

RECOMMENDATION ITU-R BT.1300-3

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

(Question ITU-R 31/6)

(1997-2000-2004-2005)

Scope

This Recommendation defines service transport methods and service multiplex methods for the terrestrial digital television broadcasting systems. It specifies the utilization of and constraints on the use of ISO/IEC Standard 13818-1 (MPEG-2 Systems).

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 (TS) syntax has been established in ISO/IEC Standard 13818-1 (Moving Picture Experts Group (MPEG-2) Systems);
- e) that a common TS 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 TS methods, and that TS 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 TS 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 TS packets.

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

NOTE – ISO/IEC Standard 13818-1 is available at the following address: <http://www.iso.org/itu>.

Annex 1

Service transport methods

1 Introduction

The service transport method shall conform with the MPEG-2 TS 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 TS syntax for the packetization and multiplexing of video, audio, and data signals for digital broadcasting systems. The MPEG-2 TS 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 (ES).

2.2.1.2 Audio T-STD

The audio T-STD for System A is specified in § 3.6 of Annex A (Appendix 1 to Annex 2 [ATSC, 2001]).

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 may be identified by the 32-bit format identifier within a registration descriptor carried in the programme (service) descriptor loop in the section of the Program Map Table (PMT) detailed in § 2.4.4.8 of ISO/IEC Standard 13818-1. When used to identify the program as conforming to the System A specification, the format identifier is coded according to § 2.6.8 of ISO/IEC Standard 13818-1, and has a value of 0x4741 3934 (“GA94” in ASCII).

2.2.2.2 Audio elementary stream format identifier

Audio ESs which conform to the System A specification may be identified by the 32-bit format identifier within a registration descriptor carried in the ES descriptor loop in the section of the Program Map Table (PMT) detailed in § 2.4.4.8 of ISO/IEC Standard 13818-1. When present, the format identifier is coded according to § 2.6.8 of ISO/IEC Standard 13818-1, and has 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, beyond those specified in § 2.2.7.1 below, 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) (Appendix 1 to Annex 2[ATSC, 2003]). The following constraints apply to the PSI information:

- TS packets identified by a particular PMT_PID value are constrained to carry only one program definition, as described by a single TS_program_map_section(). For terrestrial broadcast applications, these TS packets are further constrained to carry no other kind of PSI table.
- The TS is constructed such that the time interval between the byte containing the last bit of the TS_program_map_section() containing television program information and successive occurrences of the same TS_program_map_section() are less than or equal to 400 ms.

- The program numbers are associated with the corresponding PMT_PIDs in the Program Association Table (PAT). The TS is constructed such that the time interval between the byte containing the last bit of the `program_association_section()` and successive occurrences of the `program_association_section()` are less than or equal to 100 ms. However, when `program_association_section()`s, `CA_section()`s, and `TS_program_map_section()`s are approaching their maximum allowed sizes, the potential exists to exceed the 80 000 bit/s rate specified in § 2.4.2.3 of ISO/IEC Standard 13818-1. In cases where the table section sizes are such that the 100 ms repetition rate of the `program_association_section()` would cause the 80 000 bit/s maximum rate to be exceeded, the time interval between the byte containing the last bit of the `program_association_section()` may be increased but in no event shall exceed 140 ms, so that under no circumstances the limit of 80 000 bit/s is exceeded.
- When an ES of stream_type 0x02 (MPEG-2 video) is present in the TS, the `data_stream_alignment_descriptor()` (described in § 2.6.10 of ISO/IEC Standard 13818-1) is included in the descriptor loop immediately following the `ES_info_length` field in the `TS_program_map_section()` describing that ES. The `descriptor_tag` value is set to 0x06, the `descriptor_length` value is set to 0x01, and the `alignment_type` value is set to 0x02 (video access unit).
- Adaptation headers are not allowed to occur in TS packets identified by PID 0x0000 (the PAT 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 are not allowed to occur in TS packets identified by a `program_map_PID` value for purposes other than for signalling with the `discontinuity_indicator` that the `version_number` (§ 2.4.4.9 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 to Annex 2 [ETSI, 1997a]. 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 to Annex 2 [ETSI, 1997a]. The NIT is carried in TS 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 SI as specified in Appendix 3 to Annex 2 [ARIB, 2004a]. 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 to Annex 2 [ARIB, 2004a]. The NIT is carried in TS 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 SI with the same PID, are transmitted within the range of 4 kilobytes $\pm 100\%$ (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 ES 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 to Annex 2 [ARIB, 2004b].

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 ES 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 ES and do the combining (mixing together) on a frame (or block) basis. In order to have the audio from the two ESs 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 to Annex 2 [ARIB, 2004b].

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 Service (or System) Information (SI) of System A, System B and System C 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. 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. 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 SI is generated as specified in Appendix 1 to Annex 2 [ATSC, 2003].

The System B SI is specified in Appendix 2 to Annex 2 [ETSI, 1997a] and guidelines for its use are given in Appendix 2 to Annex 2 [ETSI, 1997b].

The System C SI and guidelines for its use are specified in Appendix 3 to Annex 2 [ARIB, 2004a].

2.2.6.2 Program guide

In System A, the data to support an interactive program guide shall be transmitted in the TS. System information and program guide data shall be conveyed in TS packets with PID 0x1FFB, which shall be reserved exclusively for SI data. The SI 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 to Annex 2 [ATSC, 2003]. 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 SI ESs identified by TS packets with PID 0x1FFB, as well as SI-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 SI data, and does not imply that a smoothing buffer descriptor for the SI 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 TS. The SI data stream shall be conveyed in TS packets with PID 0x1FFB. This PID shall be reserved exclusively for the SI information. The SI 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 to Annex 2 [ATSC, 2003]. Constraints applying to specific transmission media are given in that standard.

System B SI defines eight tables that are carried in TS packets with PID values 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 to Annex 2 [ETSI, 1997a], 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 TS packets with PID values 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 to Annex 2 [ARIB, 2004a], 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 SI ESs identified by TS packets with PID 0x1FFB, as well as SI-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 SI data, and does not imply that a smoothing buffer descriptor for the SI data is to be included in the PMT.

In System B, the SI 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 SI with the same PID, are transmitted within the range of 4 kilobytes $\pm 100\%$ (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, support of private data is given by mechanisms such as:

- Private data may be transported within the adaptation field of TS packets (§ 2.4.3.4 and 2.4.3.5 of ISO/IEC Standard 13818-1).
- Private data may be transported as a separate ESs. The stream_type codes in the range 0xC4 to 0xFF are available for stream types defined privately (not described in System A standards).