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**Digital Video Broadcasting (DVB);  
Metadata generation and deterministic  
DVB-T-mega-frame/DVB-T2-MI stream generation  
from MPEG-2 Transport Stream(s) for  
a DVB Single Illumination System (DVB-SIS)**

**EBU**  
OPERATING EUROVISION

**DVB<sup>®</sup>**

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 Reference
 

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DTS/JTC-DVB-381

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 Keywords
 

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mimo, MPEG, radio, satellite, terrestrial, TV,  
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# Foreword

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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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The Digital Video Broadcasting Project (DVB) is an industry-led consortium of broadcasters, manufacturers, network operators, software developers, regulatory bodies, content owners and others committed to designing global standards for the delivery of digital television and data services. DVB fosters market driven solutions that meet the needs and economic circumstances of broadcast industry stakeholders and consumers. DVB standards cover all aspects of digital television from transmission through interfacing, conditional access and interactivity for digital video, audio and data. The consortium came together in 1993 to provide global standardisation, interoperability and future proof specifications.

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# Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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# 1 Scope

The present document describes the Single Illumination System, which allows to deliver Parent Signals for direct reception by consumer receivers and, at the same time, for a deterministic generation of daughter streams for terrestrial retransmission. Parent Signals can be provided to the daughter site via all defined TS-based DVB means - be it satellite, cable or terrestrial. Metadata may be provided as part of the Parent Signal(s) (called "in-band" in the present document). Part of the metadata may also be provided "out-of-band".

A typical use case is described by the present document and is based on satellite broadcast signals on parent side - be it DVB-S (ETSI EN 300 421 [8]), -S2 (ETSI EN 302 307-1 [9]) or -S2X signals (ETSI EN 302 307-2 [10]) - that are addressing consumer Direct-to-Home (DTH) receivers and terrestrial transmitters on daughter side in parallel. For terrestrial retransmission of the whole or partial content, the DTH signal(s) of MPEG-2 TS format (ISO/IEC 13818-1 [5]) from one or several satellites can be used and services and service components can be selected according to terrestrial broadcasters' needs. Also other non-satellite Parent Signals and out-of-band metadata feeds can be integrated into the preparation of the terrestrial DVB-T2, ETSI EN 302 755 [2], and/or DVB-T, ETSI EN 300 744 [3] signals on daughter site. Single Frequency Networks (SFN) operation of the terrestrial networks driven by the Single Illumination System is enabled.

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## 2 References

### 2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

- [1] ETSI TS 102 773: "Digital Video Broadcasting (DVB); Modulator Interface (T2-MI) for a second generation digital terrestrial television broadcasting system (DVB-T2)".
- [2] ETSI EN 302 755: "Digital Video Broadcasting (DVB); Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2)".
- [3] ETSI EN 300 744: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television".
- [4] ETSI TS 101 191: "Digital Video Broadcasting (DVB); DVB mega-frame for Single Frequency Network (SFN) synchronization".
- [5] ISO/IEC 13818-1: "Information technology - Generic coding of moving pictures and associated audio information: Systems".
- [6] ETSI EN 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".
- [7] ETSI TS 102 034: "Digital Video Broadcasting (DVB); Transport of MPEG-2 TS Based DVB Services over IP Based Networks".
- [8] ETSI EN 300 421: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for 11/12 GHz satellite services".
- [9] ETSI EN 302 307-1: "Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications; Part 1: DVB-S2".

[10] ETSI EN 302 307-2: "Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications; Part 2: DVB-S2 Extensions (DVB-S2X)".

[11] IETF RFC 3629 (STD 63) (November 2003): "UTF-8, a transformation format of ISO 10646", F. Yergeau.

NOTE: Available at <https://www.rfc-editor.org/info/rfc3629>.

[12] IETF RFC 1952: "GZIP file format specification version 4.3", May 1996.

NOTE: Available at: <https://www.rfc-editor.org/info/rfc1952>.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

Not applicable.

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## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

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

**control stream generator:** device that generates metadata - namely Framing and Timing information (F&TI), DSA Configuration Information (DSACI) and Layer 1 signalling - for the daughter site signal(s)

**daughter site adapter:** device that creates the TMF/T2-MI streams to be output to the related DVB-T or -T2 modulators - based on the metadata it receives from the CSG, the outputs streams consist of content received from the parent side

**DSA configuration information:** information that enables deterministic generation of DVB-T2-MI streams and/or DVB-T-mega-frame streams at the output of the Daughter Site Adapter

**F&TI packet:** TS packet used for F&TI signalling in the DVB-T case

NOTE: This packet consists of the payload of the MIP packet - basis for forming a MIP packet on daughter site. An additional megafame\_timestamping function specific to SIS is part of the F&TI packet as well. The PID of the F&TI packet is allocated by the CSG and converted to the standard MIP PID using the DSACI pid\_processing element.

**in-band:** part of one of the Parent Signals

**interleaving frame:** unit over which dynamic capacity allocation for a particular PLP is carried out, made up of an integer, dynamically varying number of FEC blocks and having a fixed relationship to the T2-frames

NOTE: The Interleaving frame may be mapped directly to one T2-frame or may be mapped to multiple T2-frames, it may contain one or more TI-blocks.



**layer 1 signalling:** metadata that describes the physical layer configuration

NOTE: In the DVB-T2 case the L1 signalling provides the receiver with a means to access physical layer pipes within the T2-frames; for further details see ETSI EN 300 744 [3] for DVB-T and ETSI EN 302 755 [2] for DVB-T2.

**layer 2 signalling:** equivalent to PSI/SI - see ISO/IEC 13818-1 [5] and ETSI EN 300 468 [6], respectively - since the present document covers Transport Streams (ISO/IEC 13818-1 [5]) only, layer 2 metadata that describes the service configuration of the tuned and optionally of other multiplexes

**mode adaptation:** applicable to DVB-T2 only: the mode adaptation modules, which operate separately on the contents of each PLP, slice the input data stream into data fields which, after stream adaptation, will form baseband frames (BBFRAMEs), see also ETSI EN 302 755 [2]

**out-of-band:** not part of any of the Parent Signals, but provided to the DSA by other means

**parent network:** any DVB- and TS-based delivery network carrying the parent signal. This can be a satellite, cable or terrestrial network

**parent signal:** transport Stream present at the DSA input providing some or all the services used to build the output DTT stream

NOTE: There may be one or several Parent Signal(s) contributing to the output DTT stream (T2-MI stream or stream of T-mega-frames). Each Parent Signal consists of a time reference of the SIS system clock (PCR<sub>abs</sub>).

**PCR\_base:** 90 kHz clock

**primary sis service:** primary SIS service (one per terrestrial output/per current `_DSA_group_id`) consists of the listed mandatory elements and can consist of the listed optional elements:

- PCR<sub>abs</sub> using the transport packet adaptation mechanism (see ISO/IEC 13818-1 [5]) on a PID that is designated as the PCR\_PID in the PMT (mandatory)
- F&TI, which may be sent on the PCR<sub>abs</sub> PID (mandatory)
- DSACI (optional)
- Terrestrial-only PSI/SI tables belonging to hybrid or sheer terrestrial services, including PATs (for terrestrial TSs, with PID  $\neq$  00<sub>16</sub>) and PMTs (all optional)

**reference transport stream:** reference transport stream (RTS) is a transport stream made up entirely of null packets (see ISO/IEC 13818-1 [5]) but with a defined timing in terms of the SIS reference clock. Each packet has an associated PCR<sub>abs</sub> value

**service information:** service information is the layer 2 signalling specific to DVB usage of transport streams and consists of the MPEG programme service information and the DVB service information

**SIS service:** SIS service (one per parent signal) consists of the listed mandatory elements and can consist of the listed optional elements:

- PCR<sub>abs</sub> using the transport packet adaptation mechanism (see ISO/IEC 13818-1 [5]) on a PID that is designated as the PCR\_PID in the PMT (mandatory)
- F&TI, which may be sent on the PCR<sub>abs</sub> PID (optional)
- DSACI (optional)
- Terrestrial-only PSI/SI tables belonging to hybrid or sheer terrestrial services, including PATs (for terrestrial TSs, with PID  $\neq$  00<sub>16</sub>) and PMTs (all optional)

**SIS system clock:** 27 MHz clock that has an active edge at the SIS epoch and executes exactly 27,000,000 cycles in every subsequent second of UTC

**SIS epoch:** epoch for DVB-T2 time, i.e. 2000-01-01 T 00:00:00 UTC

**T2-frame:** fixed physical layer TDM frame that is further divided into variable size sub-slices

NOTE: The T2-frame starts with one P1 and one or multiple P2 symbols.

**T2-MI stream:** stream of T2-MI packets carrying the T2 data for a single T2 profile and optionally any non-profile data with a given value of T2-MI stream ID

## 3.2 Symbols

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

$\lceil x \rceil$	Round towards plus infinity: The smallest integer that is not less than $x$
$\lfloor x \rfloor$	Round towards minus infinity: The largest integer that does not exceed $x$
$continuity\_counter(i)$	Continuity Counter - part of PSI/SI - of TS packet(i)
$DFL(i)$	Data Field Length of BBFRAME $i$ , determined on the basis of $N_{bytesIF}$ and $N_{blocks}$ for $i$ not equal to 0, this field is a multiple of 8
$DPCR_{IF}$	The duration (as difference of $PCR_{FTSP}$ ) of the $frame\_packet\_count$ packets of the relevant interleaving frame and PLP, this duration is encoded as a 32 bit integer number of 27 MHz
$DPCR_{MF}$	Difference between the $PCR_{abs}$ values for two subsequent DVB-T mega-frames
$FIRST\_DFL$	The DFL value as defined in ETSI EN 302 755 [2] for the first BBFRAME of the relevant Interleaving Frame, this field is a multiple of 8
$FIRST\_ISCR(n)$	The ISCR value of the first complete packet of the first BBFRAME of the Interleaving Frame $n$ of the related PLP
$FIRST\_SYNCD(n)$	SYNCD of the first BBFRAME of the current interleaving frame $n$ belonging to this PLP
$f_{PCR}$	Frequency of the Program Clock Reference PCR (27 MHz)
$frame\_packet\_count(n)$	The number of TS packets that start in the Interleaving Frame $n$ of the related PLP
$ISCR(p)$	Input Stream Clock Reference for the TS packet of index $p$ within the related Interleaving Frame
$M\_actual$	Repetition period of SDT actual (part of PSI/SI), which is a multiple of the SDT other repetition period
$n_{bat}$	Number of Bouquet Association Tables transmitted
$N_{blocks}$	Number of FEC blocks in an Interleaving Frame
$N_{bytesIF}$	The number of bytes of payload to be spread over all but the first BBFRAME of the Interleaving Frame, determined on the basis of $N_{payloadIF}$ and $FIRST\_DFL$
$N_D$	Number of deleted null packets within an interleaving frame
$NEXT\_FIRST\_SYNCD(n)$	SYNCD of the first BBFRAME of the interleaving frame $n$ , which is the immediately following interleaving frame, i.e. this value is provided with interleaving frame $n-1$ of the same PLP
$N_{MF}$	Number of TS packets in a DVB-T mega-frame
$n_{other}$	Number of other Transport Streams
$N_{payloadIF}$	Number of payload bits in the Interleaving Frame
$N_{payloadIF}(n)$	Number of payload bits in the Interleaving Frame $n$
$N_{pkt}$	Number of TS packets needed to packetize a whole table according to the packetization rules applicable to the sections of this table
$N_{steps\_to\_live}$	Number of processing loops not leading to the selection of the related TS packet for insertion into the output TS before discarding it
$n_{stuff}$	Number of stuffing TS packets should stuffing section content be needed (for $continuity\_counter$ wrapping)
$offset$	PCR_base count provided as part of DSACI
$packet\_arrival\_time(n)$	Arrival time of TS packet with index $n$ at DSA
$packet\_departure\_time(n)$	Departure time from the DSA of a TS packet with index $n$
$packet\_period$	Time interval between two TS packets of the same regenerated PSI/SI table
$PCR_{abs}$	A counter at the frequency of the SIS system clock, in the form of a PCR 48-bits field as defined in ISO/IEC 13818-1 [5].

NOTE: At the SIS epoch,  $PCR_{abs} = 0$ . It is not subject to leap seconds.

$PCR_{abs}(k)$   $k^{\text{th}}$  instance of a  $PCR_{abs}$  value in parent TS

$PCR_{FTSP}$  The time (as sample of  $PCR_{abs}$ ) corresponding to the first complete TS packet of the first BBFRAME of the relevant interleaving frame and PLP

NOTE: This defines the collection window for a given interleaving frame and PLP.

$PCR_{FTSP}(n)$	$PCR_{abs}$ of the first TS packet of the Interleaving Frame n
$PCR_{input}(n)$	The PCR value carried by the related TS packet n at the input of the DSA
$PCR_{MF}(n)$	$PCR_{abs}$ value associated with the MIP packet for DVB-T mega-frame n
$PCR_{output}(n)$	The PCR value carried by the related TS packet n at the output of the DSA
$SYNCD(i)$	SYNCD value of BBFRAME i
$table\_repetition\_period$	DSACI parameter indicating the repetition period of a PSI/SI table regenerated by the DSA
$time\_since\_epoch$	Time elapsed after SIS epoch (2000-01-01 T 00:00:00 UTC), counted in 90 kHz ticks
$UPL$	User Packet Length as defined in ETSI EN 302 755 [2]
$VAT(i)$	Virtual Arrival Time for the $i^{th}$ TS packet (TS packet(i)) transmitted since SIS epoch

### 3.3 Abbreviations

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

ASI	Asynchronous Serial Interface
BAT	Bouquet Association Table
BBF	BaseBand Frame
BUFS	BUffer Size
CA_PID	Conditional Access Packet IDentifier
CAS	Conditional Access System
CAT	Conditional Access Table
CBR	Constant Bit Rate
CRC	Cyclic Redundancy Check
CSG	Control Stream Generator
DFL	Data Field Length
DNP	Deleted Null Packets
$DPCR_{IF}$	Duration Program Clock Reference of Interleaving Frame
DSA	Daughter Site Adapter
DSACI	Daughter Site Adapter Configuration Information
DTH	Direct-To-Home (from satellite)
DTT	Digital Terrestrial Television
EIT	Event Information Table
EMM	Entitlement Management Message
F&TI	Framing & Timing Information
HEM	High Efficiency Mode
ISCR	Input Stream Clock Reference
ISSY	Input Stream SYNchronizer
L1	Layer 1 (physical layer)
L2	Layer 2 (data link layer)
MIP	Megaframe Initialization Packet
NPD	Null-Packet Deletion
ONID	Original Network IDentifier
PAT	Program Association Table
PCR	Programme Clock Reference
PES	Packetized Elementary Stream
PID	Packet Identifier
PLP	Physical Layer Pipe
PLP_GROUP	Group of PLPs
PMT	Program Map Table
PSI/SI	MPEG Program-Specific Information/DVB Service Information
RF	Radio Frequency
RTS	Reference Transport Stream
SDT	Service Description Table
SFN	Single Frequency Networks
SIS	Single Illumination System

T2-MI	DVB-T2 Modulator Interface
TDT	Time Description Table
T-MF	DVB-T mega-frame
TPS	Transmission Parameter Signal
TS	Transport Stream
TSPS	Transport Stream Partial Stream
TSPSC	Transport Stream Partial Stream Common
TTO	Time To Output
TTO_E	Time To Output, Exponent
TTO_L	Time To Output, Least Significant Bits of mantissa
TTO_M	Time To Output, Most Significant Bits of mantissa
UTC	Coordinated Universal Time
VAT	Virtual Arrival Timestamp

## 4 DVB Single Illumination System definition

### 4.1 System overview and architecture

The target is, on the one hand, to feed receivers installed at consumer's households with (a) "Parent" Signal(s) suitable for direct reception and, on the other hand, to use the same signal(s) to derive services and service components for terrestrial re-transmission. The Parent Signal(s) might typically be uplinked - via DVB-S (ETSI EN 300 421 [8]), -S2 (ETSI EN 302 307-1 [9]) or -S2X (ETSI EN 302 307-2 [10]) - to (a) satellite(s). The terrestrial multiplexes could either be derived by DVB-T2 or DVB-T multiplexes and shall be suitable for use in SFN networks.

Central functional blocks on the parent site are the Control Stream Generator (CSG) and the Transport Stream multiplexer that prepares the TS (ISO/IEC 13818-1 [5]) that is transmitted to consumers. The CSG prepares all metadata that is not Layer 2 signalling (PSI/SI), i.e. the Layer 1 signalling, the Framing & Timing Information (F&TI) as well as the DSA Configuration Information (DSACI).

The CSG obtains instructions from its control interface (man-machine interface, etc.) for the configuration of the DVB-T2 (ETSI EN 302 755 [2]) and/or DVB-T (ETSI EN 300 744 [3]) transmission frames that its counter-part on the daughter site, the Daughter Site Adapter (DSA), will eventually build. On that basis it generates the required metadata. On the daughter side the DSA receives Parent Signal(s) from one or more DVB networks and extracts services and service components for terrestrial re-transmission. That selection is determined by the DSA Configuration Information (DSACI). The latter also provides instructions to the DSA for the preparation of the terrestrial PSI/SI. In the T2 case, Layer 1 signalling is only decapsulated and inserted into the output T2-MI stream. Framing & Timing information indicates frame boundaries - in the T2 case the boundaries between interleaving frames and in the T case the boundaries between T mega-frames. The latter signals are output by the DSA to the related modulator(s).

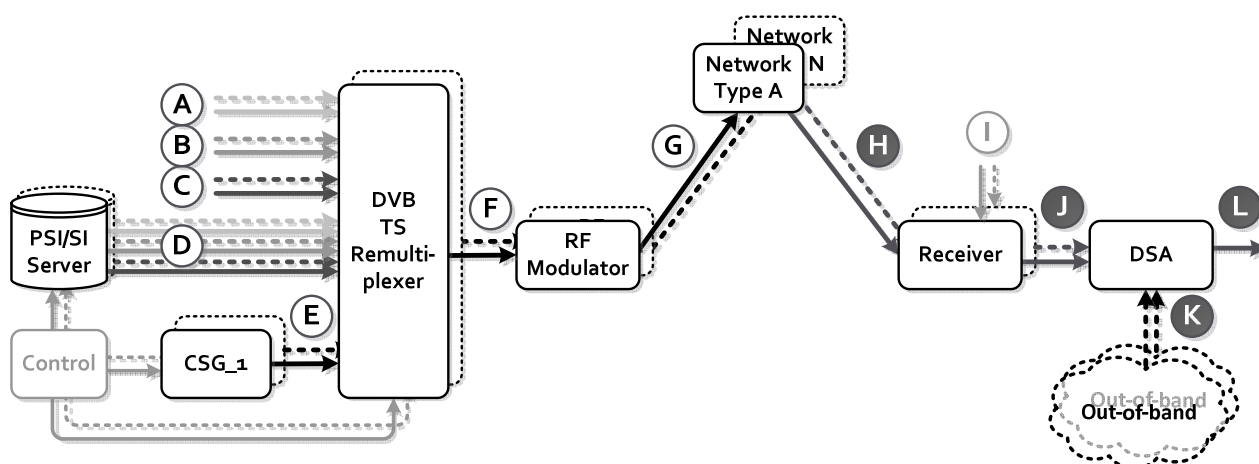
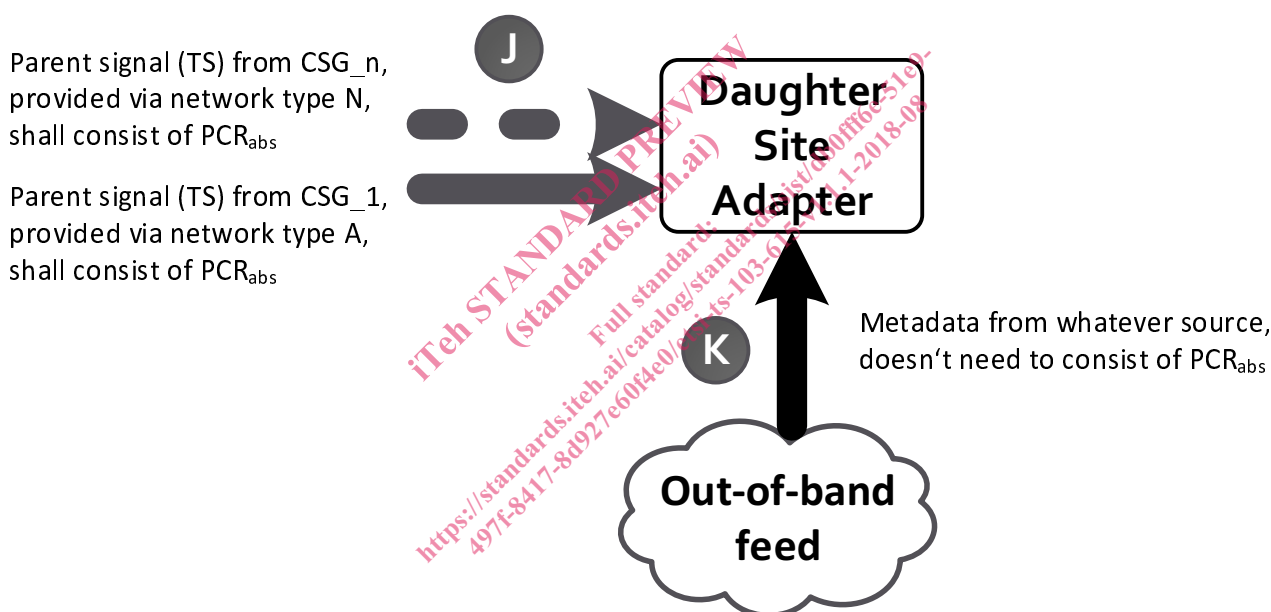


Figure 1: Conceptual block diagram of the Single Illumination transmission chain

**Table 1: Conceptual interfaces within the Single Illumination chain**

Interface	Signals at interfaces
A	TS packets containing specific DTT content
B	TS packets containing common Parent Network/DTT content
C	TS packets containing specific Parent Network content
D	TS packets containing PSI/SI sets for Parent Network, DTT and common Parent Network/DTT services
E	TS packets containing all metadata apart from PSI/SI
F	Parent TS
G	Parent TS modulated onto RF signal (uplink)
H	Parent TS modulated onto RF signal (downlink)
I	Control signal to receiver(s) for tuning, TS selection, etc. This interface is not specified by the present document
J	Parent TS (demodulated and descrambled (when needed if the service/component is sent free-to-air on the terrestrial network) downlink transport stream). These Parent Signals can be transported on any DVB-TS-based network (satellite/cable/terrestrial)
K	Out-of-band metadata: (Part of) DSACI. Out-of-band delivery of DSACI is not within the scope of the present document
L	T2-MI/T-MF stream (T2-MI stream encapsulated in TS packets in line with Data Piping described in ETSI TS 102 773 [1])

**Figure 2: Inputs of the DSA**

The present document describes the following:

- The content and structure of the "parent" Transport Stream(s) at interface H.
- The processing that shall be carried out by the DSA in order to produce the "daughter" T2-MI or T-MF signals at interface L in a deterministic manner.

The present document does not explicitly specify the processing carried out by the CSG, satellite multiplexer or other equipment at the parent site. This may be performed in any manner that results in (a) Transport Stream(s) at interface H that:

- complies/comply with clause 5; and
- after being processed as specified in clause 6, results in a T2-MI or T-MF stream at interface L that is compliant to ETSI TS 102 773 [1], ETSI EN 302 755 [2], ETSI EN 300 744 [3], ETSI TS 101 191 [4], ISO/IEC 13818-1 [5] and ETSI EN 300 468 [6].