described in the reference document.

In System B, support of private data is given by mechanisms such as:

–   within the adaptation header of Transport Stream packets;

–   as a separate elementary stream whose PID may be referenced by the PMT. The contents may by identified by one or more of the following: stream_type field, registration_descriptor, private_data_indicator_descriptor;

–   as private sections;

–   as private data within the PES packet header.

In System C, support of private data is given by mechanisms such as:

–   a separate elementary stream whose PID may be referenced by the PMT. The contents may by identified by one or more of the following: stream_type field, data_component_descriptor;

–   private sections;

–   PES packets containing private data.

2.2.6.3.1 Verification model

2.2.6.3.1.1   Verification model for System A

The System A standard is specified in terms of a verification model by defining the characteristics of the transmitted syntax and an idealized decoder. In ISO/IEC Standards 13818-1 and 13818-2, this is accomplished by using the system target decoder T-STD and video buffering verifier VBV models, respectively. The elements required for specification by System A are described in the following paragraphs.

The syntax and semantics of the transmitted bit stream that implements the ancillary service shall be completely and unambiguously specified. The decoding process shall also be completely and unambiguously specified.

An idealized decoder model must be precisely defined for the service. Figure 1 introduces a concrete model for pedagogic purposes. It is modelled after the T-STD.

The salient features of the model are the size of the transport demultiplexing buffer (TB), the minimum transfer rate out of the transport demultiplex buffer (R_{leak}), the required System buffering (BS_{sys}), and optionally the partitioning of BS_{sys} between the smoothing portion and the decoder portion. The decoding process, represented as the decoding times T_decode(i), must be completely specified. The behaviour of the BS_{sys} buffer must be completely modelled with respect to its input process and its output process. Certain parameters of the service such as bit rate, etc., should also be specified.

FIGURE 1

Ancillary service target decoder
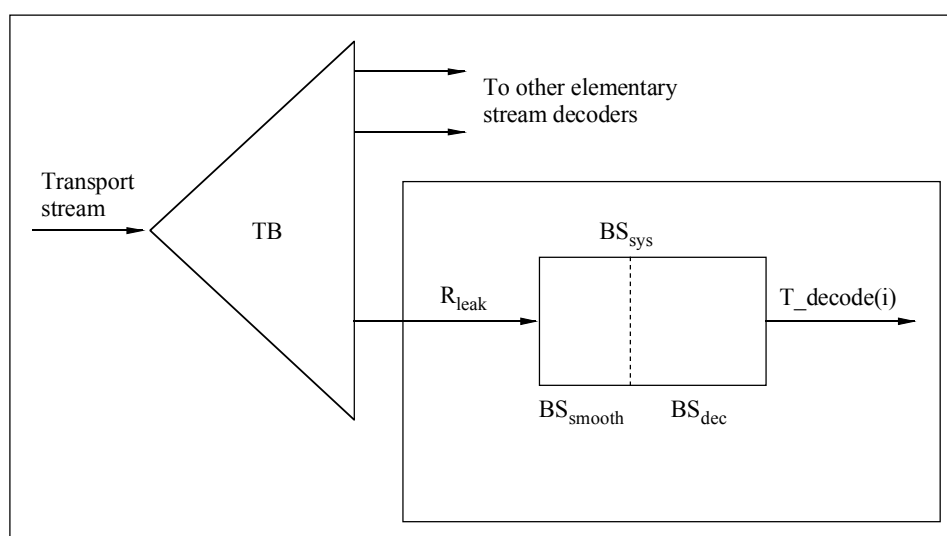
1300-01

2.2.6.3.1.2   Verification model for System B

The System B standard uses the verification model characterizing an idealized decoder, as specified in § 2.4 of ISO/IEC Standard 13818-1 for video, audio and PSI data. For the data streams defined in System B, the models are given by the following specifications:

–   § 5.1.4 of Appendix 2 [ETSI, 1996a] for Service Information,

–   § 5 Appendix 2 [ETSI, 1995a] for Teletext,

–   § 6 of Appendix 2 [ETSI, 1997] for Subtitling Systems.

2.2.6.3.1.3   Verification model for System C

The System C standard uses the verification model characterizing an idealized decoder, as specified in § 2.4 of ISO/IEC Standard 13818-1 for video, audio and PSI data. For the data streams defined in System C, the models are given in Appendix 3 [ARIB, 2003b].

2.2.6.3.2 Stream type and PMT descriptors

A new ancillary service shall be described as a program or elementary stream through documented PSI.

2.2.6.3.2.1   Stream type

Several identifiers that are part of the transport section of the System A Digital Television Standard may be used to identify either the signal or constituent parts thereof; however, the fundamental identifier is the User Private stream type. The stream_type codes shall be unambiguously assigned within the range 0x80 to 0xBF.

No user private stream type codes are assigned by System B and System C.

2.2.6.3.2.2   PMT descriptors

The Ancillary Service specification shall include all pertinent descriptors that are found within the PMT. Specifically, it is recommended that either the private_stream_identifier or the registration_descriptor, or both, be included. Although this is not required for a stream with a unique stream_type code within the System A standard, it will enhance interoperability in the case where the stream is stored outside the standard, or transmitted in some other network that has its own set of stream_type codes.

System B specifies use of descriptors defined in ISO/IEC Standard 13818-1 as follows:

video_stream_descriptor:	shall be used to indicate video streams containing still picture data, or streams which do not comply with the constraints of Main Profile at Main Level.
audio_stream_descriptor:	shall be used to indicate audio streams with sampling frequencies of 16, 22.05, or 24 kHz.
hierarchy_descriptor:	shall be used to indicate video or audio streams coded as more than one hierarchical layer.
target_background_grid_descriptor:	shall be used to indicate target background grids of other than 720×576 pixels.
CA_descriptor:	shall be encoded as described in Appendix 2 [ETSI, 1995b and 1996c].
ISO_639_language_descriptor:	shall be present if more than one audio (or video) stream with different languages are present within a program.

System C specifies use of descriptors defined in ISO/IEC Standard 13818-1 as follows:

CA_descriptor:	shall be encoded as described in Appendix 3 [ARIB, 2003a].
copyright descriptor:	shall be encoded as described in Appendix 3 [ARIB, 2003a].

2.2.7   Assignment of identifiers

In this section, those identifiers and codes which shall have a fixed value are summarized.

2.2.7.1   Transport Stream Packet Identifiers

For System A, PID 0x1FFB, as well as PSIP-defined PIDs for event information tables and extended text tables are used to carry PSIP data (Appendix 1 [ATSC, 1997]).

For System B, PIDs 0x10 through 0x14 are used by SI (Appendix 2 [ETSI, 1996a]) and PIDs 0x15 through 0x1F are reserved for future extensions to System B.

For System C, PIDs 0x10 through 0x2F are used by SI (Appendix 3 [ARIB, 2003a]) or reserved for future extensions to System C.

2.2.7.2   Stream type

In System A, stream_type codes in the range of 0x80 to 0xBF are either used or reserved for future extensions to System A. The stream_type code for streams carrying System A audio shall be value 0x81. The stream_type code for streams carrying Program Identifier tables shall be value 0x85 (see Appendix 1 [ATSC, 1996a]).

In System B and System C, no stream_type codes have been assigned.

2.2.7.3   Descriptors

2.2.7.3.1 System A audio descriptor

In System A Digital Television Standard the audio descriptor shall be included in the TS_program_map_section. The syntax is given in Table 2 of Annex A of System A Standard in Appendix 1 [ATSC, 1995a]. There are the following constraints on the System A audio descriptor:

– The value of the descriptor_tag shall be 0x81.

– If the field textlen exists, it shall have a value of '0x00'.

2.2.7.3.2 Program smoothing buffer descriptor

In System A, the PMT of each program shall contain a smoothing buffer descriptor pertaining to that program in accordance with § 2.6.30 of ISO/IEC Standard 13818-1. During the continuous existence of a program, the value of the elements of the smoothing buffer descriptor shall not change.

The fields of the smoothing buffer descriptor shall meet the following constraints:

– The field sb_leak_rate shall be allowed to range up to the maximum transport rates specified in § 7.2 in Appendix 1 [ATSC, 1995b].

– The field sb_size shall have a value less than or equal to 2 048. The size of the smoothing buffer is thus ≤ 2 048 bytes.

Inclusion of the program smoothing buffer descriptor in the PMT at the encoding stage and the usage of this information in the decoder is optional for System B compliant services.

2.2.7.3.3 Descriptor tag values

Table 1 identifies descriptor_tag values in use in System A.

TABLE 1

System A descriptor_tag use

Descriptor_tag	Use
0x00-0x01	Reserved by ISO/IEC Standard 13818-1
0x02-0x12	Used by ISO/IEC Standard 13818-1
0x13-0x3F	Reserved by ISO/IEC Standard 13818-1
0x40-0x7F	Reserved for harmonization with System B (Appendix 2 [ETSI, 1996a])
0x80-0xBF	Reserved by System A Digital Television Standard
0xC0-0xFE	User defined
0xFF	User defined by ISO/IEC Standard 13818-1

Table 2 identifies descriptor tag values in use in System B.

TABLE 2

System B descriptor_tag use

Descriptor_tag	Use
0x00-0x01	Reserved by ISO/IEC Standard 13818-1
0x02-0x12	Used by ISO/IEC Standard 13818-1
0x13-0x3F	Reserved by ISO/IEC Standard 13818-1
0x40-0x61	Used by System B (Appendix 2 [ETSI, 1996a])
0x62-0x7F	Reserved by System B (Appendix 2 [ETSI, 1996a])
0x80-0xFE	User defined[1]
0xFF	User defined by ISO/IEC Standard 13818-1

[1] For inter-operation with System A, descriptor_tag values 0x80 to 0xBF should not be used within the PMT.

Table 3 identifies descriptor tag values in use in System C.

TABLE 3

System C descriptor_tag use

Descriptor_tag	Use
0x00-0x01	Reserved by ISO/IEC Standard 13818-1
0x02-0x12	Used by ISO/IEC Standard 13818-1
0x13-0x3F	Reserved by ISO/IEC Standard 13818-1
0x40-0x7F	Used by or reserved for future use by System C (Appendix 3 [ARIB, 2003a])
0x80-0xBF	User defined[1]
0xC0-0xFE	Used by or reserved for future use by System C (Appendix 3 [ARIB, 2003a])
0xFF	User defined by ISO/IEC Standard 13818-1

[1] For inter-operation with System A, descriptor_tag values 0x80 to 0xBF should not be used within the PMT.

2.2.7.4   Table identifiers

Table 4 summarizes the allocation of table_ID in the System A Digital Television Standard system.

TABLE 4

Table ID usage in System A

Table_ID	Use
0x00-0x02	Used by ISO/IEC Standard 13818-1
0x03-0x3F	Reserved by ISO/IEC Standard 13818-1 for future use
0x40-0x7F	Reserved for harmonization with System B (Appendix 2 [ETSI, 1996a])
0x80-0xBF	User private
0xC7-0xDF, 0xE6-0xFE	Used by or reserved for future use by the System A Digital Television Standard
0xFF	Reserved by ISO/IEC Standard 13818-1 for the packet-fill function

Table 5 identifies table_ID in use in System B.

TABLE 5

Table ID usage in System B

Table_ID	Use
0x00-0x02	Used by ISO/IEC Standard 13818-1
0x03-0x3F	Reserved by ISO/IEC Standard 13818-1 for future use
0x40-0x73	Used by System B (Appendix 2 [ETSI, 1996a])
0x74-0x7F	Reserved by System B (Appendix 2 [ETSI, 1996a]) for future use
0x80-0x8F	Used by System B (Appendix 2 [ETSI, 1996c]) for CA message sections
0x90-0xFE	User defined[1]
0xFF	Reserved by ISO/IEC Standard 13818-1 for the packet-fill function

[1] For inter-operation with System A, table_id values 0xC7-0xDF and 0xE6-0xFE should not be used on PIDs carrying PMTs.

Table 6 identifies table_ID in use in System C.

TABLE 6

Table ID usage in System C

Table_ID	Use
0x00-0x02	Used by ISO/IEC Standard 13818-1
0x03-0x3F	Reserved by ISO/IEC Standard 13818-1 for future use
0x40-0x7F	Used by or reserved for future use by System C (Appendix 3 [ARIB, 2003a])
0x80-0x8F	Used by or reserved for future use by System C (Appendix 3 [ARIB, 2003c]) for CA message sections
0x90-0xBF	User defined
0xC0-FE	Used by or reserved for future use by System C (Appendix 3 [ARIB, 2003a])
0xFF	Reserved by ISO/IEC Standard 13818-1 for the packet-fill function

2.2.8   Extensions to the MPEG-2 Systems specification

This section covers extensions to the MPEG-2 Systems specification.

2.2.8.1   Scrambling control

The scrambling control field within the packet header allows all states to exist in the System A Digital Television Standard as defined in Table 7.

TABLE 7

Transport scrambling control field

Transport_scrambling_control	Function
00	Packet payload not scrambled
01	Not scrambled; state may be used as a flag for private use defined by the service provider
10	Packet payload scrambled with "even" key
11	Packet payload scrambled with "odd" key

Elementary Streams for which the transport_scrambling_control field does not exclusively have the value of '00' for the duration of the program, must carry a CA_descriptor in accordance with § 2.6.16 of ISO/IEC Standard 13818-1.

The implementation of a digital television delivery system that employs conditional access will require the specification of additional data streams and system constraints.

In System B, scrambling may occur at the Transport Stream or PES level. The transport_scrambling_control field shall be encoded as defined in Table 8. The PES_scrambling_control field shall be encoded as defined in Table 9.

TABLE 8

Transport Stream scrambling control field for System B

Transport_scrambling_ control	Function
00	Packet payload not scrambled
01	Reserved for future System B use
10	Transport Stream packet payload scrambled with "even" key
11	Transport Stream packet payload scrambled with "odd" key

TABLE 9

PES scrambling control field for System B

PES_scrambling_ control	Function
00	Packet payload not scrambled
01	Reserved for future System B use
10	PES packet payload scrambled with "even" key
11	PES packet payload scrambled with "odd" key

Transport or elementary streams for which the scrambling_control_field does not exclusively have the value of '00' for the duration of the program, must carry a CA_descriptor in accordance with § 2.6.16 of ISO/IEC 13818-1. The contents of Transport Stream Packets containing conditional access information follow the format for CA message sections specified in Appendix 2 [ETSI, 1996a].

In System C, scrambling may occur at the Transport Stream level. The transport_scrambling_control field shall be encoded as defined in Table 10.

TABLE 10

Transport Stream scrambling control field for System C

Transport_scrambling_ control	Function
00	Packet payload not scrambled
01	Reserved for future System C use
10	Transport Stream packet payload scrambled with "even" key
11	Transport Stream packet payload scrambled with "odd" key

Transport or elementary streams for which the scrambling_control_field does not exclusively have the value of '00' for the duration of the program, must carry a CA_descriptor in accordance with § 2.6.16 of ISO/IEC Standard 13818-1. The contents of Transport Stream Packets containing conditional access information follow the format for CA message sections specified in Appendix 3 [ARIB, 2003c].

2.2.8.2   Program/Episode/Version Identification

In System A, the Program/Episode/Version Identification (Program Identifier) standard referenced in Appendix 1 [ATSC, 1996a] provides a means of uniquely defining a program, episode, version, and source within the MPEG-2 syntax. The standard provides for a program identifier data packet that may be inserted into the Transport Stream. A PID is assigned to the program identifier data packets that appear in the Transport Stream for each program. This PID is identified in the PMT. The program identifier packet contents may vary to allow specific identification of the separate component works (e.g. programs, commercials, and materials of a promotional nature) that make up the program.

It is believed that this packet may also be conveyed in a System B stream.

2.3   Features of ISO/IEC Standard 13818-1 not supported by the System A, System B and the System C standards

The transport definition is based on the MPEG-2 Systems standard, ISO/IEC Standard 13818-1; however, it does not implement all parts of the standard. This section describes those elements which are omitted from System A, System B and System C standards.

2.3.1   Program streams

The System A, System B and System C standards for transmission in broadcast applications do not include those portions of ISO/IEC Standard 13818-1 which relate exclusively to Program Stream specifications.

2.3.2   Still pictures

The System A standard does not include those portions of ISO/IEC Standard 13818-1 Transport Stream specification which relate to the Still Picture model.

Annex 2

Service multiplex methods

1   Introduction

In DTTB, one digital multiplex may carry several television services, each comprised of one or more video components, one or more audio components, and optionally other components as well, including ancillary data. A standardized method is necessary to enable receiving equipment to locate the service of interest and the components of interest in that service, and to enable it to create for the user a suitable navigation environment for friendly access to the digital services available.

Digital transports for DTTB shall include PSI in accordance with § 2.4.4 of ISO/IEC Standard 13818-1 (MPEG-2 Systems) as the standard method to facilitate service access.

2 MPEG-2 program specific information

As originally defined in ISO/IEC Standard 13818-1, PSI consists of four types of tables, PAT, PMT, NIT, and the Conditional Access Table (CAT).

An amendment to ISO/IEC Standard 13818-1 has added an additional table, the Transport Stream Description Table (TSDT).

2.1 Program Association Table (PAT)

The PAT provides the correspondence between a program_number and the PID value of the Transport Stream packets which carry the program definition (PMT).

Value 0x0000 for program_number is a special case, and indicates that the associated PID shall be the Network PID. The Network PID carries data that defines physical network parameters such as carrier frequencies, modulation methods, etc. The definition of the Network PID is outside the scope of the ISO/IEC Standard 13818-1 specification.

For Transport Streams in which only System B SI or System C SI is present, program_number 0x0000 may be specified; if specified, the value of the associated PID shall be 0x0010. For Transport Streams in which only System A PSIP is present, program_number 0x0000 may be specified; if specified, the value of the associated PID shall be 0x1FFB.

For Transport Streams in which both System A PSIP and System B SI or both System A PSIP and System C SI, are present, value 0x0000 for program_number shall not be specified in the PAT.

2.2 Program Map Table (PMT)

The PMT specifies the types of elementary components that make up the service and the PID in the Transport Stream that carries them. The PMT provides a method for inclusion of descriptors, at both the level of the service and of each individual component.

2.3 Network information

The PAT may reference the Network PID, which carries data whose definition and structure is outside the scope of the MPEG-2 Systems specification.

2.4 Conditional Access Table (CAT)

To support the needs of access control, the CAT associates one or more private Entitlement Management Message streams each with a unique PID value.

2.5 Transport Stream Description Table (TSDT)

The TSDT is defined to contain data which may indicate the method for including private data in the Transport Stream, or to carry descriptors whose scope includes all services carried in the Transport Stream. ISO/IEC Standard 13818-1 compliant bitstreams are not mandatorily required to

carry the TSDT. ISO/IEC Standard 13818-1 compliant decoders are not mandatorily required to decode the data carried in the TSDT.

3   System/Service Information (SI)

The SI is included within an MPEG-2 Transport Stream to assist the user in selection of services and/or events within the digital multiplex, and so that the receiver may automatically configure itself for the selected service. Information carried within SI includes descriptions of services both within the Transport Stream carrying the SI and of services on other multiplexes that may be available in the system. In general, SI augments and extends the relevant PSI specified in ISO/IEC Standard 13818-1 (MPEG-2 Systems), PAT and PMT.

The PAT may reference the Network PID through definition of a program_number 0x0000. The definition and structure of tables carried in the Network PID is outside the scope of the MPEG-2 Systems specification. Three standards are in current use which define Network data. In the System A Digital Television standard, program and system information for United States terrestrial broadcast is standardized (Appendix 1 [ATSC, 1997]). In the System B digital television standard, the specification (Appendix 2 [ETSI, 1996a]) provides the definition of Service Information for various transmission media including cable, satellite, and terrestrial broadcast. In the System C digital television standard, the specification (Appendix 3 [ARIB, 2003a]) provides the definition of Service Information for digital broadcast.

3.1   System A system information and program guide

System A PSIP Standard (Appendix 1 [ATSC, 1997]) specifies that the PSIP data is carried in PID 0x1FFB.

The specification defines a Master Guide Table and Virtual Channel Table database. These tables may reference event information and extended text messages carried in other PID streams, or may include information for events present on other transport multiplexes or analogue channels.

3.2   System B service information

System B standard (Appendix 2 [ETSI, 1996a]) specifies a number of tables, carried in several pre-assigned PID values. Tables include the NIT, the Service Description Table (SDT), the Event Information Table (EIT), the Time Offset Table (TOT), the Running Status Table (RST), the Time and Date Table (TDT), and the Bouquet Association Table (BAT).

3.3   System C service information

System C standard (Appendix 3 [ARIB, 2003a]) specifies a number of tables, carried in several pre-assigned PID values. Tables include the NIT, the Service Description Table (SDT), the Event Information Table (EIT), the Time Offset Table (TOT), the Running Status Table (RST), the Time and Date Table (TDT), the Bouquet Association Table (BAT), the Local Event Information Table

(LIT), the Event Relation Table (ERT), the Index Transmission Table (ITT), the Partial Content Announcement Table (PCAT), the Stuffing Table (ST), the Broadcaster Information Table (BIT), the Network Board Information Table (NBIT), and the Linked Description Table (LDT).

3.4 Compatible carriage of System A PSIP, System B SI and System C SI

ITU-R recognizes that, due to differing functional requirements, the methods for conveying SI for DTTB will vary to some degree worldwide. The exchange of programming from various sources will continue to be necessary, placing special demands on the transport layer. Harmonization of SI standards simplify such exchanges and facilitate equipment inter-operability.

Harmonization of System A, System B and System C SI involves:

–   reservation of certain user-private PID values in each standard;

–   compatible allocation of table_ID values;

–   compatible allocation of descriptor tag values;

–   compatible allocation of stream_type values; and

–   compatible rules for use of MPEG-defined descriptors.

3.4.1 Transport Stream (TS) descriptors

ISO/IEC has defined the TS_description_section (table_ID 0x03) to carry Transport Stream descriptors in PID 0x0002.

When the TS carries System/Service Information of more than one System, the TS_description_section may be included to indicate that fact. If included, it shall appear in PID 0x0002, and it shall carry an ISO/IEC registration_descriptor formatted as shown in Table 11.

TABLE 11

ITU-R registration descriptor

Syntax	No. of bits	Mnemonic	Value
ITUR_registration_descriptor(){			
descriptor_tag	8	uimsbf	0x05
descriptor_length	8	uimsbf	0x0A
format_identifier	32	uimsbf	
recommendation_number	32	uimsbf	
System_A_PSIP_present	1	bslbf	
System_B_SI_present	1	bslbf	
System_C_SI_present	1	bslbf	
reserved	13	bslbf	
}			

descriptor_tag: an 8-bit field that identifies the type of descriptor. For the
                               registration_descriptor the value is 0x05.

descriptor_length: an 8-bit count of the number of bytes following the descriptor_length
                               itself, in this case 10 bytes.

format_identifier: a 32-bit value that unambiguously identifies the standard body
                               supplying the descriptor. For the purposes of associating the TS with
                               this ITU-R Recommendation, the value of the format identifier shall
                               be determined at a later time.

recommendation_number: a 32-bit field that associates the TS with this ITU-R Recommendation
                               number. The value shall be determined at a later time.

System_A_PSIP_present: a binary flag that indicates, when set, that the TS carries SI in
                               accordance with System A PSIP specification (Appendix 1 [ATSC,
                               1997]). When the flag is clear, System A PSIP is not present.

System_B_SI_present: a binary flag that indicates, when set, that the TS carries SI in
                               accordance with System B specification (Appendix 2 [ETSI, 1996a]).
                               When the flag is clear, System B SI is not present.

System_C_SI_present: a binary flag that indicates, when set, that the TS carries SI in
                               accordance with System C specification (Appendix 3 [ARIB, 2003a]).
                               When the flag is clear, System C SI is not present.

3.4.2   Reservation of PID values

Certain PID values in the "user private" range of each of the PSIP/SI specifications must be
reserved to achieve harmonious carriage of both. To this end:

0x0000 through 0x000F: are reserved by ISO/IEC 13818-1.

0x0010 through 0x001F: are reserved for carriage of System B SI (Appendix 2 [ETSI, 1996a])
                               or System C SI (Appendix 3 [ARIB, 2003a]). System A (Appendix 1
                               [ATSC, 1995b]) allows these PID values to be used for PMT and
                               elementary stream components. Applying this restriction to the
                               program paradigm defined in § 5.3 of Annex C of the System A
                               specification (Appendix 1 [ATSC, 1995b]), program number 1 shall
                               not be used. The valid range for program numbers shall be 2
                               through 255.

0x0020 through 0x002F: are used or reserved for carriage of System C SI (Appendix 3 [ARIB,
                               2003a]).

0x1FFB: is reserved for carriage of System A PSIP.

0x1FFC: is reserved for carriage of System A [ATSC, 1996b] (no longer
                               applicable for terrestrial broadcast).

0x1FFD: is reserved for carriage of System A [ATSC, 1996c] (no longer
                               applicable for terrestrial broadcast).

3.4.3 Allocation of table ID values

Strictly speaking, the scope of one table_ID does not extend beyond the PID that carries the table. To reduce confusion, however, it is very desirable that table_ID values in use in non-private PID streams do not overlap. Therefore, table_ID values shall be allocated as follows.

0x00 through 0x3F: are reserved by ISO/IEC 13818-1.

0x40 through 0x7F: are reserved for System B SI and extensions to that standard, or for System C SI and extensions to that standard. This range of table_ID values falls into the System A "user private" range.

0x80 through 0xBF: are available for user private tables without conflict with any one of the SI standards.

0xC0 through 0xFE: are reserved for System C SI and extensions to that standard. This range of table_ID values falls into the System B "user defined" range.

0xC7 through 0xDF and   are reserved for System A PSIP and extensions to that standard. This

0xE6 through 0xFE: range of table_ID values falls into the System B "user private" range.

3.4.4 Allocation of descriptor tag values

Descriptor tag values shall be allocated as follows:

0x00 through 0x3F: are reserved by ISO/IEC 13818-1.

0x40 through 0x7F: are reserved for System B SI and extensions to the standard, or for System C SI and extensions.

0x80 through 0xBF: are reserved for System A PSIP and extensions to that standard.

0xC0 through 0xFE: are reserved for System C SI and extensions to that standard.

3.4.5 Allocation of stream type values

The stream_type field is present in the PMT to specify the type of program element carried within the packets identified in the associated elementary_PID field. Stream type values shall be allocated as follows:

0x00 through 0x7F: are reserved by ISO/IEC 13818-1.

0x80 through 0xBF: are reserved for System A and extensions to the standard ([ATSC, 1997]).

0xC0 through 0xFF: are available for user private stream types without conflict with any one of the standards.

3.4.6 Rules for use of descriptors in the PMT

Given that the PMT is a structure that would be processed in common among equipment conforming to the System A PSIP, System B SI and System C SI standards, certain compatibility considerations arise.

3.4.6.1 MPEG-2 registration descriptors

System A specifies that an MPEG-2 registration_descriptor shall appear in the PMT at the service (program) level to identify a service as compliant with the System A standard. The format_identifier field for this application is specified as 0x474A 3934.

System A further specifies that a registration_descriptor is required in conjunction with audio elementary streams in the PMT. The format_identifier field in this case is 0x4143 2D33.

3.4.6.2 ISO_639_language_descriptor

System B allows use of both ISO 639.2/B and /T language codes. For compatibility with future standards derived from the System A specification (Appendix 1 [ATSC, 1995b and 1997]), it is recommended that only ISO 639.2/B codes be used. It is further recommended that all audio Elementary Streams in the PMT include an associated ISO_639_language_descriptor.

3.4.6.3 Smoothing buffer descriptor

In System A, a smoothing buffer descriptor is used to describe the STD model for the PSIP data; however, the smoothing buffer descriptor for the PSIP data is not required to be included in the PMT.

3.4.6.4 Other MPEG-defined descriptors

Other MPEG-defined descriptors may appear in the PMT without restriction. Their function and use is specified in ISO/IEC Standard 13818-1.

3.4.6.5 System B SI-defined descriptors

The following System B-defined descriptors may be present in the PMT and may be ignored by equipment processing the TS according to the System A standard: the mosaic_descriptor (tag value 0x51), the stream_identifier_descriptor (tag value 0x52), the teletext_descriptor (tag value 0x56), the subtitling_descriptor (tag value 0x59), and the service_move_descriptor (tag value 0x60). In addition, the following System B-defined descriptors may be present in the PMT and may be ignored by equipment processing the TS according to the System C standard: the teletext_descriptor (tag value 0x56), the subtitling_descriptor (tag value 0x59), and the service_move_descriptor (tag value 0x60).

3.4.6.6 System A-defined descriptors

The System A PSIP Standard reserves the range 0x80 through 0xBF for descriptor tag values. In particular, System A defines the audio_stream_descriptor, tag value 0x81 (see System A specification (Appendix 1 [ATSC, 1995a])). The audio_stream_descriptor may be present in the PMT and may be ignored by equipment not supporting the System A audio standard. Note that inclusion of a registration_descriptor for System A audio in the PMT is optional in System A specification (Appendix 1 [ATSC, 1995a]).

3.4.6.7 System C SI-defined descriptors

The following System C-defined descriptors may be present in the PMT and may be ignored by equipment processing the TS according to the System A or System B standard: the country_availability_descriptor (tag value 0x49), the linkage_descriptor (tag value 0x4A), the

component_descriptor (tag value 0x50), the parental_rating_descriptor (tag value 0x55), the hierarchical transmission_descriptor (tag value 0xC0), the digital copy control_descriptor (tag value 0xC1), the target region descriptor (tag value 0xC6), the video decode control descriptor (tag value 0xC8), the content availability_descriptor (tag value 0xDE), the carousel compatible composite_descriptor (tag value 0xF7), the conditional playback_descriptor (tag value 0xF8), the emergency information_descriptor (tag value 0xFC), the data component_descriptor (tag value 0xFD), and the system_management descriptor (tag value 0xFE). Furthermore, the following System C-defined descriptors may be present in the PMT and may be ignored by equipment processing the TS according to the System A standard: the mosaic_descriptor (tag value 0x51), the stream_identifier_descriptor (tag value 0x52).

Appendix 1

System A Standard

References

ATSC [1995a] Standard A/52. Digital audio compression standard (AC-3), December. The United States Advanced Television Systems Committee.

ATSC [1995b] Standard A/53. Digital television standard, September. The United States Advanced Television Systems Committee.

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Appendix 2

System B Standard

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Appendix 3

System C Standard

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ARIB [2003d] STD-B32. Version 1.4. Video coding, audio coding and multiplexing specifications for digital broadcasting, June. Association of Radio Industries and Businesses.

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