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YbcZ_Y_j Yb b] 'ca fYj]fG: BŁ

Digital Video Broadcasting (DVB); DVB mega-frame for Single Frequency Network (SFN) synchronization

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Technical Specification

Digital Video Broadcasting (DVB); DVB mega-frame for Single Frequency Network (SFN) synchronization

European Broadcasting Union (EBU) Union Européenne de Radio-Télévision (UER)
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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 Normalization ELECTrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI) (Broadcast).

NOTE: 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.

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Digital Video Broadcasting (DVB) Project

Founded in September 1993, the DVB Project is a market-led consortium of public and private sector organizations in the television industry. Its aim is to establish the framework for the introduction of MPEG-2 based digital television services. Now comprising over 200 organizations from more than 25 countries around the world, DVB fosters market-led systems, which meet the real needs, and economic circumstances, of the consumer electronics and the broadcast industry.

1 Scope

The present document specifies a mega-frame, including a mega-frame initialization packet (MIP), which may be used for synchronization of the Single Frequency Networks (SFN) as well as for the optional control of other important parameters in an SFN.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- 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.
- For a non-specific reference, the latest version applies.

- [1] ISO/IEC 13818-1 (1994): "Information Technology - Generic coding of moving pictures and associated audio information: Systems".
- [2] ETSI EN 300 744: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television".
- [3] ETSI EN 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

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3 Definition and abbreviations

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3.1 Definitions

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

cell: for the definition of a cell, see EN 300 468 [3], clause 3.1

frame: for the definition of a DVB-T frame, see EN 300 744 [2], clause 4.4

super-frame: for the definition of a DVB-T super-frame, see EN 300 744 [2], clause 4.4

3.2 Abbreviations

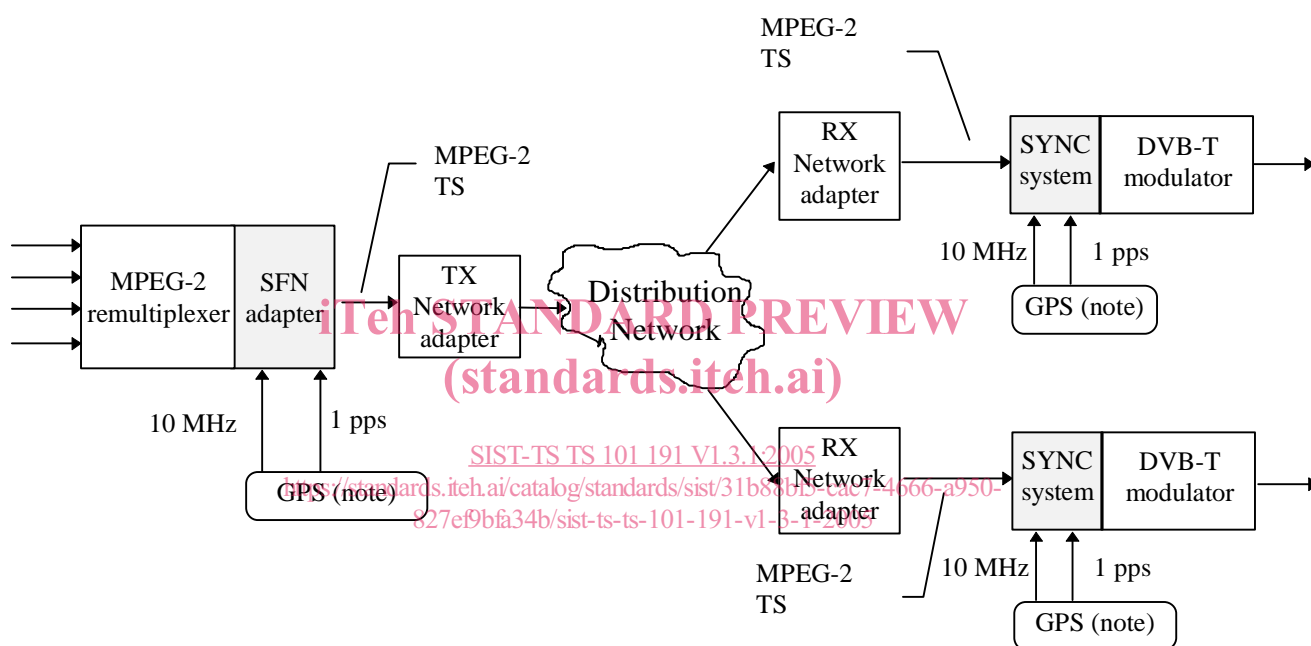
For the purposes of the present document, the following abbreviations apply:

CRC	Cyclic Redundancy Check
DVB	Digital Video Broadcasting
DVB-T	DVB-Terrestrial
ERP	Effective Radiated Power
GPS	Global Positioning System
HP	High Priority
LP	Low Priority
MFN	Multi Frequency Network
MFP	Mega-Frame Packet
MIP	Mega-frame Initialization Packet
MPEG	Moving Pictures Expert Group
PID	Packet IDentifier
pps	pulse per second

RF	Radio Frequency
RS	Reed-Solomon
SFN	Single Frequency Network
SI	Service Information
STS	Synchronization Time Stamp
SYNC	SYNChronization
TPH	Transport Packet Header
TPS	Transport Parameter Signalling
TS	Transport Stream
TX/RX	Transmitter/Receiver

4 General description

Figure 1 shows a block diagram of a complete SFN system.



NOTE: Could be any common available frequency reference.

Figure 1: DVB-T primary distribution with SFN adaptation

The SFN functionality is an extension to the DVB system. The blocks associated with SFN functionality are the grey boxes in figure 1. These blocks could be implemented either as separate equipment or integrated in the multiplexer and/or the DVB-T modulator.

4.1 SFN system blocks

MPEG-2 re-multiplexer

The MPEG-2 re-multiplexer re-multiplexes the programmes from various input channels, updates the SI and provides an MPEG-2 TS which, after SFN adaptation, is transmitted via the DVB-T modulators in the SFN.

SFN adapter

The SFN adapter forms a mega-frame, consisting of n TS-packets corresponding to 8 DVB-T frames in the 8K mode or 32 frames in the 2K mode, and inserts a Mega-frame Initialization Packet (MIP) with a dedicated PID value. Inserted anywhere within a mega-frame of index M , the MIP of that mega-frame, MIP_M , allows to uniquely identify the starting point (i.e. the first packet) of the mega-frame $M + 1$. This is accomplished by using a pointer carried by the MIP_M itself to indicate its position with regards to the start of the mega-frame $M + 1$.

The time difference between the latest pulse of the "one-pulse-per-second" reference, derived e.g. from GPS, that precedes the start of the mega-frame $M + 1$ and the actual start (i.e. first bit of first packet) of this mega-frame $M + 1$ is copied into the MIP_M . This parameter is called Synchronization Time Stamp (STS).

The time duration of a mega-frame is independent of the duration T_{sc} , constellation and code rate of the DVB-T signal. Four different time durations exist, for each type of channel width, depending on the chosen guard interval proportion, as shown table 1a:

Table 1a

Guard Interval (Δ/T_{sc})	Channel width		
	6 MHz	7 MHz	8MHz
1/4	0,812 373	0,696 320	0,609 280
1/8	0,731 136	0,626 688	0,548 352
1/16	0,690 517	0,591 872	0,517 888
1/32	0,670 208	0,574 464	0,502 656

The output of the SFN adapter shall be fully DVB/MPEG-2 TS compliant.

Transmitter/Receiver network adapter

The network adapters shall provide a transparent link for the MPEG-2 TS from the central to the local units. The maximum network delay - caused by the different paths of the transmission network - the SYNC system can handle is 1 second.

SYNC system

The SYNC system will provide a propagation time compensation by comparing the inserted STS with the local time reference and calculate the extra delay needed for SFN synchronization. See annex B for an example of the synchronization process.

DVB-T modulator

The modulator should provide a fixed delay from the input to the air interface. The information inserted in the MIP could be used for the direct control of the modulator modes or control of other transmitter parameters. The modulator clocks at the different sites have to be synchronized. Since it is a requirement of an SFN that all transmitted signals be identical, the MPEG-2 TS inputs to the various DVB-T modulators have to be bit identical.

Global Positioning System (GPS)

GPS is one among many possible time references but it is the only one available globally. GPS receivers are available which provide both a 10 MHz frequency reference and a 1 pulse per second (1 pps) time reference. The 1 pps time reference, used in SFN synchronization, is divided into 100 ns steps of the 10 MHz clock. The 10 MHz system clock is assumed to be available at all nodes in the network.

The functional blocks "SFN adapter" and "SYNC system" are additional elements for SFN use, and not necessary in MFN applications.

5 Mega-frame definition

The output of the SFN adapter shall be a valid MPEG-2 TS, where the individual packets are organized in groups, which constitute a mega-frame. Each mega-frame consists of n packets, where n is an integer number which depends on the number of RS-packets per super-frame in the DVB-T mode that will be used for DVB-T emission of the MPEG-2 TS (see EN 300 744 [2], clause 4.7). In the 8K mode n is (the number of RS-packets per super-frame) \times 2. In the 2K mode n is (the number of RS-packets per super-frame) \times 8.

Each mega-frame contains exactly one Mega-frame Initialization Packet (MIP). The actual position may vary in an arbitrary way from mega-frame to mega-frame. The pointer value in the MIP is used to indicate the start of the following mega-frame. In figure 2 the overall structure of the mega-frame, including the positioning of the MIP, is given. The exact definition of the MIP format is given in clause 6.

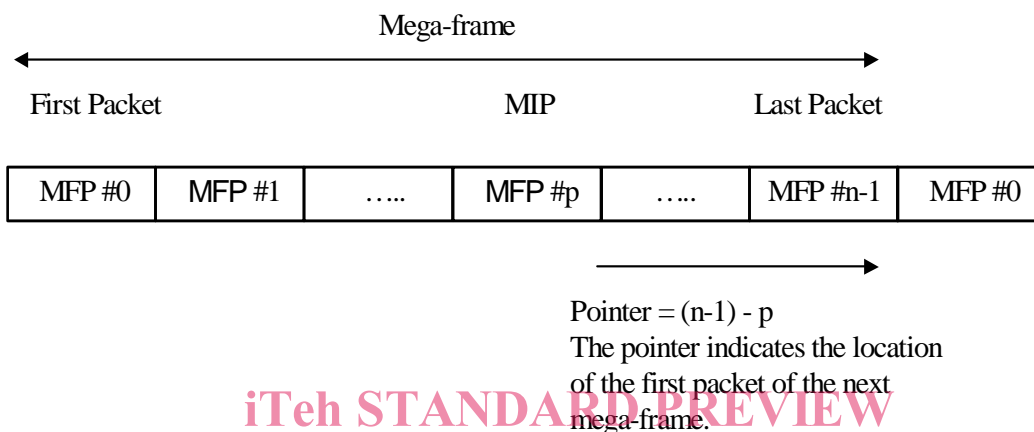


Figure 2: Overall mega-frame structure

The start of a mega-frame in the DVB-T signal is in the present document defined to coincide with the beginning of a DVB-T super-frame and the start of an inverted sync byte, being part of transport multiplex adaptation.

The use of a mega-frame and the insertion of a MIP are additional elements for SFN use, and not necessary in MFN applications.

6 Mega-frame Initialization Packet (MIP)

The MIP is an MPEG-2 compliant Transport Stream (TS) packet, made up of a 4-byte header and a 184-byte data field. The organization of the MIP is shown in table 1b.

Table 1b: Mega-frame Initialization Packet (MIP)

Syntax	Number of bits	Identifier
mega-frame_initialization_packet(){		
transport_packet_header	32	bslbf
synchronization_id	8	uimsbf
section_length	8	uimsbf
pointer	16	uimsbf
periodic_flag	1	bslbf
future_use	15	bslbf
synchronization_time_stamp	24	uimsbf
maximum_delay	24	uimsbf
tps_mip	32	bslbf
individual_addressing_length	8	uimsbf
for (i=0;i<N;i++){		
tx_identifier	16	uimsbf
function_loop_length	8	uimsbf
for(i=0;i<N;i++){		
function()		
}		
}		
crc_32	32	rpchof
for (i=0, i<N,i++){		
stuffing_byte	8	uimsbf
}		
}		

NOTE 1: Optional parameters are shown in italic.

NOTE 2: All parameter values in the MIP_M apply to mega-frame M + 1, i.e. to the mega-frame pointed out by the pointer, except for the tps_mip which describes the parameters of mega-frame M + 2. See annex C for details.

NOTE 3: For the definition of the CRC decoder model, see annex A.

NOTE 4: The length of a MIP shall always be 188 bytes.

transport_packet_header: The transport_packet_header shall comply with ISO/IEC 13818-1 [1] clause 2.4.3.2, tables 2 and 3.

The PID value for the Mega-frame initialization Packet (MIP) shall be 0 x 15.

The payload_unit_start_indicator is not used by the SFN synchronization function and shall be set to 1.

The transport_priority value is not used by the SFN synchronization function and shall be set to 1.

The transport_scrambling_control value shall be set to 00 (not scrambled).

The adaptation_field_control value shall be set to 01 (payload only).

All other parameters are according to ISO/IEC 13818-1 [1] clause 2.4.3.2.

The Transport Packet Header (TPH) is mandatory.

Mandatory SFN parameters

synchronization_id: the synchronization_id is used to identify the synchronization scheme used (see table 2).

Table 2: Signalling format for the synchronization_id

Synchronization_id	Function
0 x 00	SFN synchronization
0 x 01 - 0 x FF	Future use