TSDuck

MPEG Transport Stream Toolkit
User's Guide

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Third-party libraries

TSDuck includes a few third-party libraries, either in source form, binary form or both. For more details about the licenses of these third-party libraries, see the file named OTHERS.txt in the TSDuck source code repository.

DTAPI: On Linux and Windows, the TSDuck binary distributions contain the DTAPI library in static form. This software is available in binary format only and is distributed under the BSD 2-Clause License (see [39]). "Copyright © 2017 by Dektec Digital Video B.V."

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Acronyms and Abbreviations

ABNT	*Associação Brasileira de Normas Técnicas* (Brazilian standardization committee)
AC-3	Audio Compression Standard 3 (Dolby)
AES	Advanced Encryption Standard
AIT	Application Information Table (DVB)
ANSI	American National Standards Institute
ARIB	Association of Radio Industries and Businesses (Japan)
ASI	Asynchronous Serial Interface
ATIS	Alliance for Telecommunications Industry Solutions
ATSC	Advanced Television Systems Committee
ATR	Answer To Reset (smartcard)
AVC	Advanced Video Coding
BAT	Bouquet Association Table (DVB)
BDA	Broadcast Device Architecture (Microsoft Windows)
BDT	Binary Data Table
BER	Bit Error Ratio
BIT	Broadcaster Information Table (ISDB)
BPSK	Binary Phase Shift Keying
CA	Conditional Access
CAM	Conditional Access Module
CAS	Conditional Access System
CAT	Conditional Access Table (MPEG)
CIT	Content Identifier Table (DVB)
CMT	CA Message Table
COFDM	Coded Orthogonal Frequency Division Multiplexing
CP	Crypto-Period
CRC	Cyclic Redundancy Check
CSA	*Conseil Supérieur de l'Audiovisuel* (French national regulator for TV)
CVCT	Cable Virtual Channel Table (ATSC)
CW	Control Word
DCCT	Directed Channel Change Table (ATSC)
DCCSCT	Directed Channel Change Selection Code Table (ATSC)
DIT	Discontinuity Information Table (DVB)
DKMS	Dynamic Kernel Module Support (Linux)
DOCSIS	Data Over Cable Service Interface Specification
DRM	Digital Rights Management
DSM-CC	Digital Storage Media Command and Control (MPEG)
DTH	Direct To Home
DTS	Decoding Time Stamp
DTTV	Digital Terrestrial Television
DTV	Digital Television
DVB	Digital Video Broadcasting
DVB-C	DVB Cable modulation
DVB-C2	DVB Cable modulation, 2nd generation
DVB-CISSA	DVB Common IPTV Software-oriented Scrambling Algorithm
DVB-CSA	DVB Common Scrambling Algorithm
DVB-S	DVB Satellite modulation
DVB-S2	DVB Satellite modulation, 2nd generation
DVB-T	DVB Terrestrial modulation
DVB-T2	DVB Terrestrial modulation, 2nd generation

ECM	Entitlement Control Message
ECMG	ECM Generator
EIS	Event Information Scheduler
EIT	Event Information Table (DVB, ATSC, ISDB)
EMM	Entitlement Management Message
EMMG	EMM Generator
EPG	Electronic Program Guide
ERT	Event Relation Table (ISDB)
ES	Elementary Stream
ETSI	European Telecommunications Standards Institute
ETT	Extended Text Table (ATSC)
FEC	Forward Error Correction
FIPS	Federal Information Processing Standard
FLUTE	File Delivery over Unidirectional Transport (RFC 3926)
FTA	Free To Air
GOP	Group Of Pictures
HbbTV	Hybrid broadcast/broadband Television
HE-AAC	High Efficiency Advanced Audio Coding
HLS	HTTP Live Streaming
HTTP	Hyper-Text Transfer Protocol
HTTPS	Hyper-Text Transfer Protocol – Secure
IDSA	IIF Default Scrambling Algorithm
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IIF	IP-TV Interoperability Forum
INT	IP/MAC Notification Table (DVB)
IP	Internet Protocol
IPTV	Internet Protocol Television
ISDB	Integrated Services Digital Broadcasting
ISDB-S	ISDB Satellite modulation (ARIB)
ISDB-T	ISDB Terrestrial modulation (ARIB)
ISDB-Tb	ISDB Terrestrial modulation (ABNT-defined Brazilian version)
ISO	International Standardization Organization
ITT	Index Transmission information Table (ISDB)
ITU	International Telecommunication Union
IV	Initialization Vector (cryptography)
LDT	Linked Description Table (ISDB)
LIT	Local event Information Table (ISDB)
LNB	Low-Noise Block down-converter (satellite)
MAC	Media Access Control (networking)
MAC	Message Authentication Code (cryptography)
MGT	Master Guide Table (ATSC)
MPE	Multi-Protocol Encapsulation (DVB)
MPEG	Moving Picture Experts Group
MUX	Multiplexer
NBIT	Network Board Information Table (ISDB)
NIST	National Institute of Standards and Technology
NIT	Network Information Table (DVB)
NTSC	National Television Systems Committee
OQPSK	Offset Quadrature Phase Shift Keying
OUI	Organizationally Unique Identifier (IEEE assigned)

PAT   Program Association Table (MPEG)
PCAT   Partial Content Announcement Table (ISDB)
PCR   Program Clock Reference
PES   Packetized Elementary Stream
PID   Packet Identifier
PLP   Physical Layer Pipe
PMT   Program Map Table (MPEG)
PSI   Program Specific Information (MPEG)
PSK   Phase Shift Keying
PTS   Presentation Time Stamp
QPSK   Quadrature Phase Shift Keying
QAM   Quadrature Amplitude Modulation
RNT   Resolution provider Notification Table (DVB)
RRT   Rating Region Table (ATSC)
RST   Running Status Table (DVB)
RTP   Real-Time Protocol
RTT   Rating Text Tavle (ATSC)
SCS   SimulCrypt Synchronizer
SCTE   Society of Cable Telecommunications Engineers
SDT   Service Description Table (DVB)
SFN   Single Frequency Network
SI   Service Information (DVB)
SIT   Selection Information Table (DVB)
SMPTE   Society of Motion Picture and Television Engineers
STB   Set-Top Box
STD   System Target Decoder
STT   System Time Table (ATSC)
T2-MI   DVB-T2 Modulator Interface
TDT   Time and Date Table (DVB)
TID   Table Identifier
TNT   *Télévision Numérique Terrestre* (French DTTV network)
TOT   Time Offset Table (DVB)
TPS   Transmission Parameter Signalling
TS   Transport Stream
TSDT   Transport Stream Description Table (MPEG)
TVCT   Terrestrial Virtual Channel Table (ATSC)
UDP   User Datagram Protocol
UNT   Update Notification Table (DVB)
URI   Uniform Resource Identifier
URL   Uniform Resource Locator
UTC   Coordinated Universal Time
UUID   Universal Unique Identifier
VBI   Vertical Blanking Interval
VCT   Virtual Channel Table (ATSC)

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1 Transport Stream Toolkit Overview

1.1 Purpose

The transport stream toolkit contains a set of simple but flexible command-line utilities that run on Linux, Windows, macOS and BSD systems (FreeBSD, OpenBSD, NetBSD, DragonFly BSD). These commands are described in this document.

Through **tsp**, the "transport stream processor", many types of analysis and transformation can be applied on live or recorded transport streams. This utility can be extended through "plugins". Existing plugins can be enhanced, and new plugins can be developed using a library of C++ classes.

Structure of this guide:

- The chapter 2 describes the data formats (transport stream, binary sections files, XML files).
- The chapter 3 describes all TSDuck utilities.
- The chapter 4 describes all **tsp** plugins.
- The chapter 5 provides some concrete examples of TSDuck usage.
- The chapter 7 describes the level of test and support for some hardware devices, mainly DVB receivers and Dektec, HiDes or VATek devices.

1.2 Operating system selection guidelines

Here is a brief summary of pros and cons of using TSDuck on the various operating systems.

- Linux pros:
  ⇒ Availability of a powerful shell environment. TSDuck is a light-weight **toolkit** with elementary tools and plugins which can be combined in an infinite number of ways. The user can obtain even more flexibility when combining them with the **bash** shell and all standard UNIX utilities (**grep**, **sed**, **awk**, etc.) See some complex examples in section 5.2.
- Linux cons:
  ⇒ When used in a mobile environment, a laptop PC with Linux (or Linux/Windows dual boot) is required.
  ⇒ Some DVB tuners are not supported on Linux. Some supported tuners do not work well on Linux. Make sure to get fully supported DVB hardware.
- Windows pros:
  ⇒ Available on all "average user" laptop PC. Useful for transport stream capture and analysis in the field.
- Windows cons:
  ⇒ No or limited shell environment.
  ⇒ Some limitations in the support of DVB receiver devices (see 7.1.2.2, page 479, for more details). For instance, it is impossible to retrieve the actual tuning parameters of a transport stream as detected by the tuner device.
- macOS pros:
  ⇒ Availability of a powerful shell environment, just another UNIX system, just like Linux. Powerful user-friendly system.
- macOS cons:
  ⇒ Currently no support for hardware DVB tuners and Dektec devices. So, macOS is recommended only when dealing with transport stream files, IP networking or VATek-based modulators.
- BSD systems: For aficionados only.

Summary: Use Linux if you can. Use Windows when you do not have Linux (typically a Windows laptop in the field). Use macOS if you have a Mac and do not need DVB or Dektec hardware.

1.3 Developing applications using the TSDuck library

TSDuck is mainly a large C++ library for Digital TV applications. All TSDuck commands and plugins are thin wrappers on top of C++ classes from this library.

This library can be used by third-party applications, outside the TSDuck tools and plugins. To do that, you must install the "TSDuck development environment".

Using the TSDuck library, you can develop independent Digital TV applications or TSDuck plugins. The provided services include low-level features such as manipulating TS packets, intermediate features such as demuxing and packetizing tables and high-level features such as running TS processing pipelines inside your application (which means something like including **tsp** in your application).

See [51] for more details on the TSDuck library. This is a set of doxygen-generated pages with tutorials and reference documentation for all C++ classes in the library.

Some high-level features of the TSDuck library can also be used from Python or Java, typically running TS processing pipelines or manipulating tables and sections inside Python or Java applications. The TSDuck Python and Java bindings are also documented in [51].

The following figure illustrates the TSDuck software and how it can interact with third-party applications.
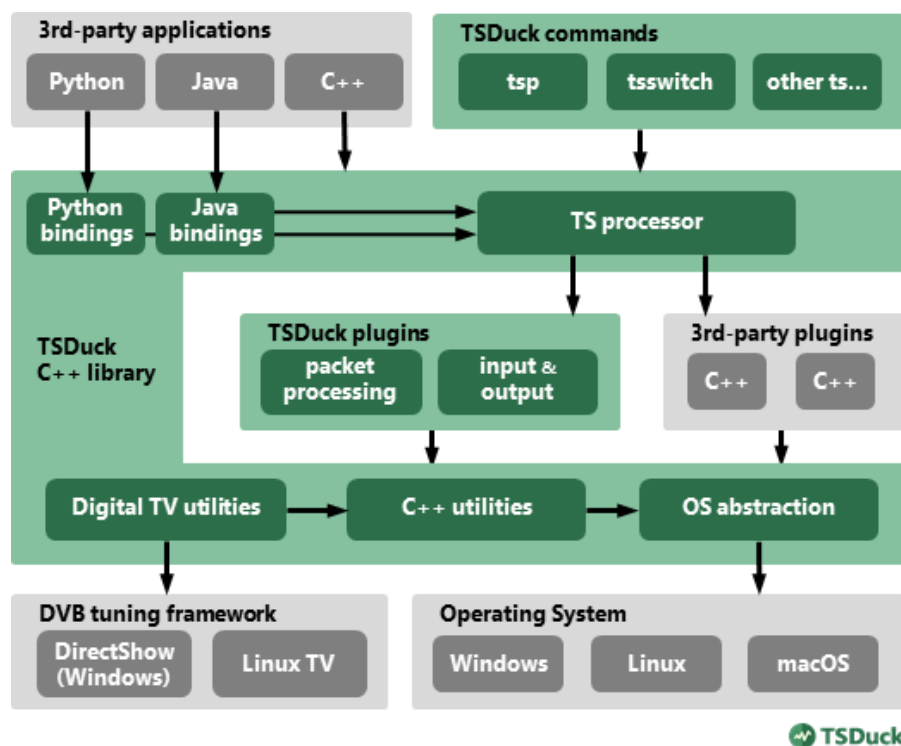
Figure 1: TSDuck software architecture

1.4 Installing TSDuck

The TSDuck installers are available from the "Download" section of the TSDuck Web site (see [50]).

The basic installation provides all TSDuck tools and plugins. The command-line tools are directly accessible from the command prompt.

Windows

On Windows systems, TSDuck can be setup using a binary installer (traditional method) or using the **winget** package manager (modern method). **Winget** is now the preferred package manager for open source and third-party products on Windows systems. It is documented and supported by Microsoft. It should be pre-installed on all recent Windows 10 and Windows 11 systems.

The TSDuck installation command is simply "**winget install tsduck**".

If you prefer the traditional method, binary executable installers are provided for 64-bit Windows platforms. Simply run the executable to install TSDuck.

The directory containing the command-line tools is automatically added to the Path. The TSDuck development environment is included in the installer but it is not installed by default. You must select it explicitly. The Java and Python bindings are required to run Java or Python applications. They are also optional and must be selected when needed.

Note that TSDuck is supported for Windows 10 and 11 only. TSDuck may work on Windows 7 or older but without guarantee.

For users without privilege, a "portable package" is provided. This is simply a zip archive file which can be expanded anywhere. The TSDuck commands are located in the **bin** subdirectory and can be executed from here without any additional setup. It is probably a good idea to add this **bin** directory in the **Path** environment variable of the user.

Note: Starting with version 3.34, pre-built 32-bit installers are no longer provided. However, it is still possible to build them yourself if needed. See the "building and installing TSDuck" section in [51].

Linux

Two flavors of packages are available: **.rpm** for Fedora systems and **.deb** for Ubuntu systems. Currently, packages are available for Intel x64 platforms. Some packages are also available for Arm64.

All tools are in **/usr/bin**. There is a separate package for the TSDuck development environment.

On Linux distributions without other packaging systems, there is no binary package for TSDuck. It must be compiled and installed using the **make** command. See the "building and installing TSDuck" section in [51].

MacOS

On macOS, TSDuck is installed using the Homebrew packaging and delivery system. Simply type "**brew install tsduck**".

All tools are accessible from **/usr/local/bin** (Intel Mac) or **/opt/homebrew/bin** (Arm Apple Silicon Mac). This is the standard installation structure for Homebrew.

The development environment is always installed with TSDuck using Homebrew.

BSD systems

There is no binary package for TSDuck on BSD systems. It must be compiled and installed using the **make** command. See the "building and installing TSDuck" section in [51].

After installation, all tools are in **/usr/local/bin** for FreeBSD, OpenBSD and DragonFly BSD. They are in **/usr/pkg/bin** for NetBSD. These are the standard locations for the installed packages on these systems.

2 Data Formats

2.1 Transport stream

Transport streams shall conform to the MPEG-2 system layer format as defined in ISO 13818-1 [1].

2.1.1 Live transport streams

Live transport streams can be read by TSDuck from:

- Live sources using specialized hardware, cheap DVB tuners or Dektec devices.
- UDP/IP using various encapsulations (the encapsulation of TS packets in UDP packets does not matter since TSDuck automatically retrieves the TS packets inside UDP packets and simply ignores everything in between).
- HTTP or HTTPS streams without encapsulation (ie. raw TS streams, but not manifest-based formats such as DASH or HLS).
- HLS (HTTP Live Streaming) with transport stream segments (not fMP4).
- SRT and RIST transport protocols.

See the documentation of the plugins **dvb**, **dektec**, **ip**, **http**, **hls**, **srt**, **rist** for more details on the reception of live transport streams.

The same plugins can also transmit live streams on Dektec devices, on UDP/IP streams (multicast or unicast), SRT and RIST transport protocols.

HLS output is possible with the help of an independent HTTP server such as Apache. The **hls** output plugin produces the playlist and segment files. These files can then be served by any HTTP server.

Additionally, output plugins are provided for HiDes and VATek modulator devices. These devices do not have input equivalent and the plugins are output only.

2.1.2 Stored transport streams

Transport streams can be read from and written to binary files, called "TS files".

A standard TS file must contain contiguous 188-byte TS packets without any encapsulation. All TS packets shall start with the MPEG-defined synchronization byte **0x47**. Any packet not starting with this synchronization byte is considered invalid and rejected.

Unless specified otherwise, most TSDuck utilities and plugins can read or write several non-standard TS formats. The supported formats are listed in the table below.

The command line option **--format name** can be used to specify a precise file format.

On input, the file format is automatically detected for each file. But the auto-detection may fail in some cases (for instance when the first timestamp of an M2TS file starts with **0x47** in which case the file would be incorrectly identified as TS). Using the option **--format** forces a specific format to avoid ambiguities.

On output, the default format is a standard TS file.

The table below lists all possible format names as used with the option **--format**.

Table 1: Transport stream file formats

Name	Description
autodetect	Auto-detection of the file format. This is the default for input files and is usually appropriate. This will always work with TS files but may fail in rare cases with M2TS files. This value is not applicable to output files.

Name	Description
TS	Standard transport stream file containing contiguous 188-byte TS packets without any encapsulation. This is the default for output files.
RS204	Raw transport stream capture with Reed-Solomon outer FEC. Each standard 188-byte TS packet is followed by a 16-byte Reed-Solomon FEC. On input, these 16 bytes are ignored. On output, they are set to zero (placeholder for real FEC).
M2TS	Blu-ray compatible format. Also found in recording files from some DVR devices. This is the same as TS format, except that each 188-byte TS packet is preceded by a 4-byte time stamp. The 2 most significant bits are copy control indicators and are ignored. The 30 least significant bits represent a time stamp in 27 MHz unit (same unit as PCR values). Note that those time stamps wrap up every 39 seconds approximately since they use only 30 bits while full PCR values use 42 bits.
duck	This is a TSDuck proprietary format. It is similar to M2TS except that the header before each TS packet uses 14 bytes and contains all packet metada. Since this is a TSDuck proprietary format, it can be used only in pipes between instances of tsp. The only advantage of this format is to transport complete original time stamps, packet labels and other metadata between instances of tsp.

When dealing with non-conformant TS files coming from outside, the utility **tsresync** can be used to extract the TS packets and recreate a pure 188-byte TS file. Here is a sample list of common non-conformant TS files which can be processed by **tsresync**:

- Raw capture of TS packets with the 16-byte trailing Reed-Solomon correction code.

- Network capture files as produced by tools like Wireshark. Such files contain network packets, containing IP packets, containing UDP packets, containing TS packets.

In all these cases, **tsresync** can extract all TS packets and recreate a "pure" TS file which can be manipulated by the various utilities and plugins from the TSDuck suite.

2.2 Bit rates

2.2.1 Interpretation

In the manipulation of transport streams, using "bitrates" is quite common. Unless specified otherwise, all bitrate values are in bits per second, based on 188-byte TS packets.

2.2.2 Representation

Although it is quite common to manipulate bitrates as integral values, there are some cases where the fractional value may have some importance. In broadcast systems, for instance, the bitrate of a transport stream is directly computed from the modulation method and its parameters. And the result is rarely an integral value.

When manipulating multi-megabits-per-second transport streams, a fraction of bit per second is usually negligible but not always. When a TSDuck tool runs for hours or days, these small fractions can make a difference.

There were several user requests to use more precise representations of bitrates instead of integers. However, requirements from different users are sometimes conflicting. Representing smaller fractions may lead to less accuracy or overflows in intermediate computations. There is no perfect representation for all needs.

As a consequence, TSDuck can be compiled with four different representations of bitrates. The default one provides the best balance so far between precision and performance. For specific needs, TSDuck may be rebuilt with a customized representation.

The four possible representations are listed below:

- **64-bit fixed-point value with 1 decimal digit:** The underlying representation is a 64-bit integer type. The performances are correct. The accurancy is better than with integers but with one decimal only. Using more than one decimal is possible but may lead to intermediate overflows.
- **64-bit integer values:** This provides the best performance but no accuracy below one bit per second.
- **Fractions of two 64-bit integer values:** The accuracy of bitrates is formally preserved, especially when computed from modulation parameters. But intermediate overflows are so frequent that this representation is hardly usable beyond basic usages. The performances are also worse than with any other representation.
- **64-bit floating-point values:** This is the default. The precision is preserved, there is almost no intermediate overflow. But the accuracy of computations is not always preserved.

To verify the bitrate representation of a given build of TSDuck, use the option **--version=bitrate** with any TSDuck command (see section 3.1.3).

2.2.3   Specifying bitrate in command lines

Many TSDuck tools or plugins get bitrates values from command line options. With all representations of bitrates, it is possible to specify integer values (see section 3.1.2 about specifying integer values in command lines).

Depending on the representation, it is also possible to specify more precise values. Using fixed-point or floating-point values, it is possible to use a decimal point. With fixed-point values, do not provide more decimal digits than the precision. With fractions, it is possible to provide fractional values, for instance "**12345/67**".

2.2.4   Rebuilding with a different bitrate representation

When compiling TSDuck, the default bitrate representation is a floating-point value. This is also the representation in pre-built binaries.

Rebuilding TSDuck with another representation is possible but must be consistent. All tools and shared libraries must have been built with the same representation. Special symbols and linker dependencies are generated to prevent mixing binaries and libraries with different representations.

To select a different representation of bitrates, simply define the corresponding C++ macro in the build system. See the source file **src/libtsduck/base/types/tsBitRate.h** for the various macros.

On Linux and macOS, the **make** command accepts direct parameters, one of the following:

```
make -j10 BITRATE_FLOAT=1
make -j10 BITRATE_FRACTION=1
make -j10 BITRATE_INTEGER=1
make -j10 BITRATE_FIXED=1 BITRATE_DECIMALS=3
```

The last command rebuilds with fixed-point and three decimal digits instead of one.

2.3 PSI/SI signalization

TSDuck can manipulate PSI/SI sections and tables outside of transport streams. Sections and tables can be extracted from a transport stream, saved and manipulated in various file formats and injected in other transport streams.

There are two main file formats for PSI/SI: binary section files and XML text files.

These two formats are documented in the next sections. In the general case, tools which extract PSI/SI sections and tables can save in any format and tools which use PSI/SI can read them from any format as well. The utility **tstabcomp**, the table compiler, can translate between the two formats.

Some key differences between the two formats are:

- Binary section files contain collections of individual sections in any order, not necessarily complete tables. XML files contain complete tables only.

- Binary section files contain the exact representation, byte by byte, of sections which were extracted from a transport stream. XML files contain a higher-level representation.

- Binary section files are not easily modifiable. XML files contain text which can be manually edited using any text editor or XML tool.

2.3.1 PSI/SI binary format

A PSI/SI binary file contains one or more sections in a simple binary format. Each section is directly written in the file without any encapsulation or synchronization information. All sections are contiguous in the file.

A binary file must be read from the beginning. The header of each section contains the section length. Using this length information, it is possible to locate the next section, starting right after the current section, and so on down to the end of the file.

2.3.1.1 Creating PSI/SI binary files

PSI/SI binary files can be extracted from live streams or TS files using **tstables** or the plugin **tables**. The extracted sections are identical, byte by byte, to the transported sections. By default, all sections of a given table are contiguously saved in the binary file, in increasing order of section number. Thus, a complete table can be easily rebuilt by reading sections one by one.

With the option **--all-sections**, **tstables** and the plugin **tables** save all individual sections in their order of reception. In that case, the order and repetition of sections in the binary files are not defined.

PSI/SI binary files can also be created by **tstabcomp**, the table compiler. Tables are described in XML format (see 2.3.2) and compiled into a binary file. Since **tstabcomp** processes complete tables, all sections of a table are also contiguously saved in the binary file, in increasing order of section number, just like **tstables** by default.

2.3.1.2 Using PSI/SI binary files

The content of binary section files can be viewed using **tstabdump**. This utility displays the content of each individual section in a human-readable format, regardless of the order of sections in the file.

Binary section files can be used to packetize or inject sections in a stream (command **tspacketize** and plugin **inject**). The sections are packetized or injected in their order of appearance in the file.

Finally, binary section files can also be decompiled by **tstabcomp** to recreate the corresponding XML files from the binary tables. But note that XML files contain complete tables only. This means that tables can be recreated only when their sections are contiguous and in increasing order of section number in the binary file.

2.3.2 PSI/SI XML format

An XML file containing PSI/SI tables for TSDuck uses **<tsduck>** as root node. The root node contains any number of tables.

Unlike binary files which may contain individual sections, XML files can only contain complete tables. The XML format represents a higher-level view of a table, regardless of the binary implementation in one or more sections.

The following sample XML file contains the definition for simple (and incomplete) PAT and PMT.

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>

  <PAT version="8" transport_stream_id="0x0012" network_PID="0x0010">
    <service service_id="0x0001" program_map_PID="0x1234"/>
    <service service_id="0x0002" program_map_PID="0x0678"/>
  </PAT>

  <PMT version="4" service_id="0x0456" PCR_PID="0x1234">
    <CA_descriptor CA_system_id="0x0777" CA_PID="0x0251"/>
    <component elementary_PID="0x0567" stream_type="0x12">
      <CA_descriptor CA_system_id="0x4444" CA_PID="0x0252"/>
      <ISO_639_language_descriptor>
        <language code="fre" audio_type="0x45"/>
        <language code="deu" audio_type="0x78"/>
      </ISO_639_language_descriptor>
    </component>
  </PMT>

</tsduck>
```

All XML files shall be encoded in UTF-8 format to allow international character sets in service names or event descriptions for instance. The initial declaration line "**<?xml version="1.0" encoding="UTF-8"?>**" is optional but recommended.

The complete definition of the XML model can be found in Appendix D, page 500.

2.4 Compatibility and conflicts between standards

2.4.1 Supported standards

The imbrication of digital TV standards is complex and sometimes problematic for the user who wants to analyze the structure of a transport stream. TSDuck tries to help, either using command line utilities and plugins, and C++ classes for applications which are built on top of the TSDuck library.

The first layer of standard is MPEG [1]. It is the common root of all regional or international standards in digital TV. The MPEG standard defines the transport stream format, PES, sections and descriptors, the PSI (Program-Specific Information such as PAT, CAT, PMT) and several descriptors. The allocated ranges of tables ids and descriptor tags for MPEG is reserved and never conflicts with other standards[1].

At the second layer, then come the regional standards: DVB (Europe), ATSC (USA), ISDB (Japan). Note that these standards are also used in other parts of the world, in addition to their original regions.

The third layer is made of ANSI/SCTE standards. They are application-level standards such as emergency alerts (SCTE 18), splice signalization for advertisement (SCTE 35) or encryption (SCTE 52), These standards were originally designed to complement ATSC in the USA but they are sometimes used in conjunction with DVB (especially SCTE 35). Parts of the SCTE 52 standard were also reused in ATIS-defined standards for IP-TV encryption.

---

[1] The DVB-defined "table-specific" descriptors are exceptions. These descriptors reuse MPEG-defined descriptor tags but are used only in very specific DVB-defined sections where the MPEG-defined descriptors with the same tags are normally not used.

DVB and ATSC are independent and mutually exclusive standards. They are never used together in the same transport stream. Most of their table ids and descriptor tags use distinct ranges. It is consequently easy to "guess" the second layer of standard of a transport stream, when one of their specific sections or descriptors is used.

DVB adds a non-ambiguous concept of "private descriptors" where properly registered entities, operators or industries may define their own privately defined descriptors.

ISDB is the troublemaker which makes things complicated and often requires manual setup using TSDuck command line options or default configuration.

- ISDB was originally defined in Japan by ARIB in two flavors, ISDB-T and ISDB-S.
- ISDB was later adopted by other countries, starting with Brazil, for terrestrial TV. At this time, the standards were redefined by ABNT (Brazil) under the name ISDB-Tb, to amend features which were too Japanese-specific, creating two branches of ISDB. The two branches diverged until a "harmonization committee" was created to limit the conflicts between the two.
- ISDB reuses some parts of DVB but not all. Each iteration of the standard incorporates more DVB descriptors, making it hard to define a stable common subset between DVB and ISDB.
- While ISDB reuses sections and descriptors ids and syntax, it sometimes redefines the semantics of some fields such as character sets or time reference.
- The semantics of some DVB-defined fields even varies between the variants of ISDB. As an example, time values are defined as UTC in DVB. In Japan, ARIB-defined ISDB redefines the same fields as JST (Japan Standard Time). In South America, ABNT-defined ISDB-Tb redefines it as UTC-3. In African countries, the field is loosely defined as local time, without more details.
- ISDB even redefines tiny details of the syntax of some DVB descriptors it reuses. This is the case for the **satellite_delivery_system_descriptor** for instance.

Therefore, an ISDB stream is sometimes hard to characterize. A transport stream first appears as MPEG-defined when we get the PAT and PMT's. Then, it looks like DVB when tables such as SDT or TDT are encountered. But later it can appear as ISDB when ISDB-specific tables such as a BIT or CDT are found. The problem is that, as this time, all information such as dates and time in TDT which were previously interpreted in the DVB semantics shall be retroactively reinterpreted in the ISDB semantics (or the multiple possible ISDB semantics in the case of date and time).

TSDuck tries to dynamically guess the type of standard based on the sections and descriptors it progressively discovers in the stream. The list of standards is consequently evolving along the packet processing. It usually starts with "MPEG" and may later evolve to "MPEG, DVB" or "MPEG, ATSC" or "MPEG, DVB, SCTE" or "MPEG, DVB, ISDB".

Because of this progressive discovery of the standards, it is possible that data structures are incorrectly interpreted in the initial phase, before a new standard becomes clear. This is especially critical in the case of ISDB where a transport stream is often initially interpreted as a DVB one.

TSDuck defines a few command-line options which can be used to specify the right standards from the beginning (see section 2.4.2). Some default options are also available in the user's TSDuck configuration file (see Appendix A).

Also note that the Appendix D lists the XML format of all tables and descriptors, structured by original standards.

2.4.2   TSDuck options for default standard selection

By default, TSDuck tries to guess the standards which are used in a transport stream. The following options can be used to indicate from the beginning how tables and descriptors should be interpreted. They are briefly repeated in the documentation of all commands to which they apply.

--abnt

>Assume that the transport stream is an ISDB one with ABNT-defined variants. ISDB streams are normally automatically detected from their signalization but there is no way to determine if this is an original ARIB-defined ISDB or an ABNT-defined variant.

--atsc

>Assume that the transport stream is an ATSC one.

>ATSC streams are normally automatically detected from their signalization. This option is only useful when ATSC-related stuff is found in the TS before the first ATSC-specific table. For instance, when a PMT with ATSC-specific descriptors is found before the first ATSC MGT or VCT.

--brazil

>A synonym for '**--isdb --abnt --time-reference UTC-3**'.

>This is a handy shortcut when working on South American ISDB-Tb transport streams.

--default-pds *value*

>Specify a default DVB-defined Private Data Specifier (PDS). The specified value is used as private data specifier to interpret private descriptors in the absence of preceding private_data_specifier_descriptor.

>This option is meaningful only when the signalization is incorrect, when DVB private descriptors appear in tables without a preceding private_data_specifier_descriptor.

>This type of invalid signalization is sometimes seen in operator-controlled networks, when operators specify their receivers and do not always care about the standards.

>The specified PDS value must be either a 32-bit integer or one of the predefined identifiers from the table below. These identifiers are not case-sensitive.

Table 2: Values for option --default-pds

Name	Value	Description
AOM	0x414F4D53	Alliance for Open Media
Australia	0x00003200	Free TV Australia
AVS	0x41565356	AVS Working Group of China
BskyB	0x00000002	BskyB British TV operator
CanalPlus	0x000000C0	Canal+ French TV operator
EACEM	0x00000028	European Association of Consumer Electronics Manufacturers, now renamed as DigitalEurope
EICTA	0x00000028	European Information, Communications and Consumer Electronics Technology Industry Associations. Merged with EACEM.
Eutelsat	0x0000055F	Eutelsat European satellite provider
Logiways	0x000000A2	Former CAS vendor
Nagra	0x00000009	Kudelski, Nagravision, CAS vendor
NorDig	0x00000029	NorDig standard committee (Northern Europe and Ireland)
OFCOM	0x0000233A	British regulator, formerly ITC
TPS	0x00000010	Former French TV operator

--ignore-leap-seconds

Do not explicitly include leap seconds in some precise UTC computations where leap seconds are specified as important.

According to Wikipedia, "*a leap second is a one-second adjustment that is occasionally applied to Coordinated Universal Time (UTC), to accommodate the difference between precise time (as measured by atomic clocks) and imprecise observed solar time (known as UT1 and which varies due to irregularities and long-term slowdown in the Earth's rotation).*"

Most computer systems (Linux, macOS, Windows) don't include leap seconds in their evaluation of UTC time, making their reported UTC times formally incorrect.

Some parts of Digital TV standards specify that leap seconds should be included in some specific computations. By default, TSDuck explicitly adds the leap seconds to the UTC time, as reported by the operating system, when necessary.

This option can be useful to disable the addition of leap seconds in the presence of some non-conformant external equipment which ignore leap seconds.

Currently, this option applies to SCTE 35 **splice_schedule()** commands only.

This option can also be set from the TSDuck user's configuration file using option **leap.seconds** (see appendix A.2).

--isdb

Assume that the transport stream is an ISDB one.

ISDB streams are normally automatically detected from their signalization. This option is only useful when ISDB-related stuff is found in the TS before the first ISDB-specific table.

--japan

A synonym for **--isdb --time-reference JST**.

This is a handy shortcut when working on Japanese transport streams.

Beyond ISDB standard, in most applications this option also uses ARIB STD-B24 character sets, uses Japan as default region name for UHF/VHF bands and activates some specificities for Japan such as different semantics for component types.

--philippines

A synonym for **--isdb --abnt --time-reference UTC+8**.

This is a handy shortcut when working on Philippines transport streams.

--time-reference *name*

Use a non-standard (non-UTC) time reference in DVB-defined TDT/TOT.

This is typically used in ARIB-defined ISDB and ABNT-defined ISDB-Tb standards. These standards reuse DVB-defined SI but change the semantics of the date and time fields, using another time reference.

The specified name can be either **UTC** (the DVB-defined default), **JST** (Japan Standard Time) or '**UTC+|-***hh*[**:***mm*]'.

Examples: **UTC+9** (same as **JST**, for ARIB-defined ISDB), **UTC-3** (for ABNT-defined ISDB-Tb in Brazil and South America) or **UTC+2:30** (if such reference should be used).

--usa

A synonym for **--atsc --hf-band-region usa**.

This is a handy shortcut when working on North American transport streams.

2.5 Character sets

2.5.1 Standards and character sets

Each standard defines its own way of representing characters in tables and descriptors.

DVB: Each string is encoded using one single character set. The default character set is a modified version of ISO-6937. For strings which cannot be encoded using ISO-6937, another character set can be selected using a specific leading binary sequence. Since DVB character sets include UTF-8 and UTF-16, all Unicode characters can be eventually represented. See [5], ETSI EN 300 468, annex A.

ISDB (ARIB): Each string is encoded using ARIB STD-B24 (see [30] part 2, chapter 7). A string may alternate between several character sets, typically Kanji, Hiragana, Katakana and alpha-numerical characters. The switching between character sets is performed using control binary sequences. While all Japanese characters can be encoded, many European accented character cannot be represented. There is no way to encode arbitrary Unicode character in ARIB STD-B24.

ISDB (ABNT): There is no standard ABNT-defined representation of strings. Each country which adopted the ABNT-defined variant of ISDB uses its own representation. For instance, Brazil and other South American countries use ISO-8859-15 while the Philippines use UTF-8. To make things worse, although these character sets are included in the DVB standard, these countries do not use the DVB-defined leading binary sequences which indicate the character set and do not allow switching to other character sets.

ATSC: Simple strings are encoded in 7-bit ASCII. But most strings are encoded using "*multiple string structures*" where all Unicode characters can be represented.

XML: TSDuck-defined XML files use some predefined non-ambiguous character set as indicated in the first directive. This is usually UTF-8. All XML strings are encoded in the same character set. It is the responsibility of TSDuck to convert them in the appropriate character set when serializing tables and descriptors.

With ATSC multiple string structures, there is no ambiguity. They are part of the ATCS tables and descriptors definition and are always encoded using the same standard.

With DVB and ISDB, there are several types of ambiguities:

- The ISDB signalization reuses some DVB-defined tables and descriptors, but texts are represented with a non-DVB character encoding. When analyzing or creating such structures, the context (DVB vs. ISDB) must be known to select the appropriate encoding method.

- Invalid DVB encoding: According to [5], the default DVB character set (without explicit character table code) is ISO-6937. However, some bogus signalization may assume that the default character set is different, typically the usual local character table for the region of the operator. The non-standard default character table must be specified using an option.

2.5.2 TSDuck options for character sets

TSDuck commands and plugins which manipulate tables and descriptors have specialized options to indicate the character set to use.

By default, the standard DVB text encoding is used in DVB and ISDB structures.

The following options can be used to alter the behavior of TSDuck. They are briefly repeated in the documentation of all commands to which they apply.

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**.
>
> All strings are interpreted and generated as ISO-8859-15 without explicit leading table code.
>
> This is a handy shortcut when working on South American ISDB-Tb transport streams.

--default-charset *name*

> When reading binary sections, this option specifies the default character set to use when interpreting strings from tables and descriptors, when there is no initial DVB sequence for character table selection. This overrides the DVB defaults and should be used with invalid streams which omit the initial DVB sequence for character table selection when using a non-default character set.
>
> By default, standard DVB encoding is used.
>
> When generating binary sections (from XML or JSON files for instance), this option specifies the preferred character encoding. The DVB rules are applied : when a non-default DVB character set is selected, the appropriate initial DVB sequence for character table selection is inserted.
>
> By default, TSDuck tries several character sets until one is capable of encoding the string. The order of selection is ISO 6937 (DVB default character set), ISO 8859-15 (convenient with most European languages) and UTF-8. Since UTF-8 can encode everything, the string will always be successfully encoded.
>
> See section 2.5.3 below for a list of available character set names.

--europe

> A synonym for **--default-charset ISO-8859-15**.
>
> Using this option, all DVB strings without explicit leading table code are assumed to use ISO-8859-15 instead of the standard ISO-6937 encoding.
>
> This is a handy shortcut for commonly incorrect DVB signalization on some European satellites. In that signalization, the default character encoding (without leading table code) is ISO-8859-15, the most common encoding for Latin & Western Europe languages. When an explicit leading table code is present, then the corresponding character set is used.

--japan

> A synonym for **--default-charset ARIB-STD-B24**.
>
> This is a handy shortcut when working on Japanese transport streams.
>
> Beyond character sets, in most applications, this option also declares ISDB as default standard, use Japan as default region name for UHF/VHF bands and activates some specificities for Japan such as the use of JST time instead of UTC or different semantics for component types.

--philippines

> A synonym for **--default-charset RAW-UTF-8**.
>
> All strings are interpreted and generated as UTF-8 without explicit leading table code.
>
> This is a handy shortcut when working on Philippines transport streams.

2.5.3 Character set names

The available table names for option **--default-charset** are:

* DVB character sets. The name specifies a standard DVB encoding with a different default character set. Without leading table code, the specified character set is used. But if a leading table code is present, the appropriate character set for that table code is used.

> **ISO-6937**
> **DVB** (synonym for **ISO-6937**)

ISO-8859-1
ISO-8859-2
ISO-8859-3
ISO-8859-4
ISO-8859-5
ISO-8859-6
ISO-8859-7
ISO-8859-8
ISO-8859-9
ISO-8859-10
ISO-8859-11
ISO-8859-13
ISO-8859-14
ISO-8859-15
UTF-8
UNICODE (in fact UTF-16)

- ARIB character sets (Japan):

  ARIB-STD-B24
  ARIB (synonym for ARIB-STD-B24)

- Raw character sets. They use the same encoding as their DVB-defined counterpart but without any leading table code. No leading code is interpreted, the specified case is unconditionally used. Using these character sets shall be reserved to specific situations.

  RAW-ISO-6937
  RAW-ISO-8859-1
  RAW-ISO-8859-2
  RAW-ISO-8859-3
  RAW-ISO-8859-4
  RAW-ISO-8859-5
  RAW-ISO-8859-6
  RAW-ISO-8859-7
  RAW-ISO-8859-8
  RAW-ISO-8859-9
  RAW-ISO-8859-10
  RAW-ISO-8859-11
  RAW-ISO-8859-13
  RAW-ISO-8859-14
  RAW-ISO-8859-15
  RAW-UTF-8
  RAW-UNICODE (in fact UTF-16)

- Debug character set.

  DUMP

The **DUMP** character set can be used for debugging. This is not a real character set in the sense that it does not return a Unicode string from a binary representation.

With this character set, *decoding* binary data returns a string containing a hexadecimal dump of the binary data. It is typically used with **tstables** or **tstabdump** to display the exact binary content of strings in tables and descriptors.

Similarly, *encoding* a string means translating the hexadecimal characters which are contained in that string into binary data. The input string shall contain only hexadecimal digits and spaces. This character set is typically used in XML files to force specific binary contents in text areas of tables and descriptors.

2.6 XML files

2.6.1 Usage of XML files by TSDuck

XML files are used as configuration and data files. They are used as input and output by TSDuck.

All TSDuck XML files use **<tsduck>** as root node. They shall be encoded in UTF-8 format. The initial declaration line "**<?xml version="1.0" encoding="UTF-8"?>**" is optional but recommended.

For TSDuck users, XML files are mostly used to represent PSI/SI tables. This format can be used anywhere tables are used, either on input or output. See section 2.3.2 and Appendix D, page 500.

XML files are also used as *channel files* containing lists of TV channels and the tuning characteristics of their respective transport streams. Channel files can be created and updated using the command **tsscan**. They can be used with the **dvb** input plugin as "tune to the transport stream of channel ABC, wherever it is". The format of channel files is documented in Appendix B, page 494.

Finally, XML files are used as configuration files (read-only). They describe the characteristics of UHF and VHF frequency bands by region (**tsduck.hfbands.xml**, see appendix A.4), the technical specifications of various models of LNB's for satellite dishes (**tsduck.lnbs.xml**, see appendix A.3) or resource monitoring configurations (**tsduck.monitor.xml**, see Appendix B). These configuration files are augmented when new information is available. Do not hesitate to request enhancement of these files through the TSDuck issue tracker (see [52]).

2.6.2 Inline XML content

In most TSDuck commands, if the name of an input XML file starts with "**<?xml**", it is considered as *inline XML content*, meaning that the string in the command line is directly the XML content and not a file name.

A similar mechanism exists for output XML files. When an application such as **tsp** runs for a long time, possibly forever, other applications may want to grab XML output files are soon as they are created. In that case, it is possible to output the whole content of an output XML file as one single line through the message logger (the standard error device by default). If another application filters the **tsp** standard error, it will get each XML file as one single text line. To facilitate the filtering of actual XML lines, it is possible to specify a *marker prefix* in the line, typically some easily recognizable pattern. See the description of the option **--log-xml-line** in the command **tstables** and the plugin **tables**.

The output of XML files as one single line is also extremely useful for third party applications which use TSDuck as a library. The C++, Java or Python class named **TSProcessor** is the equivalent of **tsp** inside an application. The log messages which are produced by this class can be processed by user-defined classes. These user-defined classes can then filter and process XML outputs as soon as they are produced. Java and Python examples of this features are provided with the TSDuck source code.

2.6.3 XML model files

For each type of XML file, TSDuck uses a "model file" which describes the expected XML structure of the corresponding data or configuration file. XML model files use the extension **.model.xml**.

This XML model mechanism can be considered as a minimalist equivalent of XML-Schema, with less features but much more light-weight.

In a model file, all allowed nodes and attributes are present as template. The contents of attributes in this template are comments describing the expected content of the corresponding attribute in real XML files. The values of these attributes in the template are descriptive only; they would be invalid if directly used in input XML files for TSDuck.

Notes on types and formats:

- Tags and attributes are not case-sensitive.

- Integer values can be represented in decimal or hexadecimal (**0x** prefix).

- Booleans are **true** or **false**.

- When an attribute or text node is described as *hexadecimal content*, it must contain an even number of hexadecimal digits. All forms of spaces, including line breaks, are ignored.

- Attributes values for date, time and date/time are represented as "YYYY-MM-DD", "hh:mm:ss" and "YYYY-MM-DD hh:mm:ss" respectively. On output, these attributes values are exactly formatted as indicated. In input, to accommodate various conventions, all non-digit characters are considered as valid separators. Therefore, an ISO 8601 date such as "2020-12-01T15:10:21Z" is accepted and interpreted as "2020-12-01 15:10:21".

- Some attributes accept symbols in addition to plain numerical values. The names of accepted symbols are listed in the attribute. Example:

      type="ATSC|DVB-C|DVB-S|DVB-T|ISDB-T"

The command **tsxml** can be used to test to conformance of XML files to a specific model.

All XML configuration and model files are located in the global TSDuck configuration directory:

- Linux : **/usr/share/tsduck**
- macOS : **/usr/local/share/tsduck** (Intel) or **/opt/homebrew/share/tsduck** (Arm)
- Windows : **%TSDUCK%\bin**
- BSD : **/usr/local/share/tsduck** or **/usr/pkg/share/tsduck** (NetBSD)

2.6.4 XML patch files

An XML patch file is a template for transformations to apply on XML files. It is typically used to apply on-the-fly transformations on various PSI/SI tables by plugins such as **pat**, **pmt**, **bat**, **cat**, **sdt**, **nit** when the requested transformations cannot be handled by other options.

This XML patching mechanism can be considered as a minimalist equivalent of XSLT, with less features but much more light weight.

The command **tsxml** can be used to test XML patch files on any arbitrary XML file.

2.6.4.1 Structure matching

A patch file is also an XML file. Its structure mimics the structure of XML input files. This is a template which is compared with the input file.

More precisely, each XML element in the patch file (including its parent hierarchy) is compared with equivalent structures in the input file. To have a match, the node name and all parent node names must be identical and all attributes which are specified in the node in the patch file must be present and have the same value in the input file.

It is also possible to match a node according to an attribute having a value different from the specified one (see below).

As an example, consider the following input XML file:

```
<tsduck>
  <PAT transport_stream_id="1">
    <service service_id="10" program_map_PID="300"/>  <!-- [1] -->
  </PAT>
  <PAT transport_stream_id="2">
    <service service_id="10" program_map_PID="400"/>  <!-- [2] -->
    <service service_id="20" program_map_PID="500"/>  <!-- [3] -->
  </PAT>
```

```
    </tsduck>
```

Using the following patch file, the **<service>** entry matches [1], [2] and [3].

```
<tsduck>
  <PAT>
    <service>
  </PAT>
</tsduck>
```

With the following patch file, the **<service>** entry matches [1] and [2] because of the **service_id** attribute:

```
<tsduck>
  <PAT>
    <service service_id="10"/>
  </PAT>
</tsduck>
```

The next patch file matches only [2] because of the combination of a **<PAT>** with **transport_stream_id** 2 and **<service>** with **service_id** 10.

```
<tsduck>
  <PAT transport_stream_id="2">
    <service service_id="10"/>
  </PAT>
</tsduck>
```

The next example illustrates how to match an attribute having any value except the specified one. In a patch file, when an attribute value starts with a "**!**", the structure matches any node where the specified attribute has a different value (or the attribute is not present).

Thus, the following patch file matches [1] and [3].

```
<tsduck>
  <PAT transport_stream_id="1">
    <service program_map_PID="!400"/>
  </PAT>
</tsduck>
```

Note: It could have been tempting to use the operator "**!=**", the syntax **program_map_PID!="400"** instead of **="!400"**. However, **!="400"** is not a valid XML syntax.

2.6.4.2 Attribute patching

Once a match is found for a given XML element, it is possible to alter the value of the attributes of this matching element using special attributes starting with "**x-**".

The name of these special attributes has the form "**x-command-name**". The **name** part is the name of an attribute to alter in the element. The possible special attributes are:

- **x-add-name="value"**
  Add the attribute **name** with the specified value in the matching element. If the attribute already existed, it is replaced.
- **x-update-name="value"**
  Update the attribute **name** with the specified value in the matching element, only if the attribute already existed.
- **x-delete-name=""**
  Delete the attribute **name** in the matching element.

2.6.4.3 Element patching

Similarly, the special attribute **x-node** is used to add or delete an entire XML element.

- **x-node="delete"**
  The matching node is completely removed.
- **x-node="delete(X)"**
  The next parent with name **X** above the matching node is completely removed.
- **x-node="add"**
  In this case, the matching node is the parent one. The inner node with attribute **x-node="add"** is added in the matching node (without the special attributes, of course).

2.6.4.4 Examples

Complete examples are available in section 5.1.8.

Smaller examples are shown in the patch file below:

```
<tsduck>

  <PAT>
    <service service_id="10" x-add-program_map_PID="1000"/>       <!-- [1] -->
    <service service_id="20" x-delete-program_map_PID=""/>        <!-- [2] -->
    <service service_id="30" x-node="delete"/>                    <!-- [3] -->
    <service>
  </PAT>

  <PAT transport_stream_id="100">
    <service service_id="80" program_map_PID="800" x-node="add"/> <!-- [4] -->
  </PAT>

  <PAT transport_stream_id="200" x-node="delete"/>                <!-- [5] -->

  <EIT>
    <event>
      <parental_rating_descriptor>
        <country rating="0x07" x-node="delete(EIT)"/>             <!-- [6] -->
      </parental_rating_descriptor>
    </event>
  </EIT>

</tsduck>
```

In [1], any service with id 10 in any PAT is updated with attribute **program_map_PID="1000"**.

In [2], in any service with id 20 in any PAT, the attribute **program_map_PID** is deleted (this results in an invalid PAT but this is for the demonstation only).

In [3], any service with id 30 in any PAT is deleted.

In [4], in any PAT with **transport_stream_id** 100, a new service is added with **service_id** 80 and **program_map_PID** 800.

In [5], any PAT with **transport_stream_id** 200 is deleted.

In [6], an EIT is deleted when it contains an event which contains a **parental_rating_descriptor** with rating equals to 0x07.

2.7 JSON and "normalized" report formats

TSDuck uses various text formats for report files. They are briefly described here.

2.7.1 "Normalized" reports

The name "normalized report" refers to a predictable text format which can be easily parsed using scripts to automate operations. This is an alternative output format for tools which otherwise produce reports in a human-friendly readable format which is harder to parse and may change in future versions.

Normalized reports are created by the commands **tsanalyze**, **tscmp**, **tsdektec** and the plugin **analyze**. Each command documents its own normalized format. A normalized report is usually requested using the option **--normalized**.

The original idea of normalized reports was a format which could be easily parsed using basic Unix tools such as **grep** and **sed**. See sample usages in sections 5.2.8, 5.2.12, 5.2.13 or 5.2.14.

2.7.2   JSON files

While the previous normalized reports are easy to parse in scripts, they were created in a time where no widely used standard parser-friendly format existed. Nowadays, most standard parsable files use the JSON format.

The open-source tool named **jq** (for JSON Query) is available on all operating systems as a standard package and makes the use of JSON files in scripts even easier than **grep** and **sed** with normalized report files.

All TSDuck tools and plugins which can produce normalized report can also produce JSON reports using the option **--json**.

With the option **--json-line**, the JSON text is output as one single line through the message logger (the standard error device by default). This feature is equivalent to the inline output XML format and can be useful for third party applications. See section 2.6.2 for details and usage examples.

2.7.3   Automated XML-to-JSON conversion

With TSDuck, JSON is used for analysis reports while XML is used to store more complex configuration or data structures such as PSI/SI tables.

An application which needs to analyze the PSI/SI tables which are extracted by some TSDuck command or plugin can simply parse the extracted XML text. Although many tools and libraries exist to parse XML, some developers may prefer to parse JSON rather than XML. In that case, TSDuck provides an automated XML-to-JSON conversion.

2.7.3.1   Conversion rules

There is no standard way to convert XML to JSON. Several tools exist and each of them has its own conversion rules. Because of the differences between XML and JSON, no conversion is perfect, and the result is sometimes not what would have been specified if JSON had been used from the beginning. However, the result is usually good enough for automatic parsing in an application.

The translation rules for the TSDuck automated XML-to-JSON conversion are described below. Note that the default rules can be fine-tuned using an *XML model* for the input document (see 2.6.3) and specific command line options (see 2.7.3.2).

- Each XML element is converted to a JSON object {...}.

- The name of the XML element is an attribute "**#name**" inside the object.

- All attributes of the XML element are directly mapped into attributes in the JSON object.
    - By default, attribute values are converted to JSON strings.
    - If the XML model has a value for this attribute and if this model value starts with "**int**" or "**uint**" (not case sensitive) and the attribute value can be successfully converted to an integer, then the value becomes a JSON number.
    - Similarly, if the XML model value for this attribute starts with "**bool**" and the value can be successfully converted to a boolean, then the value becomes a JSON literal True or False.

- The children nodes inside an element are placed in a JSON array with name "**#nodes**".

- Each XML text node is converted to a JSON string. If the XML model has a value for this text node and if this XML model value starts with "**hexa**" (not case sensitive), then all spaces are collapsed inside the string.

- XML declarations, comments and unknown nodes are dropped.

The introduction of the two artificial attributes "**#name**" and "**#nodes**" was necessary because of the differences between XML and JSON. It could have been tempting to use the XML element name as JSON attribute name and the rest of the XML element (attributes and children nodes inside a JSON object) as JSON attribute value. However, while an XML element may contain several children elements with the same name, a JSON object cannot have several attributes with the same name. Thus, the XML element name had to be pushed inside the JSON element, not as its name, outside of the object.

Sample XML source:

```
<PAT version="12" current="true" transport_stream_id="0x0438" network_PID="0x0010">
  <service service_id="0x2261" program_map_PID="0x0064"/>
  <service service_id="0x2262" program_map_PID="0x00C8"/>
</PAT>
```

Converted JSON:

```
{
  "#name": "PAT",
  "current": true,
  "network_pid": 16,
  "transport_stream_id": 1080,
  "version": 12,
  "#nodes": [
    {
      "#name": "service",
      "program_map_pid": 100,
      "service_id": 8801
    },
    {
      "#name": "service",
      "program_map_pid": 200,
      "service_id": 8802
    }
  ]
}
```

The command **tsxml** can be used to test the JSON conversion of any arbitrary XML file.

2.7.3.2 TSDuck options for automated XML-to-JSON conversion

The following command line options are used in various TSDuck commands and plugins to fine-tune the automated XML-to-JSON conversion.

--x2j-collapse-text

When converting all XML text nodes into JSON strings, remove leading and trailing spaces. Also replace all other sequences of space characters (including line breaks) with one single space.

By default, text nodes are collapsed only when there is an XML model which identifies the text node as containing hexadecimal content.

--x2j-enforce-boolean

When an attribute in an element contains a boolean value (ie. the string "**true**" or "**false**") but there is no XML model file to tell if this is really a boolean, force the creation of a JSON literal **True** or **False**.

By default, when there is no XML model, all element attributes are converted as JSON strings.

--x2j-enforce-integer

When an attribute in an element contains an integer value but there is no XML model file to tell if this is really an integer, force the creation of a JSON number.

By default, when there is no XML model, all element attributes are converted as JSON strings.

--x2j-include-root

Keep the root of the XML document as a JSON object.

By default, the JSON document is made of a JSON array containing all JSON objects resulting from the conversion of all XML elements under the root.

Usually, in an XML file, there is one root element without attributes. The root of all TSDuck XML files is a simple **<tsduck>** element. This single root XML element is required by the XML syntax but usually carries no useful information. This is why it is removed by default in the XML-to-JSON conversion.

--x2j-trim-text

When converting all XML text nodes into JSON strings, remove leading and trailing spaces.

By default, text nodes are trimmed only when there is an XML model which identifies the text node as containing hexadecimal content.

3 Transport Stream Utilities

The transport stream toolkit provides several command-line utilities. The main one is **tsp**, the transport stream processor. The other utilities are small tools which work on transport stream files.

With a few exceptions, the transport stream files are continuous streams of 188-byte TS packets. These files can also be pipes. With the help of the **tsp** and its input and output plugins, the TS packets can be piped from and to various devices and protocols (files, DVB-ASI, DVB-S, DVB-C, DVB-T, multicast IP, etc.)

The Table 3 lists all transport stream utilities:

Table 3: TSDuck utilities

Utility	Description
tsanalyze	Analyze a TS file and display various information about the transport stream and each individual service and PID.
tsbitrate	Evaluate the original bitrate of a TS based on the analysis of the PCR's and the number of packets between them.
tscharset	Test tool for DVB and ARIB character sets.
tscmp	Compare the binary content of two TS files.
tsconfig	Configuration options to build applications (developers only).
tscrc32	Compute MPEG-style CRC32 values.
tsdate	Display the date & time information (TDT & TOT) from a TS file.
tsdektec	Control a Dektec device.
tsdump	Dump the content of a TS file.
tsecmg	DVB SimulCrypt-compliant ECMG stub for system integration and debug.
tseit	Manipulate EIT's using commands and scripts.
tsemmg	DVB SimulCrypt-compliant EMMG stub for system integration and debug.
tsfclean	Cleanup the structure and boundaries of a TS file.
tsfixcc	Fix continuity counters in a TS file.
tsftrunc	Truncate a TS file, removing extraneous bytes (last incomplete TS packet) or truncating after a specified TS packet.
tsfuzz	Introduce random errors in transport stream files.
tsgenecm	Generate one ECM using any DVB SimulCrypt compliant ECMG.
tshides	List HiDes modulator devices.
tslatencymonitor	Monitor latency between two TS input sources.
tslsdvb	List DVB receiver devices.
tsp	General-purpose TS processor: receive a TS from a user-specified input plugin, apply MPEG packet processing through several user-specified packet processor plugins and send the processed stream to a user-specified output plugin.
tspacketize	Packetize PSI/SI tables in a transport stream PID.
tspcap	Analyze pcap and pcap-ng files.
tspcontrol	Send control commands to a running **tsp**.
tspsi	Display the PSI (PAT, CAT, NIT, PMT, SDT) from a TS file.

Utility	Description
tsresync	Resynchronize a captured TS file: locate start of first packet, resynchronize to next packet after holes, convert to 188-byte packets (if captured with 204-byte packets).
tsscan	Scan frequencies in a DVB network.
tssmartcard	List or reset smart-card reader devices.
tsstuff	Add stuffing to a TS file to reach a target bitrate.
tsswitch	Transport stream input source switch using remote control.
tstabcomp	PSI / SI table compiler from / to XML files.
tstabdump	Dump binary table files, as previously saved by **tstables**.
tstables	Collect specified PSI/SI tables from a TS file. Either display them or save them in binary files.
tsterinfo	Compute or retrieve various DVB-T (terrestrial) information.
tstestecmg	Test a DVB SimulCrypt compliant ECMG with an artificial load.
tsvatek	List VATek-based modulator devices.
tsversion	Check version, download and upgrade TSDuck.
tsxml	Test tool for TSDuck XML files manipulation.

3.1 Command line syntax

3.1.1 Command line options

All utilities are simple command-line tools. They accept "options" and "parameters". The syntax of options follows the GNU **getopt_long(3)** conventions. See the corresponding Linux manual page for details.

In short, this means that all options have a "long name" preceded by a double dash and optionally a "short name" (one dash, one letter). Long options can be abbreviated if there is no ambiguity.

Although this syntax is inspired by Linux and the GNU utilities, the same syntax is used on Windows.

As an example, consider a utility which accepts the two options **--verbose** (short name **–v**) and **--version** (no short name). Then, the verbose mode can be equally triggered by **–v**, **--verbose**, **--verb** but not **--ver** since there is an ambiguity with **--version**.

3.1.2 Integer values in command line options

When an option or parameter is documented to require an integer value (PID, identifier, etc.), this value can be uniformly specified in decimal or hexadecimal format with the **0x** prefix.

In decimal values, the commas which are used as separators for groups of thousands are ignored. Since most commands display large values with separators in order to improve the readability, these values can be simply copied / pasted in subsequent command lines.

Example: The following options are equivalent:

```
--count 3,100,456
--count 3100456
```

When the same option is allowed to be specified several times in one command, it is possible to use ranges of integer values (two values, separated with a dash) instead of specifying all values individually.

Example: The following sets of options are equivalent:

```
--pid 0 --pid 0x20 --pid 0x21 --pid 0x22 --pid 0x23 --pid 0x24 --pid 0x25 --pid 0x40
--pid 0 --pid 0x20-0x25 --pid 0x40
```

3.1.3   Predefined common options

All commands accept the following common options:

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N*. Do not use this option in normal operation.

Without this option, no debug output is produced. When the option is specified but not the level *N*, the default debug level is 1, that is to say a reasonable amount of information. The higher the debug level is, the more output is produced.

The amount of debug information depends on the command. Some commands do not generate any debug information.

--help

The option displays the syntax of the command and exits.

If either the standard output or the standard error is a terminal, the help text is "paged" through a system utility such as **less** or **more**, whichever is available. The environment variable **PAGER** can be used to specify an alternate pager command with its parameters (see 3.1.4).

To redirect the help text to a file, you must redirect both the standard output and standard error. Otherwise, since at least one of the two is a terminal, the pager will be used. Example:

```
tsp --help &>help.txt
```

All **tsp** plugins also accept the option**--help** which provides help on this specific plugin.

--verbose

Display verbose information.

--version[=*name*]

The option displays the TSDuck version and exits.

The optional *name* indicates which type or format of version to display. The default is **long**. Other values are described in the table below.

Table 4: Values for option --version

Name	Description
acceleration	Availability of accelerated instructions for CRC32, AES, etc.
all	All information.
bitrate	Representation of bitrate values in computations. Using compilation options, bitrates can be represented as fixed-point values, floating-point values, integer values or integer fractions. See section 2.2 for more details.
compiler	Compiler name and version.
crypto	Version of the cryptographic library.
date	Build date.
dektec	Version of the Dektec drivers and DTAPI library.
http	Version of the HTTP/HTTPS library.
integer	TSDuck version as one integer value which can be used in scripts to test against minimum required versions. Example: "**32802466**".

Name	Description
long	TSDuck version in long string format. This is the default.
nsis	TSDuck version in NSIS directive format (legacy, no longer used).
rist	Version of the RIST library.
short	TSDuck version is short format. Example: "**3.28-2466**".
srt	Version of the SRT library.
system	Description of the running system.
vatek	Version of the VATek library (for VATek-based modulators).

Example:

```
$ tsp --version=all
tsp: TSDuck - The MPEG Transport Stream Toolkit - version 3.28-2466
Built Aug 10 2021 - 23:09:27
Using GCC 10.3.0, C++ std 2011.03
System: Ubuntu (Ubuntu 21.04), on Intel x86-64, 64-bit, little-endian, page size:
4096 bytes
Bitrate: 64-bit fixed-point with 1 decimals
Web library: libcurl: 7.74.0, ssl: OpenSSL/1.1.1j, libz: 1.2.11
SRT library: libsrt version 1.4.2
Dektec: DTAPI: 5.45.0.172
```

3.1.4 Using a pager command

Some commands which produce a very verbose output are automatically redirected to a "pager" command such as **less** or **more**, whichever is available. The redirection is performed only when the standard output is a terminal.

The environment variable **PAGER** can be used to specify an alternate pager command with its parameters.

These commands always define the **--no-pager** option to disable the redirection even when the standard output is a terminal.

3.1.5 Partial command line redirection from a file

In any command, it is possible to read some or all options and parameter from a file. The syntax is "**@filename**" where **filename** is a text file containing options and parameters.

In the text file, each line must contain exactly one item (option name, option value or parameter).

Sample command:

```
tsp -v @dvb.txt -P until --seconds 20 -P analyze -o out.txt -O drop
```

The file **dvb.txt** contains a list of command line items, one per line. The content of the file **dvb.txt** exactly replaces the expression "**@dvb.txt**".

Sample content of this file:

```
-I
dvb
--frequency
12,169,000,000
--symbol-rate
27,500,000
--fec-inner
3/4
--polarity
horizontal
```

```
--delivery-system
DVB-S2
--modulation
8-PSK
```

Note that each line contains exactly one command line item. Spaces or special characters are not filtered or interpreted. Using that kind of command can be useful in several situations:

- When a custom application generates long and complicated TSDuck commands.

- When the options or parameters contain special characters, spaces or any other sequence which must be properly escaped with some shells, possibly differently between shells or operating systems.

Command line parameter redirections can be nested. When one line of such a text file contains a pattern "**@filename**", the second file is inserted here.

Finally, if a parameter really starts with a **@** character (which can be possible in a service or device name for instance), use a double **@@** to indicate that this is a literal **@** character and not a redirection.

Consider the following command:

```
tsp -v @dvb.txt -P zap @@home -O drop
```

This command reads parameters from the file **dvb.txt** to find the tuning options and extracts the service named "**@home**" (with one **@**). The double **@** has been used to indicate that this is a literal **@**.

And since redirections can be nested, the initial **@@** escape sequence can also be used inside text files containing parameters.

3.1.6   Default options from the TSDuck configuration file

It is possible to specify default command line options or alternate options in a global configuration file. This configuration file is specific per user. See Appendix A, page 490, for a complete reference of the TSDuck configuration file.

The rest of this chapter documents all TSDuck utilities, in alphabetical order.

3.1.7   Bash command line completion

For bash users, when the **bash-completion** package is installed, specific completion scripts are added for TSDuck. Plugin names, command and plugin options, predefined enumeration values for options are automatically completed.

On Linux, the completions are automatically defined.

On macOS with Homebrew, there is no TSDuck-specific setup but the Homebrew-defined bash completions, as a whole, must have been previously enabled: add the following line to you **.bashrc** file:

```
[[ -e $(brew --prefix)/etc/profile.d/bash_completion.sh ]] && \
    source $(brew --prefix)/etc/profile.d/bash_completion.sh
```

On Windows with Cygwin or Msys, add the following TSDuck-specific line to your **.bashrc** file:

```
source "$TSDUCK/setup/tsduck-completion.bash"
```

⚏ tsanalyze

Transport stream analysis

This utility analyzes a transport stream. It reports either a full analysis of the transport stream, services and PID's (either in human readable format or normalized format for automatic analysis) or selected individual information.

The output can include full synthetic analysis (options **--*-analysis**), full normalized output (options **--normalized** and **--json**) or a simple list of values on one line (options **--*-list**). The second and third type of options are useful to write automated scripts.

If output control options are specified, only the selected outputs are produced. If no such option is given, the default is:

```
--ts-analysis --service-analysis --pid-analysis --table-analysis
```

See also the **analyze** plugin for tsp for the equivalent tool in the context of tsp.

Usage

```
tsanalyze [options] [input-file]
```

Input file

MPEG transport stream, either a capture file or a pipe from a live stream (see option **--format** for binary formats).

If the parameter is omitted, is an empty string or a dash ("**-**"), the standard input is used.

General purpose options

-b *value*
--bitrate *value*

> Specifies the bitrate of the transport stream in bits/second (based on 188-byte packets). By default, the bitrate is evaluated using the PCR in the transport stream. If no bitrate can be determined (no user-specified value, no PCR), the analysis will not report the bitrates of the individual services and PID's.

> See section 2.2 for more details on the representation of bitrates.

--format *name*

> Specify the format of the input file. See section 2.1.2 for more details.

--no-pager

> Do not send output through a pager process. By default, if the output device is a terminal, the output is paged. See 3.1.4 for more details.

Analysis control options

--abnt

> Assume that the transport stream is an ISDB one with ABNT-defined variants. See section 2.4.2 for more details.

--atsc

> Assume that the transport stream is an ATSC one. See section 2.4.2 for more details.

--brazil

> A synonym for **--isdb --abnt --default-charset RAW-ISO-8859-15 --time-reference UTC-3**. See sections 2.4.2 and 2.5.2 for more details.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors.

By default, standard DVB encoding is used. See section 2.5 for more details.

--default-pds *value*

Default DVB-defined private data specifier (PDS). See section 2.4.2 for more details.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--ignore-leap-seconds

Do not explicitly include leap seconds in some UTC computations. See 2.4.2 for more details.2.4.2

--isdb

Assume that the transport stream is an ISDB one. See section 2.4.2 for more details.

--japan

A synonym for **--isdb --time-reference JST --default-charset ARIB-STD-B24**.

See sections 2.4.2 and 2.5.2 for more details.

--philippines

A synonym for **--isdb --abnt --default-charset RAW-UTF-8 --time-reference UTC+8**.

See sections 2.4.2 and 2.5.2 for more details.

--suspect-max-consecutive *value*

Specifies the maximum number of consecutive *suspect* packets. The default value is 1. If set to zero, the suspect packet detection is disabled.

Suspect packets are TS packets which are technically correct but which may be suspected of being incorrect, resulting in analysis errors. Typically, in the middle of a suite of packets with un-correctable binary errors, one packet may appear to have no such error while it has some errors in fact. To avoid adding this type of packets in the analysis, a packet is declared as *suspect* (and consequently ignored in the analysis) when:

- its PID is unknown (no other packet was found in this PID)
- it immediately follows a certain amount of packet containing errors (see option **--suspect-min-error-count**)
- it immediately follows no more than the specified number consecutive suspect packets.

--suspect-min-error-count *value*

Specifies the minimum number of consecutive packets with errors before starting "suspect" packet detection. See also option **--suspect-max-consecutive**. The default value is 1. If set to zero, the suspect packet detection is disabled.

--time-reference *name*

Use a non-standard time reference in DVB or ISDB-defined SI. See section 2.4.2 for more details.

--usa

A synonym for **--atsc**. See section 2.4.2 for more details.

Output control options

--deterministic

Enforce a deterministic and reproduceable output. Do not output non-reproduceable information such as system time (useful for automated tests).

--error-analysis

Report analysis about detected errors.

--global-pid-list

Report the list of all global PID's, that is to say PID's which are not referenced by a specific service but are standard DVB PSI/SI PID's or are referenced by them. This include, for instance, PID's of the PAT, EMM's, EIT's, stuffing, etc.

--json

Complete report about the transport stream, services, PID's and tables in JSON output format.

This type of output is useful for automatic analysis in scripts. See an example in section 5.2.29.

--json-buffer-size *value*

With **--json-tcp** or **--json-udp**, specify the network socket send buffer size.

--json-line[='*prefix*']

Same as **--json** but report the JSON text as one single line in the message logger instead of fully formatted output file.

The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--json-tcp *address:port*

Same as **--json** but report the JSON text as one single line in a TCP connection instead of the output file.

The *address* specifies an IP address or a host name that translates to an IP address. The *port* specifies the destination TCP port.

By default, a new TCP connection is established each time a JSON message is produced (see also option **--json-tcp-keep**). Be aware that a complete TCP connection cycle may introduce some latency in the processing. If latency is an issue, consider using **--json-udp**.

--json-tcp-keep

With --json-tcp, keep the TCP connection open for all JSON messages. By default, a new TCP connection is established each time a JSON message is produced.

--json-udp *address:port*

Same as **--json** but report the JSON text as one single line in a UDP datagram instead of the output file.

The *address* specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The *port* specifies the destination UDP port.

Be aware that the size of UDP datagrams is limited by design to 64 kB. If larger JSON contents are expected, consider using **--json-tcp**.

--json-udp-local *address*

With **--json-udp**, when the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--json-udp-ttl *value*

With **--json-udp**, specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address. Remember that the default Multicast TTL is 1 on most systems.

--normalized

Complete report about the transport stream, services, PID's and tables in a normalized output format (see details below). This type of output is useful for automatic analysis in scripts.

--pes-pid-list

> Report the list of all PID's which are declared as carrying PES packets (audio, video, subtitles, etc).

--pid-analysis

> Report analysis for each PID.

--pid-list

> Report the list of all PID's.

--prefix *string*

> For one-line displays (options **--*-list**), prepend the specified string to all values. For instance, options **--global --prefix -p** outputs something like '**-p 0 -p 1 -p 16**', which is an acceptable option list for the **tsp filter** plugin.

--service-analysis

> Report analysis for each service.

--service-list

> Report the list of all service ids.

--service-pid-list *value*

> Report the list of all PID's which are referenced by the specified service id.

--table-analysis

> Report analysis for each table.

--title *string*

> Display the specified string as title header.

--ts-analysis

> Report global transport stream analysis.

--unreferenced-pid-list

> Report the list of all unreferenced PID's, that is to say PID's which are neither referenced by a service nor known as or referenced by the standard DVB PSI/SI.

-w
--wide-display

> Use a wider grid display with more information on each line.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=_N_**]**

> Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

> Display command help text.

--verbose

> Produce verbose messages.

--version

> Display the version number.

Normalized output format

In normalized output, each line describes one *object* (service, PID, table, etc). The format of each line is:

```
type:name[=value]:...
```

The *type* identifies the kind of object which is described by the line. The *name* identifies a characteristics for the object with an optional *value*. There is no space characters. All integer values are in decimal format.

The normalized syntax can be used to search for specific objects with specific characteristics. It is specially designed to extract values using standard UNIX tools such as **sed** and **grep**.

Example: The following sample command extracts the list of EMM PID's for the SafeAccess CAS. The object *type* is **pid** (at beginning of line) and the two selected characteristics are **emm** (no value) and **cas** with SafeAccess DVB-assigned CA_system_id value (**0x4ADC**, which is **19164** in decimal).

```
tsanalyze --normalize ... | \
grep '^pid:' | grep ':emm:' | grep ':cas=19164:' | \
sed -e 's/.*:pid=//' -e 's/:.*//'
```

Other more complex examples of automated scripts are available in chapter 5.

Obsolescence: Note that this format was designed in the early times of TSDuck. Nowadays, more modern formats such as JSON are more appropriate. The option **--json** can be used instead of **--normalized** to produce a JSON report. Such as output is easily manipulated and explored using the open source tool **jq**.

Normalized object types

The list of types, at beginning of lines, is the following:

`ts:`	Global transport stream description. There is always one single `ts` line.
`global:`	Summary of global PID's, ie. not attached to a specific service. There is always one single `global` line.
`unreferenced:`	Summary of unreferenced PID's, ie. neither global nor attached to a specific service. There is always one single `unreferenced` line.
`service:`	Description of one service. There is one `service` line per service.
`pid:`	Description of one PID. There is one `pid` line per PID.
`table:`	Description of one table on one PID. There is one `table` line per unique table per PID.
`time:`	Time description, either from the TDT/TOT tables or from the running system.

Normalized transport stream characteristics

The characteristics in **ts:** lines are:

`:id=int:`	Optional. Transport stream id, when found.
`:packets=int:`	Total number of TS packets.
`:bytes=int:`	Total number of bytes.
`:services=int:`	Number of services.
`:clearservices=int:`	Number of clear (not scrambled) services.
`:scrambledservices=int:`	Number of scrambled services.
`:pids=int:`	Number of PID's.
`:clearpids=int:`	Number of clear (not scrambled) PID's.
`:scrambledpids=int:`	Number of scrambled PID's.

`:pcrpids=int:`	Number of PID's with PCR's.
`:unreferencedpids=int:`	Number of unreferenced PID's.
`:invalidsyncs=int:`	Number of TS packets with invalid synchronization byte.
`:transporterrors=int`	Number of TS packets with *transport error indicator*.
`:suspectignored=int`	Number of suspect TS packets which were ignored in the analysis.
`:bitrate=int:`	Best value for transport stream bitrate in b/s.
`:bitrate204=int:`	Same as previous, based on 204-byte packets.
`:userbitrate=int:`	User-specified value for transport stream bitrate in b/s. Zero if none. When used within *tsp* plugin, the user-specified bitrate comes from previous plugins in the chain.
`:userbitrate204=int:`	Same as previous, based on 204-byte packets.
`:pcrbitrate=int:`	Estimated transport stream bitrate in b/s, based on PCR analysis. Zero if unable to analyze PCR (no or not enough PCR, too many discountinuities, etc.)
`:pcrbitrate204=int:`	Same as previous, based on 204-byte packets.
`:duration=int:`	Duration of transmission in seconds, based on TS bitrate.
`:country=name:`	Optional. First region name in TOT.

Normalized global and unreferenced PID's summary characteristics

The characteristics in **global:** and **unreferenced:** lines are:

`:pids=int:`	Total number of global or unreferenced PID's.
`:clearpids=int:`	Number of clear (not scrambled) global or unreferenced PID's.
`:scrambledpids=int:`	Number of scrambled global or unreferenced PID's.
`:packets=int:`	Total number of TS packets in global or unreferenced PID's.
`:bitrate=int:`	Total bitrate of global or unreferenced PID's.
`:bitrate204=int:`	Same as previous, based on 204-byte packets.
`:access=type:`	Value is `scrambled` if there is at least one scrambled PID in the category and `clear` otherwise.
`:pidlist=int,int,...:`	List of global or unreferenced PID's.

Normalized service characteristics

The characteristics in **service:** lines are:

`:id=int:`	Service id.
`:tsid=int:`	Optional. Transport stream id, when found.
`:orignetwid=int:`	Optional. Original network id, when found.
`:lcn=int:`	Optional. Logical channel number, when found.
`:servtype=int:`	Service type.
`:access=type:`	Value is `scrambled` if there is at least one scrambled PID in the service and `clear` otherwise.
`:pids=int:`	Number of PID's in the service. Note that ECM PID's are also included.
`:clearpids=int:`	Number of clear (not scrambled) PID's in the service.
`:scrambledpids=int:`	Number of scrambled PID's in the service.
`:packets=int:`	Total number of TS packets in the service.

`:bitrate=int:`	Total bitrate of the service in b/s.
`:bitrate204=int:`	Same as previous, based on 204-byte packets.
`:hidden:`	Optional. Indicate that the service is hidden from end-user.
`:ssu:`	Optional. Indicate that the service carries a System Software Update PID.
`:t2mi:`	Optional. Indicate that the service carries a T2-MI (DVB-T2 Modulator Interface) PID.
`:pmtpid=int:`	Optional. PID of the service's PMT.
`:pcrpid=int:`	Optional. PCR PID of the service, as declared in the PMT.
`:pidlist=int,int,...:`	List of PID's in the service.
`:provider=name:`	Service provider name.
`:name=name`	Service name. Note that this is always the last item in the line. The value is not terminated by a colon (':'). So, if a colon is present, it is part of the service name.

Normalized PID characteristics

The characteristics in **pid:** lines are:

`:pid=int:`	PID number.
`:pmt:`	Optional. Indicate that this is a PMT PID.
`:ecm:`	Optional. Indicate that this is an ECM PID.
`:emm:`	Optional. Indicate that this is an EMM PID.
`:cas=int:`	Optional. Related **CA_system_id** for ECM or EMM PID's.
`:operator=int:`	Optional. Related CA system operator id, when applicable, for ECM or EMM PID's.
`:access=type:`	Value is `scrambled` if there is at least one scrambled packet in the PID and `clear` otherwise.
`:cryptoperiod=int:`	Optional. Average crypto-period duration in seconds for scrambled PID's, when it can be evaluated.
`:streamid=int:`	Optional. PES **stream_id** in PES packet headers when the PID carries PES packets and all PES packets have the same **stream_id**.
`:audio:`	Optional. Indicate that this is an audio PID.
`:video:`	Optional. Indicate that this is a video PID.
`:language=name:`	Optional. Indicate the language for the PID. Can be found on audio or subtitles PID's.
`:servcount=int:`	Number of services which reference this PID.
`:unreferenced:`	Optional. Indicate that this is an unreferenced PID.
`:global:`	Optional. Indicate that this is a global PID.
`:servlist=int,int,...:`	Optional. List of **service_id** which reference this PID.
`:ssuoui=int,int,...:`	Optional. List of manufacturers OUI for System Software Update data PID's.
`:t2mi:`	Optional. Indicate that the PID carries a T2-MI stream.
`:plp=int,int,...:`	Optional. List of T2-MI PLP (Physical Layer Pipe) id.
`:bitrate=int:`	Bitrate for this PID in b/s.

`:bitrate204=`*int*`:`	Same as previous, based on 204-byte packets.
`:packets=`*int*`:`	Total number of TS packets in this PID.
`:clear=`*int*`:`	Number of clear (not scrambled) TS packets in this PID.
`:scrambled=`*int*`:`	Number of scrambled TS packets in this PID.
`:af=`*int*`:`	Number of TS packets with adaptation field in this PID.
`:pcr=`*int*`:`	Number of TS packets with PCR in this PID.
`:discontinuities=`*int*`:`	Number of discontinuities in this PID.
`:duplicated=`*int*`:`	Number of duplicated TS packets in this PID.
`:invalidscrambling=`*int*`:`	Number of TS packets in this PID with invalid scrambling control value.
`:pes=`*int*`:`	Optional. Number of PES packets, for PID's carrying PES.
`:invalidpesprefix=`*int*`:`	Optional. Number of invalid PES prefix, for PID's carrying PES.
`:unitstart=`*int*`:`	Optional. Number of PUSI (*payload unit start indicator*), for PID's not carrying PES.
`:description=`*string*	Human-readable description of this PID. Note that this is always the last item in the line. The value is not terminated by a colon (':'). So, if a colon is present, it is part of the description.

Normalized table and sections characteristics

The characteristics in **table:** lines are:

`:pid=`*int*`:`	PID number on which the table is found.
`:tid=`*int*`:`	Table id.
`:tidext=`*int*`:`	Optional. Table id extension, for long sections only.
`:tables=`*int*`:`	Total number of occurences of the table.
`:sections=`*int*`:`	Total number of sections for this table.
`:repetitionms=`*int*`:`	Optional. Average repetition rate in milliseconds (can be computed only if the transport stream bitrate is known).
`:minrepetitionms=`*int*`:`	Optional. Minimum repetition rate in milliseconds (can be computed only if the transport stream bitrate is known).
`:maxrepetitionms=`*int*`:`	Optional. Maximum repetition rate in milliseconds (can be computed only if the transport stream bitrate is known).
`:repetitionpkt=`*int*`:`	Average repetition rate in TS packets interval.
`:minrepetitionpkt=`*int*`:`	Minimum repetition rate in TS packets interval.
`:maxrepetitionpkt=`*int*`:`	Maximum repetition rate in TS packrets interval.
`:firstversion=`*int*`:`	Optional. Version number of first occurrence of the table. For long sections only.
`:lastversion=`*int*`:`	Optional. Version number of last occurrence of the table. For long sections only.
`:versions=`*int*`,`*int*`,...:`	Optional. List of all version numbers of the table. For long sections only.

Normalized time characteristics

The characteristics in **time:** lines are:

`:utc:`	Optional. The specified time is UTC.

`:local:`	Optional. The specified time is local time.
`:tdt:`	Optional. The specified time is extracted from a TDT.
`:tot:`	Optional. The specified time is extracted from a TOT.
`:system:`	Optional. The specified time is an operating system time, not extracted from the transport stream.
`:first:`	Optional. The specified time is the first one in its category (first TDT or TOT, system time of first packet).
`:last:`	Optional. The specified time is the last one in its category (last TDT or TOT, system time of last packet).
`:date=`*dd*`/`*mm*`/`*yyyy*`:`	Date part of the time, example: "`24/11/2008`".
`:time=`*hh*`h`*mm*`m`*ss*`s:`	Hour, minute and second part of time, example: "`14h12m45s`".
`:secondsince2000=`*int*`:`	Number of seconds since 1st January 2000. Can be used to compute duration, to compare time values, etc.
`:country=`*name*`:`	Optional. First region name in TOT, if the time comes from a TOT.

⊞ **tsbitrate**

Bitrate evaluation from PCR

This utility evaluates the original bitrate of a transport stream based on an analysis of the PCR's (Program Clock Reference timestamps) and the interval between them. This is especially useful for captured files where the transmission bitrate information is lost.

Usage

```
tsbitrate [options] [input-file]
```

Input file

MPEG transport stream, either a capture file or a pipe from a live stream (see option **--format** for binary formats).

If the parameter is omitted, is an empty string or a dash ("**-**"), the standard input is used.

Options

-a
--all

> Analyze all packets in the input file. By default, stop analysis when enough PCR information has been collected.

-d
--dts

> Use DTS (Decoding Time Stamps) from video PID's instead of PCR (Program Clock Reference) from the transport layer.

--format *name*

> Specify the format of the input file. See section 2.1.2 for more details.

-f
--full

> Full analysis. The file is entirely analyzed (as with **--all**) and the final report includes a complete per PID bitrate analysis.

-i
--ignore-errors

> Ignore transport stream errors such as discontinuities.

> When errors are not ignored (the default), the bitrate of the original stream (before corruptions) is evaluated. When errors are ignored, the bitrate of the received stream is evaluated, missing packets being considered as non-existent.

--min-pcr *value*

> Stop analysis when that number of PCR's are read from the required minimum number of PID's (default: stop after 64 PCR's on 1 PID).

--min-pid *value*

> Minimum number of PID to get PCR's from (default: stop after 64 PCR's on 1 PID).

-v
--value-only

> Display only the bitrate value, in bits/seconds, based on 188-byte packets. Useful to reuse the value in command lines.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

--verbose

Produce verbose messages.

--version

Display the version number.

⊞ tscharset

Test tool for DVB and ARIB character sets

This utility performs manual string encoding and decoding using various DVB and ARIB character sets. It can be used to evaluate the validity of conversions.

By default, the converted data is displayed on one line. With the **--verbose** option, more details are displayed such as the string in UTF-8 or UTF-16 format.

Usage

```
tscharset [options]
```

Options

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

-c
--c-style

> Output binary data in C/C++ syntax, using **0x** prefix.

> The result can be easily copied into C/C++ source code.

-d *hexa-digits*
--decode *hexa-digits*

> Decode the specified binary data according to the default character set.

> The encoded data shall be represented as binary digits. Spaces are ignored.

--default-charset *name*

> Specify the character set to use when encoding or decoding strings.

> By default, standard DVB encoding is used. See section 2.5 for more details.

-e "*string*"
--encode "*string*"

> Encode the specified string according to the default character set.

> See also options **--from-utf-8** and **--from-utf-16**.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

-6
--from-utf-16

> With **--encode**, specify that the parameter value is a suite of binary digits representing the string in UTF-16 format. There must be an even number of bytes.

-8
--from-utf-8

> With **--encode**, specify that the parameter value is a suite of binary digits representing the string in UTF-8 format.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5.2 for more details.

-l
--list-charsets

> List all known character set names

-o *file-name*
--output *file-name*

    Output file name. By default, use standard output.

--philippines

    A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

--to-utf-16

    With **--decode**, display an hexadecimal representation of the decoded string in UTF-16 format.

    With **--verbose**, this option is redundant because the string is already displayed in plain form and in UTF-16 representation.

--to-utf-8

    With **--decode**, display an hexadecimal representation of the decoded string in UTF-8 format.

    With **--verbose**, use UTF-8 instead of UTF-16 for the alternate representation of the string.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=N**]**

    Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

    Display command help text.

--verbose

    Produce verbose messages.

--version

    Display the version number.

⚏ tscmp

Transport stream files comparison

This utility compares the binary content of two transport stream files. Selected fields may be omitted in the comparison to allow comparing files which went through different PID remapping or resynchronization process.

Usage

```
tscmp [options] filename-1 filename-2
```

Input files

MPEG transport stream files to be compared (see option **--format** for binary formats).

If a file name is an empty string or a dash ("**-**"), the standard input is used.

Options

--buffered-packets *value*

Specifies the files input buffer size in TS packets. This is used with **--search-reorder** to look for reordered packets. Packets which are not found within that range in the other file are considered missing.

The default is 10,000 TS packets.

-b *value*
--byte-offset *value*

Start reading the files at the specified byte offset.

The default is zero.

--cc-ignore

Ignore continuity counters when comparing packets. Useful if one file has been resynchronized.

-c
--continue

Continue the comparison up to the end of files. By default, stop after the first differing packet.

-d
--dump

Dump the content of all differing packets. Also separately dump the differing area within the packets.

-f *name*
--format *name*

Specify the format of the input files. See section 2.1.2 for more details.

By default, the format of each input file is automatically detected and can be different from one file to another. When the option **--format** is specified, the two input files must have the same format.

-j
--json

Report in JSON output format (useful for automatic analysis).

--json-buffer-size *value*

With **--json-tcp** or **--json-udp**, specify the network socket send buffer size.

--json-line[='*prefix*']

Same as **--json** but report the JSON text as one single line in the message logger instead of fully formatted output file.

The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--json-tcp *address:port*

Same as **--json** but report the JSON text as one single line in a TCP connection instead of the output file.

The *address* specifies an IP address or a host name that translates to an IP address. The *port* specifies the destination TCP port.

By default, a new TCP connection is established each time a JSON message is produced (see also option **--json-tcp-keep**). Be aware that a complete TCP connection cycle may introduce some latency in the processing. If latency is an issue, consider using **--json-udp**.

--json-tcp-keep

With --json-tcp, keep the TCP connection open for all JSON messages. By default, a new TCP connection is established each time a JSON message is produced.

--json-udp *address:port*

Same as **--json** but report the JSON text as one single line in a UDP datagram instead of the output file.

The *address* specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The *port* specifies the destination UDP port.

Be aware that the size of UDP datagrams is limited by design to 64 kB. If larger JSON contents are expected, consider using **--json-tcp**.

--json-udp-local *address*

With **--json-udp**, when the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--json-udp-ttl *value*

With **--json-udp**, specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address. Remember that the default Multicast TTL is 1 on most systems.

-m *count*
--min-reorder *count*

With **--search-reorder**, this is the minimum number of consecutive packets to consider in reordered sequences of packets. This is used to avoid random isolated packets or small sets of packet, such as null packets, to be considered as a reordered sequence.

The default is 7 TS packets.

-n
--normalized

Report in a normalized output format (useful for automatic analysis).

-p *value*
--packet-offset *value*

Start reading the files at the specified TS packet.

The default is zero.

--payload-only

Compare only the payload of the packets, ignore header and adaptation field.

--pcr-ignore

Ignore PCR and OPCR when comparing packets. Useful if one file has been resynchronized.

--pid-ignore

Ignore PID value when comparing packets. Useful if one file has gone through a remapping process.

-q
--quiet

Do not output any message. The process simply terminates with a success status if the files are identical and a failure status if they differ.

-s
--search-reorder

Search missing or reordered packets.

By default, packets are compared one by one without looking for equivalent packets somewhere else.

See also **--threshold-diff** and **--buffered-packets**.

-t *value*
--threshold-diff *value*

When used with **--search-reorder**, this value specifies the maximum number of differing bytes in packets to declare them equal. When two packets have more differing bytes than this threshold, the packets are reported as different and the first file is read ahead. The default is zero, which means that two packets must be strictly identical to declare them equal.

If you find this explanation unclear, try it with a second file which contains both missing and corrupted packets...

Generic common command options

The following options are implicitly defined in all commands.

--debug[=_N_**]**

Produce verbose debug output. Specify an optional debug level _N_ (1 by default).

--help

Display command help text.

--verbose

Produce verbose messages.

--version

Display the version number.

■ **tsconfig**

Configuration options to build applications (developers only)

This command is installed on Unix systems only (Linux, macOS, BSD).

For developers, it generates the various build options for the current operating system and is used by developers to build their applications.

Without any option, **tsconfig** displays all configuration options. With one or more specific options, it outputs command line options for the compiler, the linker or installation commands.

Usage

```
tsconfig [options]
```

Options

  --bin

      Outputs the directory for TSDuck executables.

  --cflags

      Outputs the pre-processor and compiler flags.

      In a makefile, this is used in **CFLAGS** and **CXXFLAGS**.

  --config

      Outputs the directory for TSDuck configuration files.

      Extensions should store their **.xml** or **.names** files there.

  --help

      Display command help text.

  --include

      Outputs the include directory.

  --install-dvb-firmware

      Linux only: download and install additional DVB firmware.

      Depending on the distro, some firmware files are installed with standard packages such as **linux-firmware**. Some USB tuners need additional firmware from non-standard sources. Using this option, **tsconfig** downloads and installs some known additional firmware files for DVB tuners.

      Must be root to use that option.

  --java

      Outputs the jar file for TSDuck Java bindings, to be added in **CLASSPATH**.

  --lib

      Outputs the directory for TSDuck dynamic libraries (except plugins).

      Extensions should store their **tslibext_xxx.so** libraries there (**.dylib** on macOS, **.dll** on Windows).

  --libs

      Outputs the library linking flags.

      In a makefile, this is used in **LDLIBS**.

  --nostdcpp

      When present before **--cflags**, no C++ standard level is imposed in the compilation flags.

By default, the command **tsconfig --cflags** forces C++17 as level of C++ language standard. If your application requires a more recent level, define the environment variable **TS_NOSTDCPP** to any non-empty value. This disables the C++ standard option in **tsconfig**. The application shall then define its own C++ standard in its command line. This user-specified C++ standard cannot be lower than C++17.

Alternatively, the command **tsconfig --nostdcpp --cflags** can be used to omit the C++ standard from the compilation options without defining the environment variable **TS_NOSTDCPP**.

--plugin

Outputs the directory for TSDuck plugins.

Extensions should store their **tsplugin_*xxx*.so** libraries there (**.dylib** on macOS, **.dll** on Windows).

--prefix

Outputs the installation prefix.

--python

Outputs the directory for TSDuck Python bindings, to be added in **PYTHONPATH**.

--so

Outputs the shared object files extension ("**.so**", "**.dylib**", "**.dll**").

--static-libs

Outputs the static library linking flags.

In a makefile, this is used in **LDLIBS**.

--vernum

Outputs the TSDuck version as a number.

--version

Outputs the TSDuck version as found in the development environment.

Sample usages

The following commands are used to build an application using the TSDuck library:

```
gcc $(tsconfig --cflags) app.cpp -o app.o
gcc app.o $(tsconfig --libs) -o app
```

In a GNU makefile, the developer should use:

```
CXXFLAGS += $(shell tsconfig --cflags)
LDLIBS += $(shell tsconfig --libs)
```

If the application is a TSDuck extension providing one or more plugins, the installation commands in the makefile are like this:

```
install -m 644 tslibext_foo.so $(shell tsconfig --lib)
install -m 644 tsplugin_*.so $(shell tsconfig --plugin)
```

To use the Java and Python bindings:

```
export CLASSPATH="$(tsconfig --java):$CLASSPATH"
export PYTHONPATH="$(tsconfig --python):$PYTHONPATH"
```

▪ tscrc32

Compute MPEG-style CRC32 values

This utility manually computes CRC32 values, as found in MPEG sections.

Usage

```
tscr32 [options] [input-file ...]
```

Input file

Any number of binary input files.

If the parameter is omitted, is an empty string or a dash ("**-**"), the standard input is used.

Options

-a
--accelerated

Check if the computation of CRC32 is accelerated using specialized instructions.

-d *hexa-data*
--data *hexa-data*

Raw input data instead of input files. Use hexadecimal digits.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N***]**

Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

Display command help text.

--verbose

Produce verbose messages.

--version

Display the version number.

▪ **tsdate**

Date and time extraction

This utility extracts date and time information from s transport stream, namely the TDT (Time and Data Table) and the TOT (Time Offset Utility).

Usage

```
tsdate [options] [input-file]
```

Input file

MPEG transport stream, either a capture file or a pipe from a live stream (see option **--format** for binary formats).

If the parameter is omitted, is an empty string or a dash ("**-**"), the standard input is used.

Options

--abnt

Assume that the transport stream is an ISDB one with ABNT-defined variants. See section 2.4.2 for more details.

-a
--all

Report all TDT/TOT tables (default: report only the first table of each type).

--atsc

Assume that the transport stream is an ATSC one. See section 2.4.2 for more details.

--brazil

A synonym for **--isdb --abnt --time-reference UTC-3**. See section 2.4.2 for more details.

-f *name*
--format *name*

Specify the format of the input file. See section 2.1.2 for more details.

--ignore-leap-seconds

Do not explicitly include leap seconds in some UTC computations. See 2.4.2 for more details.2.4.2

--isdb

Assume that the transport stream is an ISDB one. See section 2.4.2 for more details.

--japan

A synonym for **--isdb --time-reference JST**. See section 2.4.2 for more details.

--notdt

Ignore Time & Date Table (TDT).

--notot

Ignore Time Offset Table (TOT).

--philippines

A synonym for **--isdb --abnt --time-reference UTC+8**. See section 2.4.2 for more details.

--time-reference *name*

Use a non-standard time reference in DVB or ISDB-defined SI. See section 2.4.2 for more details.

--usa

> A synonym for **--atsc**. See section 2.4.2 for more details.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=_N_**]**

> Produce verbose debug output. Specify an optional debug level _N_ (1 by default).

--help

> Display command help text.

--verbose

> Produce verbose messages.

--version

> Display the version number.

▪ tsdektec

Dektec device control

This utility controls Dektec devices, which include input and/or output DVB-ASI devices or modulators (see [38]).

Restrictions

This command is available on Linux and Windows only, Intel processors only. Dektec provides no software support on macOS and other processors. Moreover, this command may be unavailable on some Linux distributions since it integrates a closed-source library from Dektec, which is prohibited by the policy of some distributions.

Usage

```
tsdektec [options] [device]
```

Device

The optional parameter is a device index, from 0 to N-1 (with N being the number of Dektec devices in the system). The default is 0, the first device.

Use option **--list-all** (or **-a**) to have a complete list of devices in the system.

Options

-a
--list-all

List all Dektec devices available on the system.

-i *port-number*
--input *port-number*

Set the specified port in input mode. This applies to bidirectional ports which can be either set in input or output mode. The port number of each channel can be seen using the command **tsdektec -av**.

-j
--json

With **--all**, list the Dektec devices in JSON format (useful for automatic analysis).

--json-buffer-size *value*

With **--json-tcp** or **--json-udp**, specify the network socket send buffer size.

--json-line[='*prefix*']

Same as **--json** but report the JSON text as one single line in the message logger instead of fully formatted output file.

The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--json-tcp *address:port*

Same as **--json** but report the JSON text as one single line in a TCP connection instead of the output file.

The *address* specifies an IP address or a host name that translates to an IP address. The *port* specifies the destination TCP port.

By default, a new TCP connection is established each time a JSON message is produced (see also option **--json-tcp-keep**). Be aware that a complete TCP connection cycle may introduce some latency in the processing. If latency is an issue, consider using **--json-udp**.

--json-tcp-keep

> With --json-tcp, keep the TCP connection open for all JSON messages. By default, a new TCP connection is established each time a JSON message is produced.

--json-udp *address:port*

> Same as **--json** but report the JSON text as one single line in a UDP datagram instead of the output file.
>
> The *address* specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The *port* specifies the destination UDP port.
>
> Be aware that the size of UDP datagrams is limited by design to 64 kB. If larger JSON contents are expected, consider using **--json-tcp**.

--json-udp-local *address*

> With **--json-udp**, when the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--json-udp-ttl *value*

> With **--json-udp**, specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address. Remember that the default Multicast TTL is 1 on most systems.

-l *state*
--led *state*

> Set the state of the LED on the rear panel. Useful to identify a Dektec device when more than one is present. The state is one of **off**, **green**, **red**, **yellow**, **blue**, **hardware**. See also option **--wait** (the led state is automatically returned to **hardware** after exit).

-n
--normalized

> With **--all**, list the Dektec devices in a normalized output format (useful for automatic analysis).

-o *port-number*
--output *port-number*

> Set the specified port in output mode. This applies to bidirectional ports which can be either set in input or output mode. The port number of each channel can be seen using the command **tsdektec -av**.

-p *value*
--power-mode *value*

> On DTU-315 USB modulators, set the power mode to the specified value.
>
> Must be one of **high-quality**, **low-power**.

-r
--reset

> Reset the device.

-w *seconds*
--wait *seconds*

> Wait the specified number of seconds before exiting. The default if 5 seconds if option **--led** is specified and 0 otherwise.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

> Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

> Display command help text.

-v
--verbose

> Produce verbose messages.

--version

> Display the version number.

Normalized output format

In normalized output, each line describes one *object* (driver, device, channel, etc). The format of each line is:

```
type:name[=value]:...
```

The *type* identifies the kind of object which is described by the line. The *name* identifies a characteristics for the object with an optional *value*. There is no space characters. All integer values are in decimal format.

The normalized syntax can be used to search for specific objects with specific characteristics. See also the description of the command **tsanalyze** for another example of normalized output.

Normalized object types

The list of *type*, at beginning of lines, is the following:

dtapi:
> Description of the Dektec runtime library ("DTAPI"). There is always one single dtapi line.

driver:
> Description of one type of Dektec device driver.

device:
> Description of one Dektec device.

channel:
> Description of one channel inside a Dektec device.

Normalized DTAPI characteristics

The characteristics in **dtapi:** lines are:

:version=*string*:
> Version of the DTAPI.

Normalized driver characteristics

The characteristics in **driver:** lines are:

:pci:
> This is a PCI driver (Dta1xx)

:usb:
> This is a USB driver (Dtu2xx)

:version=*string*:
> Version of the driver.

Normalized device characteristics

The characteristics in **device:** lines are:

:address=*int*:
> USB address.

:bus=*int*:
> PCI bus number.

:device=*int*:
> Device index.

:device-id=*int*:
> Device id

:fw-variant=*int*:
> Firmware variant.

`:fw-version=int:`	Firmware version.
`:model=string:`	Device model name.
`:nb-input=int:`	Count of input ports.
`:nb-output=int:`	Count of output ports.
`:nb-port=int:`	Count of all ports.
`:pci:`	This is a PCI device.
`:serial=int:`	Serial number.
`:slot=int:`	PCI slot number in the PCI bus.
`:subsys-id=int:`	Subsystem id
`:subsys-vendor-id=int:`	Subsystem vendor id
`:usb:`	This is a USB device.
`:vendor-id=int:`	Vendor id
`:vpd-bo=string:`	Bitrate offset (from Vital Product Data area)
`:vpd-cl=string:`	Customer id (from Vital Product Data area)
`:vpd-ec=string:`	Engineering change level (from Vital Product Data area)
`:vpd-id=string:`	Device description (from Vital Product Data area)
`:vpd-mn=string:`	Manufacture id (from Vital Product Data area)
`:vpd-pd=string:`	Production date (from Vital Product Data area)
`:vpd-pn=string:`	Part number (from Vital Product Data area)
`:vpd-sn=string:`	Serial number (from Vital Product Data area)
`:vpd-xt=string:`	Crystal stability (from Vital Product Data area)

Normalized channel characteristics

The characteristics in **channel:** lines are:

`:access-downconverted:`	Access to downconverted signal.
`:adjust-level:`	Adjustable level
`:asi:`	This is a DVB/ASI port.
`:asi-raw-10bit:`	Raw 10-bit ASI mode available.
`:atsc:`	ATSC modulator.
`:bidir:`	This is a bidirectional port.
`:channel=int:`	Channel index inside device.
`:channel-modelling:`	Channel modelling available.
`:cmmb:`	CMMB modulator.
`:dedicated-clock-input:`	Dedicated clock input available.
`:dedicated-clock-input-ratio:`	Dedicated clock input available, can be divided by providing a ratio.
`:device=int:`	Device index of the device containing the channel.
`:diversity:`	Diversity mode available.
`:double-buffer:`	This is a double-buffered device.
`:dtmb:`	DTMB modulator.

`:dvb-c:`	DVB-C modulator.
`:dvb-c2:`	DVB-C2 modulator.
`:dvb-raw-10bit:`	DVB 10-bit raw mode available.
`:dvb-s:`	DVB-S modulator.
`:dvb-s2:`	DVB-S2 modulator.
`:dvb-t:`	DVB-T modulator.
`:dvb-t2:`	DVB-T2 modulator.
`:dvb-t2-mi:`	DVB-T2-MI modulator.
`:failsafe:`	Failsafe
`:if-output:`	IF output
`:ip=`*string*`:`	IP address
`:io-clock-select:`	I/O clock selection available.
`:io-config:`	I/O standard and mode configuration available.
`:io-rate-select:`	TS rate clock selection available.
`:iq-output:`	Digital IQ output.
`:iq-samples:`	Direct I/Q samples available.
`:isdb-s:`	ISDB-S modulator.
`:isdb-t:`	ISDB-T modulator.
`:lband:`	L-Band
`:lock-io-rate:`	Lock output to input TS rate available.
`:loop-through:`	Loop-through available.
`:lvds1:`	SPI LVDS1 available.
`:lvds2:`	SPI LVDS2 available.
`:lvttl:`	SPI LVTTL available.
`:mac=`*string*`:`	MAC address
`:modulator:`	This is a modulator port.
`:port=`*int*`:`	Port number.
`:qam:`	QAM modulator.
`:qam-a:`	QAM-A (DVB-C) modulator.
`:qam-b:`	QAM-B (USA) modulator.
`:qam-c:`	QAM-C (Japan) modulator.
`:shared-input:`	Shared antenna input available.
`:sdi:`	This is an SDI port.
`:sdi-time-stamp:`	SDI frames time-stamping available.
`:sdi-time-stamp-64:`	SDI frames 64-bit time-stamping available.
`:snr-setting:`	SNR setting available.
`:spi:`	This is an SPI port.
`:spi-external-clock:`	SPI external clock available.
`:spi-fixed-clock:`	SPI fixed clock available.
`:spi-serial-8-bit:`	SPI serial 8-bit available.

`:spi-serial-10-bit:`	SPI serial 10-bit available.
`:transmit-on-time-stamp:`	Transmission on time-stamp available.
`:transparent:`	Transparent mode available.
`:ts-over-ip:`	This an IP port, for TS over IP.
`:uhf:`	UHF modulator.
`:vhf:`	VHF modulator.
`:virtual-stream:`	Virtual stream channel.

⋮⋮ tsdump

Dump TS packets

This utility dumps the contents of MPEG transport stream packets.

Usage

```
tsdump [options] [input-file ...]
```

Input files

Any number of MPEG transport stream files.

If the parameter is omitted, is an empty string or a dash ("**-**"), the standard input is used.

Note that if the option **–-raw** is used, the input files can be any type of file, not necessarily TS files.

Options

--adaptation-field

Include formatting of the adaptation field.

-a
--ascii

Include ASCII dump in addition to hexadecimal.

-b
--binary

Include binary dump in addition to hexadecimal.

--byte-offset *value*

Start reading each file at the specified byte offset (default: 0).

This option is allowed only if all input files are regular files.

-c
--c-style

Same as **--raw-dump** (no interpretation of packets) but dump the bytes in C-language style, eg. "**0x01, 0x02,**" instead of "**01 02**". Useful to include *tsdump* output as data in a C source file.

-f *name*
--format *name*

Specify the format of the input files. See section 2.1.2 for more details.

By default, the format of each input file is automatically detected and can be different from one file to another. When the option **--format** is specified, all input files must have the same format.

This option is ignored with **--raw-file**: the complete raw structure of the file is dumped.

-h
--headers-only

Dump packet headers only, not payload.

-l
--log

Display a short one-line log of each packet instead of full dump.

--log-size *value*

With option **--log**, specify how many bytes are displayed in each packet.

The default is 188 bytes (complete packet).

-m *value*
--max-packets *value*

> Maximum number of packets to dump per file.

-n
--nibble

> Same as `--binary` but add separator between 4-bit nibbles.

--no-headers

> Do not display header information.

--no-pager

> Do not send output through a pager process. By default, if the output device is a terminal, the output is paged. See 3.1.4 for more details.

-o
--offset

> Display offset from start of packet with hexadecimal dump.

--packet-offset *value*

> Start reading each file at the specified TS packet (default: 0).
>
> This option is allowed only if all input files are regular files.

--payload

> Hexadecimal dump of TS payload only, skip TS header.

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

> Dump only packets with these PID values. Several **--pid** options may be specified.
>
> By default, all packets are displayed.

-r
--raw-file

> Raw dump of file, do not interpret as TS packets. With this option, tsdump simply acts as an hexa / ASCII file dumper.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=_N_**]**

> Produce verbose debug output. Specify an optional debug level _N_ (1 by default).

--help

> Display command help text.

-v
--verbose

> Produce verbose messages.

--version

> Display the version number.

▦ tsecmg

Minimal generic DVB SimulCrypt-compliant ECMG

This utility behaves as a DVB SimulCrypt compliant ECMG. It can be used to debug system integration, replacing any standard ECM Generator. Most DVB SimulCrypt parameters can be adjusted from the command line to test the behaviour of an SCS.

This fake ECMG can be used with the **tsp** plugin named **scrambler** to build an end-to-end demo of a DVB SimulCrypt system.

This fake ECMG accepts all **Super_CAS_Id** values. All ECM requests are instantaneously responded. The returned ECM is a fake one. The fake ECM's are TLV messages containing the access criteria and the control words as sent by the SCS in clear format.

Warning: It is obvious that this ECMG shall never be used on a production system since it returns ECM's with clear control words.

Usage

```
tsecmg [options]
```

Options

--ac-delay-start *value*

> This option sets the DVB SimulCrypt option **AC_delay_start**, in milliseconds. By default, use the same value as **--delay-start**.

--ac-delay-stop *value*

> This option sets the DVB SimulCrypt option **AC_delay_stop**, in milliseconds. By default, use the same value as **--delay-stop**.

--comp-time *value*

> This option specifies the computation time of an ECM. The clear ECM's which are generated by this ECMG take no time to generate. But, in order to emulate the behaviour of a real ECMG, this parameter forces a delay of the specified duration before returning an ECM.

-c *value*
--cw-per-ecm *value*

> Specify the required number of control words per ECM. This option sets the DVB SimulCrypt option **CW_per_msg**. It also set **lead_CW** to **CW_per_msg-1**. By default, use 2 control words per ECM, the current one and next one.

--delay-start *value*

> This option sets the DVB SimulCrypt option **delay_start**, in milliseconds. Default: 200 ms.

--delay-stop *value*

> This option sets the DVB SimulCrypt option **delay_stop**, in milliseconds. Default: 200 ms.

--ecmg-scs-version *value*

> Specifies the version of the ECMG ⇔ SCS DVB SimulCrypt protocol. Valid values are 2 and 3. The default is 2.

--log-data[=*level*]

> Same as **--log-protocol** but applies to *CW_provision* and *ECM_response* messages only.

> To debug the session management without being flooded by data messages, use **--log-protocol=info --log-data=debug**.

--log-message-count *value*

> Specify the maximum number of buffered log messages. Log messages are displayed asynchronously in a low priority thread. This value specifies the maximum number of buffered log messages in memory, before being displayed. When too many messages are logged in a short period of time, while plugins use all CPU power, the low-priority log thread has no resource. It cannot display yet the buffered messages and extra messages are dropped. Increase this value if you think that too many messages are dropped. The default is 512 messages.
>
> See also the option **--synchronous-log**.

--log-protocol[=*level*]

> Log all ECMG ⇔ SCS protocol messages using the specified level. If the option is not present, the messages are logged at debug level only. If the option is present without value, the messages are logged at info level.
>
> A level can be a numerical debug level or any of the following: **fatal**, **severe**, **error**, **warning**, **info**, **verbose**, **debug**.

--max-comp-time *value*

> Specify the maximum ECM computation time in milliseconds. This option sets the DVB SimulCrypt option **max_comp_time**.
>
> By default, use the value of **--comp-time** (which is itself zero by default) plus 100 milliseconds.

--no-reuse-port

> Disable the reuse port socket option. Do not use unless completely necessary.

-o
--once

> Accept only one client and exit at the end of the session.

-p *value*
--port *value*

> TCP port number of the ECMG server. Default: 2222.

-r *value*
--repetition *value*

> This option sets the DVB SimulCrypt option **ECM_rep_period**, the requested repetition period of ECM's, in milliseconds.
>
> Default: 100 milliseconds.

-s
--section-mode

> Return ECM's in section format. This option sets the DVB SimulCrypt parameter **section_TSpkt_flag** to zero.
>
> By default, ECM's are returned in TS packet format.

--synchronous-log

> With this option, each logged message is guaranteed to be displayed, synchronously, without any loss of message. The downside is that a plugin thread may be blocked for a short while when too many messages are logged.

-t
--timed-log

> Each logged message contains a time stamp.

--transition-delay-start *value*

> This option sets the DVB SimulCrypt option **transition_delay_start**, in milliseconds.
>
> Default: -500 milliseconds.

--transition-delay-stop *value*

> This option sets the DVB SimulCrypt option **transition_delay_stop**, in milliseconds. Default: 0 ms.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=N**]**

> Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

> Display command help text.

-v
--verbose

> Produce verbose messages.

--version

> Display the version number.

⬛ tseit

Manipulate EIT's using commands and scripts

This utility manipulates Event Information Tables (EIT) using commands. Scripts can be used to reproduce specific test cases.

This utility is typically reserved to offline testing. To generate and inject EIT's in actual transport streams, use the **tsp** plugin **eitinject**.

Usage

```
tseit [options]
```

Options

-c *'string'*
--command *'string'*

> Specify an EIT manipulation command. See the list of available commands below.
>
> Several **--command** options can be specified. All commands are executed in sequence.
>
> The commands from **--file** options are executed first, then the **--command** options. If there is no **--file** and no **--command**, the commands are read from the standard input.

-e
--exit-on-error

> Stop executing commands when an error is encountered.
>
> By default, continue execution on error.

-f *file-name*
--file *file-name*

> Specify a text file containing EIT manipulation commands to execute (command script).
>
> If the file name is a dash ("**-**"), the standard input is used.
>
> As usual in scripts, each text line is a command. Lines starting with '**#**' are considered as comments and ignored. Lines ending with a backslash ('****') continue on the next line.
>
> Several **--file** options can be specified. All scripts are executed in sequence.
>
> The commands from **--file** options are executed first, then the **--command** options. If there is no **--file** and no **--command**, the commands are read from the standard input.

-i *path*
--input-directory *path*

> Default directory of input files in EIT manipulation commands.
>
> In all commands and scripts, each time an input file is specified without directory or with a relative path, this default directory is used as base. It is consequently possible to write position-independent scripts and specify the actual directory or base path in the **tseit** command.

-o *path*
--output-directory *path*

> Default directory of output files in EIT manipulation commands.
>
> This is equivalent to option **--input-directory**, applied to output files.

Generic common command options

The following options are implicitly defined in all commands.

-d[_N_**]**
--debug[=_N_**]**

> Produce verbose debug output. Specify an optional debug level _N_ (1 by default).

--help

> Display command help text.

-v
--verbose

> Produce verbose messages.

--version

> Display the version number.

List of EIT manipulation commands

dump	Dump the content of the EIT database.

	Usage:	`dump`

exit	Exit **tseit**. Useful in interactive sessions.

	Usage:	`exit`

generate   Generate TS packets, injecting EIT's from the event database according to the injection profile. Non-EIT packets are null packets. The TS id, TS bitrate and initial date/time must have been specified first (see command **set**).

	Usage:	`generate [`_options_`] `_filename_
	filename	Name of the output TS file to generate.
	-b _value_ **--bytes** _value_	Stop after generating the specified number of bytes.
	-p _value_ **--packets** _value_	Stop after generating the specified number of TS packets.
	-s _value_ **--seconds** _value_	Stop after generating the specified number of seconds of contents. The duration is based on the TS bitrate.
	-u _time_ **--until** _time_	Generate packets up to the specified date in the stream. The current date in the stream is based on the initial date and the bitrate. Use "_year/month/day:hour:minute:second.millisecond_" format.

help	List all internal commands. This command is useful in interactive session.

	Usage:	`help`

load	Load events from a file.

	Usage:	`load `_filename_
	filename	A binary, XML or JSON file containing EIT sections. See the **tsp** plugin **eitinject** for more details on event database files.

process   Process a transport stream file with EIT generation. The input file is read, EIT's are injected using the event database. The TS bitrate must have been specified first (see command **set**).

	Usage:	`process [`_options_`] `_infile outfile_

	infile	Name of the input TS file. Input EIT's are used to populate the event database.
	outfile	Name of the output TS file to generate, after EIT injection.
	-b *value* **--bytes** *value*	Stop after generating the specified number of bytes.
	-i **--infinite**	Repeat the input file infinitely.
	-p *value* **--packets** *value*	Stop after generating the specified number of TS packets.
	-r *value* **--repeat** *value*	Repeat the input file the specified number of times. By default, the input file is read once.
	-s *value* **--seconds** *value*	Stop after generating the specified number of seconds of contents. The duration is based on the TS bitrate.
	-o *value* **--start-offset** *value*	Start reading the input file at the specified offset in bytes.
	-u *time* **--until** *time*	Generate packets up to the specified date in the stream. The current date in the stream is based on the initial date and the bitrate. Use "*year/month/day:hour:minute:second.millisecond*" format.
quit	Exit **tseit**. Useful in interactive sessions. Same as **exit**.	
	Usage:	`Quit`
reset	Reset the content of the event database.	
	Usage:	`Reset`
save	Save all current EIT sections in a file.	
	Usage:	`save `*filename*
	filename	Name of the output file receiving EIT sections in binary format.
set	Set EIT generation options.	
	Usage:	`set [`*options*`]`
	--actual	Enable the generation of all EIT actual.
	--actual-pf	Enable the generation of EIT p/f actual.
	--actual-schedule	Enable the generation of EIT schedule actual.
	--eit-bitrate *value*	Set the EIT maximum bitrate in bits/second.
	--no-actual	Disable the generation of all EIT actual.
	--no-actual-pf	Disable the generation of EIT p/f actual.
	--no-actual-schedule	Disable the generation of EIT schedule actual.
	--no-other	Disable the generation of all EIT other.
	--no-other-pf	Disable the generation of EIT p/f other.
	--no-other-schedule	Disable the generation of EIT schedule other.
	--no-pf	Disable the generation of all EIT p/f.

--no-schedule	Disable the generation of all EIT schedule.
--other	Enable the generation of all EIT other.
--other-pf	Enable the generation of EIT p/f other.
--other-schedule	Enable the generation of EIT schedule other.
--pf	Enable the generation of all EIT p/f.
--satellite	Use the EIT cycle profile for satellite and cable networks as specified in ETSI TS 101 211.
--schedule	Enable the generation of all EIT schedule.
--terrestrial	Use the EIT cycle profile for terrestrial networks as specified in ETSI TS 101 211.
--time *time*	Set the current date and time in the transport stream. Use "*year/month/day:hour:minute:second.millisecond*" format.
--ts-bitrate *value*	Set the transport stream bitrate in bits/second.
--ts-id *value*	Set the actual transport stream id.

▦ tsemmg

Minimal generic DVB SimulCrypt-compliant EMMG

This utility behaves as a DVB SimulCrypt compliant EMMG. It can be used to debug system integration, replacing any standard EMM Generator. Most DVB SimulCrypt parameters can be adjusted from the command line to test the behaviour of a MUX.

This fake EMMG can be used with the **tsp** plugin named **datainject** to build an end-to-end demo of a DVB SimulCrypt system.

Usage

```
tsemmg [options] [section-file ...]
```

Parameters

The parameters are files containing sections in binary or XML format. Several files can be specified. All sections are loaded and injected in the MUX using the EMMG/PDG ⇔ MUX protocol. The list of all sections from all files is cycled as long as *tsemmg* is running. The sections can be of any type, not only EMM's.

By default, when no input file is specified, this EMMG generates fake EMM sections of a fixed size and all payload bytes contain the same value. The value of the fake EMM *table_id* and the value of the payload bytes are incremented in each new section. See options **--emm-size**, **--emm-min-table-id** and **--emm-max-table-id**.

Options

-b *value*
--bandwidth *value*

> Specify the bandwidth of the data which are sent to the MUX in kilobits per second.
>
> The default is 100 kb/s.

--bytes-per-send *value*

> Specify the average size in bytes of each data provision. The exact value depends on sections and packets sizes. Default: 500 bytes.

--channel-id *value*

> This option sets the DVB SimulCrypt parameter **data_channel_id**.
>
> The default is 1.

-c *value*
--client-id *value*

> This option sets the DVB SimulCrypt parameter **client_id**.
>
> The default is 0.
>
> For EMM injection, the most signification 16 bits shall be the *CA_system_id* of the corresponding CAS.

--cycles *value*

> Inject the sections from the input files the specified number of times.
>
> By default, inject sections indefinitely.

-d *value*
--data-id *value*

> This option sets the DVB SimulCrypt parameter **data_id**.
>
> The default is 0.

--emm-max-table-id *value*

Specify the maximum table id of the automatically generated fake EMM's.

The default is **0x8F**.

When generating fake EMM's, the table ids are cycled from the minimum to the maximum value.

--emm-min-table-id *value*

Specify the minimum table id of the automatically generated fake EMM's.

The default is **0x82**.

--emm-size *value*

Specify the size in bytes of the automatically generated fake EMM's.

The default is 100 bytes.

--emmg-mux-version *value*

Specify the version of the EMMG/PDG ⇔ MUX DVB SimulCrypt protocol.

Valid values are 1 to 5. The default is 2.

-i
--ignore-allocated

Ignore the allocated bandwidth as returned by the MUX. Continue to send data at the planned bandwidth, even if it is higher than the allocated bandwidth.

--log-data[=*level*]

Same as **--log-protocol** but applies to **data_provision** messages only.

To debug the session management without being flooded by data messages, use **--log-protocol=info --log-data=debug**.

--log-protocol[=*level*]

Log all EMMG/PDG ⇔ MUX protocol messages using the specified level. If the option is not present, the messages are logged at debug level only. If the option is present without value, the messages are logged at info level. A level can be a numerical debug level or any of the following: **fatal**, **severe**, **error**, **warning**, **info**, **verbose**, **debug**.

--max-bytes *value*

Stop after sending the specified number of bytes.

By default, send data indefinitely.

-m *address:port*
--mux *address:port*

Specify the IP address (or host name) and TCP port of the MUX.

This is a required parameter, there is no default.

--requested-bandwidth *value*

This option sets the DVB SimulCrypt parameter **bandwidth** in the **stream_BW_request** message. The value is in kilobits per second.

The default is the value of the **--bandwidth** option.

Specifying distinct values for --**bandwidth** and **--requested-bandwidth** can be used for testing the behavior of a MUX.

-s
--section-mode

Send EMM's or data in section format. This option sets the DVB SimulCrypt parameter **section_TSpkt_flag** to zero.

By default, EMM's and data are sent in TS packet format.

--stream-id *value*

This option sets the DVB SimulCrypt parameter **data_stream_id.**

The default is 1.

-t *value*
--type *value*

This option sets the DVB SimulCrypt parameter **data_type**.

The default is 0 (EMM).

In addition to integer values, the following names can be used: **emm** (0), **private-data** (1) and **ecm** (2).

-u *[address:]port*
--udp *[address:]port*

Specify that the **data_provision** messages shall be sent using UDP.

By default, the **data_provision** messages are sent over TCP using the same TCP connection as the management commands.

If the IP address (or host name) is not specified, use the same IP address as the **--mux** option. The port number is required, even if it is the same as the TCP port.

-w *milliseconds*
--udp-end-wait *milliseconds*

With **--udp**, specify the number of milliseconds to wait after the last *data_provision* message (UDP) and before the *stream_close_request* message (TCP).

This can be necesssary to ensure that the *stream_close_request* is processed after the processing of the last *data_provision*.

The default is 100 ms.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=N**]**

Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

▪▪ tsfclean

Cleanup the structure and boundaries of a transport stream file

In its most general form, an *MPEG transport stream file* is just a set of TS packets. It can be a capture of a live stream, in which case the file starts and ends at arbitrary points in an endless transmission.

However, when a media player manipulates stored contents, it expects the files to start with the actual beginning of an audio/video content. When the file format is an MPEG transport stream, the player expects some characteristics such as immediate identification of the services and PID's, initial intra video frame, etc. Not matching these characteristics does not prevent the content from being rendered by the player but glitches are usually present at startup.

The **tsfclean** command cleans up a TS file to make it more consistent for media players and other similar tools. The following transformations are applied:

- The output file starts with the PAT, the CAT (if present on input), the SDT (if present on input) and the PMT's of all services. Thus, the player is aware of the exact structure of the TS before processing the first audio / video data.
- EIT present/following for actual existing services are kept. All other EIT's are removed.
- All other PSI/SI (including NIT, BAT, TDT and other broadcast-related tables), all null packets and all orphan PID's are deleted.
- In each video PID, all packets preceding the first intra-frame are deleted. If no intra-frame can be found (unknown video codec or scrambled contents), all packets preceding the first complete PES packet are deleted.
- In each audio, subtitles or data component of the services, all packets preceding the first complete PES packet or section are deleted.

If the input file contains several versions of a table (PAT, CAT, SDT or PMT's), all successive versions are merged into one single version of the table. Some players are known to read the first table of each kind only and are not able to handle table updates as a TV receiver would do. Consequently, if a service or a component of a service appears and disappears several times, it becomes in fact declared from the start to the end of the output file. If incompatible non-cumulative changes are introduced in a table update, an error is reported.

Usage

```
tsfclean [options] file ...
```

File

MPEG transport stream input files to cleanup.

All input files must be regular files (no pipe) since the processing is done on two passes.

If more than one file is specified, the output name shall specify a directory.

Options

-o *path*
--output *path*

Specify the output file or directory. If the specified path is a directory, the output file is created in that directory, with the same base name as the input file.

This is a mandatory parameter, there is no default.

If more than one input file is specified, the output name shall specify a directory.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

--debug[=*N*]

▪ **tsfixcc**

Fix continuity counters

This utility fixes errors in the continuity counters (CC) in a transport stream file. If packets are missing (non continuous CC), the CC in all subsequent packets in the affected PID's are modified to remove the discontinuity.

If the file needs to be repeatedly played, **tsfixcc** can also add empty packets at the end of the file to fill the discontinuities between the end and the beginning of the file when the playback wraps to the beginning.

Usage

```
tsfixcc [options] file
```

File

MPEG transport stream. Must be a binary stream of 188-byte packets. This file must be a regular file (cannot be a pipe). It is open in read/write mode and is directly updated.

Options

-c
--circular

Enforce continuity when the file is played repeatedly. Add empty packets, if necessary, on each PID so that the continuity is preserved between end and beginning of file.

Note, however, that this method is not compliant with the MPEG-2 Transport Stream standard as defined in [1]. The standard specifies that the continuity counter shall not be incremented on packets without payload.

-n
--no-action

Display what should be performed but do not modify the file.

--no-replicate-duplicated

Two successive packets in the same PID are considered as duplicated if they have the same continuity counter and same content (except PCR, if any).

By default, duplicated input packets are replicated as duplicated on output (the corresponding output packets have the same continuity counters).

When this option is specified, the input packets are not considered as duplicated and the output packets receive individually incremented countinuity counters.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

    Display the version number.

▓ tsftrunc

Transport stream file truncation

This utility truncates a captured transport stream file to remove trailing incomplete packets.

See also the utility **tsresync** for a more powerful way to recover corrupted transport stream files.

Usage

```
tsftrunc [options] file ...
```

Files

MPEG transport stream files. They must be binary streams of 188-byte packets. The files must be regular files (cannot be pipes). They are open in read/write mode and are directly updated.

Options

-b *value*
--byte *value*

Truncate the file at the next packet boundary after the specified size in bytes. Mutually exclusive with **--packet**.

-n
--noaction

Do not perform truncation, check mode only.

-p *value*
--packet *value*

Index of first packet to truncate. If unspecified, all complete packets are kept in the file. Extraneous bytes at end of file (after last multiple of 188 bytes) are truncated.

-s *value*
--size-of-packet *value*

Specify the TS packet size in bytes.

The default is 188 bytes. Alternate packet sizes are useful for M2TS or other TS file formats.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

⬛ **tsfuzz**

Introduce random errors in transport stream files

This utility randomly corrupts transport stream files, typically to perform fuzzing attacks on media tools or receiver equipment.

The same effect can be obtained in transport stream processing pipeline using the plugin **fuzz**.

Usage

```
tsfuzz [options] file ...
```

File

MPEG transport stream input files to corrupt.

If more than one file is specified, the output name shall specify a directory.

General options

-o *path*
--output *path*

Specify the output file or directory. If the specified path is a directory, the output file is created in that directory, with the same base name as the input file.

This is a mandatory parameter, there is no default.

If more than one input file is specified, the output name shall specify a directory.

Fuzzing options

-c *value*
--corrupt-probability *value*

Probability to corrupt a byte in the transport stream.

The default is zero, meaning no corruption.

The value must be a fraction, e.g. 1/20, 1/1000, 3/20000, etc.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

PID filter: corrupt packets with these PID values only.

Several **--pid** options may be specified. By default, without **--pid** option, all PID's are eligibal to random corruption.

-s *hexa-data*
--seed *hexa-data*

Initial seed for the pseudo-random number generator.

Specify hexadecimal data. The size is not limited but at least 32 bytes are recommended.

Using the same seed on the same TS file will result in exactly the same corruptions. Without this parameter, a random seed is used, and the corruptions cannot be identically reproduced.

--sync-byte

May corrupt the 0x47 sync byte in TS packets. This may invalidate the synchronization of the transport stream.

By default, sync bytes are preserved.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

  Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

  Display command help text.

-v
--verbose

  Produce verbose messages.

--version

  Display the version number.

▸ **tsgenecm**

Generate one ECM using any DVB SimulCrypt-compliant ECMG

This command connects to a DVB SimulCrypt compliant ECMG and requests the generation of one ECM.

Restriction: The target ECMG shall support current or current/next control words in ECM, meaning **CW_per_msg** = **1** or **2** and **lead_CW** = **0** or **1**.

Usage

```
tsgenecm [options] output-file
```

Output file

Name of the binary output section file which receives the generated ECM.

If the specified name is "**-**", the standard output is used.

Options

-a *hexa-digits*
--access-criteria *hexa-digits*

Specifies the access criteria for the service as sent to the ECMG. The value must be a suite of hexadecimal digits.

--channel-id *value*

Specifies the DVB SimulCrypt *ECM_channel_id* for the ECMG (default: 1).

-d *seconds*
--cp-duration *seconds*

Specifies the crypto-period duration in seconds (default: 10 seconds).

--cp-number *value*

Crypto-period number (default: 0).

-c *hexa-digits*
--cw-current *hexa-digits*

Current control word (required). The value must be a suite of hexadecimal digits.

-n *hexa-digits*
--cw-next *hexa-digits*

Next control word (optional). The value must be a suite of hexadecimal digits.

-i *value*
--ecm-id *value*

Specifies the DVB SimulCrypt *ECM_id* for the ECMG (default: 1).

-e *host:port*
--ecmg *host:port*

Specify an ECM Generator host name (or IP address) and TCP port.

-v *value*
--ecmg-scs-version *value*

Specifies the version of the ECMG <=> SCS DVB SimulCrypt protocol. Valid values are 2 and 3. The default is 2.

--log-data[=*level*]

Same as **--log-protocol** but applies to *CW_provision* and *ECM_response* messages only.

To debug the session management without being flooded by data messages, use **--log-protocol=info --log-data=debug**.

--log-protocol[=*level*]

Log all ECMG ⇔ SCS protocol messages using the specified level. If the option is not present, the messages are logged at debug level only. If the option is present without value, the messages are logged at info level. A level can be a numerical debug level or any of the following: **fatal**, **severe**, **error**, **warning**, **info**, **verbose**, **debug**.

--stream-id *value*

Specifies the DVB SimulCrypt *ECM_stream_id* for the ECMG (default: 1).

-s *value*
--super-cas-id *value*

Specify the DVB SimulCrypt *Super_CAS_Id*. This is required when **--ecmg** is specified.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

▪ tshides

List HiDes modulator devices

This utility lists HiDes modulator devices and their characteristics.

Restrictions

This command is available on Linux and Windows only. There is no HiDes device drivers on macOS.

Usage

```
tshides [options]
```

Options

-a *value*
--adapter *value*

> Specify the HiDes adapter number to list. By default, list all HiDes devices.
>
> Use **--adapter** or **--device** but not both.

-b *value*
--bandwidth *value*

> Specify the bandwidth in Hz with **--gain-range**.
>
> For compatibility with old versions, "low" values (below 1000) are interpreted in MHz. This means that values 8 and 8,000,000 are identical. Both mean 8 MHz.
>
> The default is 8 MHz.

-c
--count

> Only display the number of devices, not their names or characteristics.

-d "*name*"
--device "*name*"

> Specify the HiDes device name to list. By default, list all HiDes devices.
>
> Use **--adapter** or **--device** but not both.

-f *value*
--frequency *value*

> Frequency, in Hz, of the output carrier with **--gain-range**.
>
> The default is the first UHF channel.

-g
--gain-range

> Display the allowed range of output gain for the specified device.
>
> Usually, the allowed range of gain depends on the frequency and the bandwidth. This is why the gain range is not displayed with the other characteristics. Use the options **--frequency** and **--bandwidth** to display the corresponding gain range.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N***]**

> Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

--help

Display command help text.

▪ tslatencymonitor

Monitor latency between two TS input sources

This utility uses the same input plugins as **tsp** or **tsswitch** to monitor the latency between these input sources.

Usage

```
tslatencymonitor [options] \
    -I input-name-1 [input-options] \
    -I input-name-2 [input-options]
```

Options

-b *seconds*
--buffer-time *seconds*

> Specify the buffer time of timing data list in seconds.
>
> By default, the buffer time is 1 seconds.

-l
--list-plugins

> List all available plugins.

--log-message-count *value*

> Specify the maximum number of buffered log messages. Log messages are displayed asynchronously in a low priority thread. This value specifies the maximum number of buffered log messages in memory, before being displayed. When too many messages are logged in a short period of time, while plugins use all CPU power, the low-priority log thread has no resource. It cannot display yet the buffered messages and extra messages are dropped. Increase this value if you think that too many messages are dropped.
>
> The default is 512 messages.
>
> See also the option **--synchronous-log**.

-o *filename*
--output-file *filename*

> Output file name for CSV reporting (standard error by default).

--output-interval *seconds*

> Specify the time interval between each output in seconds.
>
> The default is 1 second.

-s
--synchronous-log

> With this option, each logged message is guaranteed to be displayed, synchronously, without any loss of message. The downside is that a plugin thread may be blocked for a short while when too many messages are logged. This option shall be used when all log messages are needed, and the source and destination are not live streams (files for instance). This option is not recommended for live streams, when the responsiveness of the application is more important than the logged messages.

-t
--timed-log

> Each logged message contains a time stamp.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

■ **tslsdvb**

List DVB, ATSC, ISDB tuner receiver devices

This utility lists the physical tuner receiver devices in the system with their characteristics. Despite the legacy "dvb" name, all tuner devices are listed, DVB, ISDB or ATSC, terrestrial, satellite or cable.

This command lists physical devices only. It does not list *tuner emulators* (see section 7.1.4).

Usage

```
tslsdvb [options]
```

Options

-a *N*
--adapter *N*

> Specify the *N*th tuner device in the system, the first index being zero. This option can be used instead of device name.

> On Linux systems, this means **/dev/dvb/adapter*N***.

-d "*name*"
--device-name "*name*"

> Specify the name of the DVB receiver device to use. The syntax of the device name depends on the operating system. See section 7.1.3, page 480, for more details on DVB receiver devices naming.

> By default, when no device name or adapter is specified, list all available receiver devices.

-e
--extended-info

> Display extended information.

> This option comes in addition to **--verbose** to display extremely verbose information about a device such as the associated DirectShow graph on Windows.

Windows-specific options:

-l
--list-devices

> Get a list of all tuner and receiver DirectShow filters, equivalent to **--test list-devices**.

--receiver-name "*name*"

> Specify the name of the DirectShow receiver filter to use.

> By default, first try a direct connection from the tuner filter to the rest of the graph. Then, try all receiver filters and concatenate them all.

> This option is used only when a specific device name or adapter number is specified. It is ignored when all devices are listed since distinct tuner filters may need distinct receiver filters.

-t *name*
--test *name*

> Run a specific DirectShow test. Produce a very verbose output, for debug only. The names of the available tests are listed below.

>> **none**   Do not run any test. This is the default.

>> **list-devices**   Get a short list of all tuner and receiver DirectShow filters.

enumerate-devices	Enumerate all DirectShow devices which are used with DVB tuners. This test is useful to detect all devices which may not be recognized as valid tuners by TSDuck.
tuning-spaces	List all DirectShow tuning spaces which are installed in the system and their compatibility with the various network providers.
bda-tuners	List all BDA tuners and their compatibility with the various predefined "network provider" filters.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

▪▪ tsp

Transport stream processor

The transport stream processor is a general-purpose packet processing framework.

It receives an MPEG Transport Stream from a user-specified input plugin, applies MPEG packet processing through several user-specified packet processor plugins and sends the processed stream to a user-specified output plugin.

All input, processors and output plugins are shared libraries (**.so** files on Linux, **.dylib** on macOS, **.dll** on Windows).

The following figure illustrates the structure of a **tsp** process using three packet processing plugins.
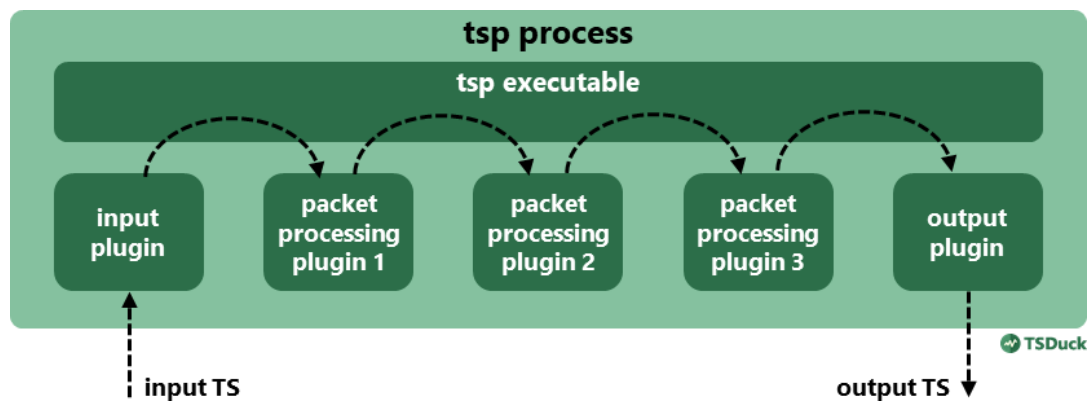
Figure 2: Transport stream processor diagram

This section describes the general syntax and usage of the **tsp** command. All plugins are documented in detail, in alphabetical order, in chapter 4, page 174. The section 5.2 gives a few examples of tsp commands, both simple and complex examples.

Usage

The general syntax of the **tsp** command is the following:

```
tsp [tsp-options] \
    [-I input-name [input-options]] \
    [-P processor-name [processor-options]] ... \
    [-O output-name [output-options]]
```

All *tsp-options* must be placed on the command line before the input, packet processing and output plugin specifications. There must be at most one input and one output plugin. There may be any number of packet processing plugins. On the command line, the order of the packet processing plugins is significant: the TS packets are passed from one processor to the other in this order.

Offline and real-time defaults

There are two main classes of usage for **tsp**, offline and real-time processing. Offline processing works on static data such as transport stream files without specific timing constraints. Real-time processing applies to streaming devices such as tuners, Dektec devices or IP streams.

In the **tsp** command and in many plugins, some command line options affect tuning and performances. Roughly, we have to find a balance between throughput and latency.

- To get a higher throughput, we must minimize the data copy and thread context switching operations. This is achieved using larger buffer sizes and letting plugins work on larger amounts

of TS packets. This requires less CPU and provides better overall performances. But this also has the side effect of increasing the latency.

- To get a lower latency, we must basically do the opposite: work on smaller data chunks, pass data faster (more frequently) from plugin to plugin. The drawback is an increase of CPU requirement.

There is no unique choice. When working on offline files, increasing the throughput and reducing the CPU load is the right choice. But for streaming and real-time processing, reducing the latency is the priority.

To optimize the offline or real-time processing, many tuning options can be adjusted. While fine tuning is sometimes useful, the user mainly needs two sets of default options: offline or real-time.

By default, **tsp** and all plugins use the offline defaults, the tuning options which give good performances at the expense of a higher latency.

The real-time defaults are used without having to specify all individual options in two cases:

- The option **--realtime** is specified in the *tsp* command line.
- At least one plugin in the chain is designed to work in real-time.

In these two cases, **tsp** and all plugins use their real-time defaults (unless, of course, options are individually set).

The second condition is an intrinsic property of a plugin. Examples of "real-time" plugins include **dvb**, **dektec**, **ip**, **play** or **regulate**. These plugins are somehow designed to work on real-time streams. Their simple presence in the **tsp** command is sufficient to trigger the use of real-time defaults for all plugins. It is still possible to force the use of offline defaults using the **tsp** option **--realtime=off**, even if a real-time plugin is present.

Rendering speed and transmission speed

With **tsp**, a stream has a *rendering* speed (the speed of the audio / video) and a *transmission* speed (the speed at which packets go through **tsp**).

As a general rule, the word *bitrate* refers to the rendering speed. So, when a plugin inserts data with a *bitrate of 100 kb/s* for instance, this means that the data will be received at this bitrate when the transport stream is played in real time (independently of the file processing speed, if the data insertion was previously performed on an offline file).

It is important to understand the differences between the two. Real-time streams, from broadcast or multicast, have identical transmission and rendering speeds because they are transmitted to watch TV. Files, on the other hand, have a very high transmission speed, typically the I/O speed of the disk, maybe 1 Gb/s or more on SSD.

Some plugins explicitly manipulate the rendering or transmission speed. The plugin **pcrbitrate**, for instance, is designed to evaluate the rendering speed based on embedded time stamps in the stream. The plugin **regulate**, on the other hand, is designed to alter the transmission speed.

Let's review some examples of where these plugins should be used.

Consider that you have recorded a 6 Mb/s single program transport stream, and you want to send it through UDP/IP to a remote media player. Using **tsp -I file**, you read it and send it to **-O ip**. The effective reading speed of the file will be 500 M/b for instance. So, on a gigabit network, you send a 6 Mb/s video stream at 1 Gb/s, 166 times faster as it should be. Thus, a 15 minute video is received in 5 seconds and the player displays almost nothing. In this case, you must use the plugin **regulate** between **-I file** and **-O ip**. The plugin acts as a bottleneck and lets packets flow out at 6 Mb/s only.

But, when the source has the same transmission and rendering speeds (DVB tuner, IP source), the plugin **regulate** is useless. At best, it does nothing. At worst, it introduces undesirable artifacts.

There are also cases where the transmission speed regulation is done automatically. If the media player is a local application and is started using **-O play**, **tsp** communicates with the player through a pipe. A pipe is a self-regulated communication mechanism. So, even if the input is a disk file with a high reading speed, using **regulate** is not necessary because the same role is played here by the pipe. The difference with the previous example is that UDP/IP is not a regulated communication channel, unlike pipes and TCP/IP.

Bitrate propagation

At any point in the chain, all plugins have some knowledge of the transport stream bitrate or *rendering* speed. Some plugins use that bitrate information, some others don't. The plugin **regulate** is a typical example. It uses the *rendering* speed as information to lower the *transmission* speed.

As a general rule, **tsp** collects the input bitrate, either from the input plugin itself which extracts the bitrate from a hardware input device (this is the case for ASI cards for instance) or, if the input plugin is not able to report a bitrate, **tsp** automatically analyzes PCR's at the output of the input plugin and computes the corresponding bitrate.

Then, the bitrate is transmitted from plugin to plugin.

Some plugins may inadvertently propagate incorrect bitrates while some plugins may force a (correct) recomputation of the bitrate. To illustrate the first case, consider "**-I file** … **-P zap** …" using sample bitrate values. You read a complete 36 Mb/s input and **tsp** evaluates this bitrate. Then, **-P zap** extracts a 4 Mb/s service and removes everything else. But it does not recompute the transport stream bitrate. So, the propagated bitrate information is still 36 Mb/s. If this information is not used downstream in other plugins, we don't care. But if we use the bitrate information in **-P regulate -O ip**, we will regulate at 36 Mb/s a stream which should be played at 4 Mb/s. This is why, in specific situations like this, we need to recompute the bitrate using **-P pcrbitrate** before **-P regulate**.

Input timestamps

For each input packet, an *input timestamp* is collected. When the source can provide its own timestamps (RTP, SRT, M2TS file), this value is used. Otherwise, **tsp** uses the system time after the input plugin returns a bulk of packets. When an input plugin is able to generate its own input timestamps, its documentation describes how this is accomplished.

The input timestamps are propagated all along the chain of plugins. Some plugins may use them. For instance:

- The **pcrverify** plugin can use them as time reference.
- The **file** output plugin uses them to create files in M2TS format.

Modifying, inserting and deleting packets

In the complete chain of processing, between the input and the output plugin, each TS packet goes through[2] all packet processing plugins, one after the other, in the order of the command line.

A packet processing plugin may read, modify or delete existing packets. **But it cannot add new packets**.

Roughly, each packet processing plugin has one of the following functions (or sometimes a combination of them):

- Analysis (read packets).
- Modification (modify existing packets).

---

[2] In fact, a TS packet never moves. It is loaded in a large circular buffer and stays there. Each plugin uses a sliding window over the circular buffer and inspects or modifies packets without moving them.

- Removal (delete packets from the stream).
- Data injection (add new packets).

The last case cannot be directly implemented. To achieve data injection, a plugin usually *steals stuffing*. Each time a new TS packet needs to be injected, a plugin waits for the next *null packet* (i.e. a packet in PID **0x1FFF**) and replaces this null packet with the new packet to insert.

Consequently, the original amount of stuffing and its distribution in a stream directly influences the insertion profile of new packets. Specifically, it is not possible to add more data than the stuffing bitrate. Moreover, precise timing cannot be always achieved. When data need to be inserted at a given bitrate, the plugin tries to reach this average bitrate (provided that there is enough stuffing) but cannot guarantee a precise constant inter-packet distance.

In broadcast streams, where the modulation parameters impose a fixed bitrate, there is always some stuffing. With variable bitrate, simple-program transport streams for IP, there can be no stuffing at all.

What are the options when the original amount of stuffing is not sufficient to insert the required data? It depends on the requirements on the stream.

If the stream is targeted for broadcast, with a given target bitrate which cannot be changed, there is no other solution than removing existing data to make room for the new data. Some plugins such as **filter** or **svremove** delete individual PID's or complete services. By default, the deleted packets are simply removed from the stream. But these plugins also have a **--stuffing** option which replaces deleted packets by stuffing instead of removing them. Thus, you can increase the stuffing bitrate without altering the global transport stream bitrate.

If there is no requirement on the global bitrate, it is possible to insert artificial stuffing at input level using the global **tsp** option **--add-input-stuffing**. The option adds a given number of null packets after a given number of input packets (for instance, add 1 null packet every 15 input packets). The parameters influence the amount and distribution of the artificial stuffing. Do not be afraid of inserting too much stuffing. It is always possible to remove the stuffing in excess using **-P filter -n -p 0x1FFF** at the end of the chain, after all injection plugins.

Merging and forking

As indicated above, **tsp** processes one single transport stream. However, specific plugins such as **merge** and **fork** respectively combine and duplicate transport streams. They are designed to route transport streams from and to other applications. When the "other" application is another instance of **tsp**, we can create complex processing graphs.

This is illustrated in the diagram below.
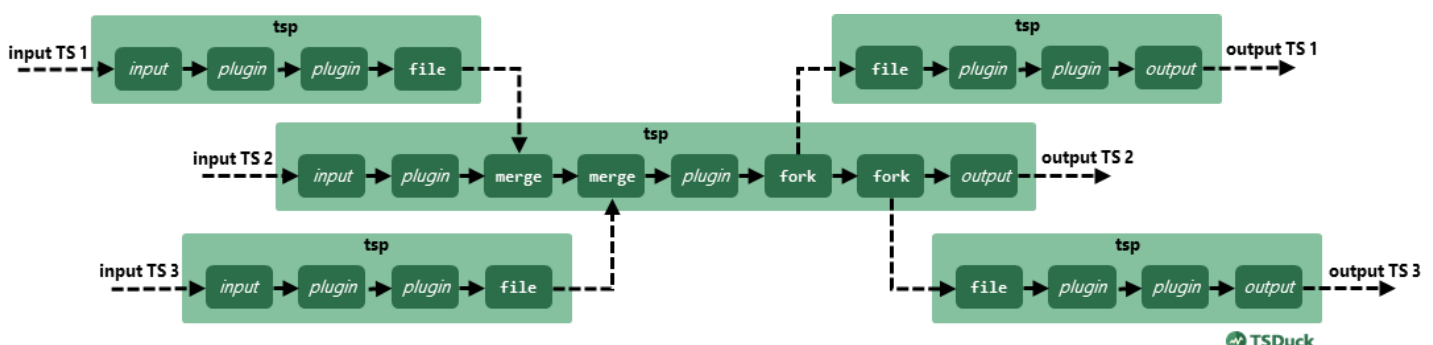
Figure 3: Merging and forking transport streams

Packet labelling

Transport streams packets may receive one or more *label* from any packet processing plugin. A label is an integer value from 0 to 31, inclusive. A label remains attached to the packet all along the chain, from

plugin to plugin. Later, it is possible to select packets with a label value or invoke a specific plugin only on packets having a given label.

The plugin **filter** has an option named **--set-label** to assign a label to the selected packets. Note that, with this option, the plugin **filter** does not drop unselected packets; it keeps all packets but assigns the specified label to the selected packets.

All packet processing plugins accept the option **--only-label** which selects only the packets with a given label. Thus, only the packets with that label pass through the plugin. All other packets, without that label, are directly passed to the next plugin in the chain.

The following example illustrates the usage of labels. The first three plugins select different kinds of packets and assign a label value depending on the kind of packet. These **filter** plugins do not drop any packet, they just assign labels to some of them. Later, three other plugins are applied only to one of these labels. In this example, we consequently count packets with unit start indicator and scrambling control value 2 and 3, respectively.

```
tsp -I ... \
    -P filter --unit-start --set-label 2 \
    -P filter --scrambling 2 --set-label 10 \
    -P filter --scrambling 3 --set-label 11 \
    -P count --only-label 2 --total --tag unit \
    -P count --only-label 10 --total --tag scr2 \
    -P count --only-label 11 --total --tag scr3 \
    -O ...

* count: unit: total: counted 5,311 packets out of 5,311
* count: scr2: total: counted 8,378 packets out of 8,378
* count: scr3: total: counted 7,439 packets out of 7,439
```

Global tsp options

-a *nullpkt/inpkt*
--add-input-stuffing *nullpkt/inpkt*

> Specify that *nullpkt* null TS packets must be automatically inserted after every *inpkt* input TS packets. Both *nullpkt* and *inpkt* must be non-zero integer values. This option is useful to artificially increase the input bitrate by adding stuffing.

> Example: the option **-a 14/24** adds 14 null packets every 24 input packets, effectively turning a 24 Mb/s input stream (terrestrial) into a 38 Mb/s stream (satellite).

--add-start-stuffing *count*

> Specify that *count* null TS packets must be automatically inserted at the start of the processing, before the first packet coming from the input plugin.

--add-stop-stuffing *count*

> Specify that *count* null TS packets must be automatically inserted at the end of the processing, after the last packet coming from the input plugin.

-b *value*
--bitrate *value*

> Specify the input bitrate, in bits/seconds. By default, the input bitrate is provided by the input plugin or by analysis of the PCR's at the beginning of the input stream. If no or not enough PCR are found, the DTS from video PID's are used.

> See section 2.2 for more details on the representation of bitrates.

> Use option **--bitrate** when you know precisely the input bitrate and you do not trust the input device, the PCR's or the DTS.

> See also the plugin **pcrbitrate** for permanent recomputation of the bitrate based on PCR's or DTS.

--bitrate-adjust-interval *value*

> Specify the interval in seconds between bitrate adjustments, ie. when the output bitrate is adjusted to the input one. The default is 5 seconds. Some output processors ignore this setting. Typically, ASI or modulator devices use it, while file devices ignore it. This option is ignored if **--bitrate** is specified.

--buffer-size-mb *value*

> Specify the global buffer size in mega-bytes. This is the size of the buffer between the input and output devices. The default is 16 MB. Increasing the buffer size may improve the performance at the expense of increasing the overall latency (implicit time-shifting).

> The value (in mega-bytes) can be decimal, for instance **--buffer-size-mb 0.5** but note that there is no good reason to decrease the buffer size below 1 MB.

> See also the options **--max-input-packets** and **--max-flushed-packets** to adjust the latency without modifying the global buffer size.

--control-local *address*

> With **--control-port**, specify the IP address of the local interface on which to listen for control commands. It can be also a host name that translates to a local address.

> By default, listen on all local interfaces.

--control-port *value*

> Specify the TCP port on which *tsp* listens for control commands.

> If unspecified, no control commands are expected.

> The control commands are sent using the command *tspcontrol*. See the documentation of this command for more details on control commands.

--control-reuse-port

> With **--control-port**, set the *reuse port* socket option on the control TCP server port.

> This option is not enabled by default to avoid accidentally running two identical *tsp* commands with the same control port.

--control-source *address*

> With **--control-port**, specify a remote IP address which is allowed to send control commands.

> By default, as a security precaution, only the local host is allowed to connect.

> Several **--control-source** options are allowed.

--control-timeout *milliseconds*

> With **--control-port**, specify the reception timeout in milliseconds for control commands.

> The default timeout is 5000 ms.

--final-wait *milliseconds*

> Wait the specified number of milliseconds after the last input packet. Zero means wait forever.

-i
--ignore-joint-termination

> Ignore all **--joint-termination** options in plugins.

> Some plugins have termination conditions. For instance, the plugin **until** passes packets until some specified condition, the plugins **mux** and **inject** may terminate **tsp** after completing the data insertion, etc.

> A plugin can decide to terminate **tsp** on its own. The termination is unconditional, regardless of the state of the other plugins. Thus, if several plugins have termination conditions, **tsp** stops

when the first plugin decides to terminate. In other words, there is an "*or*" operator between the various termination conditions.

The idea behind *joint termination* is to terminate **tsp** when several plugins have jointly terminated their processing. If several plugins have a "*joint termination*" condition (usually using the option **--joint-termination**), **tsp** stops when the last plugin triggers the joint termination condition. In other words, there is an "*and*" operator between the various joint termination conditions.

The **tsp** option **--ignore-joint-termination** disables the termination of **tsp** when all plugins have reached their joint termination condition. The plugins continue to pass packets as if some additional joint termination condition was still pending.

--initial-input-packets *value*

Specify the number of packets to initially read in the buffer before starting the processing.

The initial load is used to evaluate the bitrate so that all subsequent plugins can have a valid global bitrate value from the beginning. It is also used to make sure that the global buffer is optimally used.

The default initial load is half the size of the global buffer. For offline files and real-time devices with a sustained bitrate, it is a good idea to keep the default value.

The side effect of waiting for a significant amount of initial packets before starting the processing is that, with very low bitrates, **tsp** seems to do nothing until the global buffer is half full. The option **--initial-input-packets** is used to adjust this effect when necessary.

The downside of using a lower initial buffer load is that some plugins may not be able to use a valid bitrate for the initial part of the stream. Another downside is that the usage of the global buffer will probably be suboptimal and may even starve, creating output glitches, depending on the processing time of the intermediate plugins.

-l
--list-plugins

List all available plugins.

--log-message-count *value*

Specify the maximum number of buffered log messages. Log messages are displayed asynchronously in a low priority thread. This value specifies the maximum number of buffered log messages in memory, before being displayed. When too many messages are logged in a short period of time, while plugins use all CPU power, the low-priority log thread has no resource. It cannot display yet the buffered messages and extra messages are dropped. Increase this value if you think that too many messages are dropped.

The default is 512 messages.

See also the option **--synchronous-log**.

--log-plugin-index

In log messages, add the plugin index to the plugin name. This can be useful if the same plugin is used several times and all instances log many messages.

--max-flushed-packets *value*

Specify the maximum number of packets to be processed before flushing them to the next processor or the output. When the processing time is high and some packets are lost, try decreasing this value.

The offline default is 10 000 packets. The real-time default is 1000 packets.

--max-input-packets *value*

Specify the maximum number of packets to be received at a time from the input plugin.

By default, in offline mode, **tsp** reads as many packets as it can, depending on the free space in the buffer. The real-time default is 1000 packets.

--max-output-packets *value*

Specify the maximum number of packets to be sent at a time by the output plugin.

By default, **tsp** sends as many packets as available. This option is useful only when an output plugin or a specific output device has problems with large output requests. This option forces multiple smaller send operations.

-m[*filename*]
--monitor[=*filename*]

Continuously monitor the system resources which are used by **tsp**. This includes CPU load, virtual memory usage. Useful to verify the stability of the application or benchmarking the packet processing performance.

The optional file is an XML monitoring configuration file. See B.3.6, page 496, for more details on resource monitoring configuration files.

-r[*keyword*]
--realtime[=*keyword*]

Specifies if **tsp** and all plugins should use default values for real-time or offline processing.

By default, if any plugin prefers real-time, the real-time defaults are used. If no plugin prefers real-time, the offline default are used.

If **-r** or **--realtime** is used alone, the real-time defaults are enforced. The explicit values '**no**', '**false**', '**off**' are used to enforce the offline defaults and the explicit values '**yes**', '**true**', '**on**' are used to enforce the real-time defaults.

--receive-timeout *milliseconds*

Specify a timeout in milliseconds for all input operations.

Equivalent to the same **--receive-timeout** option in some input plugins. In practice, when an input plugin natively supports a receive timeout, this global parameter is passed to the plugin. Otherwise, *tsp* handles the receive timeout and tries to abort the stalled input operation in case of timeout.

By default, there is no input timeout.

-s
--synchronous-log

With this option, each logged message is guaranteed to be displayed, synchronously, without any loss of message. The downside is that a plugin thread may be blocked for a short while when too many messages are logged. This option shall be used when all log messages are needed, and the source and destination are not live streams (files for instance). This option is not recommended for live streams, when the responsiveness of the application is more important than the logged messages.

-t
--timed-log

Each logged message contains a time stamp.

Generic common command options

The following options are implicitly defined in all commands.

-d[*N*]
--debug[=*N*]

Produce debug output. Specify an optional debug level *N*. Do not use in normal operation.

Without this option, no debug output is produced. When the option is specified but not the level N, the default debug level is 1, that is to say a reasonable amount of information. The higher the debug level is, the more output is produced.

The debug setting is automatically transmitted to all plugins.

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

Default options for plugins

The following options are commonly found in many different plugins. They typically influence the way the signalization is interpreted or generated.

These options, when specified at **tsp** level, before specifying any plugin, have no effect on the **tsp** framework. They are only passed as initial default values for all plugins which accept the equivalent options. Explicit options at plugin level take precedence over these global defaults.

--abnt

Assume that the transport stream is an ISDB one with ABNT-defined variants. See section 2.4.2 for more details.

--atsc

Assume that the transport stream is an ATSC one. See section 2.4.2 for more details.

--brazil

A synonym for **--isdb --abnt --default-charset RAW-ISO-8859-15 --hf-band-region brazil --time-reference UTC-3**.

See sections 2.4.2 and 2.5.2 for more details.

--conax

Interpret all EMM and ECM from unknown CAS as coming from Conax.

Equivalent to **--default-cas-id 0x0B00**.

--default-cas-id *value*

Interpret all EMM's and ECM's from unknown CAS as coming from the specified *CA_System_Id*.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors.

By default, standard DVB encoding is used. See section 2.5 for more details.

--default-pds *value*

Default DVB-defined private data specifier (PDS). See section 2.4.2 for more details.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--hf-band-region *name*

Specify the region for UHF/VHF band frequency layout.

The default region is **europe**. Another default region may be specified per user in the TSDuck configuration file. See appendix A.4 page 492 for more details.

--ignore-leap-seconds

Do not explicitly include leap seconds in some UTC computations. See section 2.4.2 for more details.

--irdeto

Interpret all EMM and ECM from unknown CAS as coming from Irdeto.

Equivalent to **--default-cas-id 0x0600**.

--isdb

Assume that the transport stream is an ISDB one. See section 2.4.2 for more details.

--japan

A synonym for **--isdb --default-charset ARIB-STD-B24 --hf-band-region japan --time-reference JST**.

See sections 2.4.2 and 2.5.2 for more details.

--mediaguard

Interpret all EMM and ECM from unknown CAS as coming from MediaGuard.

Equivalent to **--default-cas-id 0x0100**.

--nagravision

Interpret all EMM and ECM from unknown CAS as coming from NagraVision.

Equivalent to **--default-cas-id 0x1800**.

--nds

Interpret all EMM and ECM from unknown CAS as coming from Synamedia (formerly known as NDS).

Equivalent to **--default-cas-id 0x0900**.

--philippines

A synonym for **--isdb --abnt --default-charset RAW-UTF-8 --hf-band-region philippines --time-reference UTC+8**.

See sections 2.4.2 and 2.5.2 for more details.

--safeaccess

Interpret all EMM and ECM from unknown CAS as coming from SafeAccess.

Equivalent to **--default-cas-id 0x4ADC**.

--time-reference *name*

Use a non-standard time reference in DVB or ISDB-defined SI. See section 2.4.2 for more details.

--usa

A synonym for **--atsc --hf-band-region usa**. See section 2.4.2 for more details.

--viaccess

Interpret all EMM and ECM from unknown CAS as coming from Viaccess.

Equivalent to **--default-cas-id 0x0500**.

--widevine

Interpret all EMM and ECM from unknown CAS as coming from Widevine CAS.

Equivalent to **--default-cas-id 0x4AD4**.

Plugin activation options

-I *name*

> Designate the shared library plugin for packet input. By default, read packets from standard input.

-O *name*

> Designate the shared library plugin for packet output. By default, write packets to standard output.

-P *name*

> Designate a shared library plugin for packet processing. Several packet processors are allowed. Each packet is successively processed by each processor, in the order of the command line. By default, there is no processor and the packets are directly passed from the input to the output.

The specified plugin *name* is used to locate a shared library for the plugin (**.so** file on Linux, **.dylib** on macOS, **.dll** on Windows). Usually, all plugins files are in the same directory as the **tsp** executable on Windows. More generally, a plugin can be designated in a number of ways, in the following order. When a method fails, the next one is attempted.

- If the plugin name is a complete path name, with a directory, this path name is used.
- Without directory in the plugin name, a list of directories is searched:
  - If the environment **TSPLUGINS_PATH** is defined, a list of directories is parsed. Directories are separated by a semicolon '**;**' on Windows and a colon '**:**' on UNIX systems.
  - The same directory as the **tsp** executable file is used as last choice.
  - In each of these directories, the file named **tsplugin_name.so** or **.dylib** or **.dll** is searched.
  - If not found, the file **name** and then **name.so** or **.dylib** or **.dll** is searched.
- If still not found, the standard algorithm of the operating system is applied to locate the shared library file, using the specified name (on Linux, see the man page of **dlopen(3)** for more details).

The *input-options*, *processor-options* and *output-options*, as specified in the general syntax of the tsp command, are specific to their corresponding plugin. All available plugins are documented in chapter 4, page 174.

All plugins accept the following common options:

--help

> The plugin displays its syntax and exits.

This means that the following type of command can be used to display the help text for a specific plugin:

```
tsp {-I|-O|-P} name --help
```

tspacketize

Packetize PSI/SI tables in a transport stream PID

This utility packetizes PSI/SI tables in a transport stream PID.

Usage

```
tspacketize [options] [input-file[=rate] ...]
```

Parameters

*input-file***[=***rate***]**

> Binary, XML or JSON files containing one or more sections or tables. By default, files with a name ending in *.bin*, *.xml* or *.json* are automatically recognized. For other file names, explicitly specify **--binary** or **--xml** or -**json**.

> If the file name is omitted, the standard input is used (binary by default, specify **--xml** or **--json** otherwise).

> The reference source format is XML. JSON files are first translated to XML using the "automated XML-to-JSON conversion" (see 2.7.3) rules of TSDuck and then compiled to binary.

> If different repetition rates are required for different files, a parameter can be "***filename=value***" where ***value*** is the repetition rate in milliseconds for all sections in that file. For repetition rates to be effective, the bitrate of the target PID must be specified, see option **--bitrate**.

> If an input file name starts with "**<?xml**", it is considered as inline XML content. Similarly, if an input file name starts with "**{**" or "**[**", it is considered as inline JSON content. In these two cases, it is not possible to specify a specific repetition rate for this XML or JSON content.

Options

--binary

> Specify that all input files are binary, regardless of their file name.

-b *value*
--bitrate *value*

> Specifies the bitrate (in bits/second) of the target PID.

> See section 2.2 for more details on the representation of bitrates.

> This information is used to schedule sections in the output list of packets when specific bitrates are specified for sections. When no specific bitrate is specified for any input file, this option is ignored.

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

-c
--continuous

> Continuous packetization. By default, generate one cycle of sections.

--default-charset *name*

> Default character set to use when encoding strings from XML files.

> By default, standard DVB encoding is used. See section 2.5 for more details.

--eit-actual

> With **--eit-normalization**, generate all EIT actual.

> Same as **--eit-actual-pf --eit-actual-schedule**.

--eit-actual-pf

With **--eit-normalization**, generate EIT p/f actual.

If no EIT selection option is specified, all EIT's are generated.

--eit-actual-schedule

With **--eit-normalization**, generate EIT schedule actual.

If no EIT selection option is specified, all EIT's are generated.

--eit-base-date *date*

With **--eit-normalization**, use the specified date as reference for the allocation of the various EIT events in sections and segments.

The date must be in the format "*year/month/day* [*hh:mm:ss*]". If only the date is present, it is used as base for the allocation of EIT schedule. If the time is also specified, it is the current time for the snapshot of EIT present/following.

By default, use the oldest date in all EIT sections as base date.

--eit-normalization

Reorganize all EIT sections according to ETSI TS 101 211 rules (see [6]).

- EIT present/following: One single EIT p/f subtable is built per service. It is split in two sections, one for present and one for following events.
- EIT schedule: All EIT schedule are kept but they are completely reorganized. All events are extracted and spread over new EIT sections according to ETSI TS 101 211 rules.

If several files are specified, the reorganization of EIT's is performed inside each file independently. This is fine as long as all EIT's for a given service are in the same input file.

See also option **--eit-base-date**.

--eit-other

With **--eit-normalization**, generate all EIT other.

Same as **--eit-other-pf --eit-other-schedule**.

--eit-other-pf

With **--eit-normalization**, generate EIT p/f other.

If no EIT selection option is specified, all EIT's are generated.

--eit-other-schedule

With **--eit-normalization**, generate EIT schedule other.

If no EIT selection option is specified, all EIT's are generated.

--eit-pf

With **--eit-normalization**, generate all EIT p/f.

Same as **--eit-actual-pf --eit-other-pf**.

--eit-schedule

With **--eit-normalization**, generate all EIT schedule.

Same as **--eit-actual-schedule --eit-other-schedule**.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

-f
--force-crc

Force recomputation of CRC32 in long sections. Ignore the CRC32 values in the input files.

By default, the CRC32 of every section is verified and sections with wrong CRC32 are rejected.

--japan

A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

-j
--json

Specify that all input files are JSON, regardless of their file name.

-o *file-name*
--output *file-name*

Output file name for TS packets. By default, use standard output.

--pack-and-flush

When loading a binary section file, pack incomplete tables, ignoring missing sections, and flush them. Sections are renumbered to remove any hole between sections.

Use with care because this may create inconsistent tables.

--philippines

A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *value*
--pid *value*

PID of the output TS packets. This is a required parameter, there is no default value.

-s
--stuffing

Insert stuffing at end of each section, up to the next TS packet boundary. By default, sections are packed and start in the middle of a TS packet, after the previous section. Note, however, that section headers are never scattered over a packet boundary.

-x
--xml

Specify that all input files are XML, regardless of their file name.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

▪ **tspcap**

Analyze pcap and pcap-ng files

This simply utility provides a summary of the content of *pcap* and *pcap-ng* files. These files contain network packets, typically captured and saved by Wireshark.

The **tspcap** utility is not meant to replace Wireshark. It only computes global analysis data which are not otherwise available in Wireshark, for instance the data bitrate over a range of packets in the file.

Wireshark is typically used to investigate issues on a network capture. Then, if some specific global analysis is required, use **tspcap**.

See some usage examples in section 5.1.10.

Usage

```
tspcap [options] [input-file]
```

Parameters

input-file

> Input file in pcap or pcap-ng format, typically as saved by Wireshark.

> Use the standard input if no file name is specified.

Options

-d [*address*][:*port*]
--destination [*address*][:*port*]

> Filter IPv4 packets based on the specified destination socket address.

> The optional port number is used for TCP and UDP packets only. If the address part is omitted, all TCP or UDP packets with any destination address but with that destination port number are used.

--dvb-simulcrypt

> Dump the content of a session as DVB SimulCrypt protocol.

> Without **--udp**, the first TCP session matching the **--source** and **--destination** options is selected. The content of the session is interpreted as one of the TLV-based DVB SimulCrypt protocols and all messages are formatted.

> With **--udp**, all packets matching the **--source** and **--destination** options are interpreted as EMMG/PDG ⇔ MUX protocol (this is the only DVB SimulCrypt protocol which is based on UDP).

-e
--extract-tcp-stream

> Extract the content of a TCP session as hexadecimal dump.

> The two directions of the TCP session are dumped.

> The first TCP session matching the **--source** and **--destination** options is selected.

--first-date *date-time*

> Filter packets starting at the specified date.

> Use format YYYY/MM/DD:hh:mm:ss.mmm.

--first-packet *value*

> Filter packets starting at the specified number.

> The packet numbering counts all captured packets from the beginning of the file, starting at 1. This is the same value as seen on Wireshark in the leftmost column.

--first-timestamp *micro-seconds*

> Filter packets starting at the specified timestamp in micro-seconds from the beginning of the capture. This is the same value as seen on Wireshark in the "Time" column (in seconds).

-i *micro-seconds*
--interval *micro-seconds*

> Print a summary of exchanged data by intervals of times in micro-seconds.
>
> By default, print a summary of the file content.

--last-date *date-time*

> Filter packets up to the specified date.
>
> Use format YYYY/MM/DD:hh:mm:ss.mmm.

--last-packet *value*

> Filter packets up to the specified number.
>
> The packet numbering counts all captured packets from the beginning of the file, starting at 1. This is the same value as seen on Wireshark in the leftmost column.

--last-timestamp *micro-seconds*

> Filter packets up to the specified timestamp in micro-seconds from the beginning of the capture. This is the same value as seen on Wireshark in the "Time" column (in seconds).

-l
--list-streams

> List all data streams in the file. A data streams is made of all packets from one source to one destination using one protocol.
>
> By default, print a summary of the file content.

--no-pager

> Do not send output through a pager process. By default, if the output device is a terminal, the output is paged. See 3.1.4 for more details.

--others

> Filter packets from "other" protocols, i.e. neither TCP nor UDP.

-o *file-name*
--output-tcp-stream *file-name*

> Extract the content of a TCP session and save it in the specified binary file.
>
> The first TCP session matching the **--source** and **--destination** options is selected.
>
> Unlike **--extract-tcp-stream**, only one side of the TCP session is saved, from **--source** to **--destination**.
>
> If the file name is "-", the standard output is used.

-s [*address*][:*port*]
--source [*address*][:*port*]

> Filter IPv4 packets based on the specified source socket address.
>
> The optional port number is used for TCP and UDP packets only. If the address part is omitted, all TCP or UDP packets with any source address but with that source port number are used.

-t
--tcp

> Filter TCP packets.

-u
--udp

    Filter UDP packets.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

    Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

    Display command help text.

-v
--verbose

    Produce verbose messages.

--version

    Display the version number.

▪ tspcontrol

Send control commands to a running tsp process

This utility controls the execution of a running **tsp** process. The target **tsp** command shall listen to control commands using the option **--control-port** (see the documentation of **tsp**).

Usage

```
tspcontrol [options] command ...
```

Parameters

command ...

> The control command to send to the target **tsp** process. See the list of control commands below.
>
> Note that everything after the control command name is considered as options and parameters of this control command. The options of **tspcontrol** must be placed before the control command name.

Options

-t [*address:*]*port*
--tsp [*address:*]*port*

> Specify the IP address (or host name) and port where the target *tsp* process expects control commands (*tsp* option **--control-port**). If the IP address is omitted, the local host is used.
>
> This is a required parameter, there is no default.

Generic common command options

> The following options are implicitly defined in all commands.

-d[*N*]
--debug[=*N*]

> Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

> Display command help text.

-v
--verbose

> Produce verbose messages.

--version

> Display the version number.

List of control commands

exit   Terminate the **tsp** process.

> Usage: `tspcontrol exit [options]`
>
> **--abort**   Specify to immediately abort the **tsp** process.
>
> > By default, this command notifies each plugin to terminate and let the processing continue until the process naturally exits.

list   List all running plugins.

> The listed plugin indexes can be used with other control commands such as **suspend**, **resume** or **restart**.

Usage: `tspcontrol list [`*`options`*`]`

-v   Produce verbose output.
--verbose

restart   Restart a plugin with different parameters.

Usage: `tspcontrol restart [`*`options`*`] `*`index`*` [`*`plugin-options ...`*`]`

Parameters: Index of the plugin to restart, followed by the new plugin parameters
               to use.

-s   Restart the plugin with the same options and parameters as the current
--same   ones. By default, when no plugin options are specified, restart with no
               option at all.

-v   Produce verbose output.
--verbose

resume   Resume a suspended plugin.

Usage: `tspcontrol resume [`*`options`*`] `*`index`*

Parameter: Index of the plugin to resume.

-v   Produce verbose output.
--verbose

set-log   Change the log level in the **tsp** process

Usage: `tspcontrol set-log `*`level`*

Parameter: Specify a new logging level for the **tsp** process. It can be one of "**fatal**",
               "**severe**", "**error**", "**warning**", "**info**", "**verbose**", "**debug**" or a positive
               value for higher debug levels.

suspend   Suspend a plugin.

               When a packet processing plugin is suspended, the TS packets are directly passed from
               the previous to the next plugin, without going through the suspended one.

               When the output plugin is suspended, the output packets are dropped.

               The input plugin cannot be suspended.

Usage: `tspcontrol suspend [options] index`

Parameters: Index of the plugin to suspend.

-v   Produce verbose output.
--verbose

⊞ tspsi

Dump all PSI tables

This utility extracts all PSI tables (PAT, CAT, PMT, NIT, BAT, SDT[3]) from a transport stream. The output is rather primitive, but it exactly exhibits the structure of tables, sections and descriptors.

Usage

```
tspsi [options] [input-file]
```

Input file

MPEG transport stream, either a capture file or a pipe from a live stream (see option **--format** for binary formats).

If the parameter is omitted, is an empty string or a dash ("**-**"), the standard input is used.

Options

-a
--all-versions

> Display all versions of PSI tables (need to read the complete transport stream). By default, display only the first version of each PSI table and stop when all expected PSI are extracted.

--cat-only

> Display only the CAT, ignore other PSI tables.

-c
--clear

> Indicate that this is a clear transport stream, without conditional access information. Useful to avoid further reading the transport stream, waiting for a non-existent CAT.

-d
--dump

> Dump all PSI sections.

--exclude-current

> Exclude PSI tables with "current" indicator. This is rarely necessary.

> See also **--include-next**.

--format *name*

> Specify the format of the input file. See section 2.1.2 for more details.

--include-next

> Include PSI tables with "next" indicator. By default, they are excluded.

-j *file-name*
--json-output *file-name*

> Save the tables in JSON format in the specified file. To output the JSON text on the standard output, explicitly specify this option with "**-**" as output file name.

> The tables are initially formatted as XML and an automated XML-to-JSON conversion is applied. See section 2.7.3 for more details on XML-to-JSON conversion.

---

[3] I know, BAT and SDT are SI, not PSI ☺

--log-json-line[='*prefix*']

>   Log each table as one single JSON line in the message logger instead of an output file.

>   Each table is initially formatted as XML and an automated XML-to-JSON conversion is applied. See section 2.7.3 for more details on XML-to-JSON conversion.

>   The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--log-xml-line[='*prefix*']

>   Log each table as one single XML line in the message logger instead of an output file.

>   The optional string parameter specifies a prefix to prepend on the log line before the XML text to facilitate the filtering of the appropriate line in the logs.

--no-pager

>   Do not send output through a pager process. By default, if the output device is a terminal, the output is paged. See 3.1.4 for more details.

-o *file-name*
--output-file *file-name*
--text-output *file-name*

>   Save the tables or sections in human-readable text format in the specified file name. By default, when no output option is specified, text is produced on the standard output.

>   If you need text formatting on the standard output in addition to other output such as XML, explicitly specify this option with "**-**" as output file name.

--strict-xml

>   Save XML documents in strictly conformant XML format. By default, do not escape characters when this is not syntactically necessary to make the XML text more human-readable.

--x2j-collapse-text
--x2j-enforce-boolean
--x2j-enforce-integer
--x2j-include-root
--x2j-trim-text

>   Specific options for automated XML-to-JSON conversion. See section 2.7.3.2 for details.

-x *file-name*
--xml-output *file-name*

>   Save the tables in XML format in the specified file. To output the XML text on the standard output, explicitly specify this option with "**-**" as output file name.

Tables and sections interpretation and formatting options

--abnt

>   Assume that the transport stream is an ISDB one with ABNT-defined variants. See section 2.4.2 for more details.

--atsc

>   Assume that the transport stream is an ATSC one. See section 2.4.2 for more details.

--brazil

>   A synonym for **--isdb --abnt --default-charset RAW-ISO-8859-15 --time-reference UTC-3**. See sections 2.4.2 and 2.5.2 for more details.

-c
--c-style

>   Same as **--raw-dump** (no interpretation of section) but dump the bytes in C-language style, e.g. "**0x01, 0x02,**" instead of "**01 02**". Useful to include this output as data in a C source file.

--default-charset *name*

>   Default character set to use when interpreting strings from tables and descriptors.
>
>   By default, standard DVB encoding is used. See section 2.5 for more details.

--default-pds *value*

>   Default DVB-defined private data specifier (PDS). See section 2.4.2 for more details.

--europe

>   A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--ignore-leap-seconds

>   Do not explicitly include leap seconds in some UTC computations. See 2.4.2 for more details.2.4.2

--isdb

>   Assume that the transport stream is an ISDB one.
>
>   ISDB streams are normally automatically detected from their signalization. This option is only useful when ISDB-related stuff are found in the TS before the first ISDB-specific table.

--japan

>   A synonym for **--isdb --time-reference JST --default-charset ARIB-STD-B24**.
>
>   See sections 2.4.2 and 2.5.2 for more details.

--nested-tlv[=*min-size***]**

>   With option `--tlv`, try to interpret the value field of each TLV record as another TLV area. If the *min-size* value is specified, the nested TLV interpretation is performed only on value fields larger than this size. The syntax of the nested TLV is the same as the enclosing TLV.

--philippines

>   A synonym for **--isdb --abnt --default-charset RAW-UTF-8 --time-reference UTC+8**.
>
>   See sections 2.4.2 and 2.5.2 for more details.

-r
--raw-dump

>   Raw dump of section, no interpretation.

--time-reference *name*

>   Use a non-standard time reference in DVB or ISDB-defined SI. See section 2.4.2 for more details.

--tlv *syntax*

>   For sections of unknown types, this option specifies how to interpret some parts of the section payload as TLV records. Several **--tlv** options are allowed, each one describes a part of the section payload.
>
>   Each syntax string has the form "*start,size,tagSize,lengthSize,order*". The *start* and *size* fields define the offset and size of the TLV area in the section payload. If the *size* field is "**auto**", the TLV extends up to the end of the section. If the start field is "**auto**", the longest TLV area in the section payload will be used. The fields *tagSize* and *lengthSize* indicate the size in bytes of the Tag and Length fields in the TLV structure. The field *order* must be either "**msb**" or "**lsb**" and indicates the byte order of the Tag and Length fields.

All fields are optional. The default values are "**auto,auto,1,1,msb**".

--usa

A synonym for **--atsc**. See section 2.4.2 for more details.

CAS identification options

By default, EMM's and ECM's are interpreted according to the *CA_descriptor* which references their PID. The following options are useful when analyzing partial transport streams without CAT or PMT to correctly identify the CA PID's.

--conax

Interpret all EMM and ECM from unknown CAS as coming from Conax.

Equivalent to **--default-cas-id 0x0B00**.

--default-cas-id *value*

Interpret all EMM's and ECM's from unknown CAS as coming from the specified *CA_System_Id*.

--irdeto

Interpret all EMM and ECM from unknown CAS as coming from Irdeto.

Equivalent to **--default-cas-id 0x0600**.

--mediaguard

Interpret all EMM and ECM from unknown CAS as coming from MediaGuard.

Equivalent to **--default-cas-id 0x0100**.

--nagravision

Interpret all EMM and ECM from unknown CAS as coming from NagraVision.

Equivalent to **--default-cas-id 0x1800**.

--nds

Interpret all EMM and ECM from unknown CAS as coming from Synamedia (formerly known as NDS).

Equivalent to **--default-cas-id 0x0900**.

--safeaccess

Interpret all EMM and ECM from unknown CAS as coming from SafeAccess.

Equivalent to **--default-cas-id 0x4ADC**.

--viaccess

Interpret all EMM and ECM from unknown CAS as coming from Viaccess.

Equivalent to **--default-cas-id 0x0500**.

--widevine

Interpret all EMM and ECM from unknown CAS as coming from Widevine CAS.

Equivalent to **--default-cas-id 0x4AD4**.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

▪ **tsresync**

Resynchronize corrupted transport stream files

This utility resynchronizes a corrupted transport stream file.

Usage

```
tsresync [options] [input-file]
```

Input file

MPEG transport stream, either a capture file or a pipe from a live stream. Must be a binary stream of transport stream packets, with various encapsulation or possible corruptions.

If the parameter is omitted, is an empty string or a dash ("**-**"), the standard input is used.

Options

-c
--continue

Continue re-resynchronizing after loss of synchronization. By default, stop after first packet not starting with **0x47**.

-h *value*
--header-size *value*

When used with **--packet-size**, specifies the size of extra data preceeding each packet in the input file. The default is zero.

-k
--keep

Keep TS packet size from input to output file. By default, strip extra data and reduce packets to 188 bytes. See option **--packet-size** for a description of supported input packet sizes.

-m *value*
--min-contiguous *value*

Minimum size containing contiguous valid packets to consider a slice of input file as containing actual packets (default: 512 kB).

-o *file-name*
--output *file-name*

Output file name (standard output by default).

-p *value*
--packet-size *value*

Expected TS packet size in bytes. By default, try:

- 188-byte (standard)
- 204-byte (trailing 16-byte Reed-Solomon outer FEC)
- 192-byte (leading 4-byte timestamp in M2TS/Blu-ray disc files).

If the input file contains any other type of packet encapsulation, use options **--packet-size** and **--header-size**.

-s *value*
--sync-size *value*

Number of initial bytes to analyze to find start of packet synchronization (default: 1 MB).

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

▪ **tsscan**

Digital TV network scanning of frequencies and services

This utility scans frequencies, transport streams and services in a DTV network.

There are two types of scanning:

- NIT-based scanning: Modulation parameters must be given. In a first phase, the specified "reference" transport stream is acquired, its NIT is read and all transport stream descriptions (with their *delivery system descriptors*) are interpreted. In a second phase, all these transport streams are acquired to check their content.

- Blind band scanning: This method applies to UHF and VHF bands only, for terrestrial DTV networks. All predefined channels in the selected band in the selected region or country are scanned one by one.

Usage

```
tsscan [options]
```

Scanning method selection

-n
--nit-scan

> Perform a NIT-based scanning.

> Tuning parameters for a reference transport stream must be present (frequency or channel reference). The NIT is read on the specified frequency and a full scan of the corresponding network is performed.

-u
--uhf-band

> Perform a complete UHF-band scanning (DVB-T, ISDB-T or ATSC).

> Use the predefined UHF frequency layout of the specified region (see option **--hf-band-region**).

> By default, scan the center frequency of each channel only. Use option **--use-offsets** to scan all predefined offsets in each channel.

-v
--vhf-band

> Perform a complete VHF-band scanning.

> See also option **--uhf-band**.

Tuner device options and tuning parameters

All options from the *dvb* input plugin are also available to *tsscan*. See page 229 for the list of options.

In the **dvb** input plugin documentation, the "reception options" specify which tuner to use and basic reception timeouts. These options are used by **tsscan** in all types of scanning.

Specific tuning parameters are used with **--nit-scan** only. They are used to receive the initial reference transport stream from which the NIT is analyzed.

Scanning options

--abnt

> Assume that the transport stream is an ISDB one with ABNT-defined variants. See section 2.4.2 for more details.

--atsc

Assume that the transport stream is an ATSC one. See section 2.4.2 for more details.

--best-strength

With UHF/VHF -band scanning, for each channel, use the offset with the best signal strength.
By default, use the average of lowest and highest offsets with required minimum strength.
Note that some tuners cannot report a correct signal strength, making this option useless.

--brazil

A synonym for **--isdb --abnt --default-charset RAW-ISO-8859-15 --hf-band-region brazil**.
See sections 2.4.2 and 2.5.2 for more details.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors.
By default, standard DVB encoding is used. See section 2.5 for more details.

--default-pds *value*

Default DVB-defined private data specifier (PDS). See section 2.4.2 for more details.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--first-channel *value*

For UHF/VHF-band scanning, specify the first channel to scan (default: lowest channel in band).

--first-offset *value*

For UHF/VHF-band scanning, specify the first offset to scan on each channel. Note that `tsscan`
may scan lower offsets. As long as some signal is found at a specified offset, **tsscan** continues
to check up to 3 lower offsets below the "first" one. This means that if a signal is found at offset
-2, offset -3 will be checked anyway, etc. up to offset -5.

-g
--global-service-list

Same as **--service-list** but display a global list of services at the end of scanning instead of per
transport stream.

-r *name*
--hf-band-region *name*

Specify the region for UHF/VHF band frequency layout.
The default region is "**europe**". Another default region may be specified per user in the TSDuck
configuration file. See appendix A.4 page 492 for more details.

--ignore-leap-seconds

Do not explicitly include leap seconds in some UTC computations. See section 2.4.2 for more
details.

--isdb

Assume that the transport stream is an ISDB one. See section 2.4.2 for more details.

--japan

A synonym for **--isdb --default-charset ARIB-STD-B24 --hf-band-region japan**.
See sections 2.4.2 and 2.5.2 for more details.

--last-channel *value*

For UHF/VHF -band scanning, specify the last channel to scan (default: highest channel in band).

--last-offset *value*

> For UHF/VHF-band scanning, specify the last offset to scan on each channel. Note that `tsscan` may scan higher offsets. As long as some signal is found at a specified offset, `tsscan` continues to check up to 3 higher offsets above the "*last*" one. This means that if a signal is found at offset +2, offset +3 will be checked anyway, etc. up to offset +5.

--min-strength *value*

> Minimum signal strength. Frequencies with lower signal strength are ignored.

> The value can be in milli-dB or percentage. It depends on the tuner and its driver. Check the displayed unit. The default is 10, whatever unit it is.

--no-offset

> For UHF/VHF-band scanning, scan only the central frequency of each channel. This is now the default. Specify option **--use-offsets** to scan all offsets.

--philippines

> A synonym for **--isdb --abnt --default-charset RAW-UTF-8 --hf-band-region philippines**.

> See sections 2.4.2 and 2.5.2 for more details.

--psi-timeout *milliseconds*

> Specifies the timeout, in milli-seconds, for PSI/SI table collection. Useful with **--service-list** or NIT-based scan. The default is 10000 milli-seconds.

--save-channels *filename*

> Save the description of all channels in the specified XML file. See Appendix B, page 494, for more details on channels configuration files.

> If the file name is "**-**", use the default tuning configuration file.

> See also option **--update-channels**.

-l
--service-list

> Read SDT of each channel and display the list of services.

--show-modulation

> Display modulation parameters.

> Windows-specific note: With UHF band scanning, the actual modulation parameters of a transponder may not be available. This depends on the driver of the tuner. Most drivers do not report the correct values.

--update-channels *filename*

> Update the description of all channels in the specified XML file. The content of each scanned transport stream is replaced in the file. If the file does not exist, it is created. See Appendix B, page 494, for more details on channels configuration files.

> If the file name is "**-**", use the default tuning configuration file.

> See also option **--save-channels**.

--usa

> A synonym for **--atsc --hf-band-region usa**. See section 2.4.2 for more details.

--use-offsets

> For UHF/VHF-band scanning, do not scan only the central frequency of each channel. Also scan frequencies with offsets.

As an example, if a signal is transmitted at offset +1, the reception may be successful at offsets -1 to +3 (but not -2 and +4). With this option, `tsscan` checks all offsets and reports that the signal is at offset +1 (central point between offsets -1 and +3).

By default, `tsscan` reports that the signal is found at the central frequency of the channel (offset zero). This significantly speeds up the scanning process but does not provide any offset information.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=N]

Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

Display command help text.

--verbose

Produce verbose messages.

--version

Display the version number.

▪ **tssmartcard**

Smartcard utility

This utility lists or resets the smart-card readers in the system.

Usage

```
tssmartcard [options] [reader-name]
```

Reader name

The optional *reader-name* parameter indicates the smart-card reader device name to list or reset.

By default, without any option or parameter, the command lists all smart-card reader devices in the system.

Options

-a *hexa-data*
--apdu *hexa-data*

Send an APDU to the smartcard. The APDU shall be specified using an even number of hexadecimal digits. In verbose mode, the APDU, the status word and the response are displayed.

Several **--apdu** options can be specified. All APDU's are sent in sequence.

-c
--cold-reset

Perform a cold reset on the smart-card.

--continue-on-error

With **--apdu**, continue sending next APDU's after a PC/SC error.

By default, stop when an APDU triggered an error.

-e
--eject

Eject the smart-card (if supported by the reader device).

-t *value*
--timeout *value*

Timeout in milliseconds. The default is 1000 ms (1 second).

-w
--warm-reset

Perform a warm reset on the smart-card.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=N**]**

Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

▪ **tsstuff**

Add stuffing to a TS file to reach a target bitrate

This utility adds stuffing packets to a TS file to reach a target bitrate. Time stamps (PCR or DTS) are extracted from one *reference PID* in the input file and stuffing packets are added so that the time stamps are approximately synchronized with the TS target bitrate.

Usage

```
tsstuff [options] [input-file]
```

Input file

The input file is a TS file, typically with variable bitrate content.

If the parameter is omitted, is an empty string or a dash ("**-**"), the standard input is used.

Options

-b *value*
--bitrate *value*

> Target constant bitrate of the output file.
>
> See section 2.2 for more details on the representation of bitrates.
>
> This is mandatory parameter, there is no default.

--buffer-size *value*

> Input buffer size, in bytes. Must be large enough to always contain two time stamps in the reference PID. Default: 4,194,304 bytes (4 MB).

-d
--dts-based

> Use Decoding Time Stamps (DTS) in the reference PID to evaluate the amount of stuffing to insert. The default is to use Program Clock References (PCR) instead of DTS.

-f *value*
--final-inter-packet *value*

> Number of stuffing packets to add between input packets after the last time stamp (PCR or DTS). By default, use the same number as in the previous segment, between the last two time stamps.

-i *value*
--initial-inter-packet *value*

> Number of stuffing packets to add between input packets before the first time stamp (PCR or DTS). By default, use the same number as in the first segment, between the first two time stamps.

--input-format *name*

> Specify the format of the input file. See section 2.1.2 for more details.

-l *value*
--leading-packets *value*

> Number of consecutive stuffing packets to add at the beginning of the output file, before the first input packet. The default is zero.

-m *value*
--min-interval *value*

> Minimum interval, in milli-seconds, between two recomputations of the amount of stuffing to insert. This duration is based on timestamps, not real time. The default is 100 ms.

-o *filename*
--output-file *filename*

>   Output file name (standard output by default). The output file is a TS file with the same packets as the input file with interspersed stuffing packets and a constant bitrate.

--output-format *name*

>   Specify the format of the output file. See section 2.1.2 for more details. By default, the format is a standard TS file.

-r *value*
--reference-pid *value*

>   PID in which to collect time stamps (PCR or DTS) to use as reference for the insertion of stuffing packets. By default, use the first PID containing the specified type of time stamps (PCR or DTS).

-t *value*
--trailing-packets *value*

>   Number of consecutive stuffing packets to add at the end of the output file, after the last input packet. The default is zero.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=N**]**

>   Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

>   Display command help text.

-v
--verbose

>   Produce verbose messages.

--version

>   Display the version number.

▪ **tsswitch**

Transport stream input source switch using remote control

This utility uses several transport stream inputs and one single output. One input is selected and passed to the output. Using either predefined policies or remote control, it is possible to switch back and forth between inputs.

All inputs and output are performed using external plugins. These plugins are the same as the plugins which are used by **tsp**.

Using the input plugins **file** or **fork**, it is possible to connect applications to some **tsswitch** input. One of these applications can be **tsp**, in which case it is possible to insert specific processing between the input plugin and the switch.

See a sample usage with a system diagram in section 5.1.7.

Cycling through input plugins

The list of input plugins is ordered by index on the command line, from 0 to n-1. By default, the input plugin 0 is started when the command starts. When a plugin terminates (end of input or error), the next one is started. When the last plugin terminates, the **tsswitch** command terminates.

Running all input plugins in sequence, from 0 to n-1, is called a *cycle*. By default, only one cycle is executed before **tsswitch** terminates. Using the option **--cycle**, it is possible to execute a given number of cycles. With the option **--infinite**, **tsswitch** runs endlessly.

With the option **--terminate**, **tsswitch** terminates when the current plugin terminates. In this case, without remote control, **tsswitch** only executes the first plugin. If the remote control was used to switch to another input, **tsswitch** terminates when the current plugin terminates, whichever it is.

Input switching modes

There are three different modes when switching from an input plugin to another one.

By default, only one input plugin is active at a time. When **tsswitch** starts, the first plugin is started. When an input switch is requested, the current plugin is first stopped. When the stop operation is complete, the next plugin is started. This mode is required when two plugins use the same input device such as a tuner. Since the device cannot be shared, it must be completely stopped and closed before being reused by the next plugin. This is the safest mode. The downside is that there could be a transmission hole in the output during the switch.

With option **--delayed-switch**, the switching operation is slightly different. The next plugin is started first. In the meantime, output packets continue to be fetched from the previous input plugin. When the next plugin starts to receive packets, the switch is performed: output packets are now read from the next plugin. Finally, the previous input plugin is stopped. This mode guarantees a smooth transition. However, the actual output switch is delayed until the next plugin is fully operational.

With option **--fast-switch**, all input plugins are started in parallel from the beginning and are never stopped. All input plugins continuously read packets and fill their buffer. The current plugin performs normal flow control with the output plugin, without packet loss. All other input plugins continuously overwrite their circular input buffer. When an input switch is requested, the output plugin immediately jumps into the next plugin buffer where the latest packets are already available. This mode guarantees a smooth and immediate switch. It is appropriate for live streams only.

Remote control

Using the option **--remote**, **tsswitch** listens to UDP datagrams on a given port. Each datagram contains one switch command. A command is an ASCII string. Any trailing control characters such as CR or LF is ignored.

The command string can be one of:

- An input index (e.g. "**0**", "**1**", "**2**", etc.) Upon reception, **tsswitch** immediately switches to the selected input plugin.
- Strings "**next**" and "**previous**" (or "**prev**") to switch to the next and previous input, respectively.
- Strings "**exit**" or "**quit**" to properly terminate **tsswitch**.
- Strings "**halt**" or "**abort**" to immediately abort the **tsswitch** process.

Note that the bash[4] shell provides an easy way to redirect output to a UDP message. The following sample commands send UDP messages on port 4444 to system 127.0.0.1 (the local host). This is the easiest way to use the **tsswitch** remote control.

```
echo >/dev/udp/127.0.0.1/4444 2
echo >/dev/udp/127.0.0.1/4444 next
echo >/dev/udp/127.0.0.1/4444 prev
echo >/dev/udp/127.0.0.1/4444 exit
```

Event notification

It is possible to notify some external system of switching events, typically when a new input is selected. This can be done in two ways. First, it is possible to launch an external shell command each time a switching event occurs. Second, it is possible to send a JSON description of the event over UDP (possibly on a multicast address if necessary).

As an example, the following command demonstrates both methods at the same time:

```
tsswitch --infinite --event-command "echo ==== EVENT" --event-udp localhost:4444 \
    -I fork "tsp -I file $FILE1 -P regulate -P until --second 5" \
    -I fork "tsp -I file $FILE2 -P regulate -P until --second 5" \
    -O drop
```

The output of the command illustrates how the **--event-command** option works:

```
==== EVENT newinput 0 0
==== EVENT newinput 0 1
==== EVENT newinput 1 0
==== EVENT newinput 0 1
==== EVENT newinput 1 0
==== EVENT newinput 0 1
...
```

The first message refers to the command startup, using input #0 as initial input. All other messages refer to switching events from input #0 to input #1 or vice-versa.

To demonstrate the usage of the JSON UDP messages, we use the following command from another session running in parallel. It loops on reception of one UDP message using the command **nc** (*netcat*). The output of **nc** is piped into **jq** (*JSON query*) to display an indented and colored output of the JSON message.

```
$ while true; do nc -u -l -w 0 4444 | jq; done
{
  "command": "tsswitch",
  "event": "newinput",
  "new-input": 0,
  "origin": "tsduck",
  "previous-input": 1,
  "timestamp": "2021/03/13 19:33:42.595"
}
{
  "command": "tsswitch",
```

---

[4] This is a feature of **bash**, not a Linux feature. It is available on all platforms, including macOS and Cygwin or Msys on Windows.

```
  "event": "newinput",
  "new-input": 1,
  "origin": "tsduck",
  "previous-input": 0,
  "timestamp": "2021/03/13 19:33:47.688"
}
{
  "command": "tsswitch",
  "event": "newinput",
  "new-input": 0,
  "origin": "tsduck",
  "previous-input": 1,
  "timestamp": "2021/03/13 19:33:52.780"
}
...
```

Usage

The general syntax of the **tsswitch** command is the following:

```
tsswitch [tsswitch-options] \
        -I input-name [input-options] ... \
        [-O output-name [output-options]]
```

All *tsswitch-options* must be placed on the command line before the input and output plugin specifications. There must be at least one input plugin and at most one output plugin. The default output plugin is **file**, sending all packets to the standard output.

On the command line, the order of the input plugins is significant. They are indexed from 0 to n-1. This index value is used in the remote control protocol to select an input stream.

Plugin activation options

-I *name*

> Designate the shared library plugin for packet input. There is no default. At least one input plugin shall be specified.

-O *name*

> Designate the shared library plugin for packet output. By default, write packets to standard output.

All input and output plugins which are available for **tsp** can be used by **tsswitch**. See the description of the command **tsp** for the method to locate the plugin files.

General options

-b *value*
--buffer-packets *value*

> Specify the size in TS packets of each input plugin buffer. The default is 512 packets.

-l
--list-plugins

> List all available plugins.

--max-input-packets *value*

> Specify the maximum number of TS packets to read at a time. This value may impact the switch response time. The default is 128 packets. The actual value is never more than half the **--buffer-packets** value.

--max-output-packets *value*

> Specify the maximum number of TS packets to write at a time. The default is 128 packets.

Input cycles options

-c *value*
--cycle *value*

> Specify how many times to repeat the cycle through all input plugins in sequence. By default, all input plugins are executed in sequence only once (**--cycle 1**). The options **--cycle**, **--infinite** and **--terminate** are mutually exclusive.

--first-input *value*

> Specify the index of the first input plugin to start. By default, the first plugin (index 0) is used.

-i
--infinite

> Infinitely repeat the cycle through all input plugins in sequence.

-t
--terminate

> Terminate execution when the current input plugin terminates.

Input modes options

-d
--delayed-switch

> Perform delayed input switching. When switching from one input plugin to another one, the second plugin is started first. Packets from the first plugin continue to be output while the second plugin is starting. Then, after the second plugin starts to receive packets, the switch occurs: packets are now fetched from the second plugin. Finally, after the switch, the first plugin is stopped.

> By default, the current input is first stopped and then the next one is started. Options **--delayed-switch** and **--fast-switch** are mutually exclusive.

-f
--fast-switch

> Perform fast input switching. All input plugins are started at once and they continuously receive packets in parallel. Packets are dropped, except for the current input plugin. This option is typically used when all inputs are live streams on distinct devices (not the same DVB tuner for instance).

> By default, only one input plugin is started at a time. When switching, the current input is first stopped and then the next one is started. Options **--delayed-switch** and **--fast-switch** are mutually exclusive.

-p *value*
--primary-input *value*

> Specify the index of the input plugin which is considered as primary or preferred.

> This input plugin is always started, never stopped, even without **--fast-switch**. When no packet is received on this plugin, the normal switching rules apply. However, as soon as packets are back on the primary input, the reception is immediately switched back to it.

> By default, there is no primary input, all input plugins are equal.

--receive-timeout *value*

> Specify a receive timeout in milliseconds (independently of any equivalent feature the input plugins).

> When the current input plugin has received no packet within this timeout, automatically switch to the next plugin.

By default, without **--primary-input**, there is no automatic switch when the current input plugin is waiting for packets. With **--primary-input**, the default is 2,000 ms.

Remote control options

-a *address*
--allow *address*

> Specify an IP address or host name which is allowed to send remote commands. Several **--allow** options can be used to specify several allowed remote control systems.
>
> By default, all received commands are accepted. If at least one **--allow** option is specified, any remote command which is not sent by an allowed host is rejected.
>
> This is a security feature, but not a perfect one since IP address spoofing is trivial with UDP.

--no-reuse-port

> Disable the reuse port socket option. Do not use unless completely necessary.

-r [*address*:]*port*
--remote [*address*:]*port*

> Specify the local UDP port which is used to receive remote commands. If an optional address is specified, it must be a local IP address of the system. By default, there is no remote control.

--udp-buffer-size *value*

> Specifies the UDP socket receive buffer size in bytes (socket option).

Logging options

--log-message-count *value*

> Specify the maximum number of buffered log messages. Log messages are displayed asynchronously in a low priority thread. This value specifies the maximum number of buffered log messages in memory, before being displayed. When too many messages are logged in a short period of time, while plugins use all CPU power, extra messages are dropped. Increase this value if you think that too many messages are dropped. The default is 512 messages.

-m[*filename*]
--monitor[=*filename*]

> Continuously monitor the system resources which are used by **tsswitch**. This includes CPU load, virtual memory usage. Useful to verify the stability of the application or benchmarking the packet processing performance.
>
> The optional file is an XML monitoring configuration file. See B.3.6, page 496, for more details on resource monitoring configuration files.

-s
--synchronous-log

> Each logged message is guaranteed to be displayed, synchronously, without any loss of message. The downside is that a plugin thread may be blocked for a short while when too many messages are logged. This option shall be used when all log messages are needed and the source and destination are not live streams (files for instance). This option is not recommended for live streams, when the responsiveness of the application is more important than the logged messages.

--timed-log

> Each logged message contains a time stamp.

Event notification options

The following options are used to notify external systems of events occurring in **tsswitch**. Currently, only one type of event is defined: its name is **newinput** and is signalled when input switching occurs (including the first input when **tsswitch** starts).

--event-command "*command***"**

> When a switch event occurs, run this external shell command. This can be used to notify some external system of the event.
>
> The command receives additional parameters:
>
> 1. Event name, currently only "**newinput**" is defined.
> 2. The input index before the event.
> 3. The input index after the event.
> 4. Optional: the user data string from **--event-user-data** option.
>
> These parameters can be used or ignored by the alarm command.

--event-local-address *address*

> With **--event-udp**, when the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--event-ttl *value*

> With **--event-udp**, specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address. Remember that the default Multicast TTL is 1 on most systems.

--event-udp *address:port*

> When a switch event occurs, send a short JSON description over UDP/IP to the specified destination. This can be used to notify some external system of the event.
>
> The *address* specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The *port* specifies the destination UDP port.

--event-user-data '*string*'

> A user-defined string which is passed to the event processing.
>
> With **--event-command**, this string is passed as last parameter of the user-specified command.
>
> With **--event-udp**, this string is passed as **"user-data"** JSON value.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N***]**

> Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

> Display command help text.

-v
--verbose

> Produce verbose messages.

--version

> Display the version number.

▪ **tstabcomp**

Compile or decompile MPEG tables from XML files

This utility is an MPEG table compiler which takes MPEG tables in *source form* as XML files and produces binary section files.

The **tstabcomp** utility is also an MPEG table decompiler. From a binary file containing sections, it recreates an XML file. This XML file can be edited by hand and recompiled for instance.

See section 2.3 for a description of the format of PSI/SI files which can be manipulated by TSDuck and more specifically section 2.3.2 for a complete description of XML files.

Additionally, TSDuck defines automated XML-to-JSON translation rules (see section 2.7.3). The command **tstabcomp** can use these translation rules to read input source files in JSON format and write output decompiled tables in JSON format. But in all cases, XML is used as intermediate format. Input JSON files are translated to XML first and then compiled in binary format. On output, the tables are first decompiled in XML format and then translated to JSON.

Usage

```
tstabcomp [options] input-file ...
```

Input files

XML source files to compile or binary table files to decompile.

By default, files ending in **.xml** or **.json** are compiled and files ending in **.bin** are decompiled. For other files, explicitly specify **--compile** or **--decompile**.

If an input file name is "**-**", the standard input is used. In that case, **--compile** or **--decompile** must be specified since the input file type cannot be deduced from its name.

If an input file name starts with "**<?xml**", it is considered as *inline XML content*. Similarly, if an input file name starts with "**{**" or "**[**", it is considered as *inline JSON content*.

Options

--abnt

Assume that the transport stream is an ISDB one with ABNT-defined variants. See section 2.4.2 for more details.

--atsc

Assume that the tables are used in an ATSC context. See section 2.4.2 for more details.

--brazil

A synonym for **--isdb --abnt --default-charset RAW-ISO-8859-15 --time-reference UTC-3**. See sections 2.4.2 and 2.5.2 for more details.

-c
--compile

Compile all files as XML source files into binary files. This is the default for **.xml** or **.json** files.

-d
--decompile

Decompile all files as binary files into XML files. This is the default for **.bin** files.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors.

By default, standard DVB encoding is used. See section 2.5 for more details.

--eit-actual

> With **--eit-normalization**, generate all EIT actual.
>
> Same as **--eit-actual-pf --eit-actual-schedule**.

--eit-actual-pf

> With **--eit-normalization**, generate EIT p/f actual.
>
> If no EIT selection option is specified, all EIT's are generated.

--eit-actual-schedule

> With **--eit-normalization**, generate EIT schedule actual.
>
> If no EIT selection option is specified, all EIT's are generated.

--eit-base-date *date*

> With **--eit-normalization**, use the specified date as reference for the allocation of the various EIT events in sections and segments.
>
> The date must be in the format "*year/month/day* [*hh:mm:ss*]". If only the date is present, it is used as base for the allocation of EIT schedule. If the time is also specified, it is the current time for the snapshot of EIT present/following.
>
> By default, use the oldest date in all EIT sections as base date.

--eit-normalization

> Reorganize all EIT sections according to ETSI TS 101 211 rules (see [6]).
>
> - EIT present/following: One single EIT p/f subtable is built per service. It is split in two sections, one for present and one for following events.
> - EIT schedule: All EIT schedule are kept but they are completely reorganized. All events are extracted and spread over new EIT sections according to ETSI TS 101 211 rules.
>
> If several files are specified, the reorganization of EIT's is performed inside each file independently. This is fine as long as all EIT's for a given service are in the same input file.
>
> See also option **--eit-base-date**.

--eit-other

> With **--eit-normalization**, generate all EIT other.
>
> Same as **--eit-other-pf --eit-other-schedule**.

--eit-other-pf

> With **--eit-normalization**, generate EIT p/f other.
>
> If no EIT selection option is specified, all EIT's are generated.

--eit-other-schedule

> With **--eit-normalization**, generate EIT schedule other.
>
> If no EIT selection option is specified, all EIT's are generated.

--eit-pf

> With **--eit-normalization**, generate all EIT p/f.
>
> Same as **--eit-actual-pf --eit-other-pf**.

--eit-schedule

> With **--eit-normalization**, generate all EIT schedule.
>
> Same as **--eit-actual-schedule --eit-other-schedule**.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

-e
--extensions

> With **--xml-model**, include the content of the available extensions.

-f
--from-json

> Each input file must be a JSON file, typically from a previous automated XML-to-JSON conversion or in a similar format.

> This is automatically detected for file names ending in **.json**. This option is only required when the input file name has a non-standard extension or is the standard input.

> By default, in the absence of **.json** extension, input files are read as XML.

--ignore-leap-seconds

> Do not explicitly include leap seconds in some UTC computations. See section 2.4.2 for more details.

--isdb

> Assume that the transport stream is an ISDB one. See section 2.4.2 for more details.

--japan

> A synonym for **--isdb --time-reference JST --default-charset ARIB-STD-B24**.

> See sections 2.4.2 and 2.5.2 for more details.

-j
--json

> When decompiling, perform an automated XML-to-JSON conversion. The output file is in JSON format instead of XML. See section 2.7.3 for more details on XML-to-JSON conversion.

-o *file-name*
--output *file-name*

> Specify the output file name.

> If the specified path is a directory, the output file is built from this directory and default file name.

> If the specified name is "**-**", the standard output is used.

> By default, the output file has the same name as the input and extension **.bin** (compile), **.xml** or **.json** (decompile). The default output file for the standard input ("**-**") is the standard output ("**-**").

> If more than one input file is specified, the output path, if present, must be either a directory name or the standard output ("**-**").

--pack-and-flush

> When loading a binary section file, pack incomplete tables, ignoring missing sections, and flush them. Sections are renumbered to remove any hole between sections.

> Use with care because this may create inconsistent tables.

--philippines

> A synonym for **--isdb --abnt --default-charset RAW-UTF-8 --time-reference UTC+8**.

> See sections 2.4.2 and 2.5.2 for more details.

--strict-xml

> Save XML documents in strictly conformant XML format. By default, do not escape characters when this is not syntactically necessary to make the XML text more human-readable.

--time-reference *name*

> Use a non-standard time reference in DVB or ISDB-defined SI. See section 2.4.2 for more details.

--usa

> A synonym for **--atsc**. See section 2.4.2 for more details.

--x2j-collapse-text
--x2j-enforce-boolean
--x2j-enforce-integer
--x2j-include-root
--x2j-trim-text

> Specific options for automated XML-to-JSON conversion. See section 2.7.3.2 for details.

-x
--xml-model

> Display the XML model of the table files. This model is not a full XML-Schema, this is an informal template file which describes the expected syntax of TSDuck XML files. If **--output** is specified, the model is saved here. Do not specify input files.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N***]**

> Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

> Display command help text.

-v
--verbose

> Produce verbose messages.

--version

> Display the version number.

▪ **tstabdump**

Dump MPEG tables and sections

This utility dumps in human readable format MPEG tables, as saved in binary files by the **tstables** utility for instance.

Usage

```
tstabdump [options] [input-file ...]
```

Input files

Binary section file. Several files can be specified. By default, without file and without **--ip-udp**, the binary tables are read from the standard input.

With **--ip-udp**, no file shall be specified. Binary sections and tables are received over UDP/IP as sent by the utility **tstables** or the plugin **tables**.

Options

-x *value*
--max-tables *value*

> Maximum number of tables or sections to dump. Stop logging tables when this limit is reached. This option is useful with **--ip-udp** which never ends otherwise.

--no-pager

> Do not send output through a pager process. By default, if the output device is a terminal, the output is paged. See 3.1.4 for more details.

Tables and sections interpretation and formatting options

--abnt

> Assume that the transport stream is an ISDB one with ABNT-defined variants. See section 2.4.2 for more details.

--atsc

> Assume that the transport stream is an ATSC one. See section 2.4.2 for more details.

--brazil

> A synonym for **--isdb --abnt --default-charset RAW-ISO-8859-15 --time-reference UTC-3**.
>
> See sections 2.4.2 and 2.5.2 for more details.

-c
--c-style

> Same as **--raw-dump** (no interpretation of section) but dump the bytes in C-language style, eg. "**0x01, 0x02,**" instead of "**01 02**". Useful to include this output as data in a C source file.

--default-charset *name*

> Default character set to use when interpreting strings from tables and descriptors.
>
> By default, standard DVB encoding is used. See section 2.5 for more details.

--default-pds *value*

> Default DVB-defined private data specifier (PDS). See section 2.4.2 for more details.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--ignore-crc32

Do not check CRC32 of input sections.

This can be used to analyze sections with incorrect CRC32 but which are otherwise correct.

--ignore-leap-seconds

Do not explicitly include leap seconds in some UTC computations. See 2.4.2 for more details.2.4.2

--isdb

Assume that the transport stream is an ISDB one. See section 2.4.2 for more details.

--japan

A synonym for **--isdb --time-reference JST --default-charset ARIB-STD-B24**.

See sections 2.4.2 and 2.5.2 for more details.

--nested-tlv[=_min-size_**]**

With option **--tlv**, try to interpret the value field of each TLV record as another TLV area. If the _min-size_ value is specified, the nested TLV interpretation is performed only on value fields larger than this size. The syntax of the nested TLV is the same as the enclosing TLV.

--philippines

A synonym for **--isdb --abnt --default-charset RAW-UTF-8 --time-reference UTC+8**.

See sections 2.4.2 and 2.5.2 for more details.

-r
--raw-dump

Raw dump of section, no interpretation.

--time-reference _name_

Use a non-standard time reference in DVB or ISDB-defined SI. See section 2.4.2 for more details.

--tlv _syntax_

For sections of unknown types, this option specifies how to interpret some parts of the section payload as TLV records. Several **--tlv** options are allowed, each one describes a part of the section payload.

Each syntax string has the form "_start,size,tagSize,lengthSize,order_". The _start_ and _size_ fields define the offset and size of the TLV area in the section payload. If the _size_ field is "**auto**", the TLV extends up to the end of the section. If the start field is "**auto**", the longest TLV area in the section payload will be used. The fields _tagSize_ and _lengthSize_ indicate the size in bytes of the Tag and Length fields in the TLV structure. The field _order_ must be either "**msb**" or "**lsb**" and indicates the byte order of the Tag and Length fields.

All fields are optional. The default values are "**auto,auto,1,1,msb**".

--usa

A synonym for **--atsc**. See section 2.4.2 for more details.

UDP reception options

These options apply only when **--ip-udp** is used. In this case, the binary sections are received using UDP/IP. No input file is used.

--buffer-size _value_

Specify the UDP socket receive buffer size in bytes (socket option).

--default-interface

Let the system find the appropriate local interface on which to listen. By default, listen on all local interfaces.

--disable-multicast-loop

Disable multicast loopback.

By default, incoming multicast packets are looped back on local interfaces, if an application sends packets to the same group from the same system. This option disables this.

Warning: On input sockets, this option is effective only on Windows systems. On Unix systems (Linux, macOS, BSD), this option applies only to output sockets.

--first-source

Filter UDP packets based on the source address. Use the sender address of the first received packet as only allowed source.

This option is useful when several sources send packets to the same destination address and port. Accepting all packets could result in a corrupted stream and only one sender shall be accepted.

To allow a more precise selection of the sender, use option **--source**. Options **--first-source** and **--source** are mutually exclusive.

-ip-udp [[*source@*]*address*:]*port*

Specify that the sections and tables are received from UDP/IP, as sent by *tstables* or the plugin *tables*.

The *port* part is mandatory and specifies the UDP port to listen on. The *address* part is optional. It specifies an IP multicast address to listen on. It can be also a host name that translates to a multicast address. If the address is not specified, the plugin simply listens on the specified local port and receives the packets which are sent to one of the local (unicast) IP addresses of the system.

An optional source address can be specified as *source@address:port* in the case of source-specific multicast (SSM).

--local-address *address*

Specify the IP address of the local interface on which to listen. It can be also a host name that translates to a local address. By default, listen on all local interfaces.

--no-encapsulation

With **--ip-udp**, receive the tables as raw binary messages in UDP packets. By default, the tables are formatted into TLV messages.

--no-reuse-port

Disable the reuse port socket option. Do not use unless completely necessary.

--receive-timeout *value*

Specify the UDP reception timeout in milliseconds. This timeout applies to each receive operation, individually. By default, receive operations wait for data, possibly forever.

--reuse-port

Set the reuse port socket option. This is now enabled by default, the option is present for legacy only.

--source *address[:port]*

Filter UDP packets based on the specified source address.

This option is useful when several sources send packets to the same destination address and port. Accepting all packets could result in a corrupted stream and only one sender shall be accepted.

Options **--first-source** and **--source** are mutually exclusive.

--ssm

This option forces the usage of source-specific multicast (SSM) using the source address which is specified by the option **--source**. Without **--ssm**, standard ("any-source") multicast is used and the option **--source** is used to filter incoming packets.

The **--ssm** option is implicit when the classical SSM syntax *source@address:port* is used.

CAS identification options

By default, EMM's and ECM's are interpreted according to the *CA_descriptor* which references their PID. The following options are useful when analyzing partial transport streams without CAT or PMT to correctly identify the CA PID's.

--conax

Interpret all EMM and ECM from unknown CAS as coming from Conax.

Equivalent to **--default-cas-id 0x0B00**.

--default-cas-id *value*

Interpret all EMM's and ECM's from unknown CAS as coming from the specified *CA_System_Id*.

--irdeto

Interpret all EMM and ECM from unknown CAS as coming from Irdeto.

Equivalent to **--default-cas-id 0x0600**.

--mediaguard

Interpret all EMM and ECM from unknown CAS as coming from MediaGuard.

Equivalent to **--default-cas-id 0x0100**.

--nagravision

Interpret all EMM and ECM from unknown CAS as coming from NagraVision.

Equivalent to **--default-cas-id 0x1800**.

--nds

Interpret all EMM and ECM from unknown CAS as coming from Synamedia (formerly known as NDS).

Equivalent to **--default-cas-id 0x0900**.

--safeaccess

Interpret all EMM and ECM from unknown CAS as coming from SafeAccess.

Equivalent to **--default-cas-id 0x4ADC**.

--viaccess

Interpret all EMM and ECM from unknown CAS as coming from Viaccess.

Equivalent to **--default-cas-id 0x0500**.

--widevine

Interpret all EMM and ECM from unknown CAS as coming from Widevine CAS.

Equivalent to **--default-cas-id 0x4AD4**.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

◫ tstables

Collect MPEG tables and sections

This utility collects MPEG tables or individual sections from a transport stream. The tables can be saved in a human readable format, in binary or XML files or sent over UDP/IP to some collecting server. It is possible to save the tables in several formats at the same time. By default, the tables are displayed in human-readable format on the standard output.

Usage

```
tstables [options] [input-file]
```

Input file

MPEG transport stream, either a capture file or a pipe from a live stream (see option **--format** for binary formats).

If the parameter is omitted, is an empty string or a dash ("**-**"), the standard input is used.

Tables and sections selection options

--all-once

Same as **--all-sections** but collect each section only once per combination of PID, table id, table id extension, section number and version.

-a
--all-sections

Display/save all sections, as they appear in the stream. By default, collect complete tables, with all sections of the tables grouped and ordered and collect each version of a table only once.

Note that this mode is incompatible with all forms of XML and JSON output since valid XML and JSON structures may contain complete tables only.

-d
--diversified-payload

Select only sections with *diversified* payload. This means that section payloads containing the same byte value (all **0x00** or all **0xFF** for instance) are ignored. Typically, such sections are stuffing and can be ignored that way.

--exclude-current

Exclude short sections and long sections with "current" indicator. This is rarely necessary.

See also **--include-next**.

--format *name*

Specify the format of the input file. See section 2.1.2 for more details.

--include-next

Include long sections with "next" indicator. By default, they are excluded.

--invalid-sections

Display and dump invalid sections. These sections are normally dropped because they are truncated, incomplete, corrupted, have an invalid CRC32, etc.

Because these sections are invalid, they cannot be formatted as normal sections. Instead, a binary and text dump is displayed.

--invalid-versions

Track invalid version numbers in sections.

Per MPEG rules, the version number of a section with long header shall be updated each time the content of the section is updated. With this option, the content of the sections is tracked to detect modified sections without version updates.

These events are considered as errors.

-x *value*
--max-tables *value*

Maximum number of tables to dump. Stop execution when this limit is reached.

--negate-pid

Negate the PID filter: specified PID's are excluded.

Warning: this can be a dangerous option on complete transport streams since PID's not containing sections can be accidentally selected.

--negate-section-number

Negate the section number filter: specified sections are excluded.

-n
--negate-tid

Negate the TID filter: specified TID's are excluded.

--negate-tid-ext

Negate the TID extension filter: specified TID extensions are excluded.

--no-deep-duplicate

Do not report identical sections in the same PID, even when non-consecutive. A hash of each section is kept for each PID and later identical sections are not reported.

Warning: This option accumulates memory for hash values of all sections since the beginning. Do not use that option for commands running too long or the process may crash with insufficient memory.

--no-duplicate

Do not report consecutive identical tables with a short section in the same PID.

This can be useful for ECM's. This is the way to display new ECM's only.

By default, tables with long sections are reported only when a new version is detected but tables with a short section are all reported.

--no-pager

Do not send output through a pager process. By default, if the output device is a terminal, the output is paged. See 3.1.4 for more details.

--only-invalid-sections

Same as **--invalid-sections** but do not display valid tables and sections, only invalid sections.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

PID filter: select packets with these PID values.

Several **--pid** options may be specified. By default, without **--pid** option, all PID's are used.

PID's containing PES data are automatically ignored.

--psi-si

Add all PID's containing PSI/SI tables, ie. PAT, CAT, PMT, NIT, SDT and BAT. The PMT PID's are dynamically collected each time a new PAT is encountered.

Note that EIT, TDT and TOT are not included. Use **--pid 18** to get EIT and **--pid 20** to get TDT and TOT.

--section-content *hexa-data*

Binary content filter: Specify binary data that must match the beginning of the section.

The value must be a string of hexadecimal digits specifying any number of bytes.

See also option **--section-mask** to specify selected bits or bytes only.

--section-mask *hexa-data*

With **--section-content**, specify a mask of meaningful bits in the binary data that must match the beginning of the section.

The value must be a string of hexadecimal digits specifying any number of bytes.

If omitted or shorter than the **--section-content** parameter, the mask is implicitly padded with **FF** bytes.

--section-number *num1*[-*num2*]

Section number filter: when sections are filtered individually instead of complete tables (**--all-sections**), select sections with this section number or range of section numbers.

Several **--section-number** options may be specified.

-t *id1*[*-id2*]
--tid *id1*[*-id2*]

TID filter: select sections with these TID (table id) values.

Several **--tid** options may be specified. Without **--tid** option, all tables are saved.

-e *id1*[*-id2*]
--tid-ext *id1*[*-id2*]

TID extension filter: select sections with these table id extension values (apply to long sections only). Several **--tid-ext** options may be specified. Without **--tid-ext** option, all tables are saved.

Output options

-b *file-name*
--binary-output *file-name*

Save the sections in raw binary format in the specified output file name.

If the file name is empty or '**-**', the binary sections are written to the standard output.

See also option **--multiple-files**.

-f
--flush

Flush standard output after each display. Useful to monitor the content if the output has been redirected to a disk file.

-i *address:port*
--ip-udp *address:port*

Send binary tables over UDP/IP to the specified destination. The *address* specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The *port* specifies the destination UDP port.

--json-output *file-name*

Save the tables in JSON format in the specified file. To output the JSON text on the standard output, explicitly specify this option with "**-**" as output file name.

The tables are initially formatted as XML and an automated XML-to-JSON conversion is applied. See section 2.7.3 for more details on XML-to-JSON conversion.

--local-udp address

With **--ip-udp**, when the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--log

Display a short one-line log of each table instead of full table display.

--log-hexa-line[='*prefix*']

Log each binary table (or section with **--all-sections**) as one single hexadecimal line in the message logger instead of an output binary file.

The optional string parameter specifies a prefix to prepend on the log line before the hexadecimal text to facilitate the filtering of the appropriate line in the logs.

--log-json-line[='*prefix*']

Log each table as one single JSON line in the message logger instead of an output file.

Each table is initially formatted as XML and an automated XML-to-JSON conversion is applied. See section 2.7.3 for more details on XML-to-JSON conversion.

The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--log-size *value*

With option **--log**, specify how many bytes are displayed at the beginning of the table payload (the header is not displayed). The default is 8 bytes.

--log-xml-line[='*prefix*']

Log each table as one single XML line in the message logger instead of an output file.

The optional string parameter specifies a prefix to prepend on the log line before the XML text to facilitate the filtering of the appropriate line in the logs.

--meta-sections

Add an hexadecimal dump of each section in the XML and JSON metadata.

-m
--multiple-files

Create multiple binary output files, one per section. A binary output file name must be specified (option **--binary-output**). Assuming that the specified file name has the form **base.ext**, each file is created with the name **base_pXXXX_tXX.ext** for short sections and **base_pXXXX_tXX_eXXXX_vXX_sXX.ext** for long sections, where the *XX* respectively specify the hexadecimal values of the PID, TID (table id), TIDext (table id extension), version and section index.

--no-encapsulation

With **--ip-udp**, send the tables as raw binary messages in UDP packets. By default, the tables are formatted into TLV messages.

-o *file-name*
--output-file *file-name*
--text-output *file-name*

Save the tables or sections in human-readable text format in the specified file name. By default, when no output option is specified, text is produced on the standard output.

If you need text formatting on the standard output in addition to other output like binary files (**--binary-output**) or UPD/IP (**--ip-udp**), explicitly specify this option with "**-**" as output file name.

--packet-index

Display the index of the first and last TS packet of each displayed section or table.

--rewrite-binary

With **--binary-output**, rewrite the same file with each table. The specified file always contains one single table, the latest one.

--rewrite-json

With **--json-output**, rewrite the same file with each table. The specified file always contains one single table, the latest one.

--rewrite-xml

With **--xml-output**, rewrite the same file with each table. The specified file always contains one single table, the latest one.

--strict-xml

Save XML documents in strictly conformant XML format. By default, do not escape characters when this is not syntactically necessary to make the XML text more human-readable.

--time-stamp

Display a time stamp (current local time) with each table.

--ttl *value*

With **--ip-udp**, specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address. Remember that the default Multicast TTL is 1 on most systems.

--x2j-collapse-text
--x2j-enforce-boolean
--x2j-enforce-integer
--x2j-include-root
--x2j-trim-text

Specific options for automated XML-to-JSON conversion. See section 2.7.3.2 for details.

--xml-output *file-name*

Save the tables in XML format in the specified file. To output the XML text on the standard output, explicitly specify this option with "**-**" as output file name.

Tables and sections manipulation options

--fill-eit

Before exiting, add missing empty sections in EIT's and flush them. This can be useful with segmented EIT schedule where empty sections at end of segments are usually not transmitted.

--pack-all-sections

Same as **--all-sections** but also modify each long section so that it becomes a valid complete table. Its *section_number* and *last_section_number* are forced to zero. Use with care because this may create inconsistent tables. This option can be useful with tables with sparse sections such as EIT's to save them in XML format (as an alternative, see also **--fill-eit**).

--pack-and-flush

Before exiting, pack incomplete tables, ignoring missing sections, and flush them. Use with care because this may create inconsistent tables. Unlike option **--pack-all-sections**, **--pack-and-flush** does not force **--all-sections** because it only applies to the last incomplete tables before exiting.

Tables and sections interpretation and formatting options

--abnt

Assume that the transport stream is an ISDB one with ABNT-defined variants. See section 2.4.2 for more details.

--atsc

Assume that the transport stream is an ATSC one. See section 2.4.2 for more details.

--brazil

A synonym for **--isdb --abnt --default-charset RAW-ISO-8859-15 --time-reference UTC-3**.

See sections 2.4.2 and 2.5.2 for more details.

-c
--c-style

Same as **--raw-dump** (no interpretation of section) but dump the bytes in C-language style, eg. "**0x01, 0x02,**" instead of "**01 02**". Useful to include this output as data in a C source file.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors.

By default, standard DVB encoding is used. See section 2.5 for more details.

--default-pds *value*

Default DVB-defined private data specifier (PDS). See section 2.4.2 for more details.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--ignore-leap-seconds

Do not explicitly include leap seconds in some UTC computations. See section 2.4.2 for more details.

--isdb

Assume that the transport stream is an ISDB one. See section 2.4.2 for more details.

--japan

A synonym for **--isdb --time-reference JST --default-charset ARIB-STD-B24**.

See sections 2.4.2 and 2.5.2 for more details.

--nested-tlv[=_min-size_**]**

With option **--tlv**, try to interpret the value field of each TLV record as another TLV area. If the _min-size_ value is specified, the nested TLV interpretation is performed only on value fields larger than this size. The syntax of the nested TLV is the same as the enclosing TLV.

--philippines

A synonym for **--isdb --abnt --default-charset RAW-UTF-8 --time-reference UTC+8**.

See sections 2.4.2 and 2.5.2 for more details.

-r
--raw-dump

> Raw dump of section, no interpretation.

--time-reference *name*

> Use a non-standard time reference in DVB or ISDB-defined SI. See section 2.4.2 for more details.

--tlv *syntax*

> For sections of unknown types, this option specifies how to interpret some parts of the section payload as TLV records. Several **--tlv** options are allowed, each one describes a part of the section payload.

> Each syntax string has the form "*start,size,tagSize,lengthSize,order*". The *start* and *size* fields define the offset and size of the TLV area in the section payload. If the *size* field is "**auto**", the TLV extends up to the end of the section. If the start field is "**auto**", the longest TLV area in the section payload will be used. The fields *tagSize* and *lengthSize* indicate the size in bytes of the Tag and Length fields in the TLV structure. The field *order* must be either "**msb**" or "**lsb**" and indicates the byte order of the Tag and Length fields.

> All fields are optional. The default values are "**auto,auto,1,1,msb**".

--usa

> A synonym for **--atsc**. See section 2.4.2 for more details.

CAS identification options

By default, EMM's and ECM's are interpreted according to the *CA_descriptor* which references their PID. The following options are useful when analyzing partial transport streams without CAT or PMT to correctly identify the CA PID's.

--conax

> Interpret all EMM and ECM from unknown CAS as coming from Conax.

> Equivalent to **--default-cas-id 0x0B00**.

--default-cas-id *value*

> Interpret all EMM's and ECM's from unknown CAS as coming from the specified *CA_System_Id*.

--irdeto

> Interpret all EMM and ECM from unknown CAS as coming from Irdeto.

> Equivalent to **--default-cas-id 0x0600**.

--mediaguard

> Interpret all EMM and ECM from unknown CAS as coming from MediaGuard.

> Equivalent to **--default-cas-id 0x0100**.

--nagravision

> Interpret all EMM and ECM from unknown CAS as coming from NagraVision.

> Equivalent to **--default-cas-id 0x1800**.

--nds

> Interpret all EMM and ECM from unknown CAS as coming from Synamedia (formerly known as NDS).

> Equivalent to **--default-cas-id 0x0900**.

--safeaccess

> Interpret all EMM and ECM from unknown CAS as coming from SafeAccess.

Equivalent to **--default-cas-id 0x4ADC**.

--viaccess

Interpret all EMM and ECM from unknown CAS as coming from Viaccess.

Equivalent to **--default-cas-id 0x0500**.

--widevine

Interpret all EMM and ECM from unknown CAS as coming from Widevine CAS.

Equivalent to **--default-cas-id 0x4AD4**.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N***]**

Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

▪ tsterinfo

DVB-Terrestrial Information

This utility performs various operations and conversions on DVB-T transmission and modulation parameters:

- Compute the carrier frequency from a UHF or VHF channel number and optional offset count.

    Triggered when option **--uhf-channel, --vhf-channel** and optionally **--offset-count**, are specified.

- Retrieve the UHF or VHF channel number and offset count from a carrier frequency.

    Triggered when option **--frequency** is specified.

- Compute the nominal transport stream bitrate from OFDM modulation parameters (bandwidth, high-priority stream error correction rate, constellation and guard interval). Supported for non-hierarchical transmission only.

    Triggered when options **--guard-interval** and **--high-priority-fec**, and optionally **--bandwidth** and **--constellation**, are specified.

- Given a transport stream bitrate, retrieve the OFDM modulation parameters (bandwidth, high-priority stream error correction rate, constellation and guard interval). Sometimes, several combinations of parameters are possible; they are all reported (see also option **--max-guess**). This could be useful on Windows systems where the tuners are not able to report their current parameters. In that case, you can use **tsanalyze**, **tsbitrate** or **tsp –v** to evaluate the transport stream bitrate based on PCR analysis. Then, **tsterinfo** will retrieve the most probable modulation parameters. Note that only the four mentioned parameters can be retrieved. All other DVB-T transmission parameters are independent from the transport stream bitrate.

    Triggered when option **--bitrate** is specified.

See some examples in section 5.1.5.

Usage

```
tsterinfo [options]
```

Options

-w *value*
--bandwidth *value*

> Specify the OFMD bandwith in Hz, used to compute the resulting bitrate.

> For compatibility with old versions, "low" values (below 1000) are interpreted in MHz. This means that values 8 and 8,000,000 are identical. Both mean 8 MHz.

> The default is 8 MHz.

-b *value*
--bitrate *value*

> Transport stream bitrate in bits/second, based on 188-byte packets.

> See section 2.2 for more details on the representation of bitrates.

> Given this bitrate, **tsterinfo** will try to guess the OFDM modulation parameters: bandwidth, high-priority stream error correction rate, constellation and guard interval.

--brazil

> A synonym for **--hf-band-region brazil**.

-c *value*
--constellation *value*

> Specify the OFMD constellation, used to compute the resulting bitrate. Must be one of **QPSK**, **16-QAM**, **64-QAM** (default: **64-QAM**).

-d
--default-region

> Display the default region for UHF/VHF band frequency layout.

> See also option **--hf-band-region**.

-f *value*
--frequency *value*

> Carrier frequency in Hz. UHF or VHF channel and offset will be displayed.

-g *value*
--guard-interval *value*

> Specify the OFMD guard interval, used to compute the resulting bitrate. Must be one of **1/32**, **1/16**, **1/8**, **1/4** (no default).

-r *name*
--hf-band-region *name*

> Specify the region for UHF/VHF band frequency layout.

> The default region is "**europe**". Another default region may be specified per user in the TSDuck configuration file. See appendix A.4 page 492 for more details.

-h *value*
--high-priority-fec *value*

> Specify the OFMD error correction for high priority streams, used to compute the resulting bitrate. Must be one of **1/2**, **2/3**, **3/4**, **5/6**, **7/8** (no default).

--japan

> A synonym for **--hf-band-region japan**.

-m *value*
--max-guess *value*

> When used with **--bitrate**, specify the maximum number of sets of modulation parameters to display. By default, display only one set of parameters, the one giving the closest bitrate. When the given bitrate is not exact and the transmission parameters are uncertain, it may be useful to display more than one possible set of values. The difference between the specified bitrate and nominal bitrate is displayed for each set of parameters. The various sets of parameters are displayed in increasing order of bitrate difference (ie. most probable parameters first).

> When more than one set of parameters give the same bitrate, they are all displayed, regardless of **--max-guess**.

-o *value*
--offset-count *value*

> Specify the number of offsets from the UHF or VHF channel. The default is zero. See options **--uhf-channel** and **--vhf-channel**.

--philippines

> A synonym for **--hf-band-region philippines**.

-s
--simple

> Produce simple output: only numbers, no comment, no formatting. Typically useful to write scripts and reuse **tsterinfo** output.

-u *value*
--uhf-channel *value*

> Specify the UHF channel number of the carrier. Can be combined with an **--offset-count** option. The resulting frequency will be displayed.

--usa

> A synonym for **--hf-band-region usa**. See section 2.4.2 for more details.

-v *value*
--vhf-channel *value*

> Specify the VHF channel number of the carrier. Can be combined with an **--offset-count** option. The resulting frequency will be displayed.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=N**]**

> Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

> Display command help text.

--verbose

> Produce verbose messages.

--version

> Display the version number.

▦ tstestecmg

Test a DVB SimulCrypt compliant ECMG with an artificial load

This utility is designed to test the resistance of an ECMG. It behaves as a DVB SimulCrypt SCS and connects to one ECMG. It creates several "ECM channels" and several "ECM streams" per channel.

In each ECM stream, **tstestecm** emulates crypto-periods. At the beginning of each crypto-period, it requests one ECM. The returned ECM is not used, no scrambling is performed, this is just a stress test on the ECMG.

It is possible to run this **tstestecmg** from multiple systems in parallel, connecting to the same ECMG, to emulate very hight loads. Each instance creates multiple channels (be sure to correctly distribute the channel numbers between instances, see option **--first-channel-id**).

Usage

```
tstestecmg [options] host:port
```

Options

-a *hexa-digits*
--access-criteria *hexa-digits*

> Specifies the access criteria as sent to the ECMG. The value must be a suite of hexadecimal digits. All ECM's are generated using these access criteria. Empty by default.

-c *value*
--channels *value*

> Specify the number of ECM channels to open. There is one TCP connection to the ECMG per channel.

> The default is 10 channels.

--cp-duration *seconds*

> Specify the crypto-period duration in seconds.

> The default is 10 seconds.

--cw-size *bytes*

> Specify the size in bytes of control words.

> The default is 8 bytes.

--ecmg-scs-version *value*

> Specify the version of the ECMG <=> SCS DVB SimulCrypt protocol.

> Valid values are 2 and 3. The default is 2.

--first-channel-id *value*

> Specify the first *ECM_channel_id* value for the ECMG. Subsequent connections use sequential values.

> The default is 0.

--first-ecm-id *value*

> Specify the first *ECM_id* value to use in the first stream. Subsequent streams use sequential values.

> The default is the value of **--first-channel-id** times the value of **--streams-per-channel**.

--first-stream-id *value*

Specify the first *ECM_stream_id* to use in each channel. Subsequent streams use sequential values.

The default is 0.

--log-data[=*level*]

Same as **--log-protocol** but applies to *CW_provision* and *ECM_response* messages only.

To debug the session management without being flooded by data messages, use **--log-protocol=info --log-data=debug**.

--log-message-count *value*

Specify the maximum number of buffered log messages. Log messages are displayed asynchronously in a low priority thread. This value specifies the maximum number of buffered log messages in memory, before being displayed. When too many messages are logged in a short period of time, while plugins use all CPU power, the low-priority log thread has no resource. It cannot display yet the buffered messages and extra messages are dropped. Increase this value if you think that too many messages are dropped. The default is 512 messages.

See also the option **--synchronous-log**.

--log-protocol[=*level*]

Log all ECMG ⇔ SCS protocol messages using the specified level. If the option is not present, the messages are logged at debug level only. If the option is present without value, the messages are logged at info level.

A level can be a numerical debug level or any of the following: **fatal**, **severe**, **error**, **warning**, **info**, **verbose**, **debug**.

--max-ecm *count*

Stop the test after generating the specified number of ECM's.

By default, the test endlessly runs.

--max-seconds *seconds*

Stop the test after the specified number of seconds.

By default, the test endlessly runs.

--statistics-interval *seconds*

Specify the interval in seconds between the display of two statistics lines. When set to zero, disable periodic statistics, only display final statistics.

The default is 10 seconds.

-s *value*
--streams-per-channel *value*

Specify the number of streams to open in each channel.

The default is 10.

--super-cas-id *value*

Specify the DVB SimulCrypt Super_CAS_Id. This is a required parameter.

--synchronous-log

With this option, each logged message is guaranteed to be displayed, synchronously, without any loss of message. The downside is that a plugin thread may be blocked for a short while when too many messages are logged.

-t
--timed-log

> Each logged message contains a time stamp.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

> Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

> Display command help text.

-v
--verbose

> Produce verbose messages.

--version

> Display the version number.

■ tsvatek

List VATek-based modulator devices

This utility lists modulator devices which are based on chips from Vision Advance Technology Inc. (VATek). The final modulator device products can be from different manufacturers.

Note

> Unlike Dektec and HiDes devices which are available on Linux and Windows only, VATek-based devices are available on all operating systems, including macOS, because VATek chips do not need a dedicated device driver. They are accessed through the portable **libusb** library which is available on all operating systems.

Usage

> ```
> tshides [options] [device]
> ```

Parameters

> The optional device index, from 0 to N-1 (with N being the number of VATek-based devices in the system) indicates which device to display.

> The default is 0. Use option **--all** to have a complete list of devices in the system.

Options

> **-a**
> **--all**
>
> > List all VATek-based devices available on the system.

Generic common command options

> The following options are implicitly defined in all commands.

> **--debug[=**N**]**
>
> > Produce verbose debug output. Specify an optional debug level N (1 by default).

> **--help**
>
> > Display command help text.

> **-v**
> **--verbose**
>
> > Produce verbose messages.

> **--version**
>
> > Display the version number.

⊞ tsversion

Check version, download and upgrade TSDuck

By default, this utility simply displays the TSDuck version.

Additionally, in prebuilt binary packages of TSDuck as available from **tsduck.io** or **github.com**, the **tsversion** command can also connect to GitHub to list all available releases of TSDuck, check for a new version, download it or upgrade TSDuck to the latest version.

These capabilities are usually disabled in TSDuck packages which are available through a package manager on Linux or through Homebrew on macOS. In these cases, the package manager handles the installation and upgrades of all packages, including TSDuck.

As an example, the following command checks for a new version online and, if one is available, downloads it and upgrades TSDuck:

```
tsversion --upgrade
```

Detecting the availability of a new release always works. However, to perform an upgrade, the binary packages for the current operating system and architecture must be available online. Not all combinations of binary packages are available. It is only guaranteed that TSDuck can be upgraded by **tsversion** for Windows 32 and 64 bits, the latest version of most 64-bit Linux distros (Fedora, RedHat, CentOS, AlmaLinux, Debian, Ubuntu, Raspbian) and MacOS (through Homebrew). For other platforms, you must recompile TSDuck from sources.

Listing versions and information about versions accesses the GitHub site. Remote information is requested from the GitHub API. GitHub limits the anonymous access to its API to a certain number of requests per hour per source IP address. If you get an error such as "*API rate limit exceeded*", you may have to wait for the next hour and retry. Alternatively, if you are a registered GitHub user and you have a registered authentication token, this rate limit is removed. Set the value of your authentication token into the environment variable **TSDUCK_GITHUB_API_TOKEN** before using **tsversion**. For macOS users, if the environment variable **HOMEBREW_GITHUB_API_TOKEN** is already defined, it will be used.

Usage

```
tsversion [options]
```

Common options

-e
--extensions

> List all available TSDuck extensions.

-i
--integer

> Display the current version of TSDuck in integer format, suitable for comparison in a script.

> Example: 31000669 for 3.10-669 (5 digits are used for the last commit number).

--support *name*

> Check support for a specific feature. By default, TSDuck is built with all features. However, it may be compiled with specific **make** options such as **NODEKTEC=1** or **NOPCSC=1** to remove dependencies on some libraries. The option **--support** can be used to test if a feature is available.

> The feature name must be one of **all**, **dektec**, **hides**, **http**, **pcsc**, **rist**, **srt**, **vatek**.

> Using **all** displays all features.

> With any other option, **tsversion** simply exits with a success or failure status, depending if the corresponding feature is implemented or not.

Upgrade options

The following options are available in prebuilt binary packages of TSDuck from **tsduck.io** or **github.com**. They may be disabled in TSDuck packages which are available through a package manager on Linux or through Homebrew on macOS.

--all

>   List all available versions of TSDuck from GitHub.

-b
--binary

>   With **--download**, fetch the binary installers of the latest version. This is the default. When **--source** is specified, you have to explicitly specify **--binary** if you also need the binary installers.

-c
--check

>   Check if a new version of TSDuck is available from GitHub.

-d
--download

>   Download the latest version (or the version specified by **--name**) from GitHub. By default, download the binary installers for the current operating system and architecture. Specify **--source** to download the source code.

>   If a local file with the same name and size already exists, the local file is reused and the download operation is skipped.

-f
--force

>   Force downloads even if a file with same name and size already exists.

-l
--latest

>   Display the latest version of TSDuck from GitHub.

-n *version-name*
--name *version-name*

>   Get information for or download from GitHub the specified version, not the latest one.

-o *dir-name*
--output-directory *dir-name*

>   Specify the output directory for downloaded files (current directory by default).

--proxy-host *name*

>   Optional proxy host name for Internet access.

--proxy-password *string*

>   Optional proxy password for Internet access (for use with **--proxy-user**).

--proxy-port *value*

>   Optional proxy port for Internet access (for use with **--proxy-host**).

--proxy-user *name*

>   Optional proxy user name for Internet access.

-s
--source

> With **--download**, download the source code archive instead of the binary installers.

-t
--this

> Display the current version of TSDuck (this executable).

-u
--upgrade

> Upgrade TSDuck to the latest version.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=N**]**

> Produce verbose debug output. Specify an optional debug level N (1 by default).

--help

> Display command help text.

-v
--verbose

> Produce verbose messages.

--version

> Display the version number.

▪ tsxml

Test tool for TSDuck XML manipulation

This simple utility can be used to test some XML files which are manipulated by TSDuck.

Usage

```
tsxml [options] [input-file ...]
```

Input files

Any number of XML files. Input files are processed in sequence.

If an input file is specified as '**-**', the standard input is used.

Options

--attributes-merge *name*

> With **--merge**, specify how attributes coming from the XML nodes to merge are processed.
> Must be one of:
> - **add**: New attributes, not present in the base node, are added. Attributes already existing in the base node are ignored. This is the default.
> - **none**: No attribute is copied from the node to merge.
> - **replace**: All attributes from the nodes to merge are copied in the base node, replacing existing ones.

-c
--channel

> A shortcut for **--model tsduck.channels.model.xml**.
> This option verifies that the input files are valid channel configuration files.

-f
--from-json

> Each input file must be a JSON file, typically from a previous automated XML-to-JSON conversion or in a similar format. A reverse automated JSON-to-XML conversion is performed first and the resulting XML document is processed as input.
> See section 2.7.3 for more details on XML-to-JSON conversion.

-h
--hf-band

> A shortcut for **--model tsduck.hfbands.model.xml**.
> This option verifies that the input files are valid HF bands definition files.

-i *value*
--indent *value*

> Specify the indentation size of output files. The default is 2 spaces.

-j
--json

> Perform an automated XML-to-JSON conversion. The output file is in JSON format instead of XML.
> See section 2.7.3 for more details on XML-to-JSON conversion.

--json-buffer-size *value*

> With **--json-tcp** or **--json-udp**, specify the network socket send buffer size.

--json-line[='*prefix*']

Same as **--json** but output the JSON text as one single line in the message logger instead of fully formatted output file.

The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--json-tcp *address:port*

Same as **--json** but report the JSON text as one single line in a TCP connection instead of the output file.

The *address* specifies an IP address or a host name that translates to an IP address. The *port* specifies the destination TCP port.

By default, a new TCP connection is established each time a JSON message is produced (see also option **--json-tcp-keep**). Be aware that a complete TCP connection cycle may introduce some latency in the processing. If latency is an issue, consider using **--json-udp**.

--json-tcp-keep

With --json-tcp, keep the TCP connection open for all JSON messages. By default, a new TCP connection is established each time a JSON message is produced.

--json-udp *address:port*

Same as **--json** but report the JSON text as one single line in a UDP datagram instead of the output file.

The *address* specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The *port* specifies the destination UDP port.

Be aware that the size of UDP datagrams is limited by design to 64 kB. If larger JSON contents are expected, consider using **--json-tcp**.

--json-udp-local *address*

With **--json-udp**, when the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--json-udp-ttl *value*

With **--json-udp**, specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address. Remember that the default Multicast TTL is 1 on most systems.

-l
--lnb

A shortcut for **--model tsduck.lnbs.model.xml**.

This option verifies that the input files are valid satellite LNB definition files.

--merge

Merge all input files into one single XML document, instead of processing all input files one by one.

With this option, all input XML files must have the same root tag.

-m *filename*
--model *filename*

Specify an XML model file which is used to validate all input files.

The file is automatically searched in the directories for TSDuck configuration files.

--monitor

A shortcut for **--model tsduck.monitor.model.xml**.

This option verifies that the input files are valid resource monitoring configuration files.

-o *filename*
--output *filename*

> Specify the name of the output file (standard output by default).
>
> An output file is produced only if **--patch**, **--reformat** or **--json** are specified.

-p *filename*
--patch *filename*

> Specify an XML patch file. See section 2.6.4 for more details on XML patch files.
>
> All operations which are specified in this file are applied on each input XML file. Several **--patch** options can be specified. Patch files are sequentially applied on each input file.
>
> This option is useful to test the XML patch files which are applied on the signalisation in various plugins using option **--patch-xml**.

-r
--reformat

> Reformat the input XML files according to the default XML layout for TSDuck XML files. This option is useful to generate an expected output file format.
>
> If more than one input file is specified, they are all reformatted in the same output file.

-s *name*
--sort *name*

> Specify that the sub-elements of all XML structures with the specified tag name will be sorted in alphanumerical order.
>
> Several **--sort** options can be specified.

--strict-xml

> Save XML documents in strictly conformant XML format. By default, do not escape characters when this is not syntactically necessary to make the XML text more human-readable.

-t
--tables

> A shortcut for **--model tsduck.tables.model.xml**. Table definitions for installed TSDuck extensions are also merged in the main model.
>
> This option verifies that the input files are valid PSI/SI table files.

--uncomment

> Remove comments from the XML documents.

--x2j-collapse-text
--x2j-enforce-boolean
--x2j-enforce-integer
--x2j-include-root
--x2j-trim-text

> Specific options for automated XML-to-JSON conversion. See section 2.7.3.2 for details.

--xml-line[='*prefix*']

> Output each transformed input XML file as one single XML line in the message logger instead of an output file.
>
> The optional string parameter specifies a prefix to prepend on the log line before the XML text to facilitate the filtering of the appropriate line in the logs.

Generic common command options

The following options are implicitly defined in all commands.

--debug[=*N*]

Produce verbose debug output. Specify an optional debug level *N* (1 by default).

--help

Display command help text.

-v
--verbose

Produce verbose messages.

--version

Display the version number.

4 TSP Plugins

This chapter contains the reference documentation of all plugins for **tsp**, the *transport stream processor*. The input and output plugins can also be used by the command **tsswitch**.

The Table 5 lists all available plugins.

Table 5: tsp plugins

Plugin	Type	Description
aes	packet	Experimental AES scrambling
analyze	packet	Analyze the structure of the transport stream
bat	packet	Perform various transformations on the BAT
bitrate_monitor	packet	Monitor the bitrate of the TS or a given set of PID's
boostpid	packet	Boost the bitrate of a PID, stealing stuffing packets
cat	packet	Perform various transformations on the CAT
clear	packet	Extract clear (non-scrambled) sequences
continuity	packet	Check TS continuity counters
count	packet	Count TS packets per PID
craft	input, packet	Build or modify specifically crafted packets
cutoff	packet	Set labels on TS packets upon reception of UDP messages
datainject	packet	DVB SimulCrypt-compliant EMM and private data injector
decap	packet	Decapsulate TS packets from a PID produced by **encap** plugin
dektec	input, output	Dektec DTA-1xx DVB-ASI and modulator devices I/O
descrambler	packet	Generic DVB descrambler
drop	output	Drop output packets
dump	packet	Dump transport stream packets
duplicate	packet	Duplicate PID's, reusing null packets
dvb	input	DVB receiver devices (DVB-S, DVB-C, DVB-T) input
eit	packet	Analyze EIT sections
eitinject	packet	Generate and inject EIT's in a transport stream
encap	packet	Encapsulate packets from several PID's into one single PID
feed	packet	Extract an inner TS from an outer feed TS (experimental)
file	input, output, packet	Transport stream files input / output. As packet processor plugin, save packets to a file and pass to next plugin
filter	packet	Filter TS packets according to various criteria
fork	input, output, packet	Exchange packets with a created process, either input or output
fuzz	packet	Introduce random errors in the transport stream
hides	output	Send the transport stream to a HiDes modulator device
history	packet	Report a history of major events on the transport stream

Plugin	Type	Description
hls	input, output	Receive or generate HTTP Live Streaming (HLS) media
http	input, output	Send / receive a transport stream as / from an HTTP server
inject	packet	Inject a table into a transport stream
ip	input, output, packet	Send / receive UDP/IP datagrams, including multicast IP and RTP
limit	packet	Limit the global bitrate by dropping packets
memory	input, output	Direct memory input / output with an application
merge	packet	Merge TS packets coming from the output of a created process
mpe	packet	Extract MPE (Multi-Protocol Encapsulation) datagrams
mpeinject	packet	Encapsulate and inject an incoming UDP stream into MPE
mux	packet	Inject TS packets from a file into the transport
nit	packet	Perform various transformations on the NIT
nitscan	packet	Scan the NIT for tuning information
null	input	Null packets generator
pat	packet	Perform various transformations on the PAT
pattern	packet	Replace packet payload with a binary pattern
pcap	input	Read TS packets from a pcap or pcap-ng file
pcradjust	packet	Adjust PCR's according to a constant bitrate
pcrbitrate	packet	Permanently recompute bitrate based on PCR's
pcrcopy	packet	Copy and synchronize PCR's from one PID to another
pcredit	packet	Edit PCR, PTS and DTS values in various ways
pcrextract	packet	Extract PCR's from TS packets
pcrverify	packet	Verify PCR values
pes	packet	Analyze PES packets
pidshift	packet	Shift one or more PID's forward in the transport stream
play	output	Play output TS on a media player
pmt	packet	Perform various transformations on the PMT
psi	packet	Extract all PSI tables (PAT, CAT, PMT, NIT, BAT, SDT)
psimerge	packet	Merge PSI/SI from mixed streams
reduce	packet	Reduce the bitrate by removing stuffing packets
regulate	packet	Regulate TS packets flow according to a bitrate or PCR
remap	packet	Generic PID remapper
rist	input, output	Send / receive using Reliable Internet Stream Transport (RIST)
rmorphan	packet	Remove unreferenced ("orphan") PID's
rmsplice	packet	Remove ads insertions using SCTE 35 splicing information
scrambler	packet	DVB scrambler
sdt	packet	Perform various transformations on the SDT
sections	packet	Remove or merge sections from various PID's

Plugin	Type	Description
sifilter	packet	Extract PSI/SI PID's
skip	packet	Skip leading packets in a TS
slice	packet	Pass or drop packets based on packet numbers or relative time
spliceinject	packet	Inject SCTE 35 splice commands in a transport stream
splicemonitor	packet	Monitor SCTE 35 splice information
srt	input, output	Send / receive packets using Secure Reliable Transport (SRT)
stats	packet	Report various statistics on PID's and labels
stuffanalyze	packet	Analyze the level of stuffing in sections
svremove	packet	Remove a service
svrename	packet	Rename a service (modify service id, name, type, etc.)
svresync	packet	Resynchronize the clock of a service based on another service
t2mi	packet	Extract T2-MI (DVB-T2 Modulator Interface) packets
tables	packet	Collect MPEG tables
teletext	packet	Extract Teletext subtitles in SRT format
time	packet	Schedule packets pass or drop
timeref	packet	Update TDT and TOT with a new time reference
timeshift	packet	Delay transmission by a fixed amount of packets
trigger	packet	Trigger actions on selected labeled TS packets
tsrename	packet	Rename a transport stream (modify ts id, etc.)
until	packet	Pass TS packets until specified conditions
vatek	output	Send the transport stream to a VATek-based modulator device
zap	packet	Zap on one or more services, remove all other services

Some plugins are related to the scrambling of TS packets and Conditional Access Systems. Please note the following:

- The DVB-CSA scrambling algorithm is inherently and purposely very slow with a software implementation. A 3.4 GHz Pentium 4 CPU, for instance, cannot (de)scramble more than 20 Mb/s. Be cautious not to ask for impossible tasks, like real time (de)scrambling of a complete TS on a regular PC.

- These **tsp** plugins are implemented for testing Conditional Access Systems, either on the head-end or set-top box side. TSDuck does not provide any support to hack or circumvent Conditional Access Systems and will never do so. The CAS-related plugins require and use external CAS-provided systems (ECMG, EMMG and smartcards). All secrecy and proprietary CAS information remain isolated inside these external systems and TSDuck does not attempt to access this type of secret and private information. TSDuck only interacts with these systems using their external communication protocols.

⊞ aes

Experimental AES scrambling

This plugin scrambles or descrambles the payload of packets from a specified service using AES and a fixed key. Various chaining modes are allowed. All video, audio and subtitles components of the service are scrambled.

By default, the plugin scrambles the packets. Use option **--descramble** to descramble the packets.

Usage

```
tsp -P aes [options] [service]
```

Parameter

Specifies the service to scramble or descramble. If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id. Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored.

If the service is unspecified, individual PID's are scrambled (see option **--pid**).

Options

--brazil

A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--cbc

Use Cipher Block Chaining (CBC) mode without padding. The residue (last part of the packet payload, shorter than 16 bytes) is left clear.

--cts1

Use Cipher Text Stealing (CTS) mode. TS packets with a payload shorter than 17 bytes are left clear.

Several incompatible designs of CTS exist. This one implements the description in:

1) Bruce Schneier, Applied Cryptography (2nd, Ed.), pp 191, 195

2) RFC 2040, The RC5, RC5-CBC, RC5-CBC-Pad, and RC5-CTS Algorithms

3) "CBC ciphertext stealing" in http://en.wikipedia.org/wiki/Ciphertext_stealing

--cts2

Use Cipher Text Stealing (CTS) mode. TS packets with a payload shorter than 16 bytes are left clear.

Several incompatible designs of CTS exist. This one implements the description in http://csrc.nist.gov/groups/ST/toolkit/BCM/documents/ciphertext%20stealing%20proposal.pdf

--cts3

Use ECB Cipher Text Stealing (CTS) mode. TS packets with a payload shorter than 17 bytes are left clear.

Several incompatible designs of CTS exist. This one implements the description of "ECB ciphertext stealing" in http://en.wikipedia.org/wiki/Ciphertext_stealing

--cts4

Use ECB Cipher Text Stealing (CTS) mode. TS packets with a payload shorter than 17 bytes are left clear.

Several incompatible designs of CTS exist. This one implements the ECB ciphertext stealing which is used in ST 71xx chips.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.

By default, standard DVB encoding is used. See section 2.5 for more details.

-d
--descramble

Descramble instead of scramble.

--dvs042

Use DVS 042 (now ANSI/SCTE 52 2003) cipher block chaining mode.

TS packets with a payload shorter than 16 bytes are left clear. Note that the DVS 042 standard allows the scrambling of short messages (shorter than the cipher block size, ie. 16 bytes with AES) but the two versions of the standard (ANSI/SCTE 52 2003 and ANSI/SCTE 52 2008) have incompatible descriptions of the processing of short messages. To avoid conflicts, this plugin does not scramble these short messages.

--ecb

Use Electronic Code Book (ECB) mode without padding. The residue (last part of the packet payload, shorter than 16 bytes) is left clear. This is the default mode.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

-i *hexa-digits*
--iv *hexa-digits*

Specifies the initialization vector. Must be a string of 32 hexadecimal digits. Must not be used in ECB mode and the various ECB-CTS modes (CTS3, CTS4). The default IV is all zeroes.

--japan

A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

-k *hexa-digits*
--key *hexa-digits*

Specifies a fixed and constant AES key for all TS packets. The value must be a string of 32 or 64 hexadecimal digits. This is a mandatory parameter.

--philippines

A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

Specifies PID's to scramble. Can be used instead of specifying a service.

Several **--pid** options may be specified.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

 Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

 Several **--only-label** options may be specified.

▉ analyze

Global transport stream analysis

This plugin performs various types of global analysis on the transport stream. It is equivalent to the **tsanalyze** utility. The following two commands produce the same result:

```
tsanalyze options filename
tsp –I file filename –P analyze options –O drop
```

Usage

```
tsp -P analyze [options]
```

General purpose options

-c
--cumulative

>   With **--interval**, accumulate analysis data of all intervals. With this option, each new report is an analysis from the beginning of the stream.

>   By default, the analyzed data are reset after each report.

-i *seconds*
--interval *seconds*

>   Produce a new output file at regular intervals. After outputting a file, the analysis context is reset, i.e. each output file contains a fully independent analysis.

-m
--multiple-files

>   When used with **--interval** and **--output-file**, create a new file for each analysis instead of rewriting the previous file. Assuming that the specified output file name has the form **base.ext**, each file is created with a time stamp in its name as **base-*YYYYMMDD-hhmmss*.ext**.

-o *filename*
--output-file *filename*

>   Specify the output text file for the analysis result. By default, use the standard output.

>   Warning: if you do not specify this option, be sure to redirect the output plugin to something different from the default. Otherwise, the text output of the analysis will be mixed with the binary output of the TS packets!

Analysis and output control options

The options for controlling the analysis and the output are the same as for the **tsanalyze** utility.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

>   Display this help text.

--only-label *label1*[-*label2*]

>   Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

>   Several **--only-label** options may be specified.

⠿ bat

Perform various transformations on a BAT

This plugin performs various transformations on the BAT, either all BAT's of the transport stream or one specific BAT for one specific bouquet.

Usage

```
tsp -P bat [options]
```

Options

--bitrate *value*

Specifies the bitrate in bits / second of the PID containing the BAT if a new one is created.

See section 2.2 for more details on the representation of bitrates.

The default is 3,000 b/s.

-b *value*
--bouquet-id *value*

Specify the bouquet id of the BAT to modify and leave other BAT's unmodified. By default, all BAT's are modified.

--cleanup-private-descriptors

Remove all private descriptors without preceding *private_data_specifier_descriptor*.

-c
--create

Create a new empty BAT if none was received after one second.

This is equivalent to **--create-after 1000**.

--create-after *milliseconds*

Create a new empty BAT if none was received after the specified number of milliseconds. If an actual BAT is received later, it will be used as the base for transformations instead of the empty one.

-i
--increment-version

Increment the version number of the BAT.

--inter-packet *value*

When a new BAT is created and **--bitrate** is not present, this option specifies the packet interval for the BAT PID, that is to say the number of TS packets in the transport between two packets of the PID.

Use instead of **--bitrate** if the global bitrate of the TS cannot be determined.

-v *value*
--new-version *value*

Specify a new value for the version of the BAT.

--patch-xml *filename*

Specify an XML patch file which is applied to each BAT on the fly. The XML patches are applied first. The other options of this plugin are applied on the patched table.

If the specified name starts with "**<?xml**", it is considered as *inline XML content*, meaning that the string in the command line is directly the XML content and not a file name.

Several **--patch-xml** options can be specified. Patch files are sequentially applied on each table.

See section 2.6.4 for more details on XML patch files.

--pds *value*

With option **--remove-descriptor**, specify the private data specifier which applies to the descriptor tag values above **0x80**.

--remove-descriptor *value*

Remove from the BAT all descriptors with the specified tag. Several **--remove-descriptor** options may be specified to remove several types of descriptors. See also option **--pds**.

-r *value*
--remove-service *value*

Remove the specified service_id from the following descriptors: *service_list_descriptor*, *logical_channel_number_ descriptor*. Several **--remove-service** options may be specified to remove several services.

--remove-ts *value*

Remove from the BAT all references to the transport stream with the specified *ts_id* value. Several **--remove-ts** options may be specified to remove several TS.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ bitrate_monitor

Monitor the bitrate of the transport stream or a given set of PID's

This plugin is used to monitor the bitrate of the complete transport stream or a given set of PID's. Note that the bitrate is the instantaneous bitrate, meaning that it is computed from the packets received during the last *n* seconds (*n* is a plugin parameter, default value = 5).

If the bitrate value is outside of the specified range, an alarm is reported.

An alarm command can be specified to report anomalies in a custom way. If such a command is present, it will be called with the problem description as parameters. See an example in section 5.2.30.

Usage

```
tsp -P bitrate_monitor [options]
```

Options

-a "*command***"**
--alarm-command "*command***"**

>   Command to run when the bitrate goes either out of range or back to normal.

>   The command receives the following additional parameters:

>>   1.   A human-readable alarm message.
>>   2.   Either "**ts**" or the decimal integer value of the first PID to monitor.
>>   3.   Bitrate alarm state string, one of "**lower**", "**greater**", "**normal**".
>>   4.   Current bitrate in b/s (decimal integer) of TS or set of PID's.
>>   5.   Minimum bitrate in b/s (decimal integer).
>>   6.   Maximum bitrate in b/s (decimal integer).
>>   7.   Net bitrate, without null packets, in b/s (decimal integer).

>   These parameters can be used or ignored by the alarm command.

--json-line[='*prefix*']

>   Report the bitrate information as one single line in JSON format.

>   The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--min *value*

>   Set minimum allowed value for bitrate in bits/s.

>   See section 2.2 for more details on the representation of bitrates.

>   The default is 10 bits/s.

--max *value*

>   Set maximum allowed value for bitrate bits/s.

>   See section 2.2 for more details on the representation of bitrates.

>   The default is 2^{32} bits/s. Note that default values for minimum and maximum bitrate are only useful to detect if the given PID is present or not.

-p *value*
--periodic-bitrate *value*

>   Always report the bitrate and net bitrate (without null packets) at the specific intervals in seconds, even if the bitrate is in range.

--periodic-command *value*

Run the **--alarm-command** at the specific intervals in seconds, even if the bitrate is in range.

With this option, the alarm command is run on state change and at periodic intervals.

--pid *pid1[-pid2]*

Specifies the PID or set of PID's to monitor.

By default, when no **--pid** is specified, monitor the bitrate of the full TS.

Several **--pid** options may be specified. When several PID's are specified, the tested bitrate is the global bitrate of all the selected PID's.

Compatibility: Previously, the PID to monitor could be specified as a command line parameter, without explicit **--pid** option. This is still accepted for compatibility for old scripts.

--set-label-above *label1[-label2]*

Set the specified labels on all packets while the bitrate is above normal.

Several **--set-label-above** options may be specified.

--set-label-below *label1[-label2]*

Set the specified labels on all packets while the bitrate is below normal.

Several **--set-label-below** options may be specified.

--set-label-go-above *label1[-label2]*

Set the specified labels on one packet when the bitrate goes above normal.

Several **--set-label-go-above** options may be specified.

--set-label-go-below *label1[-label2]*

Set the specified labels on one packet when the bitrate goes below normal.

Several **--set-label-go-below** options may be specified.

--set-label-go-normal *label1[-label2]*

Set the specified labels on one packet when the bitrate goes back to normal (within range).

Several **--set-label-go-normal** options may be specified.

--set-label-normal *label1[-label2]*

Set the specified labels on all packets while the bitrate is normal (within range).

Several **--set-label-normal** options may be specified.

--tag '*string*'

Message tag to be displayed in alarms. Useful when the plugin is used several times in the same process.

-s
--summary

Display a final summary of bitrate statistics.

-t *value*
--time-interval *value*

Time interval in seconds used to compute the bitrate. The default is 5 seconds.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

>   Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

>   Several **--only-label** options may be specified.

▦ boostpid

Boost the bitrate of a PID

This plugin artificially increases the bitrate of a selected PID by adding empty packets (ie. without payload). The plugin does not really insert new packets in the TS, it "steals" stuffing packets.

Usage

```
tsp -P boostpid [options] pid addpkt inpkt
```

Parameters

pid

  The first parameter specifies the PID to boost.

addpkt inpkt

  The second and third parameters specify that *addpkt* TS packets must be automatically added after every *inpkt* input TS packets in the PID. Both *addpkt* and *inpkt* must be non-zero integer values.

  As an example, the parameters 3 1 indicate to add 3 new empty packets in the PID for every existing packet. The resulting bitrate of the PID is multiplied by 4.

  Take care to limit the added packet ratio to something realistic. The value 1000/1, for instance, is unrealistic since it is impossible in most cases to find 1000 stuffing packets to replace between all existing packets of the PID.

Generic packet processing plugin options

  The following options are implicitly defined in all packet processing plugins.

  --help

    Display this help text.

  --only-label *label1*[-*label2*]

    Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

    Several **--only-label** options may be specified.

⚏ cat

Perform various transformations on the CAT

This plugin performs various transformations on the CAT.

Usage

```
tsp -P cat [options]
```

Options

-a casid/pid[/private-data]
--add-ca-descriptor *casid/pid[/private-data]*

> Add a *CA_descriptor* in the CAT with the specified CA System Id and EMM PID. The optional private data must be a suite of hexadecimal digits. Several --add-ca-descriptor options may be specified to add several descriptors.

-b *value*
--bitrate *value*

> Specifies the bitrate in bits / second of the PID containing the CAT if a new one is created.

> See section 2.2 for more details on the representation of bitrates.

> The default is 3,000 b/s.

--cleanup-private-descriptors

> Remove all private descriptors without preceding *private_data_specifier_descriptor*.

-c
--create

> Create a new empty CAT if none was received after one second.

> This is equivalent to **--create-after 1000**.

--create-after *milliseconds*

> Create a new empty CAT if none was received after the specified number of milliseconds. If an actual CAT is received later, it will be used as the base for transformations instead of the empty one.

> This can be useful to force the creation of a CAT in a TS which has none (the CAT is an optional table).

-i
--increment-version

> Increment the version number of the CAT.

--inter-packet *value*

> When a new CAT is created and --bitrate is not present, this option specifies the packet interval for the CAT PID, that is to say the number of TS packets in the transport between two packets of the PID.

> Use instead of **--bitrate** if the global bitrate of the TS cannot be determined.

-v *value*
--new-version *value*

> Specify a new value for the version of the CAT.

--patch-xml *filename*

> Specify an XML patch file which is applied to each CAT on the fly. The XML patches are applied first. The other options of this plugin are applied on the patched table.

If the specified name starts with "**<?xml**", it is considered as *inline XML content*, meaning that the string in the command line is directly the XML content and not a file name.

Several **--patch-xml** options can be specified. Patch files are sequentially applied on each table.

See section 2.6.4 for more details on XML patch files.

-r `id1`[`-id2`]
--remove-casid `id1`[`-id2`]

Remove all *CA_descriptors* with any of the specified CA System Ids.

Several **--remove-casid** options may be specified.

--remove-pid `pid1`[`-pid2`]

Remove all *CA_descriptors* with the specified EMM PID values.

Several **--remove-pid** options may be specified.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⠇ **clear**

Extract clear (non scrambled) sequences

This plugin extracts clear (non scrambled) sequences of a transport stream.

The extraction is based on one "*reference*" service (see option **--service**). When a clear packet is found on any audio or video stream of the reference service, all subsequent packets in the TS are transmitted. When no clear packet has been found in the last second, all subsequent packets in the TS are dropped.

This plugin is typically used after the plugin **zap**. It let the service pass when it is clear and drops it when it is scrambled.

Usage

```
tsp -P clear [options]
```

Options

-a
--audio

> Check only audio PIDs for clear packets. By default, audio and video PIDs are checked.

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--default-charset *name*

> Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.

> By default, standard DVB encoding is used. See section 2.5 for more details.

-d *value*
--drop-after-packets *value*

> Specifies the number of packets after the last clear packet to wait before stopping the packet transmission. By default, stop 1 second after the last clear packet (based on current bitrate).

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5.2 for more details.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5.2 for more details.

--philippines

> A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-s *name-or-id*
--service *name-or-id*

> Specify the reference service. If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id. Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored. If this option is not specified, the first service in the PAT is used.

--stuffing

> Replace excluded packets with stuffing (null packets) instead of removing them. Useful to preserve bitrate.

-v
--video

Check only video PIDs for clear packets. By default, audio and video PIDs are checked.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⠿ continuity

Check continuity counters

This plugin checks the continuity counters on TS packets, PID per PID.

Usage

```
tsp -P continuity [options]
```

Options

-f
--fix

> Fix incorrect continuity counters. By default, only display discontinuities.

--json-line[='*prefix*']

> Report the continuity information as one single line in JSON format.

> The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--no-replicate-duplicated

> Two successive packets in the same PID are considered as duplicated if they have the same continuity counter and same content (except PCR, if any).

> By default, with **--fix**, duplicated input packets are replicated as duplicated on output (the corresponding output packets have the same continuity counters).

> When this option is specified, the input packets are not considered as duplicated and the output packets receive individually incremented countinuity counters.

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

> Check or fix continuity counters only in packets with these PID values. Several **--pid** options may be specified. By default, all PID's are checked or fixed.

-t "*string*"
--tag "*string*"

> Message tag to be displayed when packets are missing. Useful when the plugin is used several times in the same command line.

Generic packet processing plugin options

> The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

⚏ count

Count TS packets per PID

This plugin counts packets per PID and provides either a summary of packet counts or a detailed list of packet per PID.

Usage

```
tsp -P count [options]
```

Options

-a
--all

> Report packet index and PID for all packets from the selected PID's. By default, only a final summary is reported.

-b
--brief

> Brief display. Report only the numerical values, not comment on their usage. This option is useful for automatic processing of the resulting output.

-i *value*
--interval *value*

> Report a timestamp and global packet counts at regular intervals. The specified value is a number of packets.

-n
--negate

> Negate the filter: specified PID's are excluded.

-o *filename*
--output-file *filename*

> Specify the output file for reporting packet counters. By default, report on standard error using the tsp logging mechanism.

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

> PID filter: select packets with these PID values. Several **--pid** options may be specified. By default, if **--pid** is not specified, all PID's are selected.

-s
--summary

> Display a final summary of packet counts per PID. This is the default, unless **--all** or **--total** is specified, in which case the final summary is reported only if **--summary** is specified.

--tag "*string*"

> Message tag to be displayed with count report lines. Useful when the plugin is used several times in the same command line.

-t
--total

> Display the total packet counts in all PID's.

Generic packet processing plugin options

> The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

--help

Display this help text.

⠿ craft (input)

Build specifically crafted input packets

This plugin generates fake transport stream packets from scratch. The various fields in the packets are specified using command line options.

Usage

```
tsp -I craft [options]
```

Options

--cc *value*

Specify the initial value of the *continuity_counter* field (0 by default).

--constant-cc

Do not increment the continuity counter.

By default, the continuity counter in incremented when the packet has a payload.

-c *value*
--count *value*

Specify the number of crafted packets to generate. After the last packet, an end-of-file condition is generated.

By default, if **--count** is not specified, crafted packets are generated endlessly.

--discontinuity

Set the *discontinuity_indicator* in the packets.

An adaptation field is created.

--error

Set the *transport_error_indicator* in the packets.

--es-priority

Set the *elementary_stream_priority_indicator* in the packets.

An adaptation field is created.

-j
--joint-termination

When **--count** is specified, perform a *joint termination* when completed instead of unconditional termination. See the description of the **tsp** command for more details on *joint termination*.

--no-payload

Do not use a payload.

--opcr *value*

Set this OPCR value in the packets.

An adaptation field is created.

--payload-pattern *hexa-digits*

Specify the binary pattern to apply on packets payload.

The value must be a string of hexadecimal digits specifying any number of bytes. The pattern is repeated to fill the payload. The last repetition of the pattern is truncated if necessary.

The default is **FF**.

--payload-size *value*

> Specify the size of the packet payload in bytes. When necessary, an adaptation field is created.
>
> Note that **--payload-size 0** specifies that a payload exists with a zero size. This is different from **--no-payload** which also specifies that the payload does not exist.
>
> By default, the payload uses all free space in the packet.

--pcr *value*

> Set this PCR value in the packets.
>
> An adaptation field is created.

-p *value*
--pid *value*

> Specify the PID for the packets (0 by default).

--priority

> Set the *transport_priority* flag in the packets.

--private-data *hexa-digits*

> Specify the complete binary content of the *transport_private_data* in the adaptation field.
>
> The value must be a string of hexadecimal digits specifying any number of bytes.

--pusi

> Set the *payload_unit_start_indicator* in the packets.

--random-access

> Set the *random_access_indicator* in the packets.
>
> An adaptation field is created.

--scrambling *value*

> Specify the value of the *transport_scrambling_control* field (0 by default).

--splice-countdown *value*

> Create a splicing point and set this splice countdown value in the packets.
>
> An adaptation field is created.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

> Display plugin help text.

▪ craft (packet processing)

Craft specific low-level transformations on packets

This plugin modifies precise fields in all TS packets.

Some operations may need space in the adaptation field. By default, the payload is left unmodified and a transformation is rejected if it needs to enlarge the adaptation field since this would destroy part of the existing payload. Enlarging the adaptation field is possible only when **--payload-pattern** is specified, in which case the payload is overwritten anyway.

Usage

```
tsp -P craft [options]
```

Options

--clear-discontinuity

   Clear the *discontinuity_indicator* in the packets.

--clear-error

   Clear the *transport_error_indicator* in the packets.

--clear-es-priority

   Clear the *elementary_stream_priority_indicator* in the packets.

--clear-priority

   Clear the *transport_priority* flag in the packets.

--clear-pusi

   Clear the *payload_unit_start_indicator* in the packets.

--clear-random-access

   Clear the *random_access_indicator* in the packets.

--continuity-counter *value*

   Specify the value of the *continuity_counter* field.

--discontinuity

   Set the *discontinuity_indicator* in the packets.

   Space is required in the adaptation field.

--error

   Set the *transport_error_indicator* in the packets.

--es-priority

   Set the *elementary_stream_priority_indicator* in the packets.

   Space is required in the adaptation field.

--no-opcr

   Remove the OPCR from the packets.

--no-payload

   Remove the payload.

--no-pcr

   Remove the PCR from the packets.

--no-private-data

Remove the private data from adaptation field.

--no-repeat

Do not repeat payload pattern operations as specified by options **--payload-pattern**, **--payload-and**, **--payload-or**, **--payload-xor**. The operation is performed once only.

--no-splice-countdown

Remove the splicing point from the packets.

--offset-pattern *value*

Specify starting offset in payload when using **--payload-pattern**. By default, the pattern replacement starts at the beginning of the packet payload.

--opcr *value*

Set this OPCR value in the packets.

Space is required in the adaptation field.

--pack-pes-header

When a TS packet contains the start of a PES packet and the header of this PES packet contains stuffing, shift the TS payload to remove all possible stuffing from the PES header. Create TS stuffing in the adaptation field to compensate.

With PES data streams such as subtitles, the PES header sometimes contains stuffing to make sure that the PES packet uses an integral number of full TS packets. This option is a way to create space in the adaptation field of TS packets without destroying data. Then, PCR or other data can be added in the adaptation fields.

--payload-and *hexa-digits*

Apply a binary "and" operation on the payload using the specified *hexvalue* binary pattern.

The value must be a string of hexadecimal digits specifying any number of bytes.

The "and" operation is repeated up to the end of the payload (unless **--no-repeat** is specified).

--payload-or *hexa-digits*

Apply a binary "or" operation on the payload using the specified *hexvalue* binary pattern.

The value must be a string of hexadecimal digits specifying any number of bytes.

The "or" operation is repeated up to the end of the payload (unless **--no-repeat** is specified).

--payload-pattern *hexa-digits*

Overwrite the payload with the specified *hexvalue* binary pattern.

The value must be a string of hexadecimal digits specifying any number of bytes.

The pattern is repeated to fill the payload (unless **--no-repeat** is specified).

--payload-size *size*

Resize the packet payload to the specified value in bytes.

When necessary, an adaptation field is created or enlarged. Without **--payload-pattern**, the existing payload is either shrunk or enlarged.

When an existing payload is shrunk, the end of the payload is truncated. When an existing payload is enlarged, its end is padded with **0xFF** bytes.

Note that **--payload-size 0** specifies that a payload exists with a zero size. This is different from **--no-payload** which also specifies that the payload does not exist.

--payload-xor *hexa-digits*

Apply a binary "exclusive or" operation on the payload using the specified binary pattern.

The value must be a string of hexadecimal digits specifying any number of bytes.

The "exclusive or" operation is repeated up to the end of the payload (unless **--no-repeat** is specified).

--pcr *value*

Set this PCR value in the packets.

Space is required in the adaptation field.

--pes-payload

With this option, the modified payload is the PES payload, not the TS payload. When the TS packet does not contain the start of a PES packet, the TS payload is not modified.

With **--payload-size**, the TS payload is resized so that the part of the PES payload which is in the TS packet gets the specified size.

With **--payload-pattern** and **--offset-pattern**, the pattern is applied inside the PES payload at the specified offset.

-p *value*
--pid *value*

Modify the PID to the specified value.

--priority

Set the transport_priority flag in the packets.

--private-data *hexa-digits*

Specify the binary content of the *transport_private_data* in the adaptation field.

The value must be a string of hexadecimal digits specifying any number of bytes.

Space is required in the adaptation field.

--pusi

Set the *payload_unit_start_indicator* in the packets.

--random-access

Set the *random_access_indicator* in the packets.

Space is required in the adaptation field.

--scrambling *value*

Specify the value of the *transport_scrambling_control* field.

--splice-countdown *value*

Create a splicing point and set this splice countdown value in the packets.

Space is required in the adaptation field.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ cutoff

Set labels on TS packets upon reception of UDP messages

This plugin set or clear labels on the TS packets upon reception of text commands from UDP.

This plugin is typically used as a remote command reception. Depending on the remote commands, packets are marked and can be processed differently in subsequent plugins in the chain.

Remote commands

The plugin **cutoff** listens to UDP datagrams on a given port. Each datagram contains exactly one command. A command is an ASCII string. Any trailing control characters such as CR or LF is ignored.

The command string can be one of:

`pulse-label` *n*	Set the label *n* on the next TS packet (only once).
`start-label` *n*	Set the label *n* on all TS packets (until the next **stop-label** command).
`stop-label` *n*	Stop setting the label *n* on all TS packets.
`exit`	Exit the *tsp* execution, simulate an end of stream at the next TS packet.

Note that the bash[5] shell provides an easy way to redirect output to an UDP message. The following sample commands send UDP messages on port 4444 to system 127.0.0.1 (the local host). This is the easiest way to control the plugin cutoff.

```
echo >/dev/udp/127.0.0.1/4444 pulse-label 1
echo >/dev/udp/127.0.0.1/4444 start-label 2
echo >/dev/udp/127.0.0.1/4444 stop-label 2
echo >/dev/udp/127.0.0.1/4444 exit
```

Usage

```
tsp -P cutoff [options] [[source@]address:]port
```

Parameter

The parameter [*address:*]*port* describes the destination of incoming UDP datagrams. All datagrams which are received on this stream are text commands.

The *port* part is mandatory and specifies the UDP port to listen on. The *address* part is optional. It specifies an IP multicast address to listen on. It can be also a host name that translates to a multicast address.

An optional source address can be specified as *source@address:port* in the case of source-specific multicast (SSM).

If the address is not specified, the plugin simply listens on the specified local port and receives the packets which are sent to one of the local (unicast) IP addresses of the system.

Options

-a *address*
--allow *address*

    Specify an IP address or host name which is allowed to send remote commands. Several **--allow** options can be used to specify several allowed remote control systems.

    By default, all received commands are accepted. If at least one **--allow** option is specified, any remote command which is not sent by an allowed host is rejected.

---

[5] This is a feature of *bash*, not a Linux feature. It is available on all platforms, including macOS or Cygwin.

This is a security feature, but not a perfect one since IP address spoofing is trivial with UDP.

-b *value*
--buffer-size *value*

Specify the UDP socket receive buffer size in bytes (socket option).

--default-interface

Let the system find the appropriate local interface on which to listen. By default, listen on all local interfaces.

--disable-multicast-loop

Disable multicast loopback.

By default, incoming multicast packets are looped back on local interfaces, if an application sends packets to the same group from the same system. This option disables this.

Warning: On input sockets, this option is effective only on Windows systems. On Unix systems (Linux, macOS, BSD), this option applies only to output sockets.

-f
--first-source

Filter UDP packets based on the source address. Use the sender address of the first received packet as only allowed source.

This option is useful when several sources send packets to the same destination address and port. Accepting all commands could result in inconsistent processing and only one sender shall be accepted.

To allow a more precise selection of the sender, use option **--source**. Options **--first-source** and **--source** are mutually exclusive.

-l *address*
--local-address *address*

Specify the IP address of the local interface on which to listen. It can be also a host name that translates to a local address.

By default, listen on all local interfaces.

--max-queue *value*

Specify the maximum number of queued UDP commands before their execution into the stream.

The default is 128.

--no-reuse-port

Disable the reuse port socket option. Do not use unless completely necessary.

--receive-timeout *value*

Specify the UDP reception timeout in milliseconds. This timeout applies to each receive operation, individually.

By default, receive operations wait for commands, possibly forever.

-r
--reuse-port

Set the reuse port socket option. This is now enabled by default, the option is present for legacy only.

-s *address[:port]*
--source *address[:port]*

Filter UDP packets based on the specified source address.

This option is useful when several sources send packets to the same destination address and port. Accepting all commands could result in inconsistent processing and only one sender shall be accepted.

Options **--first-source** and **--source** are mutually exclusive.

--ssm

This option forces the usage of source-specific multicast (SSM) using the source address which is specified by the option **--source**. Without **--ssm**, standard ("any-source') multicast is used and the option **--source** is used to filter incoming packets.

The **--ssm** option is implicit when the classical SSM syntax *source@address:port* is used.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

datainject

DVB-SimulCrypt EMM and private data injector

This plugin receives EMM's and/or private data using the DVB SimulCrypt EMMG/PDG ⇔ MUX protocol and injects them into the transport stream in a specific PID.

This plugin is a TCP server (MUX side of the protocol). It accepts only one EMMG/PDG connection at a time.

If the injected data are EMM's, make sure to update the CAT accordingly (see the plugin **cat**).

Usage

```
tsp -P datainject [options]
```

Options

-b *value*
--bitrate-max *value*

> Specifies the maximum bitrate for the data PID in bits / second.

> See section 2.2 for more details on the representation of bitrates.

> By default, the data PID bitrate is limited by the stuffing bitrate (data insertion is performed by replacing stuffing packets).

--buffer-size *value*

> Specify the TCP and UDP socket receive buffer size in bytes (socket option).

-v *value*
--emmg-mux-version *value*

> Specifies the version of the EMMG/PDG ⇔ MUX DVB SimulCrypt protocol.

> Valid values are 1 to 5. The default is 2.

--log-data[=*level*]

> Same as **--log-protocol** but applies to *data_provision* messages only.

> To debug the session management without being flooded by data messages, use **--log-protocol=info --log-data=debug**.

--log-protocol[=*level*]

> Log all EMMG/PDG ⇔ MUX protocol messages using the specified level. If the option is not present, the messages are logged at debug level only. If the option is present without value, the messages are logged at info level. A level can be a numerical debug level or any of the following: **fatal**, **severe**, **error**, **warning**, **info**, **verbose**, **debug**.

--no-reuse-port

> Disable the reuse port socket option. Do not use unless completely necessary.

-p *value*
--pid *value*

> Specifies the PID for the data insertion. This option is mandatory.

-q *value*
--queue-size *value*

> Specifies the maximum number of data sections or TS packets in the internal queue, i.e. messages which are received from the EMMG/PDG client but not yet inserted into the transport stream.

> The default is 1000.

-r
--reuse-port

> Set the reuse port socket option. This is now enabled by default, the option is present for legacy only.

-s *[address:]port*
--server *[address:]port*

> Specifies the local TCP port on which the plugin listens for an incoming EMMG/PDG connection. This option is mandatory.

> When present, the optional address shall specify a local IP address or host name (by default, the plugin accepts connections on any local IP interface). This plugin behaves as a MUX, ie. a TCP server, and accepts only one EMMG/PDG connection at a time.

-u *[address:]port*
--udp *[address:]port*

> Specifies the local UDP port on which the plugin listens for data provision messages (these messages can be sent using TCP or UDP).

> By default, the UDP reception uses the same port and optional local address as specified for TCP using option **--server**.

--unregulated

> Insert data packets immediately. Do not regulate the insertion of data packets, do not limit the data bitrate.

> This is useful to test invalid EMMG's which do not comply with the allocated bitrate policy.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

⊞ decap

Decapsulate TS packets from a PID produced by the *encap* plugin

This plugin is the counterpart of the **encap** plugin. It decapsulates the original TS packets from a *tunnel PID* which was created by **encap**. See the documentation of the **encap** plugin for more details.

The decapsulated packets replace the tunnel PID. Because of the encapsulation overhead, the total volume of decapsulated packets is slightly smaller (approximately 2%) than the encapsulation PID. The packets in excess are replaced by null packets after decapsulation.

Usage

```
tsp -P decap [options]
```

Options

-i
--ignore-errors

   Ignore errors such malformed encapsulated stream.

-p *value*
--pid *value*

   Specify the input PID containing all encapsulated PID's. This is a mandatory parameter, there is no default.

Generic packet processing plugin options

   The following options are implicitly defined in all packet processing plugins.

   --help

      Display this help text.

   --only-label *label1*[-*label2*]

      Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

      Several **--only-label** options may be specified.

dektec (input)

Dektec DTA-1xx and DTU-2xx ASI, GigE and demodulator devices

This input plugin receives packets from a Dektec DTA-1xx or DTU-2xx DVB-ASI or demodulator device.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Restrictions

This plugin is available on Linux and Windows only, Intel processors only. Dektec provides no software support on macOS and other processors. Moreover, this plugin may be unavailable on some Linux distributions since it integrates a closed-source library from Dektec, which is prohibited by the policy of some distributions.

TSDuck manipulates transport stream packets only. Consequently, this plugin only supports input/output modes which process MPEG-TS packets. Some Dektec devices support other modes such as SDI, HDMI, ATSC-3.0 which handle other formats. These modes cannot be used with TSDuck.

Usage

```
tsp -I dektec [options]
```

General options

-c *value*
--channel *value*

Channel index on the input Dektec device. By default, use the first input channel on the device.

-d *value*
--device *value*

Device index, from 0 to N-1 (with N being the number of Dektec devices in the system). Use the command "**tsdektec -a**" to have a complete list of devices in the system.

By default, use the first input Dektec device.

--fifo-size *value*

Set the reception FIFO size in bytes of the input channel in the Dektec device.

The default value depends on the device type.

--io-standard *name*

Specify the I/O standard to use on the device port. This option applies to multi-standard ports such as ASI/SDI ports. The list possible values for this option is given in the table below.

Which modes are supported in practice depend on the device model. See the Dektec documentation for more details.

Table 6: Values for option --io-standard (dektec plugins)

Value	Description
ASI	DVB-ASI transport stream
SPI	DVB-SPI transport stream
IF-AD-converter	IF A/D converter
IP	Transport stream over IP
dektec-streaming	DekTec Streaming-data Interface
demodulator	Demodulator input

Value	Description
modulator	Modulator output

--preload-fifo

> Wait for the reception FIFO (hardware buffer) to be half-full before starting reception.

-t *value*
--receive-timeout *value*

> Specify the data reception timeout in milliseconds. This timeout applies to each receive operation, individually. By default, receive operations wait for data, possibly forever.

Demodulators options

The following options are used with Dektec demodulator devices.

--c2-bandwidth *value*

> DVB-C2 demodulators: indicate the DVB-C2 bandwidth.
>
> Must be one of **6-MHz**, **8-MHz**. The default is **8-MHz**.

--code-rate *value*

> For demodulator devices only: specify the code rate. The specified value depends on the modulation type.
>
> DVB-S: **1/2**, **2/3**, **3/4**, **4/5**, **5/6**, **6/7**, **7/8**.
>
> DVB-S2: **1/2**, **1/3**, **1/4**, **2/3**, **2/5**, **3/4**, **3/5**, **4/5**, **5/6**, **6/7**, **7/8**, **8/9**, **9/10**.
>
> DVB-T: **1/2**, **2/3**, **3/4**, **5/6**, **7/8**.
>
> The value **auto** can be used to automatically detect the code rate. This is the default.

--constellation *value*

> DVB-T demodulators: indicate the constellation type.
>
> Must be one of **16-QAM**, **64-QAM**, **QPSK**, **auto**.
>
> The value **auto** can be used to automatically detect the constellation. This is the default.

--dvbt-bandwidth *value*

> DVB-T/T2 demodulators: indicate the bandwidth in MHz. The default is 8 MHz.
>
> Must be one of **1.7**, **10**, **5**, **6**, **7**, **8**. The bandwidth values 1.7, 5 and 10 MHz are valid for DVB-T2 only.

-f *value*
--frequency *value*

> For demodulator devices only: specify the frequency, in Hz, of the input carrier. There is no default.
>
> For DVB-S/S2 receivers, the specified frequency is the *intermediate* frequency. For convenience, the option **--satellite-frequency** can be used instead of **--frequency** when the intermediate frequency is unknown. When **--frequency** is used with DVB-S/S2, the original satellite frequency is unknown, it is impossible to determine if a high band is used and no "high band 22 kHz tone" is send to the LNB.
>
> For DTA-2137 receivers, the valid range is 950 MHz to 2150 MHz (L Band).

--guard-interval *value*

> DVB-T demodulators: indicate the guard interval.
>
> Must be one of **1/16**, **1/32**, **1/4**, **1/8**, **auto**. The default is **auto**.

--isdbt-bandwidth *value*

ISDB-T demodulators: indicate the bandwidth in MHz.

Must be one of **5**, **6**, **7**, **8**. The default is 8 MHz.

--isdbt-segments *value*

ISDB-T demodulators: indicate the number of segments.

Must be one of **1**, **3** or **13**. The default is 1.

--isdbt-subchannel *value*

ISDB-T demodulators: indicate the sub-channel number (0 to 41) of the centre segment of the spectrum. The default is 22.

--j83 *value*

QAM demodulators: indicate the ITU-T J.83 annex to use. Must be one of "**A**", "**B**", "**C**".

A is DVB-C, B is "American QAM", C is "Japanese QAM". The default is A.

--lnb *string*

DVB-S/S2 receivers: description of the LNB which is used to convert the **--satellite-frequency** into an *intermediate* frequency. This option is useless when **--satellite-frequency** is not specified.

See appendix A.3 page 491 for more details.

-m *value*
--modulation *value*

For demodulators, indicate the modulation type. The supported modulation types depend on the device model. The default modulation type is DVB-S.

Must be one of **ATSC-VSB**, **DAB**, **DVB-C2**, **DVB-S**, **DVB-S-QPSK** (same as **DVB-S**), **DVB-S2**, **DVB-S2-QPSK** (same as **DVB-S2**), **DVB-S2-8PSK**, **DVB-S2-16APSK**, **DVB-S2-32APSK**, **DVB-T**, **DVB-T2**, **ISDB-T**, **QAM** (auto-detection of QAM type), **128-QAM**, **16-QAM**, **256-QAM**, **32-QAM**, **64-QAM**.

--polarity *value*

DVB-S/S2 receivers: indicate the polarity.

Must be one of **horizontal**, **vertical**. The default is **vertical**.

--qam-b *value*

QAM demodulators: with **--j83 B**, indicate the QAM-B interleaver mode.

Must be one of **I8-J16**, **I16-J8**, **I32-J4**, **I64-J2**, **I128-J1**, **I128-J1D**, **I128-J2**, **I128-J3**, **I128-J4**, **I128-J5**, **I128-J6**, **I128-J7**, **I128-J8**, **auto**. The default is **auto**.

--satellite-frequency *value*

DVB-S/S2 receivers: indicate the target satellite frequency, in Hz, of the input carrier. The actual frequency at the input of the receiver is the *intermediate* frequency which is computed based on the characteristics of the LNB (see option **--lnb**). This option is useful when the satellite frequency is better known than the intermediate frequency.

The options **--frequency** and **--satellite-frequency** are mutually exclusive.

--satellite-number *value*

DVB-S/S2 receivers: indicate the satellite/dish number.

Must be 0 to 3 with DiSEqC switches and 0 to 1 for non-DiSEqC switches. The default is 0.

--symbol-rate *value*

> DVB-C/S/S2 demodulators: Specify the symbol rate in symbols/second. By default, automatically detect the symbol rate.

--t2-profile *value*

> DVB-T2 demodulators: indicate the DVB-T2 profile.
>
> Must be one of **base**, **lite**. The default is **base**.

--transmission-mode *value*

> DVB-T demodulators: indicate the transmission mode.
>
> Must be one of **2K**, **8K**, **auto**. The default is **auto**.

--vsb *value*

> ATSC demodulators: indicate the VSB constellation.
>
> Must be one of **8**, **16**. The default is **8**.

TS-over-IP options

The following options are used with Dektec Ethernet devices.

--ip4 *ipv4-address:port*

> TS-over-IP: Destination IPv4 address and port.
>
> Either **--ip4** or **--ip6** must be specified with Dektec Ethernet devices.
>
> The address part is mandatory for multicast, optional for unicast.
>
> With SMPTE 2022-7 network redundancy, this parameter can be specified twice, main and redundant link.

--ip6 [*ipv6-address*]:*port*

> TS-over-IP: Destination IPv6 address and port.
>
> Important: The square brackets are literal, as in any IPv6 URL, not an indication of an optional field.
>
> Either **--ip4** or **--ip6** must be specified with Dektec Ethernet devices.
>
> The address part is mandatory for multicast, optional for unicast.
>
> With SMPTE 2022-7 network redundancy, this parameter can be specified twice, main and redundant link.

--smpte-2022-fec

> TS-over-IP: Use SMPTE-2022 error correction.

--ssm4-filter *ipv4-address:port*

> TS-over-IP: Specify optional IPv4 source-specific multicast (SSM) filter.
>
> The port number is optional. This option may be repeated to filter on multiple sources.
>
> With SMPTE 2022-7 network redundancy, the same list of filters is used in both links.

--ssm6-filter [*ipv6-address*]:*port*

> TS-over-IP: Specify optional IPv6 source-specific multicast (SSM) filter.
>
> Important: The square brackets are literal, as in any IPv6 URL, not an indication of an optional field.
>
> The port number is optional. This option may be repeated to filter on multiple sources.
>
> With SMPTE 2022-7 network redundancy, the same list of filters is used in both links.

--vlan-id *value*

> TS-over-IP: Optional VLAN identifier as specified in IEEE 802.1Q.
>
> With SMPTE 2022-7 network redundancy, this parameter can be specified twice, main and redundant link.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

> Display plugin help text.

▉ dektec (output)

Dektec DTA-1xx and DTU-2xx ASI, GigE and modulator devices

This output plugin sends packets to a DVB-ASI Dektec DTA-1xx or DTU-2xx device or a Dektec DTA-1xx modulator.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Restrictions

This plugin is available on Linux and Windows only, Intel processors only. Dektec provides no software support on macOS and other processors. Moreover, this plugin may be unavailable on some Linux distributions since it integrates a closed-source library from Dektec, which is prohibited by the policy of some distributions.

TSDuck manipulates transport stream packets only. Consequently, this plugin only supports input/output modes which process MPEG-TS packets. Some Dektec devices support other modes such as SDI, HDMI, ATSC-3.0 which handle other formats. These modes cannot be used with TSDuck.

Usage

```
tsp -O dektec [options]
```

Overview of options

For multi-standard modulators such as the DTA-115, the type of required modulation must be specified if it is different from the default modulation. See Table 7 for the default modulation type by device model.

Table 7: Dektec modulators default modulation types

Device model	Default modulation
DTA-107	DVB-S (QPSK)
DTA-107.S2	DVB-S2 (QPSK)
DTA-110	DVB-C (64-QAM)
DTA-110T	DVB-T
DTA-115	DVB-T

Depending on the type of output, the combination of required and optional options is different. See Table 8 for the applicability of options by modulation type. The modulation type is specified using option **--modulation**. Mandatory options are marked using (*).

Table 8: Command line options for Dektec modulators

Modulation	Applicable options
All (common options)	`--bitrate --channel --device --stuffing --fifo-size`
DVB-ASI	`--204`
All except DVB-ASI	`--frequency --instant-detach --inversion --level --modulation --offset-count --uhf-channel --vhf-channel`
x-QAM	`--j83 --qam-b`

Modulation	Applicable options

ADBT-T, DMB-T/H	`--bandwidth --dmb-constellation --dmb-fec`
	`--dmb-frame-numbering --dmb-header --dmb-interleaver`
	`--pilots`

ATSC	`--vsb --vsb-taps`
DVB-S	`--convolutional-rate --lnb --satellite-frequency` `--symbol-rate`
DVB-S2	`--convolutional-rate --lnb –pilots --roll-off --s2-gold-code` `--s2-short-fec-frame --satellite-frequency --symbol-rate`

DVB-T	`--bandwidth --cell-id --constellation`
	`--convolutional-rate --guard-interval`
	`--indepth-interleave --mpe-fec --time-slice`
	`--transmission-mode`

DVB-T2	`--bandwidth --bandwidth-extension --cell-id –fef`
	`--fef-interval --fef-length --fef-s1 --fef-s2`
	`--fef-signal --fef-type --fft-mode --miso –papr`
	`--pilot-pattern --plp0-code-rate --plp0-fec-type`
	`--plp0-group-id --plp0-high-efficiency --plp0-id`
	`--plp0-il-length --plp0-il-type --plp0-in-band`
	`--plp0-issy --plp0-modulation --plp0-null-packet-deletion`
	`--plp0-rotation --plp0-tsrate --plp0-type`
	`--t2-fpsf --t2-guard-interval --t2-l1-modulation`
	`--t2-network-id --t2-system-id`

General options

--204

For DVB-ASI devices only: Send 204-byte packets (188 meaningful bytes plus 16 stuffing bytes for Reed-Solomon coding). By default, send 188-byte packets.

-b *value*
--bitrate *value*

Specify the output bitrate in bits/second.

By default, use the input device bitrate or, if the input device cannot report bitrate, analyze some PCR's at the beginning of the input stream to evaluate the original bitrate of the transport stream.

See section 2.2 for more details on the representation of bitrates.

-c *value*
--channel *value*

Channel index on the output Dektec device. By default, use the first output channel on the device.

-d *value*
--device *value*

Device index, from 0 to N-1 (with N being the number of Dektec devices in the system). Use the command "**tsdektec -a**" to have a complete list of devices in the system. By default, use the first output Dektec device.

--drop-to-maintain-preload

If the FIFO were preloaded, and maintaining the preload via option **--maintain-preload**, drop any packets that would exceed the preload FIFO size plus a small threshold.

--fifo-size *value*

Set the FIFO size in bytes of the output channel in the Dektec device. The default value depends on the device type.

--instant-detach

At end of stream, perform an *instant detach* of the output channel. The transmit FIFO is immediately cleared without waiting for all data to be transmitted. With some Dektec devices, the default mode may hang at end of stream and **--instant-detach** avoids this.

The options **--instant-detach** and **--wait-detach** are mutually exclusive.

--io-standard *name*

Specify the I/O standard to use on the device port. This option applies to multi-standard ports such as ASI/SDI ports. The list possible values for this option is given in the documentation of the **dektec** input plugin (same option).

Which modes are actually supported depend on the device model. See the Dektec documentation for more details.

--maintain-preload

If the FIFO were preloaded (see options **--preload-fifo** and **--drop-to-maintain-preload**), roughly maintain the FIFO buffer size in order to maintain the delay from real-time. If the FIFO size drops to zero bytes, pause transmission till it gets back to the preload FIFO size.

--power-mode *value*

DTU-315 modulators: set the power mode to the specified value.

Must be one of **high-quality**, **low-power**.

--preload-fifo

Preload FIFO (hardware buffer) before starting transmission.

Preloading the FIFO will introduce a variable delay to the start of transmission, *if* the delivery of packets to the plug-in is pre-regulated, based on the size of the FIFO, the TS bit rate, and the size of the FIFO to preload, as controlled by the **--preload-fifo-percentage** or **--preload-fifo-delay** options.

If the delivery of packets to the plug-in isn't self-regulated (i.e. they are delivered faster than real-time, as might occur when loading from file), there is no benefit to preloading the FIFO, because in that case, the FIFO will fill up quickly anyway.

This option is implicitly set when using a modulator for output.

--preload-fifo-delay *value*

The use of this option indicates that the size of the FIFO to preload prior to starting transmission should be calculated based on the specified delay, in milliseconds, and the configured bit rate. That is, transmission will start after the specified delay worth of media has been preloaded.

This option takes precedence over the **--preload-fifo-percentage** option.

There is no default value, and the valid range is 100-100000.

--preload-fifo-percentage *value*

Percentage of size of FIFO to preload prior to starting transmission (default: 80%).

-s
--stuffing

Automatically generate stuffing packets if tsp fails to provide packets fast enough.

This option applies only to ASI, SDI and hardware-based modulators (DVB-C, DVB-S). This option is ineffective on modulators which are partially software-based (DVB-T on DTA-110T or DTA-115).

--wait-detach

At end of stream, the plugin waits until all bytes in the transmit FIFO are sent. Some Dektec devices may hang on detach in that case. You should try first.

The options **--instant-detach** and **--wait-detach** are mutually exclusive.

Modulators options

The following options are used with Dektec modulator devices.

--bandwidth *value*

DVB-T/H, DVB-T2, ADTB-T and DMB-T/H modulators: indicate bandwidth in MHz. Must be one of **1.7**, **5**, **6**, **7**, **8** or **10**. The default is 8 MHz. The bandwidth values 1.7 and 10 MHz are valid for DVB-T2 only.

--bandwidth-extension

DVB-T2 modulators: indicate that the extended carrier mode is used. By default, use normal carrier mode.

--carrier-only

Output the carrier frequency only, without modulated transport stream. All output packets are dropped.

Sample usage: To generate an empty carrier and wait forever, use the following command.

```
tsp –final-wait 0 -I null 1 -O dektec --carrier-only --frequency ...
```

This is a minimal command which generates only one input packet and then wait forever. Using the **null** input plugin alone would also work. However, it would saturate the CPU, looping on null packet generation, dropping them later. The above command just generates one packet (this is the required minimum to start the output plugin) and then does nothing except maintaining the output carrier frequency.

--cell-id *value*

DVB-T and DVB-T2 modulators: indicate the cell identifier to set in the transmission parameters signaling (TPS). Disabled by default with DVB-T. Default value is 0 with DVB-T2.

--constellation *value*

DVB-T modulators: indicate the constellation type. Must be one of "QPSK", "16-QAM", "64-QAM". The default is 64-QAM.

-r *rate*
--convolutional-rate *rate*

For modulators devices only: specify the convolutional rate. The specified value depends on the modulation type. The default is **3/4**.

DVB-S: **1/2**, **2/3**, **3/4**, **4/5**, **5/6**, **6/7**, **7/8**.

DVB-S2:   **1/2**, **1/3**, **1/4**, **2/3**, **2/5**, **3/4**, **3/5**, **4/5**, **5/6**, **6/7**, **7/8**, **8/9**, **9/10**.

DVB-T: **1/2**, **2/3**, **3/4**, **5/6**, **7/8**.

--dmb-constellation *value*

DMB-T/H, ADTB-T modulators: indicate the constellation type. Must be one of: **4-QAM-NR**, **4-QAM**, **16-QAM**, **32-QAM**, **64-QAM**. The default is **64-QAM**. **4-QAM-NR** and **32-QAM** can be used only with **--dmb-fec 0.8**.

--dmb-fec *value*

> DMB-T/H, ADTB-T modulators: indicate the FEC code rate. Must be one of **0.4**, **0.6**, **0.8**. The default is **0.8**.

--dmb-frame-numbering

> DMB-T/H, ADTB-T modulators: indicate to use frame numbering. The default is to use no frame numbering.

--dmb-header *value*

> DMB-T/H, ADTB-T modulators: indicate the FEC frame header mode. Must be one of **PN420**, **PN595** (ADTB-T only) or **PN945**". The default is **PN945**.

--dmb-interleaver *value*

> DMB-T/H, ADTB-T modulators: indicate the interleaver mode. Must be one **1** (B=54, M=240) or **2** (B=54, M=720). The default is **1**.

--fef

> DVB-T2 modulators: enable insertion of FEF's (Future Extension Frames). Not enabled by default.

--fef-interval *value*

> DVB-T2 modulators: indicate the number of T2 frames between two FEF parts. The valid range is 1 to 255 and **--t2-fpsf** shall be divisible by **--fef-interval**. The default is 1.

--fef-length *value*

> DVB-T2 modulators: indicate the length of a FEF-part in number of T-units (= samples). The valid range is **0** to **0x3FFFFF**. The default is **1**.

--fef-s1 *value*

> DVB-T2 modulators: indicate the S1-field value in the P1 signalling data. Valid values: 2, 3, 4, 5, 6 and 7. The default is 2.

--fef-s2 *value*

> DVB-T2 modulators: indicate the S2-field value in the P1 signalling data. Valid values: 1, 3, 5, 7, 9, 11, 13 and 15. The default is 1.

--fef-signal *value*

> DVB-T2 modulators: indicate the type of signal generated during the FEF period. Must be one of **0** (zero I/Q samples during FEF), **1K** (1K OFDM symbols with 852 active carriers containing BPSK symbols, same PRBS as the T2 dummy cells, not reset between symbols) or **1K-384** (1K OFDM symbols with 384 active carriers containing BPSK symbols). The default is **0**.

--fef-type *value*

> DVB-T2 modulators: indicate the FEF type. The valid range is 0 … 15. The default is 0.

--fft-mode *value*

> DVB-T2 modulators: indicate the FFT mode. Must be one of **1K**, **2K**, **4K**, **8K**, **16K** or **32K**. The default is **32K**.

-f *value*
--frequency *value*

> For modulator devices only: specify the frequency, in Hz, of the output carrier. There is no default.
>
> For OFDM modulators, the options **--uhf-channel** or **--vhf-channel** and **--offset-count** (optional) may be used instead.

For DVB-S/S2 modulators, the specified frequency is the *intermediate* frequency. For convenience, the option **--satellite-frequency** can be used instead of **--frequency** when the intermediate frequency is unknown.

For DTA-107 (DVB-S) modulators, the valid range is 950 MHz to 2150 MHz.

For DTA-110 (DVB-C) and 110T (DVB-T/H) modulators, the valid range is 400 MHz to 862 MHz.

For DTA-115 (DVB-C/T/H) modulators, the valid range is 47 MHz to 862 MHz.

-g *value*
--guard-interval *value*

> DVB-T modulators: indicate the guard interval. Must be one of: **1/32**, **1/16**, **1/8**, **1/4**. The default is **1/32**.

--hf-band-region *name*

> Specify the region for UHF/VHF band frequency layout.

> The default region is **europe**. Another default region may be specified per user in the TSDuck configuration file. See appendix A.4 page 492 for more details.

--indepth-interleave

> DVB-T modulators: use in-depth interleave. The default is native interleave.

-i
--input-modulation

> All modulators devices: try to guess default modulation parameters from input stream. All explicitely specified parameters override these defaults.

> If the input plugin is **dvb**, use the modulation parameters of the input signal as default values for their counterparts in the Dektec modulator. On Linux systems, the actual modulation parameters of the input signal are used. On Windows systems, the DirectShow/BDA drivers cannot return the actual modulation parameters and only the user-specified parameters in the input plugin are used (they can be different from the actual parameters of the input signal).

> With other input plugins, if the specified output modulation is DVB-T or DVB-T2, try to guess the following modulation parameters from the input bitrate: **--bandwidth --constellation --convolutional-rate --guard-interval**. When a specific bitrate can be produced by distinct combinations of modulation parameters, a deterministic order is applied to select the prefered combination.

--inversion

> For modulators devices only: enable spectral inversion.

--j83 *value*

> QAM modulators: indicate the ITU-T J.83 annex to use. Must be one of **A** (DVB-C), **B** (American QAM) or **C** (Japanese QAM). The default is **A**.

-l *value*
--level *value*

> Modulators: indicate the output level in units of 0.1 dBm (e.g. **--level -30** means -3 dBm). Not supported by all devices.

> For DTA-107 modulators, the valid range is -47.0 to -27.0 dBm.

> For DTA-115, QAM, the valid range is -35.0 to 0.0 dBm.

> For DTA-115, OFDM, ISDB-T, the valid range is -38.0 to -3.0 dBm.

--lnb *string*

DVB-S/S2 modulators: description of the LNB which is used to convert the **--satellite-frequency** into an *intermediate* frequency. This option is useless when **--satellite-frequency** is not specified.

See appendix A.3 page 491 for more details.

--miso *value*

DVB-T2 modulators: indicate the MISO mode. Must be one of **OFF**, **1**, **2** or **BOTH**. The default si **OFF**. This mode can be used to simulate antenna 1, antenna 2 or the average of antenna 1 and antenna 2 to simulate reception halfway between the antennas.

-m *value*
--modulation *value*

For modulators, indicate the modulation type. Must be one of: **4-QAM**, **16-QAM**, **32-QAM**, **64-QAM**, **128-QAM**, **256-QAM**, **ADTB-T**, **ATSC-VSB**, **DMB-T**, **DVB-S**, **DVB-S-QPSK** (same as **DVB-S**), **DVB-S-BPSK**, **DVB-S2**, **DVB-S2-QPSK** (same as **DVB-S2**), **DVB-S2-8PSK**, **DVB-S2-16APSK**, **DVB-S2-32APSK**, **DVB-T**, **DVB-T2**, **ISDB-T**. For DVB-H, specify **DVB-T**. For DMB-H, specify **DMB-T**.

The supported modulation types depend on the device model. See Table 7 above for the default modulation type by device model.

--mpe-fec

DVB-T/H modulators: indicate that at least one elementary stream uses MPE-FEC (DVB-H signalling).

-o *value*
--offset-count *value*

UHF and VHF modulators: specify the number of offsets from the UHF or VHF channel. Can be positive or negative. The default is zero. See options **--uhf-channel** and **--vhf-channel**.

--papr *value*

DVB-T2 modulators: indicate the Peak to Average Power Reduction method. Must be one of **NONE**, **ACE** (Active Constellation Extension), **TR** (power reduction with reserved carriers) or **BOTH** (both ACE and TS). The default is **NONE**.

--pilots

DVB-S2 and ADTB-T modulators: enable pilots (default: no pilot).

-p *value*
--pilot-pattern *value*

DVB-T2 modulators: indicate the pilot pattern to use, a value in the range 1 to 8. The default is 7.

--plp0-code-rate *value*

DVB-T2 modulators: indicate the convolutional coding rate used by the PLP #0. Must be one of **1/2**, **3/5**, **2/3**, **3/4**, **4/5**, **5/6**. The default is **2/3**.

--plp0-fec-type *value*

DVB-T2 modulators: indicate the FEC type used by the PLP #0. Must be one of **16K**, **64K**. The default is **64K** LPDC.

--plp0-group-id *value*

DVB-T2 modulators: indicate the PLP group with which the PLP #0 is associated. The valid range is 0 to 255. The default is 0.

--plp0-high-efficiency

> DVB-T2 modulators: indicate that the PLP #0 uses High Efficiency Mode (HEM). Otherwise Normal Mode (NM) is used.

--plp0-id *value*

> DVB-T2 modulators: indicate the unique identification of the PLP #0 within the T2 system. The valid range is 0 to 255. The default is 0.

--plp0-il-length *value*

> DVB-T2 modulators: indicate the time interleaving length for PLP #0. The valid range is 0 to 255. The default is 3.

> If **--plp0-il-type** is set to **ONE-TO-ONE** (the default), this parameter specifies the number of TI-blocks per interleaving frame.

> If **--plp0-il-type** is set to **MULTI**, this parameter specifies the number of T2 frames to which each interleaving frame is mapped.

--plp0-il-type *value*

> DVB-T2 modulators: indicate the type of interleaving used by the PLP #0. Must be one of **ONE-TO-ONE** (one interleaving frame corresponds to one T2 frame) or **MULTI** (one interleaving frame is carried in multiple T2 frames). The default is **ONE-TO-ONE**.

--plp0-in-band

> DVB-T2 modulators: indicate that the in-band flag is set and in-band signalling information is inserted in PLP #0.

--plp0-issy *value*

> DVB-T2 modulators: type of ISSY field to compute and insert in PLP #0. Must be one of **NONE**, **SHORT**, **LONG**. The default is **NONE**.

--plp0-modulation *value*

> DVB-T2 modulators: indicate the modulation used by PLP #0. Must be one of **BPSK**, **QPSK**, **16-QAM**, **64-QAM**, **256-QAM**. The default is **256-QAM**.

--plp0-null-packet-deletion

> DVB-T2 modulators: indicate that null-packet deletion is active in PLP #0. Otherwise it is not active.

--plp0-rotation

> DVB-T2 modulators: indicate that constellation rotation is used for PLP #0. Otherwise not.

--plp0-tsrate *value*

> DVB-T2 modulators: PLP #0 bitrate. The default is 0 (use all available).

--plp0-type *value*

> DVB-T2 modulators: indicate the PLP type for PLP #0. Must be one of **COMMON**, **1**, **2**. The default is **COMMON**.

-q *value*
--qam-b *value*

> QAM modulators: with **--j83 B**, indicate the QAM-B interleaver mode. Must be one of: **I128-J1D**, **I64-J2**, **I32-J4**, **I16-J8**, **I8-J16**, **I128-J1**, **I128-J2**, **I128-J3**, **I128-J4**, **I128-J5**, **I128-J6**, **I128-J7**, **I128-J8**. The default is **I128-J1D**.

--roll-off *value*

DVB-S2/S2X modulators: indicate the roll-off factor. Must be one of **0.03**, **0.05**, **0.10**, **0.15**, **0.20**, **0.25**, **0.35**, **auto**, **none**. The default is auto.

--s2-gold-code *value*

DVB-S2 modulators: indicate the physical layer scrambling initialization sequence, aka *gold code*.

--s2-short-fec-frame

DVB-S2 modulators: use short FEC frames, 12 000 bits (default: long FEC frames, 64 800 bits).

--satellite-frequency *value*

DVB-S/S2 modulators: indicate the target satellite frequency, in Hz, of the output carrier. The actual frequency at the output of the modulator is the *intermediate* frequency which is computed based on the characteristics of the LNB (see option **--lnb**). This option is useful when the satellite frequency is better known than the intermediate frequency.

The options **--frequency** and **--satellite-frequency** are mutually exclusive.

--symbol-rate *value*

DVB-C/S/S2 modulators: Specify the symbol rate in symbols/second.

By default, the symbol rate is implicitly computed from the convolutional rate, the modulation type and the bitrate. But when **--symbol-rate** is specified, the input bitrate is ignored and the output bitrate is forced to the value resulting from the combination of the specified symbol rate, convolutional rate and modulation type.

The options **--symbol-rate** and **--bitrate** are mutually exclusive.

--t2-fpsf *value*

DVB-T2 modulators: indicate the number of T2 frames per super-frame. Must be in the range 1 to 255. The default is 2.

--t2-guard-interval *value*

DVB-T2 modulators: indicates the guard interval. Must be one of: **1/128**, **1/32**, **1/16**, **19/256**, **1/8**, **19/128**, **1/4**. The default is **1/128**.

--t2-l1-modulation *value*

DVB-T2 modulators: indicate the modulation type used for the L1-post signalling block. Must be one of **BPSK**, **QPSK**, **16-QAM**, **64-QAM**. The default is **16-QAM**.

--t2-network-id *value*

DVB-T2 modulators: indicate the DVB-T2 network identification. The default is 0.

--t2-system-id *value*

DVB-T2 modulators: indicate the DVB-T2 system identification. The default is 0.

--time-slice

DVB-T/H modulators: indicate that at least one elementary stream uses time slicing (DVB-H signalling).

-t *value*
--transmission-mode *value*

DVB-T modulators: indicates the transmission mode. Must be one of **2K**, **4K** or **8K**. The default is **8K**.

-u *value*
--uhf-channel *value*

> UHF modulators: specify the UHF channel number of the output carrier. Can be used in replacement to **--frequency**. Can be combined with an **--offset-count** option. The UHF frequency layout depends on the region, see **--hf-band-region** option.

-v *value*
--vhf-channel *value*

> VHF modulators: specify the VHF channel number of the output carrier. Can be used in replacement to **--frequency**. Can be combined with an **--offset-count** option. The VHF frequency layout depends on the region, see **--hf-band-region** option.

--vsb *value*

> ATSC modulators: indicate the VSB constellation. Must be one of **8** (19,392,658 Mb/s) or **16** (38,785,317 Mb/s). The default is **8**.

--vsb-taps *value*

> ATSC modulators: indicate the number of taps of each phase of the root-raised cosine filter that is used to shape the spectrum of the output signal. The number of taps can have any value between 2 and 256 (the implementation is optimized for powers of 2). Specifying more taps improves the spectrum, but increases processor overhead. The recommend (and default) number of taps is 64 taps. If insufficient CPU power is available, 32 taps produces acceptable results, too.

TS-over-IP options

The following options are used with Dektec Ethernet devices.

--gw4 *ipv4-address*

> TS-over-IP: Specify a non-default IPv4 gateway address.
>
> With SMPTE 2022-7 network redundancy, this parameter can be specified twice, main and redundant link.

--gw6 *ipv6-address*

> TS-over-IP: Specify a non-default IPv6 gateway address.
>
> With SMPTE 2022-7 network redundancy, this parameter can be specified twice, main and redundant link.

--ip4 *ipv4-address:port*

> TS-over-IP: Destination IPv4 address and port.
>
> Either **--ip4** or **--ip6** must be specified with Dektec Ethernet devices.
>
> With SMPTE 2022-7 network redundancy, this parameter can be specified twice, main and redundant link.

--ip6 [*ipv6-address*]:*port*

> TS-over-IP: Destination IPv6 address and port.
>
> Important: The square brackets are literal, as in any IPv6 URL, not an indication of an optional field.
>
> Either **--ip4** or **--ip6** must be specified with Dektec Ethernet devices.
>
> With SMPTE 2022-7 network redundancy, this parameter can be specified twice, main and redundant link.

--rtp

> TS-over-IP: Use RTP protocol.

By default, TS packets are sent in UDP datagrams without RTP or other protocol header.

--smpte-2022-fec *type*

TS-over-IP: Specify type of SMPTE-2022 error correction mode to use.

Must be one of **2d-m1**, **2d-m1-b**, **2d-m2**, **2d-m2-b** or **none**.

The default is **none**.

--smpte-2022-d *value*

TS-over-IP with SMPTE-2022 error correction: Specify the number of rows in the FEC matrix, aka '**D**' parameter.

--smpte-2022-l *value*

TS-over-IP with SMPTE-2022 error correction: Specify the number of columns in the FEC matrix, aka '**L**' parameter.

--source-port *value*

TS-over-IP: Optional UDP source port for outgoing packets.

By default, use a random port.

With SMPTE 2022-7 network redundancy, this parameter must be specified twice, main and redundant link.

--tos *value*

TS-over-IP: Type-of-service (TOS) or *differentiated services* value of outgoing IP datagrams.

--ts-per-ip *value*

TS-over-IP: Number of TS packets per IP datagram.

The default is 7.

--ttl *value*

TS-over-IP: Time-to-live (TTL) value of outgoing IP datagrams.

--vlan-id *value*

TS-over-IP: Optional VLAN identifier as specified in IEEE 802.1Q.

With SMPTE 2022-7 network redundancy, this parameter can be specified twice, main and redundant link.

--vlan-priority *value*

TS-over-IP: Optional VLAN priority code point as specified in IEEE 802.1Q.

With SMPTE 2022-7 network redundancy, this parameter can be specified twice, main and redundant link.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

Display plugin help text.

⚏ descrambler

Generic DVB descrambler

This plugin descrambles fixed PID's with fixed control words.

As a demo, it can also descramble services for which clear ECM's were generated using the utility named **tsecmg**, a DVB SimulCrypt-compliant ECMG for test and demo.

Usage

```
tsp -P descrambler [options] [service]
```

Parameter

The optional parameter specifies the service to descramble.

If no fixed control word is specified, ECM's from the service are used to extract control words.

In the absence of explicit option such as **--atis-idsa**, **--dvb-cissa**, **--aes-cbc** or **--dvb-csa2**, the descrambling type is based on the *scrambling_descriptor* in the PMT of the service (if there is one).

If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id.

If it is an empty string or "**-**", the first service in the PAT is descrambled.

Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored. If the input TS does not contain an SDT, use service ids only.

Options

--brazil

A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--cas-id *value*

Specify the *CA_system_id* to filter when searching for ECM streams. Since this descrambler is a demo tool using clear ECM's, it is unlikely that other real ECM streams exist. So, by default, any ECM stream is used to get the clear ECM's.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.

By default, standard DVB encoding is used. See section 2.5 for more details.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5.2 for more details.

--japan

A synonym for **--default-charset ARIB-STD-B24**. See section 2.5.2 for more details.

--philippines

A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *pid1[-pid2]*
--pid *pid1[-pid2]*

Descramble packets with these PID values. Several **--pid** options may be specified.

By default, descramble the specified service.

--swap-cw

Swap even and odd control words from the ECM. Useful when a crazy ECMG inadvertently swapped the CW before generating the ECM.

--synchronous

Specify to synchronously decipher the ECM's.

In real-time mode, the processing of packets continues in parallel while ECM's are deciphered. Use this option to force the stream processing to wait for ECM's at the point where the each ECM is received.

In offline mode, this option is always on. This is usually the right thing to do. Otherwise, if an ECM takes too long to be deciphered, the stream processing may reach the next crypto-period before the control word is available.

Note: this plugin only processes clear ECM's as generated by *tsecmg*. These ECM's are not ciphered and their processing is immediate. So, this option is useless in practice. However, this plugin is based on a generic descrambler implementation. For other conditional access systems, processing an ECM may be delegated to a smartcard and take a relatively long time. So, this option can be useful in that case.

Transport stream scrambling options

--aes-cbc

Use AES-CBC scrambling instead of DVB-CSA2 (the default).

The control words are 16-byte long instead of 8-byte. The residue is left clear. Specify a fixed initialization vector using the **--iv** option.

Note that this is a non-standard TS scrambling mode. The only standard AES-based scrambling modes are ATIS-IDSA and DVB-CISSA (DVB-CISSA is the same as AES-CBC with a DVB-defined IV).

A *scrambling_descriptor* is automatically added to the PMT of the service to indicate the use of AES-CBC scrambling. Since there is no standard value for AES-CBC, the user-defined *scrambling_mode* value **0xF0** is used.

--aes-ctr

Use AES-CTR scrambling instead of DVB-CSA2 (the default).

The control words are 16-byte long instead of 8-byte. The residue is included in the scrambling. Specify a fixed initialization vector using the **--iv** option. See the option **--ctr-counter-bits** for the size of the counter part in the IV.

Note that this is a non-standard TS scrambling mode. The only standard AES-based scrambling modes are ATIS-IDSA and DVB-CISSA.

A *scrambling_descriptor* is automatically added to the PMT of the service to indicate the use of AES-CTR scrambling. Since there is no standard value for AES-CTR, the user-defined *scrambling_mode* value **0xF1** is used.

--atis-idsa

Use ATIS-IDSA descrambling (ATIS-0800006) instead of DVB-CSA2 (the default).

The control words are 16-byte long instead of 8-byte.

--ctr-counter-bits *value*

With **--aes-ctr**, specifies the size in bits of the counter part.

In the initialization vector, the fixed nonce part uses the first 128-N bits and the counter part uses the last N bits.

By default, the counter part uses the second half of the IV (64 bits).

-c *hexa-digits*
--cw *hexa-digits*

> Specifies a fixed and constant control word (no crypto-period scheduling, no ECM insertion). The value must be a string of 16 hexadecimal digits (32 digits with **--atis-idsa** or **--dvb-cissa**).

--dvb-cissa

> Use DVB-CISSA descrambling (see [16]) instead of DVB-CSA2 (the default).
>
> The control words are 16-byte long instead of 8-byte.

--dvb-csa2

> Use DVB-CSA2 descrambling. This is the default.

-f *name*
--cw-file *name*

> Specifies a text file containing the list of control words to apply. Each line of the file must contain exactly 16 hexadecimal digits (32 digits with **--atis-idsa** or **--dvb-cissa**).
>
> The next control word is used each time a new *transport_scrambling_control* value is found in the header of a TS packet. At the end of the list of control words, restart with the first one.

--iv *hexa-digits*

> With **--aes-cbc** or **--aes-ctr**, specifies a fixed initialization vector for all TS packets.
>
> The value must be a string of 32 hexadecimal digits. The default IV is all zeroes.

-n
--no-entropy-reduction

> Do not perform DVB-CSA2 control word entropy reduction to 48 bits, keep full 64-bit control words. This option is ignored with other encryption algorithms.

--output-cw-file *name*

> Specifies a text file to create with all control words. Each line of the file will contain a control word with 16 or 32 hexadecimal digits, depending on the scrambling algorithm. Each time a new control word is used to descramble packets, it is logged in the file.
>
> This option is specifically useful when the control words are dynamically extracted from ECM's. The created file can be used later using **--cw-file** to perform a direct descrambling test.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

■ drop (output)

Drop output packets

This output plugin simply drops all packets. This plugin is useful when the interesting work is done by the various packet processing plugins and the actual output packets are useless.

Usage

```
tsp -O drop [options]
```

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

Display plugin help text.

⚏ dump

Dump transport stream packets

This plugin is equivalent to the command **tsdump**.

Usage

```
tsp -P dump [options]
```

Options

--adaptation-field

>   Include formatting of the adaptation field.

-a
--ascii

>   Include ASCII dump in addition to hexadecimal.

-b
--binary

>   Include binary dump in addition to hexadecimal.

-h
--headers-only

>   Dump packet headers only, not payload.

-l
--log

>   Display a short one-line log of each packet instead of full dump.

--log-size *value*

>   With option **--log**, specify how many bytes are displayed in each packet.
>   The default is 188 bytes (complete packet).

-n
--nibble

>   Same as `--binary` but add separator between 4-bit nibbles.

--no-headers

>   Do not display header information.

--offset

>   Display offset from start of packet with hexadecimal dump.

-o *file-name*
--output-file *file-name*

>   Output file for dumped packets.
>   By default, use the standard output.

--payload

>   Hexadecimal dump of TS payload only, skip TS header.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

>   Dump only packets with these PID values. Several **--pid** options may be specified.
>   By default, all packets are displayed.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[*-label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⚏ duplicate

Duplicate PID's, reusing null packets

This plugin duplicates the content of several PID's into new PID's. The duplicated packets are created by replacing existing null packets. The input stream shall consequently contain at least as many null packets as packets to duplicate.

Usage

```
tsp -P duplicate [options] [pid[-pid]=newpid ...]
```

Specifying PID duplication

Each duplication is specified as "*pid=newpid*" or "*pid1-pid2=newpid*". All PID's can be specified as decimal or hexadecimal values. More than one PID duplication can be specified.

In the first form, the PID *pid* is duplicated as *newpid*.

In the latter form, all PID's within the range *pid1* to *pid2* (inclusive) are respectively duplicated as *newpid*, *newpid*+1, etc. (this behaviour is changed using option **--single**).

The null PID **0x1FFF** cannot be duplicated.

Options

-d
--drop-overflow

Silently drop overflow packets. By default, overflow packets trigger warnings.

See also option **--max-buffered-packets**.

-m *value*
--max-buffered-packets *value*

Specify the maximum number of buffered packets. The input packets to duplicate are internally buffered until a null packet is found and replaced by the buffered packet. An overflow is usually caused by insufficient null packets in the input stream.

The default is 1,024 packets.

--reset-label *label1*[-*label2*]

Clear the specified labels on the duplicated packets.

Several **--reset-label** options may be specified.

--set-label *label1*[-*label2*]

Set the specified labels on the duplicated packets.

Several **--set-label** options may be specified.

-s
--single

When a duplication is in the form "*pid1-pid2=newpid*", duplicate all input PID's within the range *pid1* to *pid2* to the same *newpid* value, not *newpid*, *newpid*+1, etc.

This option forces **--unchecked** since distinct PID's are duplicated to the same one.

-u
--unchecked

Do not perform any consistency checking while duplicating PID's. Duplicating two PID's to the same PID or to a PID which is already present in the input is accepted.

Note that this option should be used with care since the resulting stream can be illegal or inconsistent.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⚏ dvb (input)

DVB, ATSC, ISDB tuner receivers input

This input plugin receives TS packets from a tuner receiver device. These devices include a wide range of satellite, cable and terrestrial adapters. Most of them are simple tuners. See section 7.1 for more details on tuner receiver devices.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Note: This plugin originally supported DVB receivers only. Later, support was added for ATSC and ISDB receivers, but the plugin retained its original name **dvb**.

Usage

```
tsp -I dvb [options]
```

Reception options

-a *N*
--adapter *N*

> Specify the *N*th tuner device in the system, the first index being zero. This option can be used instead of device name.
>
> On Linux systems, this means **/dev/dvb/adapter*N*.**

-d "name**"**
--device-name *"name"*

> Specify the name of the receiver device to use. Use the **tslsdvb** utility to list all available devices.
>
> By default, the first receiver device is used. The syntax of the device name depends on the operating system. See section 7.1.3, page 480, for more details on receiver devices naming.
>
> The specified name can also be the path of an XML file (a file name ending in **.xml**) which is used as *tuner emulator*. See section 7.1.4 for more details on tuner emulators.

--lnb *string*

> For satellite reception, specifies the description of the LNB (*low-noise block* in the dish). See appendix A.3 page 491 for more details.

--receive-timeout *milliseconds*

> Specify the timeout, <u>in milliseconds</u>, for each receive operation. To disable the timeout and wait indefinitely for packets, specify zero. This is the default.

--signal-timeout *seconds*

> Specify the timeout, <u>in seconds</u>, for the DVB frontend signal locking. If no signal is detected within this timeout, the command aborts. To disable the timeout and wait indefinitely for the signal, specify zero. The default is 5 seconds.

Linux-specific options

--demux-buffer-size *value*

> Default buffer size, in bytes, of the demux device. The default is 1 MB.

Windows-specific options

--demux-queue-size *value*

> Specify the maximum number of media samples in the queue between the DirectShow capture thread and the input plugin thread. The default is 1000 media samples.

--receiver-name "*name*"

> Specify the name of the DirectShow receiver filter to use.
>
> By default, first try a direct connection from the tuner filter to the rest of the graph. Then, try all receiver filters and concatenate them all.

Tuning

By default, no tuning is performed on the DVB frontend. The transponder on which the frontend is currently tuned is used.

There are two ways to specify a new transponder:

- Specifying individual tuning options, one for each tuning parameters. Common values are provided as default.

- The name of a channel contained in the transponder, using a channels configuration file. See Appendix B, page 494, for more details on channels configuration files.

Tuning method 1: Individual tuning options

--bandwidth *value*

> Used for terrestrial tuners only. Specify the bandwidth in Hz.
>
> For compatibility with old versions, low values (below 1000) are interpreted in MHz. This means that values 8 and 8,000,000 are identical. Both mean 8 MHz.
>
> The default is 8 MHz for DVB-T/T2 and 6 MHz for ISDB-T.

--brazil

> A synonym for **--hf-band-region brazil**.

--delivery-system *value*

> Specify which delivery system to use. Must be one of the following values:

Table 9: Values for option --delivery-system (dvb plugin)

Value	Description	Supported options
ATSC	ATSC	`--frequency --modulation --spectral-inversion`
ATSC-MH	ATSC -M/H (handheld)	Unsupported
CMMB	CMMB Terrestrial	Unsupported
DAB	DAB (digital audio)	Unsupported
DSS	DSS Satellite	Unsupported
DTMB	DTMB Terrestrial	Unsupported
DVB-C	DVB-C (same as **DVB-C/A**)	Same as **DVB-C/A**
DVB-C/A	DVB-C ITU-T J.83 Annex A	`--fec-inner --frequency --modulation --spectral-inversion --symbol-rate`
DVB-C/B	DVB-C ITU-T J.83 Annex B	Unsupported
DVB-C/C	DVB-C ITU-T J.83 Annex C	Same as **DVB-C/A**
DVB-C2	DVB-C2	Unsupported
DVB-H	DVB-H (deprecated)	Unsupported
DVB-S	DVB-S	`--fec-inner --frequency --polarity --satellite-number --spectral-inversion --symbol-rate`

Value	Description	Supported options
DVB-S-Turbo	DVB-S Turbo	Unsupported
DVB-S2	DVB-S2	`--fec-inner --frequency --isi --modulation --pilots --pls-code --pls-mode --polarity --roll-off --satellite-number --spectral-inversion --symbol-rate`
DVB-T	DVB-T	`--bandwidth --frequency --guard-interval --hierarchy --high-priority-fec --low-priority-fec --modulation --spectral-inversion --transmission-mode`
DVB-T2	DVB-T2	`--bandwidth --frequency --guard-interval --hierarchy --high-priority-fec --low-priority-fec --modulation --plp --spectral-inversion --transmission-mode`
ISDB-C	ISDB-C	Unsupported
ISDB-S	ISDB-S	`--fec-inner --frequency --polarity --satellite-number --spectral-inversion --stream-id --symbol-rate`
ISDB-T	ISDB-T	`--bandwidth --frequency --guard-interval --isdbt-layer-a-fec --isdbt-layer-a-modulation --isdbt-layer-a-segment-count --isdbt-layer-a-time-interleaving --isdbt-layer-b-fec --isdbt-layer-b-modulation --isdbt-layer-b-segment-count --isdbt-layer-b-time-interleaving --isdbt-layer-c-fec --isdbt-layer-c-modulation --isdbt-layer-c-segment-count --isdbt-layer-c-time-interleaving --sb-segment-count --sb-segment-index --sb-subchannel-id --sound-broadcasting --spectral-inversion --transmission-mode`
undefined	Undefined	Unsupported

Note that some delivery systems are not available on some operating systems.

By default, use the default system for the tuner.

--fec-inner *value*

Used for satellite and cable tuners only.

Specify the Inner Forward Error Correction. Must be one of **none**, **auto**, **1/2**, **1/3**, **1/4**, **2/3**, **2/5**, **3/4**, **3/5**, **4/5**, **5/6**, **5/11**, **6/7**, **7/8**, **8/9**, **9/10**. The default is **auto**.

-f value

--frequency *value*

Specify the carrier frequency in Hz (all tuners).

For DVB-T tuners, the options **--uhf-channel** or **--vhf-channel** (and associated optional **--offset-count**) can be used instead of **--frequency**.

--guard-interval *value*

Used for terrestrial tuners only.

Must be one of **auto**, **1/32**, **1/16**, **1/8**, **1/4**.

For DVB-T2, also accept **1/128**, **19/128**, **19/256**.

The default is **1/32**.

--hf-band-region *name*

Specify the region for UHF/VHF band frequency layout.

The default region is **europe**. Another default region may be specified per user in the TSDuck configuration file. See appendix A.4 page 492 for more details.

--hierarchy *value*

Used for DVB-T tuners only.

Must be one of **auto**, **none**, **1**, **2**, **4**. The default is **none**.

--high-priority-fec *value*

Used for DVB-T tuners only.

Error correction for high priority streams. See option **--fec-inner** for the list of possible values. The default is **auto**.

--isdbt-layer-a-fec *value*

Used for ISDB-T tuners only.

Error correction for layer A. The default is automatically detected.

Must be one of **1/2**, **2/3**, **3/4**, **5/6**, **7/8**, **auto**.

--isdbt-layer-a-modulation *value*

Used for ISDB-T tuners only.

Modulation for layer A. The default is automatically detected.

Must be one of **QPSK**, **DQPSK**, **16-QAM**, **64-QAM**, **QAM** (auto).

--isdbt-layer-a-segment-count *value*

Used for ISDB-T tuners only.

Number of segments for layer A. Possible values: 0 to 13. The default is automatically detected.

--isdbt-layer-a-time-interleaving *value*

Used for ISDB-T tuners only.

Time interleaving for layer A. Possible values: 0 to 3. The default is automatically detected.

--isdbt-layer-b-fec *value*

Used for ISDB-T tuners only.

Error correction for layer B. The default is automatically detected.

Must be one of **1/2**, **2/3**, **3/4**, **5/6**, **7/8**, **auto**.

--isdbt-layer-b-modulation *value*

Used for ISDB-T tuners only.

Modulation for layer B. The default is automatically detected.

Must be one of **QPSK**, **DQPSK**, **16-QAM**, **64-QAM**, **QAM** (auto).

--isdbt-layer-b-segment-count *value*

Used for ISDB-T tuners only.

Number of segments for layer B. Possible values: 0 to 13. The default is automatically detected.

--isdbt-layer-b-time-interleaving *value*

Used for ISDB-T tuners only.

Time interleaving for layer B. Possible values: 0 to 3. The default is automatically detected.

--isdbt-layer-c-fec *value*

Used for ISDB-T tuners only.

Error correction for layer C. The default is automatically detected.

Must be one of **1/2**, **2/3**, **3/4**, **5/6**, **7/8**, **auto**.

--isdbt-layer-c-modulation *value*

Used for ISDB-T tuners only.

Modulation for layer C. The default is automatically detected.

Must be one of **QPSK**, **DQPSK**, **16-QAM**, **64-QAM**, **QAM** (auto).

--isdbt-layer-c-segment-count *value*

Used for ISDB-T tuners only.

Number of segments for layer C. Possible values: 0 to 13. The default is automatically detected.

--isdbt-layer-c-time-interleaving *value*

Used for ISDB-T tuners only.

Time interleaving for layer C. Possible values: 0 to 3. The default is automatically detected.

--isdbt-layers '*string*'

Used for ISDB-T tuners only.

Hierarchical reception in ISDB-T is achieved by enabling or disabling layers in the decoding process. The specified string contains a combination of characters '**A**', '**B**', '**C**', indicating which layers shall be used.

The default is **ABC** (all layers).

--isdbt-partial-reception

Used for ISDB-T tuners only.

Specify that the reception of the ISDB-T channel is in partial reception mode. The default is automatically detected.

--isi *value*

Used for DVB-S2 tuners only.

Specify the Input Stream Id (ISI) number to select, from 0 to 255. Used with multi-stream, see also options **--pls-code** and **--pls-mode**.

The default is to keep the entire stream, without multi-stream selection.

Warning: this option is supported on Linux only. Currently, Windows provides no support for multi-stream.

--japan

A synonym for **--hf-band-region japan**.

--low-priority-fec *value*

Used for DVB-T tuners only.

Error correction for low priority streams. See option **--fec-inner** for the list of possible values. The default is **auto**.

-m *value*
--modulation *value*

Used for DVB-C, DVB-T, DVB-S2 and ATSC tuners.

Modulation type (aka *constellation* for DVB-T). Must be one of **QPSK**, **8-PSK**, **16-APSK**, **32-APSK**, **QAM** (auto-detected QAM), **16-QAM**, **32-QAM**, **64-QAM**, **128-QAM**, **256-QAM**, **8-VSB**, **16-VSB**.

The default is **64-QAM** for DVB-T and DVB-C, **QPSK** for DVB-S2, **8-VSB** for ATSC.

--offset-count *value*

Used for terrestrial tuners only.

Specify the number of offsets from the UHF or VHF channel. The default is zero.

See options **--uhf-channel** and **--vhf-channel**.

--philippines

A synonym for **--hf-band-region philippines**.

--pilots *value*

Used for DVB-S2 tuners only.

Presence of pilots frames. Must be one of **auto**, **on** or **off**. The default is **off**.

--plp *value*

Used for DVB-T2 tuners only.

Specify the Physical Layer Pipe (PLP) number to select, from 0 to 255. The default is to keep the entire stream, without PLP selection.

--pls-code *value*

Used for DVB-S2 tuners only.

Specifiy the Physical Layer Scrambling (PLS) code value, from 0 to 262143 (**0x3FFFF**). Used with multi-stream, see also option **--isi**.

Warning: this option is supported on Linux only. Currently, Windows provides no support for multi-stream.

--pls-mode *mode*

Used for DVB-S2 tuners only.

Specify the Physical Layer Scrambling (PLS) mode. Used with multi-stream, see also option **--isi**. Must be one of **COMBO**, **GOLD**, **ROOT**. The default is **ROOT**.

Warning: this option is supported on Linux only. Currently, Windows provides no support for multi-stream.

--polarity *value*

Used for satellite tuners only.

Must be one of **horizontal** or **vertical** for linear polarization, **left** or **right** for circular polarization. The default is **vertical**.

--roll-off *value*

Used for DVB-S2 tuners only.

Roll-off factor. Must be one of `auto`, **0.35**, **0.25**, **0.20**. The default is **0.35** (implied for DVB-S, default for DVB-S2).

--satellite-number *value*

Used for satellite tuners only.

Satellite/dish number. Must be **0** to **3** with DiSEqC switches and **0** to **1** for non-DiSEqC switches. The default is zero.

--sb-segment-count *value*

Used for ISDB-T tuners only.

With **--sound-broadcasting**, specify the total count of connected ISDB-Tsb channels.

Possible values: 1 to 13. The default is 13.

--sb-segment-index *value*

> Used for ISDB-T tuners only.
>
> With **--sound-broadcasting**, specify the index of the segment to be demodulated for an ISDB-Tsb channel where several of them are transmitted in the connected manner.
>
> Possible values: 0 to value of **--sb-segment-count** minus 1. The default is 0.

--sb-subchannel-id *value*

> Used for ISDB-T tuners only.
>
> With **--sound-broadcasting**, specify the sub-channel id of the segment to be demodulated in the ISDB-Tsb channel.
>
> Possible values: 0 to 41. The default is 0.

--sound-broadcasting

> Used for ISDB-T tuners only.
>
> Specify that the reception is an ISDB-Tsb (sound broadcasting) channel instead of an ISDB-T one.

--spectral-inversion *value*

> Spectral inversion. Must be one of **on**, **off** or **auto**. The default is **auto**.

--stream-id *value*

> Used for ISDB-S tuners only.
>
> In the case of multi-stream broadcasting, specify the inner transport stream id. By default, use the first inner transport stream, if any is found.
>
> Warning: this option is supported on Linux only. Currently, Windows provides no support for multi-stream.

-s *value*
--symbol-rate *value*

> Used for satellite and cable tuners only.
>
> Symbol rate in symbols/second. The default is 27.5 mega-symbols/second for DVB-S, 6.9 mega-symbols/second for DVB-C, 28.86 mega-symbols/second for ISDB-S.

--transmission-mode *value*

> Used for terrestrial tuners only.
>
> Must be one of **auto**, **2K**, **4K**, **8K**.
>
> For DVB-T2, also accept **1K**, **2K-interleaved**, **4K-interleaved**, **16K**, **32K**.
>
> The default is **8K**.

--uhf-channel *value*

> Used for terrestrial tuners only.
>
> Specify the UHF channel number of the carrier. Can be used in replacement to **--frequency**. Can be combined with an **--offset-count** option.
>
> The UHF frequency layout depends on the region, see **--hf-band-region** option.

--usa

> A synonym for **--hf-band-region usa**. See section 2.4.2 for more details.

--vhf-channel *value*

> Used for terrestrial tuners only.
>
> Specify the VHF channel number of the carrier. Can be used in replacement to **--frequency**. Can be combined with an **--offset-count** option.

The VHF frequency layout depends on the region, see **--hf-band-region** option.

Tuning method 2: Locating the transponder by channel name

-c *name*
--channel-transponder *name*

> Tune to the transponder containing the specified channel. The channel name is not case-sensitive and blanks are ignored. It is either an "HF band channel" or a "TV channel".

> An "HF band channel" has the format "*band-number*" such as "**UHF-22**" (terrestrial) or "**BS-12**" (Japanese satellite). See also option **--offset-count**.

> A "TV channel" name is searched in a *channels configuration file* and the corresponding tuning information in this file is used. See also option **--tuning-file**.

> For ATSC networks, the channel name can be replaced by the channel id using the format "*major-id.minor-id*" (e.g. "**1.2**" or "**12.8**").

--tuning-file *file-name*

> Specify the channels configuration file to use for option **--channel-transponder**.

> Channel configuration files can be created manually or using the utility **tsscan** or the plugin **nitscan**. The location of the default configuration file depends on the system.

> See Appendix B, page 494, for more details on channels configuration files.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

> Display plugin help text.

⸬ **eit**

Analyze EIT sections

This plugin analyzes EIT sections and produces a report of *EIT present/following* and *EIT schedule* by transport stream and by service. The EPG depth in days is also reported by service (number of days in advance an event is signaled by an EIT schedule). See 5.2.16 for an example of report.

Usage

```
tsp -P eit [options]
```

Options

-o *file-name*
--output-file *file-name*

> Specify the output file for the report (default: standard output).

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

▪ eitinject

Generate and inject EIT's in a transport stream

This plugin generates EIT's from a database of events and injects those EIT's on time in the transport stream. The plugin can selectively generate "EIT actual" and/or "EIT other" and "EIT present/following" (or "p/f") and/or "EIT schedule".

EIT's are "injected" in the transport stream by replacing null packets or pre-existing EIT packets. All EIT's are injected in the DVB-defined PID for EIT's, the PID number 18. There must be enough null or EIT packets to replace, otherwise EIT's won't be correctly injected or not injected at all.

The events can be loaded at any time but the actual EIT injection can start only when the actual transport stream id and the current time reference are known. The actual transport stream id is required to determine if events for a given service shall be included in EIT actual or EIT other. The current time is required to generate EIT p/f on time and drop obsolete events from EIT schedule. The organization of EIT schedule table ids also depends on the current date.

By default, the actual transport stream id is extracted from the first PAT. The current time is permanently resynchronized on TDT and TOT. See also options **--ts-id** and **--time**.

Note that the concept of "current time" is always relative to the transport stream. It is possible to inject EIT's in a transport stream file at the speed of file read/write. The "current time" of a packet (for EIT generation and insertion) is based on the last reference (typically from a TDT or TOT), the transport stream bitrate and the number of packets since the last reference.

Electronic Program Guide (EPG) database

The events are loaded in an in-memory EPG database. There are several sources for events: files and incoming EIT's (from the TS upstream).

Event files shall contain EIT tables or sections in binary, XML or JSON format. The organization of events in the EIT's and the type of EIT's are ignored. Only the events descriptions and the DVB triplets (service id, transport stream id and original network id) are important, all the rest is ignored.

When event files are loaded or when incoming EIT's are received, all events are individually extracted and stored in the in-memory EPG database. The EIT encapsulation is just a convenient pre-existing format to store events, nothing more.

The event input files can be specified using wildcards (be sure to use quotes in order to avoid the interpretation of the wildcards by the shell). The **eitinject** plugin polls the corresponding files at regular intervals. Whenever a file matching the wildcards is created or updated, the file is loaded. Existing events are ignored.

Events are automatically removed from the EPG database when they become obsolete (the current transport stream time goes beyong the end time of the event). There is currently no way to delete an event from the database before its completion.

Injection profiles

The EIT's are injected and cycled according to ETSI TS 101 211 section 4.4 (see [6]). Several cycle profiles can be used. A profile defines the repetition cycle of each type of EIT.

The default profile is defined in [6] for satellite and cable networks. It is possible to select the profile for terrestrial networks (generating a lower EIT bandwidth). In addition to a predefined profile, it is possible to tune individual cycle values.

EIT schedule are divided into two periods:

- The *prime* period extends over the next few days. The repetition rate of those EIT's is typically longer than EIT present/following but still reasonably fast. The duration in days of the prime period depends on the type of network.
- The *later* period includes all events after the prime period. The repetition rate of those EIT's is typically longer that in the prime period.

The following table lists the details of the two standard EIT profiles as defined in ETSI TS 101 211.

Table 10: Standard EIT repetition rates

EIT section type	Satellite and cable	Terrestrial
EIT p/f actual	2 seconds	2 seconds
EIT p/f other	10 seconds	20 seconds
EIT schedule prime days	8 days	1 day
EIT schedule actual (prime)	10 seconds	10 seconds
EIT schedule other (prime)	10 seconds	60 seconds
EIT schedule actual (later)	30 seconds	30 seconds
EIT schedule other (later)	30 seconds	300 seconds

Usage

```
tsp -P eitinject [options]
```

Options

--actual

Generate all EIT actual.

Same as **--actual-pf --actual-schedule**.

--actual-pf

Generate EIT p/f actual.

If no EIT selection option is specified, all EIT's are generated.

--actual-schedule

Generate EIT schedule actual.

If no EIT selection option is specified, all EIT's are generated.

-b *value*
--bitrate *value*

Specify the maximum bitrate of the EIT PID in bits/second.

By default, the EIT sections are inserted as soon as possible, with respect to their individual cycle time.

See section 2.2 for more details on the representation of bitrates.

--brazil

A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--cycle-pf-actual *value*

Repetition cycle in seconds for EIT p/f actual.

The default is 2 seconds.

--cycle-pf-other *value*

Repetition cycle in seconds for EIT p/f other.

The default is 10 seconds.

--cycle-schedule-actual-later *value*

Repetition cycle in seconds for EIT schedule actual after the "prime" period.

The default is 30 seconds.

See options **--prime-days**.

--cycle-schedule-actual-prime *value*

Repetition cycle in seconds for EIT schedule actual in the "prime" period.

The default is 10 seconds.

See options **--prime-days**.

--cycle-schedule-other-later *value*

Repetition cycle in seconds for EIT schedule other after the "prime"period.

The default is 30 seconds.

See options **--prime-days**.

--cycle-schedule-other-prime *value*

Repetition cycle in seconds for EIT schedule other in the "prime" period.

The default is 10 seconds.

See options **--prime-days**.

--default-charset *name*

Default character set to use when serializing strings to tables and descriptors. This option is useful only when tables are read from XML files and converted to binary sections for injection.

By default, standard DVB encoding is used. See section 2.5 for more details.

-d
--delete-files

Specifies that the event input files should be deleted after being loaded.

By default, the files are left unmodified after being loaded.

When a loaded file is modified later, it is reloaded and re-injected.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

-f '*file-wildcard*'
--files '*file-wildcard*'

A file specification with optional wildcards indicating which event files should be polled. When such a file is created or updated, it is loaded and its content is interpreted as binary, XML or JSON tables.

If the specified name contains wildcards, be sure to surround it with quotes to prevent the interpretation of the wildcards by the shell.

All tables shall be EIT's. The structure and organization of events inside the input EIT tables is ignored. All events are individually extracted from the EIT tables and loaded in the EPG. They are later reorganized in the injected EIT's p/f and schedule. In the input files, the EIT structure shall be only considered as a convenient format to describe events.

--incoming-eits

Load events from incoming EIT's in the EPG. A typical use case is the generation of EIT p/f from EIT schedule.

By default, events are loaded from EIT files only.

Since events must be loaded from somewhere, either **--incoming-eits** or **--files** must be specified. If both are specified, events are merged from the two sources.

--japan

A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

--lazy-schedule-update

When an event completes, do not remove it from the current EIT schedule segment. Obsolete events are removed from the EPG only when their 3-hour segment is completed.

By default, each time an event completes, the EIT schedule section which contains that event is updated.

With this option, EIT schedule update is less frequent and the load on the plugin and the receiver is lower. This option is recommended with **--synchronous-versions** where all sections of an EIT schedule sub-table are updated each time one of them is updated.

--min-stable-delay *milliseconds*

An input file size needs to be stable during that duration, in milliseconds, for the file to be reported as added or modified. This prevents too frequent poll notifications when a file is being written and his size modified at each poll.

The default is 500 ms.

--other

Generate all EIT other.

Same as **--other-pf --other-schedule**.

--other-pf

Generate EIT p/f other.

If no EIT selection option is specified, all EIT's are generated.

--other-schedule

Generate EIT schedule actual.

If no EIT selection option is specified, all EIT's are generated.

--pf

Generate all EIT p/f (present/following).

Same as **--actual-pf --other-pf**.

--philippines

A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *value*
--pid *value*

Specify the PID for EIT injection.

The default is 18, the standard PID for EIT's.

--poll-interval *milliseconds*

Interval, in milliseconds, between two poll operations to detect new or modified input files.

The default is 500 ms.

--prime-days *value*

Duration, in days, of the "prime" period for EIT schedule. EIT schedule for events in the prime period (i.e. the next few days) are repeated more frequently than EIT schedule for later events.

The default is 8 days.

--schedule

Generate all EIT schedule.

Same as **--actual-schedule --other-schedule**.

--stuffing

Insert stuffing inside TS packets at end of EIT sections. Do not pack EIT sections.

By default, EIT sections are packed.

--synchronous-versions

Keep version numbers synchronous on all sections of an EIT sub-table.

By default, since EIT's are sparse sections and not full tables, the version number of an EIT section is updated only when the section is modified. This is more efficient and reduces the load on the receivers.

An EIT schedule sub-table is an aggregate of sparse sections which covers an EPG duration of 4 days. There are between 32 and 256 sections in an EIT schedule sub-table. Using this option, all sections are regenerated each time one event is updated. Consequently, the load on the receivers is much higher. Using it should be reserved for situations where some receivers are unable to update individual EIT sections. It is also recommended to specify **--lazy-schedule-update** with **--synchronous-version**s.

--terrestrial

Use the EIT cycle profile for terrestrial networks as specified in ETSI TS 101 211 section 4.4.

By default, use the cycle profile for satellite and cable networks from the same standard.

See also options **--cycle-*** and **--prime-days** to modify individual values.

--time *value*

Specify the UTC date & time reference for the first packet in the stream. Then, the time reference is updated according to the number of packets and the bitrate.

The time value must be in the format "*year/month/day:hour:minute:second*".

The predefined name "system" can be used to specify the current UTC time from the system clock (use **--time system**).

By default, the current time is resynchronized on all TDT and TOT.

EIT injection starts when the time reference and actual transport stream id are known.

--ts-id *value*

Specify the actual transport stream id. This is used to differentiate events for EIT actual and EIT other.

By default, the actual transport stream id is read from the PAT.

EIT injection starts when the actual transport stream id and time reference are known.

-w
--wait-first-batch

When this option is specified, the start of the plugin is suspended until the first batch of events is loaded from files. Without this option, the input files are asynchronously loaded.

This option is typically useful when inserting events into a transport stream file. Since files are read much faster than the normal playout speed, it is possible that the input transport stream file is already mostly processed when the event files are loaded. With this option, we have the guarantee that the event files are loaded before the transport stream processing starts.

On the other hand, this option should not be used on live transport streams. In that case, the transport stream processing must be allowed to start without event to inject. The EIT's may be sent much later.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▦ encap

Encapsulate packets from several PID's into one single PID

This plugin encapsulates all packets from several PID's into one single PID. This unique output PID replaces all input PID's in the transport stream. The output PID is called the *tunnel* or *outer* PID through which all original or *inner* PID's are conveyed.

The reverse operation, the decapsulation, is performed by the **decap** plugin. It replaces the tunnel PID by all original PID's.

The default encapsulation format is proprietary and defined below. Since this is not a standard format, it is not interoperable with external systems. The **encap** and **decap** plugins are typically used to hide the structure of some part of the transport stream into a private PID to cross some equipment which does not support the structure of the original stream or could damage its original structure.

Because of the encapsulation overhead, the total volume of encapsulated packets is slightly greater (by approximately 2%) than the original PID's. The encapsulation operation consequently needs some null packets in the original transport stream in addition to the original packets. The output tunnel PID replaces all original packets from the encapsulated PID's plus some null packets. It the original input stream has no stuffing at all, then the **tsp** option **--add-input-stuffing 1/50** is sufficient to reserve the additional overhead.

Usage

```
tsp -P encap [options]
```

Options

-i
--ignore-errors

Ignore errors such as PID conflict or packet overflow.

By default, a PID conflict is reported when the output PID is already present on input but not encapsulated. A packet overflow is reported when the input stream does not contain enough null packets to absorb the encapsulation overhead.

-m *value*
--max-buffered-packets *value*

Specify the maximum number of buffered packets. The buffered packets are produced by the encapsulation overhead. An overflow is usually caused by insufficient null packets in the input stream. The default is 1,024 packets.

-o *value*
--output-pid *value*

Specify the output PID containing all encapsulated PID's. This is a mandatory parameter, there is no default. The null PID **0x1FFF** cannot be the output PID.

--pack[=*value*]

Emit outer packets when they are full only.

By default, emit outer packets as soon as possible, when null packets are available on input. With the default behavior, inner packets are decapsulated with a better time accuracy, at the expense of a higher bitrate of the outer PID when there are many null packets in input.

With the option **--pack**, the emission of an outer packet is delayed until it is full. The bitrate of the outer PID is usually smaller but inner packets may be decapsulated later.

When packing is on, it is possible to limit the distance between packed packets by specifying a positive value. When an outer packet is not yet full but no other input packet is found after the

specified number of packets in the TS, then the outer packet is forced to be emitted. With a zero value the distance is disabled (ie. the distance between input packets is unlimited). The value 1 is equivalent to not using the pack mode since outer packets are emitted after one TS packet.

--pcr-pid *value*

Specify a reference PID containing PCR's. The output PID will contain PCR's, based on the same clock. By default, the output PID does not contain any PCR.

--pes-mode *mode*

Enable PES mode encapsulation. See the description of the encapsulation below.

Must be one of **disabled**, **fixed**, **variable**.

--pes-offset *value*

Offset used in Synchronous PES mode encapsulation. The value (positive or negative) is added to the current PCR to generate the PTS timestamp inserted in the PES header.

The recommended values are between -90000 and +90000 (1 second). The value 0 is equivalent to use the Asynchronous PES encapsulation.

It requires to use the PCR option **--pcr-pid**.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

Specify an input PID or range of PID's to encapsulate.

Several **--pid** options can be specified. The null PID **0x1FFF** cannot be encapsulated.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[*-label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

Encapsulation format

This section describes the private encapsulation format. It is informative only.

Due to the encapsulation overhead, the number of output packets is slightly larger than the input packets. The input stream must contain a few null packets to absorb the extra output packets. For this reason, null packets (PID **0x1FFF**) are never encapsulated.

There are two encapsulation formats, the *plain* mode and the *PES* mode. The plain mode is more compact but its structure is specific to TSDuck. The PES mode uses more overhead but it encapsulates the TS packets into PES packets, which may be easier to process in some cases.

Plain encapsulation format

We define the output elementary stream (ES) as the concatenation of all payloads of all TS packets in the output tunnel PID. In this ES, all input TS packets are contiguous, without encapsulation. The initial **0x47** synchronization byte is removed from all input packets since it is redundant and contains no information. Only the remaining 187 bytes are copied in the output ES.

The Payload Unit Start Indicator (PUSI) bit is set in the header of outer TS packets containing the start of an encapsulated packet. When the PUSI bit is set, the first byte of the payload is a *pointer field* to the

beginning of the first encapsulated packet. This packetization method is directly adapted from the standard packetization process for sections, with 187-byte packets instead of sections.

PES encapsulation format

The same plain elementary stream is used, but with a PES envelope. This reduces the payload size for encapsulated packets but this makes the outer encapsulation more transparent. The overhead is increased by approximately 14 to 20%.

The PES envelope uses a KLVA SMPTE-336M encapsulation[6] to insert the inner payload into one private (testing) key. Each TS packet contains only one key, with a size no larger than the payload of one TS packet. So each PES packet fits into a single TS packet.

The SMPTE-336M encapsulation can be either asynchronous (without timestamps) or synchronous (with PTS). The latter consumes more space (+10 bytes) and is only useful when it is needed to remux the encapsulated stream with an external tool that requires to use PTS marks. No other advantages are provided.

Two variant strategies are implemented. The *fixed* mode uses the short (7-bit) BER encoding. This limits the PES payload to a maximum of 127 bytes. And the adaptation field of the outer packet is enlarged with some stuff. However, the advantage is that the PES is sufficient small to include more data in the outer TS packet. This reduces the possibility than some external processing will split the outer packet in two to accommodate the entire PES data.

The *variable* mode does not impose this restriction and outer packets are filled to the maximum. The drawback is that sometimes the long form of BER encoding is used with two bytes and others the short form with one byte. Furthermore, this increases the chances that some external processing occupies two outer packets for the same inner PES packet. Still, support for those split PES packets is included. The only requirement is that the 26 or 27 PES+KLVA header is inserted in the first packet (with PUSI on). The remaining payload can be distributed in the following TS packets.

The PES envelope has an overhead of 26, 27, 36 or 37 bytes based on:

- 9 bytes for the PES header.
- 0 or 5 bytes for the PTS (synchronous mode).
- 0 or 5 bytes for the Metadata AU Header (synchronous mode)
- 16 bytes for the UL key.
- 1 or 2 bytes for the payload size (BER short or long format).

To enable the use of the Synchronous encapsulation, it is required to use PCR's and provide an offset. This value (positive or negative) will be added to the PCR to compute the PTS. Recommended values are between -90000 and +90000 (-1 and +1 second, respectively). If you use negative values, then you can restore in advance the encapsulated stream after remuxing. However, this will be valid only if you use an external tool to remux. If you're unsure, then don't enable it.

Warning about the Synchronous mode: At start, the PTS marks can't be synchronized with the target PCR PID. This is because the PCR value is not read at start. But the PTS is required to be in all PES packets of the encapsulation. So, it is recommended to discard the outcoming stream until valid PTS values appear in the encapsulated stream.

In order to correctly identify the encapsulated PES stream, it is recommended to declare its PID as a component of an existing or new service. This PID component shall be described as follow in the PMT of the service:

- Stream type :
  - Asynchronous mode : Private Type (**0x06**)

---

[6] See https://impleotv.com/2017/02/17/klv-encoded-metadata-in-stanag-4609-streams/

         o   Synchronous mode : Metadata Type (**0x15**)
- Descriptors :
  - o   Add a registration descriptor for "KLVA" (**0x4B4C5641**)

Example

We encapsulate several PID's in outer PID 7777. We attach this outer PID to service id 100. We add a **registration_descriptor** in the description of the outer PID in the PMT.

Asynchronous PES mode encapsulation :

```
tsp ... \
    -P encap --output-pid 7777 --pes-mode fixed ... \
    -P pmt --service 100 --add-pid 7777/0x06 --add-pid-registration 7777/0x4B4C5641 \
    ...
```

Synchronous PES mode encapsulation (with PCR) :

```
tsp ... \
    -P encap --output-pid 7777 --pes-mode fixed --pes-offset -50000 --pcr-pid 101 ... \
    -P pmt --service 100 --add-pid 7777/0x15 --add-pid-registration 7777/0x4B4C5641 \
    ...
```

⁙ feed

Extract an encapsulated TS from an outer feed TS

This plugin is experimental and implements no identified specification.

It selects one PID from the input transport stream. This PID shall contain an encapsulated transport stream. This plugin extracts the embedded transport stream from the original PID.

The encapsulation format has been observed in a few real-world feeds. It is rudimentary and unreliable. The TS packets of the inner transport stream are concatenated and the resulting stream is simply spread over the payloads of the encapsulation PID. There is no synchronization mechanism. There is no payload unit start indicator in any TS packet of the encapsulation PID. Resynchronization of the inner TS is empirically done on 0x47 bytes, even though such a byte can be in fact a data byte inside a packet payload.

By default, the input transport stream is completely replaced with the extracted stream. Using the option **--output-file**, the extracted encapsulated transport stream is saved in a file and, in that case, the input transport stream is passed unmodified.

The encapsulation PID is automatically detected as the first PID with stream type 0x90 in the PMT of a service which has service type 0x80. Options exist to override these values. If there are several encapsulation PID's in the outer TS or if the encapsulation PID is not correctly identified in the PMT, use the option **--pid** to specify the target encapsulation PID.

Usage

```
tsp -P feed [options]
```

Options

-a
--append

> With **--output-file**, if the file already exists, append to the end of the file.
>
> By default, existing files are overwritten.

-k
--keep

> With **--output-file**, keep existing file (abort if the specified file already exists).
>
> By default, existing files are overwritten.

-o *filename*
--output-file *filename*

> Specify that the extracted stream is saved in this file. In that case, the outer transport stream is passed unchanged to the next plugin.

-p *value*
--pid *value*

> Specify the PID carrying the inner encapsulated stream.
>
> By default, the plugin automatically locates and uses the first component with the specified stream type in a service with the specified service type.

--service-type *value*

> Specify the service type carrying inner encapsulated streams.
>
> By default, use 0x80.

--stream-type *value*

Specify the stream type carrying inner encapsulated streams inside a service.

By default, use 0x90.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ file (input)

Transport stream files input

This input module reads transport stream packets from one or more files. The specified files do not need to be regular files, they can be named pipes or anything that can be named and read from.

The default file is the standard input, which can also be a pipe. Since the plugin **file** is the default input plugin (if no option **-I** is specified), this means that the default **tsp** input is the standard input.

By default, the input files must contain a flow of contiguous 188-bytes TS packets. If this is not the case, see option **--format** or consider using the **tsresync** utility.

Input timestamps

With M2TS files, each TS packet is preceded by a 4-byte header containing a timestamp. This value is used as input timestamp by **tsp**.

The specific TSDuck proprietary format (see option **--format**) propagates all metadata of all TS packets. When the input is such a file (typically piped from another instance of **tsp**), the original input timestamps from the first instance of *tsp* are propagated and used as input timestamps by the receiving instance of **tsp**.

Usage

```
tsp -I file [options] [file-name ...]
```

Parameter

Name of the input files. The files are read in sequence, unless **--interleave** is specified.

If no file is specified, the standard input is read by default. When several files are specified, use '**-**' as file name to specify the standard input.

Options

--add-start-stuffing *count*

Specify that *count* null TS packets must be automatically inserted at the start of the input file, before the first actual packet in the file.

If several input files are specified, several options **--add-start-stuffing** are allowed. If there are less options than input files, the last value is used for subsequent files.

--add-stop-stuffing *count*

Specify that *count* null TS packets must be automatically appended at the end of the input file, after the last actual packet in the file.

If several input files are specified, several options **--add-stop-stuffing** are allowed. If there are less options than input files, the last value is used for subsequent files.

-b *value*
--byte-offset *value*

Start reading each file at the specified byte offset (default: zero). This option is allowed only if the input file is a regular file.

-f
--first-terminate

With **--interleave**, terminate the processing when any file reaches the end of file.

By default, continue reading until the last file reaches the end of file (other files are replaced with null packets after their end of file).

--format *name*

> Specify the format of the input files. See section 2.1.2 for more details.
>
> By default, the format of each input file is automatically detected and can be different from one file to another. When the option **--format** is specified, all input files must have the same format.

-i
--infinite

> Repeat the playout of the file infinitely (default: only once). This option is allowed only if the input file is a regular file and there is only one input file.

--interleave[=*value*]

> Interleave files instead of reading them one by one. All files are simultaneously opened.
>
> The optional value is a chunk size *N*, a packet count (default is 1). *N* packets are read from the first file, then *N* from the second file, etc. and then loop back to *N* packets again from the first file, etc.

-l *value*
--label-base *value*

> Set a label on each input packet. Packets from the first file are tagged with the specified base label, packets from the second file with base label plus one, and so on.
>
> For a given file, if the computed label is above the maximum (31), its packets are not labelled.

-p *value*
--packet-offset *value*

> Start reading each file at the specified TS packet (default: zero).
>
> This option is allowed only if all input files are regular file.

-r *count*
--repeat *count*

> Repeat the playout of each file the specified number of times (default: only once).
>
> This option is allowed only if all input files are regular files.
>
> If several input files are specified, the first file is repeated the specified number of times, then the second file is repeated the same number of times, and so on.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

> Display plugin help text.

▚ file (output)

Transport stream files output

This output plugin writes the TS packets to a file. The output file receives a flow of contiguous 188-bytes TS packets.

The default file is the standard output, which can be a pipe. Since the plugin **file** is the default output plugin (if no option **–O** is specified), this means that the default **tsp** output is the standard output.

Usage

```
tsp -O file [options] [file-name]
```

Parameter

> Name of the created output file.

> If the parameter is omitted, is an empty string or a dash ("**-**"), the standard output is used.

Options

> **--add-start-stuffing** *count*

>> Specify that *count* null TS packets must be automatically inserted at the start of the output file, before what comes from the previous plugins.

> **--add-stop-stuffing** *count*

>> Specify that *count* null TS packets must be automatically appended at the end of the output file, after what comes from the previous plugins.

> **-a**
> **--append**

>> If the file already exists, append to the end of the file. By default, existing files are overwritten.

> **--format** *name*

>> Specify the format of the output file. See section 2.1.2 for more details.

>> By default, the format is a standard TS file. If the format is M2TS, the inserted time stamp is identical to the input time stamp for each packet.

> **-k**
> **--keep**

>> Keep existing file (abort if the specified file already exists). By default, existing files are overwritten.

> **--max-duration** *value*

>> Specify a maximum duration in seconds during which an output file is written. After the specified duration, the output file is closed and another one is created. This is a wall-clock processing duration, not a transport stream playout duration.

>> A timestamp is automatically added to the name part so that successive output files receive distinct names.

>> Example: if the specified file name is **foo.ts**, the various files are named **foo-*YYYYMMDD-hhmmss*.ts**.

>> The options **--max-duration** and **--max-size** are mutually exclusive.

> **--max-files value**

>> With **--max-duration** or **--max-size**, specify a maximum number of files. When the number of created files exceeds the specified number, the oldest files are deleted.

By default, all created files are kept.

--max-retry *value*

With **--reopen-on-error**, specify the maximum number of times the file is reopened on error.

By default, the file is indefinitely reopened.

--max-size *value*

Specify a maximum size in bytes for the output files. When an output file grows beyond the specified limit, it is closed and another one is created.

The size limit is not exactly enforced. When a group of packets is written in one single write operation, there is no attempt to split the file at the exact specified size. The file is closed and the next one is opened after all packets are written in that single write operation.

A number is automatically added to the name part so that successive output files receive distinct names.

Example: if the specified file name is **foo.ts**, the various files are named **foo-000000.ts**, **foo-000001.ts**, etc.

If the specified template already contains trailing digits, this unmodified name is used for the first file. Then, the integer part is incremented.

Example: if the specified file name is **foo-027.ts**, the various files are named **foo-027.ts**, **foo-028.ts**, etc.

The options **--max-duration** and **--max-size** are mutually exclusive.

-r
--reopen-on-error

In case of write error, close the file and try to reopen it several times. After a write error, attempt to reopen or recreate the file immediately. Then, in case of open error, periodically retry to open the file.

See also options **--retry-interval** and **--max-retry**.

--retry-interval *milliseconds*

With **--reopen-on-error**, specify the number of milliseconds to wait before attempting to reopen the file after a failure.

The default is 2000 milliseconds.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

Display plugin help text.

▪ file (packet processing)

Save packets to a file and pass to next plugin

This plugin writes the TS packets to a file and passes them to the next plugin in the chain. The output file receives a flow of contiguous 188-bytes TS packets.

Usage

```
tsp -P file [options] file-name
```

Parameter

Name of the created output file.

Options

--add-start-stuffing *count*

Specify that *count* null TS packets must be automatically inserted at the start of the output file, before what comes from the previous plugins.

--add-stop-stuffing *count*

Specify that *count* null TS packets must be automatically appended at the end of the output file, after what comes from the previous plugins.

-a
--append

If the file already exists, append to the end of the file. By default, existing files are overwritten.

--format *name*

Specify the format of the output file. See section 2.1.2 for more details.

By default, the format is a standard TS file. If the format is M2TS, the inserted time stamp is identical to the input time stamp for each packet.

-k
--keep

Keep existing file (abort if the specified file already exists). By default, existing files are overwritten.

--max-duration *value*

Specify a maximum duration in seconds during which an output file is written. After the specified duration, the output file is closed and another one is created. This is a wall-clock processing duration, not a transport stream playout duration.

A timestamp is automatically added to the name part so that successive output files receive distinct names.

Example: if the specified file name is **foo.ts**, the various files are named **foo-*YYYYMMDD-hhmmss*.ts**.

The options **--max-duration** and **--max-size** are mutually exclusive.

--max-files *value*

With **--max-duration** or **--max-size**, specify a maximum number of files. When the number of created files exceeds the specified number, the oldest files are deleted.

By default, all created files are kept.

--max-retry *value*

With **--reopen-on-error**, specify the maximum number of times the file is reopened on error.

By default, the file is indefinitely reopened.

--max-size *value*

Specify a maximum size in bytes for the output files. When an output file grows beyond the specified limit, it is closed and another one is created.

The size limit is not exactly enforced. When a group of packets is written in one single write operation, there is no attempt to split the file at the exact specified size. The file is closed and the next one is opened after all packets are written in that single write operation.

A number is automatically added to the name part so that successive output files receive distinct names.

Example: if the specified file name is **foo.ts**, the various files are named **foo-000000.ts**, **foo-000001.ts**, etc.

If the specified template already contains trailing digits, this unmodified name is used for the first file. Then, the integer part is incremented.

Example: if the specified file name is **foo-027.ts**, the various files are named **foo-027.ts**, **foo-028.ts**, etc.

The options **--max-duration** and **--max-size** are mutually exclusive.

-r
--reopen-on-error

In case of write error, close the file and try to reopen it several times. After a write error, attempt to reopen or recreate the file immediately. Then, in case of open error, periodically retry to open the file.

See also options **--retry-interval** and **--max-retry**.

--retry-interval *milliseconds*

With **--reopen-on-error**, specify the number of milliseconds to wait before attempting to reopen the file after a failure.

The default is 2000 milliseconds.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[*-label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▦ filter

General-purpose packet filter

This plugin filters TS packets according to various conditions. When a packet meets at least one of the specified conditions, it is passed to the next packet in the chain. Otherwise, it is dropped.

To filter packets which meets several simultaneous conditions ("and" instead of "or"), simply chain several filter plugins on the command line.

Some specific options (**--set- label**, **--reset- label**, **--set-permanent-label**, **--reset-permanent-label**) do not drop unfiltered packets. Instead, these options set or reset labels on the filtered packets. This is a way to mark selected packets in the stream with specific labels. The marked packets can then be selectively processed by another plugin using the options **--only-label**. See the reference section of **tsp** in chapter 3 for more details on *packet labelling*.

Usage

```
tsp -P filter [options]
```

Options

  --adaptation-field

      Select packets with an adaptation field.

  --after-packets *count*

      Let the specified number of packets pass transparently without filtering. Start to apply the filtering criteria after that number of packets.

  --audio

      Select packets from an audio PID.

  -c
  --clear

      Select clear (unscrambled) packets. Equivalent to **--scrambling-control 0**.

  --codec *name*

      Select packets from PID's which were encoded with the specified codec format.

      The name must be one of **AAC**, **AC3**, **AC4**, **AV1**, **AVC**, **AVS3**, **DTS**, **DTSHD**, **DVBSubtitles**, **EAC3**, **EVC**, **H264**, **H265**, **H266**, **HEAAC**, **HEVC**, **JPEG2000**, **LCEVC**, **MP1Audio**, **MPEG-1-Audio**, **MP1Video**, **MPEG-1-Video**, **MP2Audio**, **MPEG-2-Audio**, **MP2Video**, **MPEG-2-Video**, **MP3**, **MP4Video**, **MPEG-4-Video**, **Teletext**, **VP9**, **VVC**, **undefined**.

  --ecm

      Select packets from any ECM PID.

  --emm

      Select packets from any EMM PID.

  --every *count*

      Select one packet every that number of packets.

  --has-splice-countdown

      Select packets which contain a *splice_countdown* value in adaptation field.

  --input-stuffing

      Select packets which were artificially inserted as stuffing before the input plugin using **tsp** options **--add-start-stuffing**, **--add-input-stuffing** and **--add-stop-stuffing**.

Be aware that these packets may no longer be null packets if some previous plugin injected data, replacing stuffing.

-i *index1*[-[*index2*]]
--interval *index1*[-[*index2*]]

Select all packets in the specified interval from the start of the stream. The packets in the stream are indexed starting at zero.

- In the form *index1*, only one packet is selected, at the specified index.
- In the form *index1-index2*, all packets in the specified range of indexes, inclusive, are selected.
- In the form *index1-*, all packets starting at the specified index are selected, up to the end of the stream.

Several options **--interval** can be specified.

--intra-frame

Select packets which contain the start of a video intra-frame.

The accurate detection of intra-frame depends on the codec. There is also a minimal risk of false positive on non-video PID's.

-l *label1*[-*label2*]
--label *label1*[-*label2*]

Select packets with any of the specified labels. Labels should have typically been set by a previous plugin in the chain.

Several **--label** options may be specified.

Note that the option **--label** is different from the generic option **--only-label**. The generic option **--only-label** acts at **tsp** level and controls which packets are passed to the plugin. All other packets are directly passed to the next plugin without going through this plugin. The option **--label**, on the other hand, is specific to the **filter** plugin and selects packets with specific labels among the packets which are passed to this plugin.

--max-adaptation-field-size *value*

Select packets with no adaptation field or with an adaptation field the size (in bytes) of which is not greater than the specified value.

--max-payload-size *value*

Select packets with no payload or with a payload the size (in bytes) of which is not greater than the specified value.

--max-splice-countdown *value*

Select packets with a *splice_countdown* value in adaptation field which is lower than or equal to the specified value.

--min-adaptation-field-size *value*

Select packets with an adaptation field the size (in bytes) of which is equal to or greater than the specified value.

--min-payload-size *value*

Select packets with a payload the size (in bytes) of which is equal to or greater than the specified value.

--min-splice-countdown *value*

Select packets with a *splice_countdown* value in adaptation field which is greater than or equal to the specified value.

-n
--negate

Negate the filter: specified packets are excluded.

--nullified

Select packets which were explicitly turned into null packets by some previous plugin in the chain (typically using a **--stuffing** option).

Be aware that these packets may no longer be null packets if some intermediate plugin injected data, replacing stuffing.

--pattern *hexa-digits*

Select packets containing the specified pattern bytes. The value must be a string of hexadecimal digits specifying any number of bytes.

By default, the packet is selected when the value is anywhere inside the packet.

With option **--search-payload**, only search the pattern in the payload of the packet.

With option **--search-offset**, the packet is selected only if the pattern is at the specified offset in the packet.

When **--search-payload** and **--search-offset** are both specified, the packet is selected only if the pattern is at the specified offset in the payload.

--payload

Select packets with a payload.

--pcr

Select packets with PCR or OPCR.

--pes

Select packets with clear PES headers.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

PID filter: select packets with these PID values.

Several **--pid** options may be specified.

--psi-si

Select packets from any PSI/SI PID. This includes global signalization PID's for DVB, ATSC and ISDB standards as well as the PMT of each service.

--reset-label *label1*[*-label2*]

Clear the specified labels on the selected packets.

Do not drop unselected packets, simply clear one or more labels on selected ones.

Several **--reset-label** options may be specified.

--reset-permanent-label *label1*[*-label2*]

Clear the specified labels on all packets, selected and unselected ones, after at least one was selected.

Do not drop unselected packets, simply use selected ones as trigger.

Several **--reset-permanent-label** options may be specified.

--scrambling-control *value*

Select packets with the specified scrambling control value.

Valid values are 0 (clear), 1 (reserved), 2 (even key), 3 (odd key).

--search-offset *value*

With **--pattern**, only search the set of bytes at the specified offset in the packet (the default) or in the payload (with **--search-payload**).

--search-payload

With **--pattern**, only search the set of bytes in the payload of the packet. Do not search the pattern in the header or adaptation field.

--service *id-or-name*

Select packets belonging to any of the specified services as PMT, component or ECM.

If the argument is an integer, it is considered as a service id. Otherwise, this is a service name.

Several **--service** options may be specified.

--set-label *label1*[-*label2*]

Set the specified labels on the selected packets.

Do not drop unselected packets, simply mark selected ones with one or more labels.

Several **--set-label** options may be specified.

--set-permanent-label *label1*[-*label2*]

Set the specified labels on all packets, selected and unselected ones, after at least one was selected.

Do not drop unselected packets, simply use selected ones as trigger.

Several **--set-permanent-label** options may be specified.

--splice-countdown *value*

Select packets with the specified *splice_countdown* value in adaptation field.

--stream-id *id1*[-*id2*]

Select PES PID's with any of the specified stream ids.

The PID's are dynamically selected. A PID starts to be selected when a specified stream id is detected in a PES header. Such a PID becomes no longer selected when a non-specified stream id is found in this PID.

Several **--stream-id** options may be specified.

-s
--stuffing

Replace excluded packets with stuffing (null packets) instead of removing them. Useful to preserve bitrate.

--subtitles

Select packets from any PID carrying subtitles.

--unit-start

Select packets with payload unit start indicator.

-v
--valid

Select valid packets. A valid packet starts with **0x47** and has its *transport_error_indicator* cleared.

--video

Select packets from a video PID.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

   Display this help text.

--only-label *label1*[*-label2*]

   Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

   Several **--only-label** options may be specified.

⊞ fork (input)

Receive packets from a forked process

This input plugin forks a process and receives all TS packets from the standard output of this process.

Using this input plugin with **tsp** is equivalent to reading the input pipe. The following two commands have the same effect (the command **receive** being a fictitious one):

```
receive stream | tsp ...
tsp –I fork 'receive stream' ...
```

So, this plugin is redundant with the shell pipe features. However, this plugin is useful when the **tsp** process is created from another native application (not a shell script). In that case, it is much easier for this application to create a simple binary process rather than a shell and its commands.

Additionally, this input plugin becomes necessary with **tsswitch** which accepts several inputs. The following command has no equivalent with shell pipes:

```
tsswitch –I fork 'receive stream1' –I fork 'receive stream2' -O ...
```

Usage

```
tsp -I fork [options] 'command'
```

Parameter

The *'command'* parameter specifies the shell command to execute in the forked process. The standard output of this process is a pipe from which the TS packets are received by the input plugin. If the command contains spaces or shell special sequences, the complete command string must be surrounded by quotes.

If the command is too long or too complicated, it is recommended to use a script. If the created command is another TSDuck command, it is possible to shorten the command using partial command line redirection (see 3.1.5).

Options

-b *value*
--buffered-packets *value*

> Windows only: Specifies the pipe buffer size in number of TS packets.

--format *name*

> Specify the format of the input stream which comes from the created process. See section 2.1.2 for more details.

-n
--nowait

> Do not wait for child process termination at end of input.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

> Display plugin help text.

▪ fork (output)

Send packets to a forked process

This output plugin forks a process and sends all TS packets to the standard input of this process.

Using this output plugin with **tsp** is equivalent to writing to the output pipe. The following two commands have the same effect (the command "*send*" being a fictitious one):

```
tsp ... | send stream
tsp ... –O fork 'send stream'
```

So, this plugin is redundant with the shell pipe features. However, this plugin is useful when the **tsp** process is created from another native application (not a shell script). In that case, it is much easier for this application to create a simple binary process rather than a shell and its commands.

Usage

```
tsp -O fork [options] 'command'
```

Parameter

The *'command'* parameter specifies the shell command to execute in the forked process. The standard input of this process is a pipe receiving the TS packets. If the command contains spaces or shell special sequences, the complete command string must be surrounded by quotes.

If the command is too long or too complicated, it is recommended to use a script. If the created command is another TSDuck command, it is possible to shorten the command using partial command line redirection (see 3.1.5).

Options

-b *value*
--buffered-packets *value*

Windows only: Specifies the pipe buffer size in number of TS packets.

--format *name*

Specify the format of the output stream which is passed to the created process. See section 2.1.2 for more details.

By default, the format is a standard TS file. If the format is M2TS, the inserted time stamp is identical to the input time stamp for each packet.

-n
--nowait

Do not wait for child process termination at end of input.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

Display plugin help text.

◫ fork (packet processing)

Redirect packets to a forked process

This plugin forks a process and sends all TS packets to the standard input of this process. The TS packets are also normally passed to the next processor in the chain.

This plugin can be used to duplicate the output stream at any point in the packet processing chain.

Usage

```
tsp -P fork [options] 'command'
```

Parameter

The *'command'* parameter specifies the shell command to execute in the forked process. The standard input of this process is a pipe receiving the TS packets. If the command contains spaces or shell special sequences, the complete command string must be surrounded by quotes.

If the command is too long or too complicated, it is recommended to use a script. If the created command is another TSDuck command, it is possible to shorten the command using partial command line redirection (see 3.1.5).

Options

-b *value*
--buffered-packets *value*

Specifies the number of TS packets to buffer before sending them through the pipe to the forked process. When set to zero, the packets are not buffered and sent one by one.

The default is 500 packets in real-time mode and 1000 packets in offline mode.

--format *name*

Specify the format of the output stream which is passed to the created process. See section 2.1.2 for more details.

By default, the format is a standard TS file. If the format is M2TS, the inserted time stamp is identical to the input time stamp for each packet.

-i
--ignore-abort

Ignore early termination of child process. By default, if the child process aborts and no longer reads the packets, **tsp** also aborts.

-n
--nowait

Do not wait for child process termination at end of input.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⁙ fuzz

Introduce random errors in the transport stream

This plugin randomly corrupts packets in the transport stream. It is equivalent to the **tsfuzz** utility. Actually, the following two commands produce the same result:

```
tsfuzz options infile -o outfile
tsp –I file infile –P fuzz options –O file outfile
```

Usage

```
tsp -P fuzz [options]
```

Fuzzing options

The plugin accepts exactly the same fuzzing options as the **tsfuzz** utility.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪▪ hides (output)

Send the transport stream to a HiDes modulator device

This plugin sends the output transport stream to a HiDes modulator device.

Restrictions

This plugin is available on Linux and Windows only. There is no HiDes device drivers on macOS.

Usage

```
tsp -O hides [options]
```

Options

-a *value*
--adapter *value*

Specify the HiDes adapter number to use. By default, the first HiDes device is selected.

Use the command **tshides** to list all HiDes devices.

Use **--adapter** or **--device** but not both.

-b *value*
--bandwidth *value*

Bandwidth in Hz.

For compatibility with old versions, low values (below 1000) are interpreted in MHz. This means that values 8 and 8,000,000 are identical. Both mean 8 MHz.

The default is 8 MHz.

-c *value*
--constellation *value*

Constellation type. Must be one of **QPSK**, **16-QAM**, **64-QAM**.

The default is **64-QAM**.

--dc-compensation *i-value/q-value*

Specify the DC offset compensation values for I and Q. Each offset value shall be in the range -512 to 512.

-d "*name*"
--device "*name*"

Specify the HiDes device name to use. By default, the first HiDes device is selected.

Use the command **tshides** to list all HiDes devices.

Use **--adapter** or **--device** but not both.

-f *value*
--frequency *value*

Frequency, in Hz, of the output carrier. There is no default, this is a mandatory parameter.

--gain *value*

Adjust the output gain to the specified value in dB.

-g *value*
--guard-interval *value*

Guard interval. Must be one of **1/32**, **1/16**, **1/8**, **1/4**.

The default is **1/32**.

--h *value*

--high-priority-fec *value*

Error correction for high priority streams. Must be one of **1/2**, **2/3**, **3/4**, **5/6**, **7/8**.

The default is **2/3**.

--s *value*

--spectral-inversion *value*

Spectral inversion. Must be one of **off**, **on**, **auto**.

The default is **auto**.

Note that this option is ignored on Windows.

-t *value*

--transmission-mode *value*

Transmission mode. Must be one of **4K**, **2K**, **8K**. The default is **8K**.

Generic output plugin options

The following options are implicitly defined in all output plugins.

--help

Display this help text.

▪ history

Report a history of major events on the transport stream

This plugin reports a history of the major events on the transport stream: new PID's, new tables, clear ⇔ scrambled transitions, suspended and restarted PID's, etc.

Event reporting format

By default, the messages are reported, like all other **tsp** messages, on the standard error file. Each output line is formatted as follow:

```
* history: packet-number: MESSAGE
```

With option **--milli-seconds**, the *packet-number* is replaced by a number of milliseconds (based on the TS bitrate).

Some events are detected only some time after they occurred (determining if a PID is suspended, for instance, is detected long after the last packet on this PID). As a consequence, some messages may be unsorted. To sort messages according to packet numbers, use a command like:

```
tsp -P history ...  2>&1 | grep '* history:' | sort –t : -k 2 –n
```

When an output file is specified using option **--output-file**, the log prefix "*** history:**" is not present. In this case, the sort command becomes:

```
sort -n output-file-name
```

Reported events

By default, the following events are reported:

- New versions of PAT, CAT, PMT, SDT, TSDT, BAT, NIT.

- First and last packet of each PID, including when a PID is suspended for a while.

- The last TDT or TOT time before an event.

- Per-PID clear to scrambled and scrambled to clear transistions.

- Per-PID first PES stream id.

With option **--cas**:

- All occurrences of a new ECM. Repeated values of the same ECM are not reported.

- Per-PID crypto-period boundaries.

With option **--eit**:

- All EIT sections.

With option **--time-all**:

- All system time tables (TDT, TOT).

Without option **--ignore-stream-id-change**:

- Change of PES stream id in a PID.

Usage

```
tsp -P history [options]
```

Options

-c
--cas

> Report all CAS events (new ECM, crypto-period change). By default, only clear to/from scrambled transitions are reported.

-e
--eit

> Report all EIT. By default, EIT are not reported.

-i
--ignore-stream-id-change

> Do not report stream_id modifications in a stream. Some subtitle streams may constantly swap between "private stream" and "padding stream". This option suppresses these annoying messages.

-m
--milli-seconds

> For each message, report time in milli-seconds from the beginning of the stream instead of the TS packet number. This time is a playback time based on the current TS bitrate (use plugin **pcrbitrate** just before plugin **history** when necessary).

-o *filename*
--output-file *filename*

> Specify the output file for reporting history lines. By default, report history lines on standard error using the **tsp** logging mechanism.

-s *value*
--suspend-packet-threshold *value*

> Number of packets in the TS after which a PID is considered as suspended. By default, if no packet is found in a PID during 60 seconds (according to the TS bitrate), the PID is considered as suspended.

-t
--time-all

> Report all TDT and TOT. By default, only report TDT preceeding another event.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

⁙ hls (input)

Receive HTTP Live Streaming (HLS) media

This plugin reads a combined transport stream from an HLS streaming server. All media segments are concatenated into one single transport stream.

In the case of live content, the HLS playlist is reloaded as often as necessary to get a continuous content.

Restriction: The HLS specification allows two kinds of media content: TS and fMP4 (fragmented MP4). Since TSDuck is a *transport stream* toolkit, this plugin can only receive TS media.

Usage

```
tsp -I hls [options] url
```

Parameter

Specify the URL of an HLS manifest or playlist. This is typically an URL ending in **.m3u8**.

This can be a **master playlist**, referencing several versions of the same content (with various bitrates or resolutions). This can also be a **media playlist**, referencing all segments of one single content.

When the playlist is a master one, the first media playlist is selected by default. Specify options can be used to select a playlist based on criteria (bandwidth or resolution for instance) When a media playlist failed to load, the next one is used (with respect to the selection criteria), etc.

Although HLS is inherently based on HTTP, it is possible to specify a local file as playlist, either using a **file:** URI or a simple file specification. This is typically useful to test the files which are produced by the **hls** output plugin.

Options

--alt-group-id *'string'*

When the URL is a master playlist, use the *alternative rendition content* with the specified group id.

If several **--alt-*** options are specified, the selected alternative rendition content must match all of them.

--alt-language *'string'*

When the URL is a master playlist, use the first *alternative rendition content* with the specified language.

If several **--alt-*** options are specified, the selected alternative rendition content must match all of them.

--alt-name *'string'*

When the URL is a master playlist, use the 'alternative rendition content' with the specified name.

If several **--alt-*** options are specified, the selected alternative rendition content must match all of them.

--alt-type *'string'*

When the URL is a master playlist, use the first 'alternative rendition content' with the specified type.

If several **--alt-*** options are specified, the selected alternative rendition content must match all of them.

--compressed

> Accept compressed HTTP responses.
>
> By default, compressed responses are not accepted.

--connection-timeout *value*

> Specify the connection timeout in milliseconds.
>
> By default, let the operating system decide.

--headers *'header: value'*

> Specify a custom header, e. g. 'x-header-name: value' for all HTTP requests (playlists and media segments).
>
> This option can be set multiple times.

--highest-bitrate

> When the URL is a master playlist, use the content with the highest bitrate.

--highest-resolution

> When the URL is a master playlist, use the content with the highest screen resolution.

-l
--list-variants

> When the URL is a master playlist, list all possible streams bitrates and resolutions.

--live

> Specify that the input is a live stream and the playout shall start at the last segment in the playlist.
>
> This is an alias for **--start-segment -1**

--lowest-bitrate

> When the URL is a master playlist, use the content with the lowest bitrate.

--lowest-resolution

> When the URL is a master playlist, use the content with the lowest screen resolution.

--max-bitrate *value*

> When the URL is a master playlist, select a content the bitrate of which is lower than the specified maximum.
>
> See section 2.2 for more details on the representation of bitrates.

--max-height *value*

> When the URL is a master playlist, select a content the resolution of which has a lower height than the specified maximum.

--max-width *value*

> When the URL is a master playlist, select a content the resolution of which has a lower width than the specified maximum.

--min-bitrate *value*

> When the URL is a master playlist, select a content the bitrate of which is higher than the specified minimum.
>
> See section 2.2 for more details on the representation of bitrates.

--min-height *value*

> When the URL is a master playlist, select a content the resolution of which has a higher height than the specified minimum.

--min-width *value*

> When the URL is a master playlist, select a content the resolution of which has a higher width than the specified minimum.

--proxy-host *name*

> Optional proxy host name for Internet access.

--proxy-password *string*

> Optional proxy password for Internet access (for use with **--proxy-user**).

--proxy-port *value*

> Optional proxy port for Internet access (for use with **--proxy-host**).

--proxy-user *name*

> Optional proxy user name for Internet access.

--receive-timeout *value*

> Specify the data reception timeout in milliseconds. This timeout applies to each receive operation, individually.
>
> By default, let the operating system decide.

--save-files *directory-name*

> Specify a directory where all downloaded files, media segments and playlists, are saved before being passed to the next plugin.
>
> This is typically a debug option to analyze the input HLS structure.

-s *value*
--segment-count *value*

> Stop receiving the HLS stream after receiving the specified number of media segments.
>
> By default, receive the complete content.

--start-segment *value*

> Start at the specified segment in the initial playlist.
>
> The value can be positive or negative. Positive values are indexes from the start of the playlist: 0 is the first segment (the default), +1 is the second segment, etc. Negative values are indexes from the end of the playlist: -1 is the last segment, -2 is the preceding segment, etc.
>
> By default, start with the first media segment.

--user-agent *string*

> Specify the user agent string to send in HTTP requests.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

> Display plugin help text.

⬚ hls (output)

Generate HTTP Live Streaming (HLS) media

This output plugin generates HLS playlists and media segments on local files only. It can also purge obsolete media segments and regenerate live playlists. The plugin always generate media segments. The playlist generation is optional.

To setup a complete HLS server, it is necessary to setup an external HTTP server such as Apache which simply serves the files, playlist and media segments.

Usage

```
tsp -O hls [options] filename
```

Parameter

> Specify the name template of the output media segment files. A number is automatically added to the name part so that successive segment files receive distinct names.
>
> > Example: if the specified file name is **foo.ts**, the various segment files are named **foo-000000.ts**, **foo-000001.ts**, etc.
>
> If the specified template already contains trailing digits, this unmodified name is used for the first segment. Then, the integer part is incremented.
>
> > Example: if the specified file name is **foo-027.ts**, the various segment files are named **foo-027.ts**, **foo-028.ts**, etc.

Options

> **-a**
> **--align-first-segment**
>
> > Force the standard alignment of the first output segment:
> >
> > - Start with a PAT and PMT.
> > - Force the reference video PID to start on a PES packet boundary.
> > - With **--intra-close**, also force this video PID to start on an intra-coded image (I-Frame).
> >
> > Using this option, all packets before these starting conditions are dropped.
> >
> > By default, the first output segment starts with the first packets in the TS.
> >
> > Note that all subsequent output segments always start with a copy of the last PAT and PMT, on a video PES packet boundary, with or without this option.

> **-c** *'string'*
> **--custom-tag** *'string'*
>
> > Specify a custom tag to add in the playlist files. The specified string shall start with '**#**'. If omitted, the leading '**#**' is automatically added.
> >
> > Several **--custom-tag** options can be specified. Each tag is added as an independent tag line.

> **-d** *value*
> **--duration** *value*
>
> > Specify the target duration in seconds of media segments.
> >
> > The default is 10 seconds per segment for VoD streams and 5 seconds for live streams.

> **-e**
> **--event**
>
> > Specify that the output is a event playlist.

By default, the output stream is considered as VoD.

-f *value*
--fixed-segment-size *value*

> Specify the size in bytes of all media segments. By default, the segment size is variable and based on the **--duration** parameter. When **--fixed-segment-size** is specified, the **--duration** parameter is only used as a hint in the playlist file.

-i
--intra-close

> Start new segments on the start of an intra-coded image (I-frame) of the reference video PID.
>
> The reference video PID is the first video PID of the first service in the PAT.
>
> By default, a new segment starts on a PES packet boundary on this video PID.
>
> Note that it is not always possible to guarantee the detection of I-frames if the video coding format is not fully supported, if the start of an intra-image cannot be found in the start of the PES packet which is contained in a TS packet or if the TS packet is encrypted.

--label-close *label1*[-*label2*]

> Close the current segment as soon as possible after a packet with any of the specified labels. Labels should have typically been set by a previous plugin in the chain. In practice, the current segment is closed and renewed at the start of the next PES packet on the video PID.
>
> Several **--label-close** options may be specified.
>
> This option is compatible with **--duration**. The current segment is closed on a labelled packed or segment duration, whichever comes first.

-l *value*
--live *value*

> Specify that the output is a live stream. The specified value indicates the number of simultaneously available media segments. Obsolete media segment files are automatically deleted.
>
> By default, the output stream is considered as VoD and all created media segments are preserved.

--live-extra-segments *value*

> In a live stream, specify the number of unreferenced segments to keep on disk before deleting them. The extra segments were recently referenced in the playlist and can be downloaded by clients after their removal from the playlist.
>
> The default is 1 extra segment.

-m *value*
--max-extra-duration *value*

> With **--intra-close**, specify the maximum additional duration in seconds after which the segment is closed on the next video PES packet, even if no intra-coded image was found.
>
> The default is to wait for an intra-coded image up to 2 additional seconds after the theoretical end of the segment.

--no-bitrate

> With **--playlist**, do not specify **EXT-X-BITRATE** tags for each segment in the playlist.
>
> This optional tag is present by default.

-p *filename*
--playlist *filename*

> Specify the name of the playlist file. The playlist file is rewritten each time a new segment file is completed or an obsolete one is deleted.
>
> The playlist and the segment files can be written to distinct directories but, in all cases, the URI of the segment files in the playlist are always relative to the playlist location.
>
> By default, no playlist file is created (the plugin creates media segments only).
>
> An HLS playlist can be of one of the following types:
>
> - VoD playlist. A static media playlist for a fully recorded content. The list of media segments cannot change. This is the default with the **hls** output plugin.
>
> - Event playlist. A growing media playlist for a running event. It is possible to move backward in the event, up to the beginning. New media segments can be added at the end of the playlist. No segment can be removed. Use option **--event** to generate such a playlist.
>
> - Live playlist. A sliding media playlist for a live channel, without backward browsing. The initial segments are regularly removed. New segments are regularly added at the end of the list. Use option **--live** to generate such a playlist.
>
> - Master playlist: A higher-level playlist which contains references to several media playlists. Each media playlist typically represents the same content with various bitrates. The **hls** output plugin can only create media playlists, not master playlists.

--slice-only

> Disable the insertion of the PAT and PMT at start of each segment. Note that this generates a non-standard HLS output.

-s *value*
--start-media-sequence *value*

> Initial media sequence number in **#EXT-X-MEDIA-SEQUENCE** directive in the playlist.
>
> The default is zero.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

> Display plugin help text.

▪ **http (input)**

Read a transport stream from an HTTP server

This plugin reads a transport stream from a URL. The HTTP server is expected to send a valid transport stream without encapsulation.

It is possible to repeat the operation a number of times. In that case, the URL is re-opened each time and the content may be different if the served stream is not a static file.

The expected MIME type for an MPEG transport stream is **video/mp2t**. If a different type is reported by the server, a warning message is displayed but the content is accepted as long as it is a valid transport stream.

Usage

```
tsp -I http [options] url
```

Parameter

Specify the URL from which to read the transport stream.

Options

--compressed

Accept compressed HTTP responses.

By default, compressed responses are not accepted.

--connection-timeout *value*

Specify the connection timeout in milliseconds.

By default, let the operating system decide.

--headers *'header: value'*

Specify a custom header, e. g. 'x-header-name: value' for all HTTP requests (playlists and media segments).

This option can be set multiple times.

--ignore-errors

With **--repeat** or **--infinite**, repeat also in case of error.

By default, repetition stops on error.

-i
--infinite

Repeat the playout of the content infinitely (default: only once).

--proxy-host *name*

Optional proxy host name for Internet access.

--proxy-password *string*

Optional proxy password for Internet access (for use with **--proxy-user**).

--proxy-port *value*

Optional proxy port for Internet access (for use with **--proxy-host**).

--proxy-user *name*

Optional proxy user name for Internet access.

--receive-timeout *value*

> Specify the data reception timeout in milliseconds. This timeout applies to each receive operation, individually.
>
> By default, let the operating system decide.

--reconnect-delay *value*

> With **--repeat** or **--infinite**, wait the specified number of milliseconds.
>
> By default, repeat immediately.

-r *count*
--repeat *count*

> Repeat the playout of the content the specified number of times (default: only once).

--user-agent *string*

> Specify the user agent string to send in HTTP requests.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

> Display plugin help text.

▉ http (output)

Act as an HTTP server and send TS packets to the incoming client

This plugin implements a rudimentary HTTP server. This server accepts only one client. The output is suspended until a clients connects. Then, all TS packets are transmitted to the client.

No SSL/TLS is supported, only the **http:** protocol is accepted.

Only one client is accepted at a time. By default, **tsp** terminates if the client disconnects. Use the option **--multiple-clients** to wait for the next incoming client and continue the output when the previous client disconnects.

The HTTP request "GET /" returns the transport stream content. All other requests are considered as invalid (see option **--ignore-bad-request**). Therefore, the only valid URL to access the server is **http://hostname:port/** where **hostname** designates the system on which **tsp** run and **port** is specified in the plugin options.

There is no **Content-Length** response header since the size of the returned TS is unknown at the time the client connects and the HTTP request is received.

The server disconnects at the end of the data. The **Keep-Alive** option is not supported.

Usage

```
tsp -O http [options]
```

Options

--buffer-size *value*

Specifies the TCP socket send buffer size in bytes to the client connection (socket option).

--ignore-bad-request

Ignore invalid HTTP requests and unconditionally send the transport stream.

By default, any HTTP request other than "GET /" is rejected and an error status is returned to the client.

-m
--multiple-clients

Specifies that the server handle multiple clients, one after the other. If a client disconnects, the output is suspended until a new client connects. The TS packets are then sent to the new client.

By default, the plugin terminates the tsp session when the first client disconnects.

--no-reuse-port

Disable the reuse port socket option. Do not use unless completely necessary.

-s [*ip-address*:]*port*
--server [*ip-address*:]*port*

Specifies the local TCP port on which the plugin listens for incoming HTTP connections. This option is mandatory. The server accepts only one HTTP connection at a time.

When present, the optional address shall specify a local IP address or host name. By default, the server listens on all local interfaces.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

Display plugin help text.

▪ inject

Inject tables in a transport stream

This plugin injects MPEG tables and sections into a transport stream, replacing a PID or stealing packets from stuffing.

When the PID is replaced, all previous content of this PID is lost and all its packets are replaced at the same position in the stream. The bitrate of the PID is unchanged.

When a new PID is created, replacing some stuffing packets, its bitrate must be known. There are several explicit or implicit ways to specify the bitrate of the new PID. First, the option **--bitrate** can be used. Second, the option **--inter-packet** can be used to specify the placement of the packets in the stream. The last option is to specify an explicit repetition rate for each input section file.

Usage

```
tsp -P inject [options] input-file[=rate] ...
```

Parameters

*input-file***[=***rate***]**

>   Binary, XML or JSON files containing one or more sections or tables. By default, files with a name ending in **.bin**, **.xml** or **.json** are automatically recognized. For other file names, explicitly specify **--binary** or **--xml** or --**json**.

>   The reference source format is XML. JSON files are first translated to XML using the "automated XML-to-JSON conversion" (see 2.7.3) rules of TSDuck and then compiled to binary.

>   If different repetition rates are required for different files, a parameter can be ***filename=value*** where *value* is the repetition rate in milliseconds for all sections in that file.

>   If an input file name starts with "**<?xml**", it is considered as inline XML content. Similarly, if an input file name starts with "**{**" or "**[**", it is considered as inline JSON content. In these two cases, it is not possible to specify a specific repetition rate for this XML or JSON content.

Options

--binary

>   Specify that all input files are binary, regardless of their file name.

-b *value*
--bitrate *value*

>   Specifies the bitrate for the new PID, in bits / second.

>   See section 2.2 for more details on the representation of bitrates.

--brazil

>   A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--default-charset *name*

>   Default character set to use when serializing strings to tables and descriptors. This option is useful only when tables are read from XML files and converted to binary sections for injection.

>   By default, standard DVB encoding is used. See section 2.5 for more details.

--eit-actual

>   With **--eit-normalization**, generate all EIT actual.

>   Same as **--eit-actual-pf --eit-actual-schedule**.

--eit-actual-pf

>> With **--eit-normalization**, generate EIT p/f actual.
>>
>> If no EIT selection option is specified, all EIT's are generated.

--eit-actual-schedule

>> With **--eit-normalization**, generate EIT schedule actual.
>>
>> If no EIT selection option is specified, all EIT's are generated.

--eit-base-date *date*

>> With **--eit-normalization**, use the specified date as reference for the allocation of the various EIT events in sections and segments.
>>
>> The date must be in the format "*year/month/day* [*hh:mm:ss*]". If only the date is present, it is used as base for the allocation of EIT schedule. If the time is also specified, it is the current time for the snapshot of EIT present/following.
>>
>> By default, use the oldest date in all EIT sections as base date.

--eit-normalization

>> Reorganize all EIT sections according to ETSI TS 101 211 rules (see [6]).
>>
>> - EIT present/following: One single EIT p/f subtable is built per service. It is split in two sections, one for present and one for following events.
>> - EIT schedule: All EIT schedule are kept but they are completely reorganized. All events are extracted and spread over new EIT sections according to ETSI TS 101 211 rules.
>>
>> If several files are specified, the reorganization of EIT's is performed inside each file independently. This is fine as long as all EIT's for a given service are in the same input file.
>>
>> See also option **--eit-base-date**.
>>
>> Important: This option reorganizes the EIT's as they are loaded from the input file. The reorganized EIT sections are then injected and cycled without modification. If you need a dynamic EIT injection, where EIT sections evolve over time, use the plugin **eitinject**.

--eit-other

>> With **--eit-normalization**, generate all EIT other.
>>
>> Same as **--eit-other-pf --eit-other-schedule**.

--eit-other-pf

>> With **--eit-normalization**, generate EIT p/f other.
>>
>> If no EIT selection option is specified, all EIT's are generated.

--eit-other-schedule

>> With **--eit-normalization**, generate EIT schedule other.
>>
>> If no EIT selection option is specified, all EIT's are generated.

--eit-pf

>> With **--eit-normalization**, generate all EIT p/f.
>>
>> Same as **--eit-actual-pf --eit-other-pf**.

--eit-schedule

>> With **--eit-normalization**, generate all EIT schedule.
>>
>> Same as **--eit-actual-schedule --eit-other-schedule**.

--europe

>> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

-e *value*
--evaluate-interval *value*

> When used with **--replace** and when specific repetition rates are specified for some input files, the bitrate of the target PID is re-evaluated on a regular basis. The value of this option specifies the number of packet in the target PID before re-evaluating its bitrate. The default is 100 packets.

-f
--force-crc

> Force recomputation of CRC32 in long sections. Ignore CRC32 values in input file.

-i *value*
--inter-packet *value*

> Specifies the packet interval for the new PID, that is to say the number of TS packets in the transport between two packets of the new PID. Use instead of **--bitrate** if the global bitrate of the TS cannot be determined.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

-j
--joint-termination

> Perform a *joint termination* when section insertion is complete. Meaningful only when --repeat is specified. See the description of the **tsp** command for more details on *joint termination*.

--json

> Specify that all input files are JSON, regardless of their file name.

--pack-and-flush

> When loading a binary section file, pack incomplete tables, ignoring missing sections, and flush them. Sections are renumbered to remove any hole between sections.

> Use with care because this may create inconsistent tables.

--philippines

> A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *value*
--pid *value*

> PID of the output TS packets. This is a required parameter, there is no default value. To replace the content of an existing PID, use option **--replace**. To steal stuffing packets and create a new PID, use either option **--bitrate** or **--inter-packet**. Exactly one option **--replace**, **--bitrate** or **--inter-packet** must be specified.

--poll-files

> Poll the presence and modification date of the input files at regular intervals. When a file is created, modified or deleted, reload all files at the next section boundary and restart the injection cycles. When a file is deleted, its sections are no longer injected. If the file reappears later, its sections will be injected again.

> By default, all input files are loaded once at initialization time and an error is generated if a file is missing.

--repeat *count*

> Repeat the insertion of a complete cycle of sections the specified number of times.

By default, the sections are infinitely repeated.

-r
--replace

Replace the content of an existing PID. Do not steal stuffing.

-s
--stuffing

Insert stuffing at end of each section, up to the next TS packet boundary. By default, sections are packed and start in the middle of a TS packet, after the previous section. Note, however, that section headers are never scattered over a packet boundary.

-t
--terminate

Terminate packet processing when section insertion is complete. Meaningful only when **--repeat** is specified. By default, when section insertion is complete, the transmission continues and the stuffing is no longer modified (if **--replace** is specified, the PID is then replaced by stuffing).

--xml

Specify that all input files are XML, regardless of their file name.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

■ ip (input)

UDP/IP unicast or multicast input

This input plugin receives TS packets from UDP/IP, multicast or unicast.

The received UDP datagrams are analyzed and all TS packets are extracted. Optional extra data at the beginning of the datagram (such as RTP headers) are discarded.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Input timestamps

When the input is an RTP stream, the RTP timestamp value is used as input timestamp by **tsp**.

On Linux systems, the kernel reports a system timestamp for each UDP datagram. This value is used as input timestamp by **tsp** for all TS packets in the UDP datagram.

Usage

```
tsp -I ip [options] [[source@]address:]port
```

Parameter

The parameter [*address:*]*port* describes the destination of UDP packets to receive. The *port* part is mandatory and specifies the UDP port to listen on. The *address* part is optional. It specifies an IP multicast address to listen on. It can be also a host name that translates to a multicast address.

An optional source address can be specified as *source@address:port* in the case of source-specific multicast (SSM).

If the address is not specified, the plugin simply listens on the specified local port and receives the packets which are sent to one of the local (unicast) IP addresses of the system.

UDP reception options

-b *value*
--buffer-size *value*

Specify the UDP socket receive buffer size in bytes (socket option).

--default-interface

Let the system find the appropriate local interface on which to listen. By default, listen on all local interfaces.

--disable-multicast-loop

Disable multicast loopback.

By default, incoming multicast packets are looped back on local interfaces, if an application sends packets to the same group from the same system. This option disables this.

Warning: On input sockets, this option is effective only on Windows systems. On Unix systems (Linux, macOS, BSD), this option applies only to output sockets.

-f
--first-source

Filter UDP packets based on the source address. Use the sender address of the first received packet as only allowed source.

This option is useful when several sources send packets to the same destination address and port. Accepting all packets could result in a corrupted stream and only one sender shall be accepted.

To allow a more precise selection of the sender, use option **--source**. Options **--first-source** and **--source** are mutually exclusive.

-l *address*
--local-address *address*

> Specify the IP address of the local interface on which to listen. It can be also a host name that translates to a local address. By default, listen on all local interfaces.

--no-reuse-port

> Disable the reuse port socket option. Do not use unless completely necessary.

--receive-timeout *value*

> Specify the UDP reception timeout in milliseconds. This timeout applies to each receive operation, individually. By default, receive operations wait for data, possibly forever.

-r
--reuse-port

> Set the reuse port socket option. This is now enabled by default, the option is present for legacy only.

-s *address[:port]*
--source *address[:port]*

> Filter UDP packets based on the specified source address.
>
> This option is useful when several sources send packets to the same destination address and port. Accepting all packets could result in a corrupted stream and only one sender shall be accepted.
>
> Options **--first-source** and **--source** are mutually exclusive.

--ssm

> This option forces the usage of source-specific multicast (SSM) using the source address which is specified by the option **--source**. Without **--ssm**, standard ("any-source") multicast is used and the option **--source** is used to filter incoming packets.
>
> The **--ssm** option is implicit when the classical SSM syntax *source@address:port* is used.

Other options

-d *value*
--display-interval *value*

> Specify the interval in seconds between two displays of the evaluated real-time input bitrate. The default is to never display the bitrate. This option is ignored if **--evaluation-interval** is not specified.

-e *value*
--evaluation-interval *value*

> Specify that the real-time input bitrate shall be evaluated on a regular basis. The value specifies the number of seconds between two evaluations. By default, the real-time input bitrate is never evaluated and the input bitrate is evaluated from the PCR in the input packets.

--timestamp-priority *name*

> Specify how the input timestamp of each packet is computed.
>
> The name specifies an ordered list of timestamp sources. The first available timestamp value is used as input timestamp. The name must be one of **rtp-kernel-tsp**, **kernel-rtp-tsp**, **kernel-tsp**, **rtp-tsp**, **tsp**.
>
> The possible timestamp sources are:

- **rtp**: The RTP time stamp, when the UDP packet is an RTP packet.
- **kernel**: A kernel-provided timestamp for the packet, when available (Linux only).
- **tsp**: A software timestamp, provided by tsp when the input plugin returns a chunk of packets. The tsp-provided timestamp is always available, always comes last and is less precise.

The default is **rtp-kernel-tsp**.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

Display plugin help text.

▣ ip (output)

UDP/IP unicast or multicast output

This output plugin sends TS packets using UDP/IP, multicast or unicast.

Each UDP datagram is filled with one or more TS packets (see option **--packet-burst**). By default, the datagrams contain TS packets without any extra information or encapsulation. Use the option **--rtp** to generate RTP datagrams.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Usage

```
tsp -O ip [options] address:port
```

Parameter

The parameter **address:port** describes the destination for UDP packets. The **address** specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The **port** specifies the destination UDP port.

Options

-e
--enforce-burst

Enforce that the number of TS packets per UDP packet is exactly what is specified in option **--packet-burst**. By default, this is only a maximum value.

For instance, without **--enforce-burst** and the default **--packet-burst** value (7 packets), if the output plugin receives 16 TS packets, it immediately sends 3 UDP packets containing 7, 7 and 2 TS packets respectively.

With option **--enforce-burst**, only the first 14 TS packets would be sent, using 2 UDP packets. The remaining 2 TS packets are buffered, delaying their departure until 5 more TS packets are available.

-p *value*
--packet-burst *value*

Specifies the maximum number of TS packets to be grouped into each UDP datagram.

The default is 7, the maximum is 128.

--rs204

Use a 204-byte format for TS packets in UDP datagrams. Each TS packet is followed by a zeroed placeholder for a 16-byte Reed-Solomon FEC.

This format is meaningful for modulators only, but some tools also require or allow it in UDP datagrams.

IP options

-b *value*
--buffer-size *value*

Specify the UDP socket send buffer size in bytes (socket option). The actual impact depends on the operating system. Be sure to check the specificities of your system.

-d
--disable-multicast-loop

Disable multicast loopback.

By default, outgoing multicast packets are looped back on local interfaces, if an application added membership on the same multicast group. This option disables this.

Warning: On output sockets, this option is effective only on Unix systems (Linux, macOS, BSD). On Windows systems, this option applies only to input sockets.

-f
--force-local-multicast-outgoing

When the destination is a multicast address and **--local-address** is specified, this option forces the multicast outgoing traffic on this local interface (using the socket option **IP_MULTICAST_IF**).

Use this option with care. Its usage depends on the operating system. If no route is declared at system level for the multicast destination address, this option may be necessary to force the multicast to the specified local interface. On the other hand, if a route is declared, this option may transport multicast IP packets in unicast Ethernet frames to the gateway, preventing multicast reception on the local network (this has been seen on Linux).

-l *address*
--local-address *address*

When the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--local-port *value*

Specify the local UDP source port for outgoing packets.

By default, a random source port is used.

-s *value*
--tos *value*

Specifies the TOS (Type-Of-Service) socket option. Depending on the specified value or on the operating system, this option may require privileges or may even have no effect at all.

-t *value*
--ttl *value*

Specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address.

Warning: Remember than the default Multicast TTL is 1 on most systems.

RTP options

-r
--rtp

Use the Real-time Transport Protocol (RTP) in output UDP datagrams.

By default, TS packets are sent in UDP datagrams without encapsulation.

--payload-type *value*

With **--rtp**, specify the payload type.

By default, use 33, the standard RTP type for MPEG2-TS. Do not modify unless there is a good reason to do so.

--pcr-pid *value*

With **--rtp**, specify the PID containing the PCR's which are used as reference for RTP timestamps.

By default, use the first PID containing PCR's.

--ssrc-identifier *value*

With **--rtp**, specify the SSRC identifier.

By default, use a random value. Do not modify unless there is a good reason to do so.

--start-sequence-number *value*

With **--rtp**, specify the initial sequence number.

By default, use a random value. Do not modify unless there is a good reason to do so.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

Display plugin help text.

⊞ ip (packet processing)

UDP/IP unicast or multicast output and pass to next plugin

This plugin sends TS packets using UDP/IP, multicast or unicast and passes them to the next plugin in the chain.

This is a convenience to send an intermediate state of the stream over UDP without using the **fork** plugin. The options are the same as the **ip** output plugin, except **--enforce-burst** which is not present. In packet processing plugins, TS packets are processed one by one. To avoid a suboptimal usage of the UDP datagrams, burst is always enforced in this plugin.

Each UDP datagram is filled with one or more TS packets (see option **--packet-burst**). By default, the datagrams contain TS packets without any extra information or encapsulation. Use the option **--rtp** to generate RTP datagrams.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Usage

```
tsp -O ip [options] address:port
```

Parameter

> The parameter **address:port** describes the destination for UDP packets. The **address** specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The **port** specifies the destination UDP port.

Options

> **-p** *value*
> **--packet-burst** *value*
>
> > Specifies the maximum number of TS packets to be grouped into each UDP datagram.
> >
> > The default is 7, the maximum is 128.
>
> **--rs204**
>
> > Use a 204-byte format for TS packets in UDP datagrams. Each TS packet is followed by a zeroed placeholder for a 16-byte Reed-Solomon FEC.
> >
> > This format is meaningful for modulators only, but some tools also require or allow it in UDP datagrams.

IP options

> **-b** *value*
> **--buffer-size** *value*
>
> > Specify the UDP socket send buffer size in bytes (socket option). The actual impact depends on the operating system. Be sure to check the specificities of your system.
>
> **-d**
> **--disable-multicast-loop**
>
> > Disable multicast loopback.
> >
> > By default, outgoing multicast packets are looped back on local interfaces, if an application added membership on the same multicast group. This option disables this.
> >
> > **Warning:** On output sockets, this option is effective only on Unix systems (Linux, macOS, BSD). On Windows systems, this option applies only to input sockets.

-f
--force-local-multicast-outgoing

> When the destination is a multicast address and **--local-address** is specified, this option forces the multicast outgoing traffic on this local interface (using the socket option **IP_MULTICAST_IF**).

> Use this option with care. Its usage depends on the operating system. If no route is declared at system level for the multicast destination address, this option may be necessary to force the multicast to the specified local interface. On the other hand, if a route is declared, this option may transport multicast IP packets in unicast Ethernet frames to the gateway, preventing multicast reception on the local network (this has been seen on Linux).

-l *address*
--local-address *address*

> When the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--local-port *value*

> Specify the local UDP source port for outgoing packets.

> By default, a random source port is used.

-s *value*
--tos *value*

> Specifies the TOS (Type-Of-Service) socket option. Depending on the specified value or on the operating system, this option may require privileges or may even have no effect at all.

-t *value*
--ttl *value*

> Specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address.

> Warning: Remember than the default Multicast TTL is 1 on most systems.

RTP options

-r
--rtp

> Use the Real-time Transport Protocol (RTP) in output UDP datagrams.

> By default, TS packets are sent in UDP datagrams without encapsulation.

--payload-type *value*

> With **--rtp**, specify the payload type.

> By default, use 33, the standard RTP type for MPEG2-TS. Do not modify unless there is a good reason to do so.

--pcr-pid *value*

> With **--rtp**, specify the PID containing the PCR's which are used as reference for RTP timestamps.

> By default, use the first PID containing PCR's.

--ssrc-identifier *value*

> With **--rtp**, specify the SSRC identifier.

> By default, use a random value. Do not modify unless there is a good reason to do so.

--start-sequence-number *value*

> With **--rtp**, specify the initial sequence number.

By default, use a random value. Do not modify unless there is a good reason to do so.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

Display plugin help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪▪ limit

Limit the global bitrate by dropping packets

This plugin limits the global bitrate of the transport stream. Packets are dropped when necessary to maintain the overall bitrate below a given maximum. The bitrate is computed from PCR's (the default) or from the processing wall clock time.

Packets are not dropped randomly. Some packets are more likely to be dropped than others. When the bitrate exceeds the maximum, the number of packets in excess is permanently recomputed. The type of packets to drop depends on the number of packets in excess. There are several thresholds which are specified by the corresponding options:

- Below **--threshold1**, only null packets are dropped.
- Below **--threshold2**, if **--pid** options are specified, video packets from the specified PID's are dropped (except packets containing a PUSI or a PCR).
- Below **--threshold3**, if **--pid** options are specified, all packets (not only video) from the specified PID's are dropped (except packets containing a PUSI or a PCR).
- Below **--threshold4**, packets from any video or audio PID are dropped (except packets containing a PUSI or a PCR).
- Above the last threshold, any packet can be dropped.

Note: All thresholds, except the last one, can be disabled using a zero value.

Usage

```
tsp -P limit [options]
```

Options

-b *value*
--bitrate *value*

> Limit the overall bitrate of the transport stream to the specified value in bits/second. This is a mandatory option, there is no default.
>
> See section 2.2 for more details on the representation of bitrates.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

> Specify PID's the content of which can be dropped when the maximum bitrate is exceeded. Several **--pid** options can be specified.

-1 *value*
--threshold1 *value*

> Specify the first threshold for the number of packets in excess. The default is 10 packets.

-2 *value*
--threshold2 *value*

> Specify the second threshold for the number of packets in excess. The default is 100 packets.

-3 *value*
--threshold3 *value*

> Specify the third threshold for the number of packets in excess. The default is 500 packets.

-4 *value*
--threshold4 *value*

> Specify the fourth threshold for the number of packets in excess. The default is 1000 packets.

-w
--wall-clock

> Compute bitrates based on real wall-clock time. The option is meaningful with live streams only.
> By default, compute bitrates based on PCR's.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are
> transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

▦ memory (input)

Direct memory input from an application

This input plugin receives TS packets from the calling application using memory buffers.

This is a developer plugin. It is useful only to C++, Java or Python developers who run an instance of **TSProcessor** pipeline inside their applications and want this application to directly interact with the input of the pipeline. Using this plugin in a **tsp** command line does nothing.

In practice, this plugin is useful to Java and Python developers only since it is not possible to develop TSDuck plugins in these languages. To develop some custom form of transport stream input, C++ developers should rather develop their own input plugin. This is simpler and more efficient than handling input events for the **memory** plugin.

Developers may start from the sample code which is available for the three languages in the TSDuck source code tree in the directory **sample/sample-memory-plugins**.

Principle of operation

Each time the **memory** input plugin needs to receive TS packets, it signals an event. The application shall register an event handler which handles this event and waits for input packets as long as necessary. When input packets are available, the event handler returns them to the **memory** plugin.

The way an event handler returns data to the plugin depends on the language:

- In C++, the event data is an instance of **PluginEventData** pointing to the input buffer. The event handler shall return TS packets in this buffer.
- In Java, the event handler shall pass a **byte[]** containing the TS packets to the method **setOutputData()** of the **PluginEventContext**.
- In Python, the event handler shall return a **bytearray** containing the TS packets.

Returning zero packet (or not handling the event at all) means end if input.

Usage

```
tsp -I memory [options]
```

Options

-e *value*
--event-code *value*

Event code of the plugin event which is signalled each time the plugin needs input packets.

The default is zero.

Specifying a non-default value is necessary only when the application registers its input event handler *by event code value*. If the application registers its event handler *by plugin type* (here for input plugins), it is not necessary to specify an event code value.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

Display plugin help text.

▪ memory (output)

Direct memory output to an application

This output plugin sends TS packets to the calling application using memory buffers.

This is a developer plugin. It is useful only to C++, Java or Python developers who run an instance of **TSProcessor** pipeline inside their applications and want this application to directly interact with the output of the pipeline. Using this plugin in a **tsp** command line does nothing.

In practice, this plugin is useful to Java and Python developers only since it is not possible to develop TSDuck plugins in these languages. To develop some custom form of transport stream output, C++ developers should rather develop their own output plugin. This is simpler and more efficient than handling output events for the **memory** plugin.

Developers may start from the sample code which is available for the three languages in the TSDuck source code tree in the directory **sample/sample-memory-plugins**.

Principle of operation

Each time the **memory** output plugin needs to send TS packets, it signals an event. The application shall register an event handler which handles this event. The TS packets to output are referenced by the event data.

- In C++, the event data is an instance of **PluginEventData** pointing to the output TS packets. To abort the transmission, the event handler shall set the error indicator in the event data.
- In Java, the event handler receives the TS packets in the event data array of **bytes**. To abort the transmission, the event handler shall return **false**.
- In Python, the event handler receives the TS packets in the event data **bytearray**. To abort the transmission, the event handler shall return **False**.

Usage

```
tsp -O memory [options]
```

Options

-e *value*
--event-code *value*

Event code of the plugin event which is signalled each time the plugin outputs packets.

The default is zero.

Specifying a non-default value is necessary only when the application registers its output event handler *by event code value*. If the application registers its event handler *by plugin type* (here for output plugins), it is not necessary to specify an event code value.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

Display plugin help text.

⠿ merge

Merge TS packets coming from the standard output of a command

This plugin creates a process. The process is expected to write TS packets on its standard output. The resulting transport stream is merged with the main transport stream which is processed by **tsp** and the chain of plugins.

As usual with **tsp** plugins, the TS packets which come from the merged transport stream are inserted into the main transport stream by replacing stuffing packets. The obvious requirement is that the stuffing bitrate of the main stream is greater than the overall bitrate of the merged stream. Otherwise, it wouldn't fit in the main transport steam.

Typically (although not required), the created process is another **tsp** command which prepares the merged transport stream. Preparing the transport stream may include reducing the bitrate by removing stuffing and services, remapping PID's or renaming services which could conflict with existing PID's or services in the other transport stream.

By default, the following operations are performed while merging transport streams. These defaults can be changed using appropriate options.

- The PAT and SDT from the merged transport stream are merged into the corresponding tables in the main transport stream. The merged services are consequently correctly referenced in the main transport stream.

  More precisely, the PAT and SDT tables in the main transport stream are modified to include all services from the merged stream. The original PAT and SDT PID's from the merged stream are nullified.

- Similarly, the CAT is also merged so that EMM PID's from the merged transport stream are correctly referenced in the main transport stream.

  Warning: The CAT is an optional table, and the **merge** plugin will not create one if there is none. If you want to make sure that a merged CAT will be present, use an instance of the **cat** plugin before **merge**.

- The EIT sections from the two transport streams are merged. Unlike PAT, SDT and CAT, the EIT sections are left unmodified. The EIT sections from the two streams are interspersed into one larger EIT PID.

- The PID's **0x00** to **0x1F** are dropped from the merged transport stream. These PID's contain the base PSI/SI which are normally present in all transport streams. Merging these PID's would create conflicts. Instead, the most important PSI/SI tables are correctly merged as previously described (unless **--no-psi-merge** is used).

  All other PID's are passed. This can be modified using options **--drop** and **--pass**.

- PID conflicts are detected. If packets from the same PID are found in the two transport streams, the PID is dropped from the merged stream.

- In packets coming from the merged transport stream, the PCR's are restamped according to their new placement in the main transport stream.

Usage

```
tsp -P merge [options] 'command'
```

Parameter

The command parameter specifies the shell command to execute in the forked process. The standard output of this process is a pipe into which the TS packets are written. If the command contains spaces or shell special sequences, the complete command string must be surrounded by quotes.

If the command is too long or too complicated, it is recommended to use a script. If the created command is another TSDuck command, it is possible to shorten the command using partial command line redirection (see 3.1.5).

Options

--acceleration-threshold *value*

When the insertion of the merged stream is smoothened, packets are inserted in the main stream at some regular interval, leaving additional packets in the queue until their natural insertion point. However, to avoid losing packets, if the number of packets in the queue is above the specified threshold, the insertion is accelerated.

When set to zero, insertion is never accelerated, the packet queue may overflow, and packets may be dropped.

The default threshold is half the size of the packet queue. See option **--max-queue**.

-b *value*
--bitrate *value*

Specify the target bitrate of the merged stream, in bits/seconds.

By default, the bitrate of the merged stream is computed from its PCR.

The value of the bitrate of the merged stream is used to smoothen packet insertion in the main stream.

-d *pid*[*-pid*]
--drop *pid*[*-pid*]

Drop the specified PID or range of PID's from the merged stream. Several options **--drop** can be specified.

-f *name*
--format *name*

Specify the format of the input stream which comes from the created process. See section 2.1.2 for more details.

-i
--ignore-conflicts

Ignore PID conflicts. By default, when packets with the same PID are present in the two streams, the PID is dropped from the merged stream.

Warning: this is a dangerous option which can result in an inconsistent transport stream.

--incremental-pcr-restamp

When restamping PCR's from the merged TS into the main TS, compute each new PCR from the last restampted one.

By default, all PCR's are restampted from the initial PCR in the PID.

The default method is more precise on constant bitrate (CBR) streams. The incremental method gives better results on variable bitrate (VBR) streams.

See also option **--no-pcr-restamp**.

-j
--joint-termination

>   Perform a *joint termination* when the merged stream is terminated. See the description of the `tsp` command for more details on *joint termination*.

-m *value*
--max-queue *value*

>   Specify the maximum number of queued TS packets before their insertion into the stream. The default is 1000.

--no-pcr-restamp

>   Do not restamp PCR's from the merged TS into the main TS. By default, PCR's in the merged stream are restamped to match their position in the final stream.

>   The DTS and PTS are never restamped because they are independent from their position in the stream. When the PCR's in the merged stream have discontinuities (such as when cycling a TS file), restamping the PCR's can break the video playout since they become decorrelated with the DTS and PTS.

--no-psi-merge

>   Do not merge PSI/SI from the merged TS into the main TS. By default, the PAT, CAT, SDT and EIT's are merged so that the services from the merged stream are properly referenced and PID's **0x00** to **0x1F** are dropped from the merged stream.

--no-smoothing

>   Do not attempt to smoothen the insertion of the merged stream. Incoming packets from the merged stream are inserted as soon as null packets are available in the main stream. If the main stream contains a lot of null packets, this may lead to bursts in the merged packets.

>   By default, if the bitrate of the merged stream is known, the merged packets are inserted at the target interval in the main stream.

--no-wait

>   Do not wait for child process termination at end of processing.

-p *pid*[*-pid*]
--pass *pid*[*-pid*]

>   Pass the specified PID or range of PID's from the merged stream. Several options **--pass** can be specified.

--pcr-reset-backwards

>   When restamping PCR's, the PCR adjustment is usually small and stays behind the PTS and DTS. But, after hours of continuous restamping, some inaccuracy may appear and the recomputed PCR may move ahead of PCR and DTS. This prevents proper decoding of video and audio.

>   With this option, as soon as a recomputed PCR is ahead of the PTS or DTS in the same packet, PCR restamping is reset and restarts from the original PCR value in this packet. Note that this creates a small PCR leap in the stream.

>   This option has, of course, no effect on scrambled streams.

--reset-label *label1*[*-label2*]

>   Clear the specified labels on the merged packets. Apply to original packets from the merged stream only, not to updated PSI packets.

>   Several **--reset-label** options may be specified.

-r
--restart

>   Restart the merge command whenever it terminates or fails.

>   By default, when packet insertion is complete, the transmission continues and the stuffing is no
>   longer modified.

>   The options **--restart** and **--terminate** are mutually exclusive.

--restart-interval *milliseconds*

>   With **--restart**, specify the number of milliseconds to wait before restarting the merge
>   command.

>   By default, with **--restart**, the merge command is restarted immediately after termination.

--set-label *label1*[-*label2*]

>   Set the specified labels on the merged packets. Apply to original packets from the merged
>   stream only, not to updated PSI packets.

>   Several **--set-label** options may be specified.

--terminate

>   Terminate packet processing when the merged stream is terminated. By default, when packet
>   insertion is complete, the transmission continues, and the stuffing is no longer modified.

>   The options **--restart** and **--terminate** are mutually exclusive.

-t
--transparent

>   Pass all PID's without logical transformation.

>   Equivalent to **--no-psi-merge --ignore-conflicts --pass 0x00-0x1F**.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

>   Display this help text.

--only-label *label1*[-*label2*]

>   Invoke this plugin only for packets with any of the specified labels. Other packets are
>   transparently passed to the next plugin, without going through this one.

>   Several **--only-label** options may be specified.

⊞ mpe

Extract MPE (Multi-Protocol Encapsulation) datagrams

This plugin extracts MPE (Multi-Protocol Encapsulation) datagrams from one or more PID's. The extracted datagrams can be either forwarded on the local network, saved in a binary file or simply logged for monitoring. See [14] for more details on MPE.

The extracted datagrams must be valid UDP/IP datagrams. Otherwise, they are ignored. When saved in a binary file or forwarded on the network, only the UDP payload is used. The original IP and UDP headers are dropped.

If the extracted datagrams are forwarded on the local network, it is recommended to activate the real-time defaults of **tsp** using the option **--realtime** (see the reference documentation for **tsp**).

Usage

```
tsp -P mpe [options]
```

General options

-m *value*
--max-datagram *value*

> Specify the maximum number of datagrams to extract, then stop. By default, all datagrams are extracted.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

> Extract MPE datagrams from these PID's. Several **-p** or **--pid** options may be specified. When no PID is specified, use all PID's carrying MPE which are properly declared in the signalization.

MPE filtering options

-d *address*[**:***port*]
--destination *address*[**:***port*]

> Filter MPE UDP datagrams based on the specified destination IP address.

--net-size *value*

> Specify the exact size in bytes of the complete network datagrams to filter, including IP headers.
>
> This option is incompatible with **--min-net-size** and **--max-net-size**.

--min-net-size *value*

> Specify the minimum size in bytes of the complete network datagrams to filter.

--max-net-size *value*

> Specify the maximum size in bytes of the complete network datagrams to filter.

-s *address*[**:***port*]
--source *address*[**:***port*]

> Filter MPE UDP datagrams based on the specified source IP address.

--udp-size *value*

> Specify the exact size in bytes of the UDP datagrams to filter.
>
> This option is incompatible with **--min-udp-size** and **--max-udp-size**.

--min-udp-size *value*

> Specify the minimum size in bytes of the UDP datagrams to filter.

--max-udp-size *value*

    Specify the maximum size in bytes of the UDP datagrams to filter.

Display options

--dump-datagram

    With **--log** or **--log-hexa-line**, dump each complete network datagram.

--dump-max *value*

    With **--dump-datagram**, **--dump-udp** or **--log-hexa-line**, specify the maximum number of bytes to dump. By default, dump everything.

--dump-udp

    With **--log** or **--log-hexa-line**, dump the UDP payload of each network datagram.

-l
--log

    Log all MPE datagrams using a short summary for each of them.

--log-hexa-line[='*prefix*']

    Same as **--log** but log the full content of each datagram as one single hexadecimal line in the message logger. Dump either the full datagram (the default) or the UDP payload (with **--dump-udp**).

    The optional string parameter specifies a prefix to prepend on the log line before the hexadecimal text to facilitate the filtering of the appropriate line in the logs.

--skip *value*

    With **--output-file**, **--dump-datagram**, **--dump-udp** or **--log-hexa-line**, specify the initial number of bytes to skip. By default, save or dump from the beginning.

--sync-layout

    With **--log**, display the layout of **0x47** sync bytes in the UDP payload.

Save options

-a
--append

    With **--output-file**, if the file already exists, append to the end of the file. By default, existing files are overwritten.

-o *filename*
--output-file *filename*

    Specify that the extracted UDP datagrams are saved in this file. The UDP messages are written without any encapsulation.

UDP forwarding options

--local-address *address*

    With **--udp-forward**, specify the IP address of the outgoing local interface for multicast traffic. It can be also a host name that translates to a local address.

--local-port *value*

    With **--udp-forward**, specify the local UDP source port for outgoing packets.

    By default, a random source port is used.

-r *address*[**:***port*]
--redirect *address*[**:***port*]

> With **--udp-forward**, redirect all UDP datagrams to the specified socket address.
>
> By default, all datagram are forwarded to their original destination address. If you specify a redirected address, it is recommended to use **--destination** to filter a specific stream.
>
> If the port is not specified, the original destination port from the MPE datagram is used.

--ttl *value*

> With **--udp-forward**, specify the TTL (Time-To-Live) socket option.
>
> The actual option is either *Unicast TTL* or *Multicast TTL*, depending on the destination address.
>
> By default, use the same TTL as specified in the received MPE encapsulated datagram.

-u
--udp-forward

> Forward all received MPE encapsulated UDP datagrams on the local network.
>
> By default, the destination address and port of each datagram is left unchanged. The source address of the forwarded datagrams will be the address of the local machine.

Developers options

The following options are reserved to C++, Java or Python developers. They are useful only when the plugin is used inside a custom application.

--event-code *value*

> Signal a plugin event with the specified code for each MPE packet.
>
> The event data is an instance of **PluginEventData** pointing to the network datagram (default) or the UDP payload (with **--dump-udp**).

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[**-***label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

❚❚ mpeinject

Inject an incoming UDP stream into MPE (Multi-Protocol Encapsulation)

This plugin receives UDP datagrams from the local network, encapsulates them and inserts them in an MPE (Multi-Protocol Encapsulation) PID. See [14] for more details on MPE.

By default, the inserted PID containing MPE sections replaces null packets.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Usage

```
tsp -P mpeinject [options] [[source@]address:]port ...
```

Parameter

The parameter **[address:]port** describes the destination of incoming UDP datagrams. All datagrams which are received on this stream will be MPE-encapsulated.

The **port** part is mandatory and specifies the UDP port to listen on. The **address** part is optional. It specifies an IP multicast address to listen on. It can be also a host name that translates to a multicast address.

An optional source address can be specified as **source@address:port** in the case of source-specific multicast (SSM).

If the address is not specified, the plugin simply listens on the specified local port and receives the packets which are sent to one of the local (unicast) IP addresses of the system.

Several **[address:]port** parameters can be specified to receive multiple UDP streams. All UDP streams are multiplexed in the same output MPE PID.

Warning: when several **[address:]port** parameters are specified with the same **port** value, this may work or not, depending on the operating system.

UDP reception options

These options apply to the incoming UDP/IP stream from the local network.

-b *value*
--buffer-size *value*

Specify the UDP socket receive buffer size in bytes (socket option).

--default-interface

Let the system find the appropriate local interface on which to listen. By default, listen on all local interfaces.

--disable-multicast-loop

Disable multicast loopback.

By default, incoming multicast packets are looped back on local interfaces, if an application sends packets to the same group from the same system. This option disables this.

Warning: On input sockets, this option is effective only on Windows systems. On Unix systems (Linux, macOS, BSD), this option applies only to output sockets.

-f
--first-source

Filter UDP packets based on the source address. Use the sender address of the first received packet as only allowed source.

This option is useful when several sources send packets to the same destination address and port. Accepting all packets could result in a corrupted stream and only one sender shall be accepted.

To allow a more precise selection of the sender, use option **--source**. Options **--first-source** and **--source** are mutually exclusive.

-l *address*
--local-address *address*

Specify the IP address of the local interface on which to listen. It can be also a host name that translates to a local address.

If several **[address:]port** parameters are specified, several **--local-address** options can be specified, one for each received stream, in the same order as the **[address:]port** parameters. If there are less **--local-address** options than receivers, the last **--local-address** option applies to remaining receivers.

By default, listen on all local interfaces.

--no-reuse-port

Disable the reuse port socket option. Do not use unless completely necessary.

--receive-timeout *value*

Specify the UDP reception timeout in milliseconds. This timeout applies to each receive operation, individually.

By default, receive operations wait for data, possibly forever.

-r
--reuse-port

Set the reuse port socket option. This is now enabled by default, the option is present for legacy only.

-s *address[:port]*
--source *address[:port]*

Filter UDP packets based on the specified source address.

This option is useful when several sources send packets to the same destination address and port. Accepting all packets could result in a corrupted stream and only one sender shall be accepted.

If several **[address:]port** parameters are specified, several **--source** options can be specified, one for each received stream, in the same order as the **[address:]port** parameters. If there are less **--source** options than receivers, the last **--source** option applies to remaining receivers.

Options **--first-source** and **--source** are mutually exclusive.

--ssm

This option forces the usage of source-specific multicast (SSM) using the source address which is specified by the option **--source**. Without **--ssm**, standard ("any-source') multicast is used and the option **--source** is used to filter incoming packets.

The **--ssm** option is implicit when the classical SSM syntax *source@address:port* is used.

MPE encapsulation options

These options specify how the incoming UDP datagrams are encapsulated into MPE sections.

--mac-address *nn:nn:nn:nn:nn:nn*

Specify the default destination MAC address to set in MPE sections for unicast IP packets. The default is `00:00:00:00:00:00`.

For multicast IP packets, the MAC address is automatically computed.

--new-destination *address[:port]*

Change the destination IP address and UDP port of the network datagram in MPE sections. If the port is not specified, the original destination port from the UDP datagram is used.

If several **[address:]port** parameters are specified, several **--new-destination** options can be specified, one for each received stream, in the same order as the **[address:]port** parameters. If there are less **--new-destination** options than receivers, the last **--new-destination** option applies to remaining receivers.

By default, the destination address is not modified.

--new-source *address[:port]*

Change the source IP address and UDP port of the network datagram in MPE sections. If the port is not specified, the original source port from the UDP datagram is used.

If several **[address:]port** parameters are specified, several **--new-source** options can be specified, one for each received stream, in the same order as the **[address:]port** parameters. If there are less **--new-source** options than receivers, the last **--new-source** option applies to remaining receivers.

By default, the source address is not modified.

Other options

--max-queue *value*

Specify the maximum number of queued UDP datagrams before their insertion into the MPE stream. The default is 32.

If incoming datagrams arrive too fast and more than this number of UDP datagrams are internally buffered before having the opportunity to be inserted in the transport stream, additional datagrams are dropped and a warning message is reported.

--pack-sections

Specify to pack DSM-CC sections containing MPE datagrams. With this option, each DSM-CC section starts in the same TS packet as the previous section, when possible.

By default, the last TS packet of a DSM-CC section is stuffed and the next section starts in the next TS packet of the PID.

-p *value*
--pid *value*

Specify the PID into which the MPE datagrams shall be inserted. This is a mandatory parameter.

--replace

Replace the target PID if it exists. By default, the plugin only replaces null packets and *tsp* stops with an error if incoming packets are found with the target PID.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1[-label2]*

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⊞ mux

Inject TS packets in a transport stream

This plugin injects TS packets from a file into a transport stream, replacing packets from stuffing.

Usage

```
tsp -P mux [options] input-file
```

Parameters

input-file

>   Binary transport stream file.

Options

-b *value*
--bitrate *value*

>   Specifies the bitrate for the inserted packets, in bits/second.

>   See section 2.2 for more details on the representation of bitrates.

>   By default, all stuffing packets are replaced which means that the bitrate is neither constant nor guaranteed.

--byte-offset *value*

>   Start reading the file at the specified byte offset (default: 0).

>   This option is allowed only if the input file is a regular file.

--format *name*

>   Specify the format of the input file. See section 2.1.2 for more details.

-i *value*
--inter-packet *value*

>   Specifies the packet interval for the inserted packets, that is to say the number of TS packets in the transport between two new packets. Use instead of **--bitrate** if the global bitrate of the TS cannot be determined.

--inter-time *value*

>   Specifies the time interval for the inserted packets, that is to say the difference between the nearest PCR clock value at the point of insertion in milliseconds.

>   Example: 1000 will keep roughly 1 second space between two inserted packets. The default is 0, it means inter-time is disabled. Use **--pts-pid** to specify the PID carrying the PCR clock of interest.

-j
--joint-termination

>   Perform a *joint termination* when the file insertion is complete. See the description of the `tsp` command for more details on *joint termination*.

--max-insert-count *value*

>   Stop inserting packets after this number of packets was inserted.

--max-pts *value*

>   Stop inserting packets when this PTS time has passed in the **--pts-pid**.

--min-pts *value*

>   Start inserting packets when this PTS time has passed in the **--pts-pid**.

--no-continuity-update

> Do not update continuity counters in the inserted packets. By default, the continuity counters are updated in each inserted PID to preserve the continuity.

--no-pid-conflict-check

> Do not check PID conflicts between the TS and the new inserted packets. By default, the processing is aborted if packets from the same PID are found both in the TS and the inserted packets.

--packet-offset *value*

> Start reading the file at the specified TS packet (default: 0). This option is allowed only if the input file is a regular file.

-p *value*
--pid *value*

> Force the PID value of all inserted packets.

--pts-pid *value*

> Defines the PID carrying PCR or PTS values for **--min-pts** and **--max-pts**. When no PTS values are found, PCR are used. PCR values are divided by 300, the system clock sub-factor, to get the corresponding PTS values.

-r *count*
--repeat *count*

> Repeat the playout of the file the specified number of times. By default, the file is infinitely repeated. This option is allowed only if the input file is a regular file.

--reset-label *label1*[-*label2*]

> Clear the specified labels on the muxed packets.
>
> Several **--reset-label** options may be specified.

--set-label *label1*[-*label2*]

> Set the specified labels on the muxed packets.
>
> Several **--set-label** options may be specified.

-t
--terminate

> Terminate packet processing when the file insertion is complete. By default, when packet insertion is complete, the transmission continues and the stuffing is no longer modified.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

∷ nit

Perform various transformations on a NIT

This plugin performs various transformations on a NIT, either the NIT Actual or some specific NIT Other. The other NIT's, if present, are left unchanged.

Usage

```
tsp -P nit [options]
```

Options

--bitrate *value*

Specifies the bitrate in bits / second of the PID containing the NIT if a new one is created.

See section 2.2 for more details on the representation of bitrates.

The default is 3,000 b/s.

--build-service-list-descriptors

Build service list descriptors in the NIT according to the information which is collected in the PAT and the SDT.

See also option **--default-service-type**.

--cleanup-private-descriptors

Remove all private descriptors without preceding *private_data_specifier_descriptor*.

-c
--create

Create a new empty NIT if none was received after one second.

This is equivalent to **--create-after 1000**.

--create-after *milliseconds*

Create a new empty NIT if none was received after the specified number of milliseconds. If an actual NIT is received later, it will be used as the base for transformations instead of the empty one.

--default-service-type *value*

With **--build-service-list-descriptors**, specify the default service type of services which are found in the PAT but not in the SDT.

By default, services without known service type are not added in created service list descriptors.

-i
--increment-version

Increment the version number of the NIT.

--inter-packet *value*

When a new NIT is created and **--bitrate** is not present, this option specifies the packet interval for the NIT PID, that is to say the number of TS packets in the transport between two packets of the PID.

Use instead of **--bitrate** if the global bitrate of the TS cannot be determined.

-l *value*
--lcn *value*

Specify which operation to perform on *logical_channel_number* (LCN) descriptors. The *value* is a positive integer:

    1 : Remove all LCN descriptors.

    2 : Remove one entry every two entries in each LCN descriptor.

    3 : Duplicate one entry every two entries in each LCN descriptor.

--mpe-fec *value*

Set the *MPE-FEC_indicator* in all *terrestrial_delivery_system_descriptor*s to the specified value (0 or 1).

--network-id *id*

Set the specified new value as network id in the NIT.

--network-name *name*

Set the specified value as network name in the NIT. Any existing *network_name_descriptor* is removed. A new *network_name_descriptor* is created with the new name.

-v *value*
--new-version *value*

Specify a new value for the version of the NIT.

-o *id*
--other *id*
--nit-other *id*

Do not modify the NIT Actual. Modify the NIT Other with the specified network id.

--patch-xml *filename*

Specify an XML patch file which is applied to each NIT on the fly. The XML patches are applied first. The other options of this plugin are applied on the patched table.

If the specified name starts with "**<?xml**", it is considered as *inline XML content*, meaning that the string in the command line is directly the XML content and not a file name.

Several **--patch-xml** options can be specified. Patch files are sequentially applied on each table.

See section 2.6.4 for more details on XML patch files.

--pds *value*

With option **--remove-descriptor**, specify the private data specifier which applies to the descriptor tag values above **0x80**.

-p `value`
--pid `value`

Specify the PID on which the NIT is expected.

By default, use PID 16 (**0x0010**), as specified for DVB-compliant networks.

--remove-descriptor *value*

Remove from the NIT all descriptors with the specified tag. Several **--remove-descriptor** options may be specified to remove several types of descriptors. See also option **--pds**.

-r `value`
--remove-service `value`

Remove the specified service_id from the following descriptors: *service_list_descriptor*, *logical_channel_number_ descriptor*. Several **--remove-service** options may be specified to remove several services.

--remove-ts *value*

Remove from the NIT all references to the transport stream with the specified transport stream id value. Several **--remove-ts** options may be specified to remove several TS.

-s *value*
--sld *value*

> Specify which operation to perform on *service_list_descriptors*. The *value* is a positive integer:
>> 1 : Remove all *service_list_descriptors*.
>>
>> 2 : Remove one entry every two entries in each *service_list_descriptor*.

--time-slicing *value*

> Set the *Time_Slicing_indicator* in all *terrestrial_delivery_system_descriptor*s to the specified value (0 or 1).

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

▪ nitscan

Scan NIT for tuning information

This plugin analyzes the NIT (Network Information Table) of the transport stream and outputs a list of tuning information, one per transport. The format of the tuning information is compatible with the **dvb** input plugin.

Usage

```
tsp -P nitscan [options]
```

Options

-a
--all-nits

> Analyze all NIT's (the NIT-Actual and all NIT-Other).
>
> By default, only the NIT-Actual is analyzed.

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

-c[_prefix_**]**
--comment[=_prefix_**]**

> Add a comment line before each tuning information. The optional prefix designates the comment prefix. If the option **--comment** is present but the prefix is omitted, the default prefix is "**#** ".

--default-charset _name_

> Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.
>
> By default, standard DVB encoding is used. See section 2.5 for more details.

-d
--dvb-options

> The characteristics of each transponder are formatted as a list of command-line options for the **dvb** input plugin such as **--frequency**, **--symbol-rate**, etc.
>
> This is the default when no **--save-channels** or **--update-channels** is specified.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

-n _value_
--network-id _value_

> Specify the network-id of a NIT-Other to analyze instead of the NIT-Actual.
>
> By default, the NIT-Actual is analyzed.

-o _filename_
--output-file _filename_

> Specify the output text file for the analysis result. By default, use the standard output.
>
> Warning: if you do not specify this option, be sure to redirect the output plugin to something different from the default. Otherwise, the text output of the analysis will be mixed with the binary output of the TS packets!

--philippines

> A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *value*
--pid *value*

> Specify the PID on which the NIT is expected. By default, the PAT is analyzed to get the PID of the NIT. DVB-compliant networks should use PID **16** (**0x0010**) for the NIT and signal it in the PAT.

--save-channels *filename*

> Save the description of all transport streams in the specified XML file. See Appendix B, page 494, for more details on channels configuration files.

> If the file name is "**-**", use the default tuning configuration file.

> See also option **--update-channels**.

-t
--terminate

> Stop the packet transmission after the first NIT is analyzed. Should be specified when *tsp* is used only to scan the NIT.

--update-channels *filename*

> Update the description of all transport streams in the specified XML file. The content of each transport stream is preserved, only the tuning information is updated. If the file does not exist, it is created. See Appendix B, page 494, for more details on channels configuration files.

> If the file name is "**-**", use the default tuning configuration file.

> See also option **--save-channels**.

-v[*prefix***]**
--variable[=*prefix***]**

> Each tuning information line is output as a shell environment variable definition. The name of each variable is built from a prefix and the TS id. The default prefix is **TS** and can be changed through the optional value of the option **--variable**.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

■ null (input)

Null input packets generator

This input module generates null packets.

Usage

```
tsp -I null [options] [count]
```

Parameters

count

Specify the number of null packets to generate. After the last packet, an end-of-file condition is generated. By default, if *count* is not specified, null packets are generated endlessly.

Options

-j
--joint-termination

When the number of null packets is specified, perform a *joint termination* when completed instead of unconditional termination. See the description of the **tsp** command for more details on *joint termination*.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

Display plugin help text.

⠿ **pat**

Perform various transformations on the PAT

This plugin performs various transformations on the PAT.

Usage

```
tsp -P pat [options]
```

Options

-a *sid/pid*
--add-service *sid/pid*

> Add the specified *service_id* / *PMT-PID* in the PAT. Several **--add-service** options may be specified to add several services.

--bitrate *value*

> Specifies the bitrate in bits / second of the PID containing the PAT if a new one is created.
>
> See section 2.2 for more details on the representation of bitrates.
>
> The default is 3,000 b/s.

-c
--create

> Create a new empty PAT if none was received after one second.
>
> This is equivalent to **--create-after 1000**.

--create-after *milliseconds*

> Create a new empty PAT if none was received after the specified number of milliseconds. If an actual PAT is received later, it will be used as the base for transformations instead of the empty one.

-i
--increment-version

> Increment the version number of the PAT.

--inter-packet *value*

> When a new PAT is created and **--bitrate** is not present, this option specifies the packet interval for the PAT PID, that is to say the number of TS packets in the transport between two packets of the PID.
>
> Use instead of **--bitrate** if the global bitrate of the TS cannot be determined.

-n *pid*
--nit *pid*

> Add or modify the NIT PID in the PAT.

--patch-xml *filename*

> Specify an XML patch file which is applied to each PAT on the fly. The XML patches are applied first. The other options of this plugin are applied on the patched table.
>
> If the specified name starts with "**<?xml**", it is considered as *inline XML content*, meaning that the string in the command line is directly the XML content and not a file name.
>
> Several **--patch-xml** options can be specified. Patch files are sequentially applied on each table.
>
> See section 2.6.4 for more details on XML patch files.

-r *sid*
--remove-service *sid*

> Remove the specified *service_id* from the PAT. Several **--remove-service** options may be specified to remove several services.

-u
--remove-nit

> Remove the NIT PID from the PAT.

-t *id*
--ts-id *id*
--tsid *id*

> Specify a new value for the transport stream id in the PAT.

-v *value*
--new-version *value*

> Specify a new value for the version of the PAT.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

⋮⋮ **pattern**

Replace packet payload with a binary pattern

This plugin replaces the payload of TS packets with a binary pattern on selected PID's. The resulting packets are meaningless on an MPEG standpoint but can be used to trace packets in order to debug transport stream routing problems either inside a transmission system or inside a set-top box.

Usage

```
tsp -P pattern [options] pattern
```

Parameter

Specifies the binary pattern to apply on TS packets payload. The value must be a string of hexadecimal digits specifying any number of bytes.

Options

-n
--negate

Negate the PID filter: modify packets on all PID's, expect the specified ones.

-o *value*
--offset-non-pusi *value*

Specify starting offset in payload of packets with the PUSI (payload unit start indicator) not set.

By default, the pattern replacement starts at the beginning of the packet payload (offset 0).

-u *value*
--offset-pusi *value*

Specify starting offset in payload of packets with the PUSI (payload unit start indicator) set.

By default, the pattern replacement starts at the beginning of the packet payload (offset 0).

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

Select packets with these PID values.

Several **--pid** options may be specified to select multiple PID's.

If no such option is specified, packets from all PID's are modified.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

pcap (input)

Read TS packets from a pcap or pcap-ng file

This input plugin reads a **pcap** or **pcap-ng** file and extracts TS packets from UDP/IP captured datagrams. The UDP datagrams are analyzed and all TS packets are extracted. Optional extra data at the beginning of the datagram (such as RTP headers) are discarded.

The **pcap** or **pcap-ng** files are typically created by network analysis tools such as **tcpdump** or Wireshark. This plugin is consequently useful to analyze problems on IP/TV networks from a capture of the traffic.

To get a consistent transport stream, one single UDP stream (meaning one combination of destination IP address and UDP port) is selected and all TS packets in this UDP stream are read as input to **tsp**. The UDP stream can be selected using option **--destination**. Without this option, the first UDP stream containing TS packets is selected. This default is convenient because most network captured traffic contains many different types of packets, TCP, UDP, multicast, unicast but only a few streams, maybe only one, contain transport stream packets.

In addition to extracting a transport stream from UDP/IP multicast, this plugin can also extract TS packets from a captured EMMG/PDG ⇔ MUX DVB SimulCrypt connection. In that kind of connection, an EMM or private data generator feeds a MUX with one or more data PID's (usually EMM PID's). With **--tcp-emmg-mux** or **--udp-emmg-mux**, the plugin extract the corresponding data or EMM PID's.

Input timestamps

When the input is a captured RTP stream, the RTP timestamp value is used as input timestamp by **tsp**. Otherwise, the capture timestamp is used.

Usage

```
tsp -I pcap [options] [file-name]
```

Parameter

The optional parameter is the name of a **.pcap** or **.pcapng** capture file as produced by Wireshark for instance. This input plugin extracts IPv4 UDP datagrams which contain transport stream packets.

By default, when no file name is provided, use the standard input.

Options

-d [*address*][:*port*]
--destination [*address*][:*port*]

Filter UDP datagrams based on the specified destination socket address.

If only one of the address and port is specified, use the first UDP stream containing TS packets matching the provided criteria, address or port.

By default, use the destination of the first UDP stream containing TS packets.

Once a UDP stream is selected, either from this option or from the first UDP stream containing TS packets, only use UDP datagrams with this destination socket address.

--emmg-client-id *value*

With **--tcp-emmg-mux** or **--udp-emmg-mux**, select the EMMG ⇔ MUX *client_id* to extract.

By default, use all client ids.

--emmg-data-id *value*

With **--tcp-emmg-mux** or **--udp-emmg-mux**, select the EMMG ⇔ MUX *data_id* to extract.

By default, use all data ids.

--first-date *date-time*

Filter packets starting at the specified date.

Use format YYYY/MM/DD:hh:mm:ss.mmm.

--first-packet *value*

Filter packets starting at the specified number.

The packet numbering counts all captured packets from the beginning of the file, starting at 1. This is the same value as seen on Wireshark in the leftmost column.

--first-timestamp *micro-seconds*

Filter packets starting at the specified timestamp in micro-seconds from the beginning of the capture. This is the same value as seen on Wireshark in the "Time" column (in seconds).

-h
--http

Select a TCP stream in the pcap file using the HTTP protocol and extract TS packets from the response. To some extent, it also works with RTSP sessions.

The **--source** and **--destination** options define the TCP stream. At least one of the two shall be defined. If some address or port are undefined in these two options, the first TCP stream matching the specified portions is selected.

--last-date *date-time*

Filter packets up to the specified date.

Use format YYYY/MM/DD:hh:mm:ss.mmm.

--last-packet *value*

Filter packets up to the specified number.

The packet numbering counts all captured packets from the beginning of the file, starting at 1. This is the same value as seen on Wireshark in the leftmost column.

--last-timestamp *micro-seconds*

Filter packets up to the specified timestamp in micro-seconds from the beginning of the capture. This is the same value as seen on Wireshark in the "Time" column (in seconds).

-m
--multicast-only

When there is no **--destination** option, select the first multicast address which is found in a UDP datagram containing TS packets.

By default, use the destination address of the first UDP datagram containing TS packets, unicast or multicast.

-s [*address*][:*port*]
--source [*address*][:*port*]

Filter UDP datagrams based on the specified source socket address.

By default, do not filter on source address.

--tcp-emmg-mux

Select a TCP stream in the pcap file using the DVB SimulCrypt EMMG/PDG ⇔ MUX protocol.

The transport stream is made of the TS packets from the *data_provision* messages (the session must have been set in packet mode, not in section mode).

This option is typically used to extract EMM PID's as produced by a standard EMMG which feeds a MUX.

The **--source** and **--destination** options define the TCP stream. If some address or port are undefined in these two options, the first TCP stream matching the specified portions is selected.

--timestamp-priority *name*

Specify how the input timestamp of each packet is computed.

The name specifies an ordered list of timestamp sources. The first available timestamp value is used as input timestamp. The name must be one of **rtp-pcap-tsp**, **pcap-rtp-tsp**, **pcap-tsp**, **rtp-tsp**, **tsp**.

The possible timestamp sources are:

- **rtp**: The RTP time stamp, when the UDP packet is an RTP packet.
- **pcap**: pcap capture time stamp.
- **tsp**: A software timestamp, provided by tsp when the input plugin returns a chunk of packets. The tsp-provided timestamp is always available, always comes last and is less precise.

The default is **rtp-pcap-tsp**.

--udp-emmg-mux

Consider each selected UDP datagram as containing a *data_provision* message as defined by the DVB SimulCrypt EMMG/PDG ⇔ MUX protocol. The transport stream is made of the TS packets from these *data_provision* messages (the session must have been set in packet mode, not in section mode).

This option is typically used to extract EMM PID's as produced by a standard EMMG which feeds a MUX.

By default, the UDP datagrams contain raw TS packets, with or without RTP headers.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

Display plugin help text.

pcradjust

Adjust PCR's according to a constant bitrate

This plugin recomputes all PCR values, assuming that the transport stream has a constant bitrate.

In the general case, it is impossible to recompute PCR values in non-real-time streams with a variable bitrate because the instant bitrate is usually computed according to the PCR values which are found in the stream, hence assuming that these PCR values are correct and do not need any adjustment.

In each PID, the first PCR is left unmodified and all others are recomputed according to the constant bitrate and the distance between packets.

Usage

```
tsp -P pcradjust [options]
```

Options

-b value
--bitrate value

Specify a constant bitrate for the transport stream. The PCR values will be adjusted according to this bitrate.

See section 2.2 for more details on the representation of bitrates.

By default, use the input bitrate as reported by the input device or a previous plugin.

--ignore-dts

Do not modify DTS (decoding time stamps) values.

By default, the DTS are modified according to the PCR adjustment.

--ignore-pts

Do not modify PTS (presentation time stamps) values.

By default, the PTS are modified according to the PCR adjustment.

--ignore-scrambled

Do not modify PCR values on PID's containing scrambled packets.

By default, on scrambled PID's, the PCR's are modified but not the PTS and DTS since they are scrambled. This may result in problems when playing video and audio.

--min-ms-interval *milliseconds*

Specify the minimum interval between two PCR's in milliseconds.

On a given PID, if the interval between two PCR's is larger than the minimum, the next null packet will be replaced with an empty packet with a PCR for that PID.

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

Specifies PID's where PCR, DTS and PTS values shall be adjusted.

Several **--pid** options may be specified.

By default, all PID's are modified.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[*-label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ pcrbitrate

Permanently recompute bitrate based on PCR's

This plugin permanently recomputes the bitrate based on the analysis of PCR's on the packets. All packets are transparently passed.

Normally, **tsp** determines the input bitrate at the input plugin: either the input plugin itself can report the actual input bitrate (from a hardware device for instance) or tsp computes the bitrate based on PCR analysis. Then, the bitrate information is automatically propagated from one plugin to another, up to the output plugin. The output plugin may use or ignore this information. Typically, output to a file ignores the bitrate information while output to a hardware device (ASI or modulator) will use it as device parameter.

There may be a problem if some packet processor plugin drops packets from the transport stream. The **zap** plugin, for instance, creates an SPTS containing only one service, dropping all other packets.

Let's take an example: tsp is used to read a full MPTS from a file, extract one channel and send it to a Dektec ASI device. **tsp** reads the input bitrate (here, it analyzes the PCR from the input file and finds, say, 38 Mb/s). Then, **tsp** propagates this bitrate along the plugin chain, up to the output plugin. By default, the output plugin will send the SPTS at 38 Mb/s, the bitrate of the original MPTS, which is a non-sense since the "normal" bitrate of the SPTS is more likely something like 3 or 4 Mb/s. By inserting the **pcrbitrate** plugin between the **zap** plugin and the **dektec** output plugin, the bitrate information will be altered and the output plugin receives a bitrate value which is consistent with the PCR's in the SPTS.

Usage

```
tsp -P pcrbitrate [options]
```

Options

-d
--dts

> Use DTS (Decoding Time Stamps) from video PID's instead of PCR (Program Clock Reference) from the transport layer.

-i
--ignore-errors

> Ignore transport stream errors such as discontinuities.

> When errors are not ignored (the default), the bitrate of the original stream (before corruptions) is evaluated. When errors are ignored, the bitrate of the received stream is evaluated, missing packets being considered as non-existent.

--min-pcr *value*

> Stop analysis when that number of PCR are read from the required minimum number of PID (default: 128).

--min-pid *value*

> Minimum number of PID to get PCR from (default: 1).

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

pcrcopy

Copy and synchronize PCR's from one PID to another

This plugin uses a PID with exiting PCR's as time reference and copies or recomputes PCR's in another PID.

Usage

```
tsp -P pcrcopy [options]
```

Options

-e *packet-count*
--every *packet-count*

> Insert a PCR every N packets in the target PID.

> By default, insert a PCR in packets with a payload unit start only.

--max-shift *bytes*

> When a PCR is inserted in a TS packet which did not have one, the TS adaptation field must be created or extended. Consequently, the TS payload must be shrunk. The end of the payload must then be shifted to the next TS packet in the PID. When several PCR's are included in the PID, shifted bytes accumulate. When enough shifted bytes have been accumulated to fill a TS packet, the next null packet is replaced by a new packet for the target PID.

> If the transport stream does not include enough null packets to absorb the shifted bytes, there is a risk of overflow.

> This options specifies the maximum number of target packet payload bytes which can be shifted, due to PCR insertion. When this value is reached, usually because of a lack of null packets, the current PES packet is truncated.

> By default, allow the buffering of up to 16 packet payloads.

-n
--no-pusi

> Do not insert a PCR in packets with a payload unit start indicator (PUSI).

> By default, a PCR is inserted in all PUSI packets, even if **--every** is also specified.

--reference-label *value*

> Packet label indicating the PID containing the reference PCR to copy. Each time a packet with that label is encountered, the reference PID switches to the PID of this packet, if different from the previous reference PID.

> Exactly one of **--reference-pid** and **--reference-label** shall be specified.

-r *value*
--reference-pid *value*

> PID containing the reference PCR to copy.

> Exactly one of **--reference-pid** and **--reference-label** shall be specified.

--target-label *value*

> Packet label indicating the PID containing the target PID into which PCR's shall be created and copied. Each time a packet with that label is encountered, the target PID switches to the PID of this packet, if different from the previous target PID.

> Exactly one of **--target-pid** and **--target-label** shall be specified.

-t *value*
--target-pid *value*

> PID into which PCR's shall be created and copied.
>
> Exactly one of **--target-pid** and **--target-label** shall be specified.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

▪ pcredit

Edit PCR, PTS and DTS values in various ways

This plugin edits PCR, PTS and DTS values in selected PID's, shifting the corresponding timestamps.

Usage

```
tsp -P pcredit [options]
```

Options

--add-dts *value*

> Add the specified quantity to all DTS values (can be negative).
>
> See options **--unit** and **--random** for the interpretation of the value.

--add-pcr *value*

> Add the specified quantity to all PCR values (can be negative).
>
> See options **--unit** and **--random** for the interpretation of the value.

--add-pts *value*

> Add the specified quantity to all PTS values (can be negative).
>
> See options **--unit** and **--random** for the interpretation of the value.

-i
--ignore-scrambled

> Do not modify PCR values on PID's containing scrambled packets.
>
> On scrambled PID's, only the PCR's can be modified. The PTS and DTS are scrambled and cannot be edited.

-n
--negate-pids

> Negate the selection of **--pid** options.
>
> All PID's except the specified ones will have their timestamps edited.

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

> Specifies PID's where PCR, DTS and PTS values shall be edited.
>
> Several **--pid** options may be specified.
>
> By default, all PID's are modified.

-r
--random

> The absolute values of **--add-pcr**, **--add-dts**, **--add-pts** are used as maximum values. For each time stamp to modify, the added value is a new random number in the range -n to +n where n is the absolute value of the corresponding parameter.
>
> This option is typically used to intentionally corrupt time stamps.

-u *name*
--unit *name*

> Specify the unit of numeric values for options such as **--add-pcr**, **--add-pts** or **--add-dts**.
>
> The default unit is **default**, meaning that each value is a raw number to be applied (**--add-pcr** value is in PCR units, **--add-pts** value is in PTS units, etc.)

Otherwise, it is possible to provide uniform values for all options in PCR units, PTS/DTS units (the same), nanoseconds or milliseconds. The specified values will be converted into the appropriate PCR or PTS/DTS units for each edited field.

Must be one of **default**, **dts**, **millisecond**, **nanosecond**, **pcr**, **pts**.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[*-label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

∷ pcrextract

Extracts PCR, OPCR, PTS, DTS from TS packets

This plugin extracts PCR, OPCR, PTS and DTS from TS packets. The output is typically suitable for analysis with tools like Microsoft Excel.

Usage

```
tsp -P pcrextract [options]
```

Options

-c
--csv

> Report data in CSV (*comma-separated values*) format. All values are reported in decimal. This is the default output format. It is suitable for later analysis using tools such as Microsoft Excel.

-d
--dts

> Report Decoding Time Stamps (DTS).

> By default, if none of **--pcr**, **--opcr**, **--pts**, **--dts** is specified, report them all.

-e
--evaluate-pcr-offset

> Evaluate the offset from the PCR to PTS/DTS for packets with PTS/DTS but without PCR. This evaluation may be incorrect if the bitrate is not constant or incorrectly estimated.

> By default, the offset is reported only for packets containing a PTS/DTS and a PCR.

-g
--good-pts-only

> Keep only "good" PTS, ie. PTS which have a higher value than the previous good PTS. This eliminates PTS from out-of-sequence B-frames.

-i
--input-timestamp

> Add an input timestamp of the corresponding TS packet, if available. This can be an RTP, SRT, kernel timestamp. This input timestamp value is always converted in PCR units.

> In CSV output format, the type of input timestamp is indicated (**rtp**, **srt**, etc.), as well as the difference between the timestamp value and the input timestamp. If the timestamp is a PTS or DTS, the input timestamp is converted to the corresponding unit before computing the difference.

> There is no synchronization between the input timestamps and the PCR, PTS, DTS in the stream. Therefore, the difference between a timestamp and its input timestamp is some arbitrary value. Inside a given PID, only the fluctuation of that difference is meaningful.

-l
--log

> Report data in *log* format through the standard **tsp** logging system. All values are reported in hexadecimal.

-n
--noheader

> Do not output initial header line in CSV format.

--opcr

Report Original Program Clock References (OPCR).

By default, if none of **--pcr**, **--opcr**, **--pts**, **--dts** is specified, report them all.

-o *filename*
--output-file *filename*

Output file name for CSV format (standard error by default).

--pcr

Report Program Clock References (PCR).

By default, if none of **--pcr**, **--opcr**, **--pts**, **--dts** is specified, report them all.

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

Specifies PID's to analyze. By default, all PID's are analyzed.

Several **--pid** options may be specified.

--pts

Report Presentation Time Stamps (PTS).

By default, if none of **--pcr**, **--opcr**, **--pts**, **--dts** is specified, report them all.

--scte35

Also detect and report PTS in SCTE 35 commands. This option forces **--log** and **--pts**.

If no **--pid** option is specified, detect all PID's carrying SCTE 35 splice information.

If some **--pid** options are specified, they designate PID's carrying PCR or PTS. In that case, SCTE 35 commands are analyzed only from PID's which are referenced by the same services as the specified **--pid** options.

-s '*string*'
--separator '*string*'

Field separator string in CSV format. The default is a comma '**,**'.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⊞ **pcrverify**

Verify the PCR's values

This plugin verifies the values of all PCR's and report invalid values.

By default, each PCR is compared to its expected theoretical value as computed from the previous PCR value and the transport bitrate. Note that this method works perfectly on constant bitrate streams (CBR) only. With variable bitrate streams (VBR) with high amplitudes of variation, the reported errors are usually meaningless.

For real-time streams, it is possible to use the input timestamps as reference which is a better alternative for VBR streams.

Usage

```
tsp -P pcrverify [options]
```

Options

-a
--absolute

> Use absolute values in PCR units. By default, use micro-second equivalent values (one micro-second = 27 PCR units).

-b *value*
--bitrate *value*

> Verify the PCR's according to this transport bitrate.

> See section 2.2 for more details on the representation of bitrates.

> By default, use the input bitrate as reported by the input device.

-i
--input-synchronous

> Verify the PCR's according to each packet input timestamp. See the documentation of *tsp* for a description of input timestamps.

> This method is meaningful only with real-time input sources or if the input source can recreate reliable input timestamps (M2TS files for instance). With this option, the bitrate is ignored.

-j *value*
--jitter-max *value*

> Maximum allowed jitter. PCR's with a higher jitter are reported, others are ignored.

> If **--absolute**, the specified value is in PCR units, otherwise it is in micro-seconds.

> The default is 27,000 PCR units or 1,000 micro-seconds. Use **--jitter** `0` to check that all PCR have their exact expected value.

--jitter-unreal *value*

> Maximum realistic jitter. Any jitter above this value is unrealistic and ignored (probably because of a PCR leap).

> If **--absolute**, the specified value is in PCR units, otherwise it is in micro-seconds.

> The default is 270,000,000 PCR units (10 seconds).

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

> PID filter: select packets with these PID values. Several **--pid** options may be specified. Without **--pid** option, PCR's from all PID's are used.

-t
--time-stamp

    Display time of each event.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

    Display this help text.

--only-label *label1*[-*label2*]

    Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

    Several **--only-label** options may be specified.

:: pes

Analyze PES packets

This plugin detects and analyzes PES packets in all selected PID's (all PID's by default). Note that, without any option, this plugin does not report anything, you need to specify what you want to analyze.

Usage

```
tsp -P pes [options]
```

Options

-a
--audio-attributes

> Display audio attributes such as audio layer, stereo mode or sampling rate in MPEG-1, MPEG-2, AC-3 and Enhanced-AC-3 audio.

--avc-access-unit

> Dump all AVC (H.264), HEVC (H.265) or VVC (H.266) access units (aka "NALunits").

-b
--binary

> Include binary dump in addition to hexadecimal.

-f
--flush-last-unbounded-pes

> At end of stream, consider the last unbounded PES packet as complete in each PID.

> By default, there is no guarantee that the unbounded buffered data at end of stream form a valid PES packet and they are discarded.

--h26x-default-format name

> The video formats AVC (H.264), HEVC (H.265) and VVC (H.266) use the same binary bitstream format. But the formats of their NALunits are different.

> When analyzing PES packets of one of these formats, the plugin must know which the actual one is. This is usually automatically done from the stream type in the PMT of the service. However, if the PID is unreferenced or if the PMT was previously filtered out, this option indicates which format to use.

> Must be one of **AVC**, **H.264**, **HEVC**, **H.265**, **VVC**, **H.266**. The default is **AVC**.

-h
--header

> Dump all PES packets header.

-i
--intra-image

> Report intra images.

-x *value*
--max-dump-count *value*

> Specify the maximum number of times data dump occurs with options **--trace-packets**, **--header**, **--payload**, **--start-code**, **--avc-access-unit**. Default: unlimited.

-m *value*
--max-dump-size *value*

Specify the maximum dump size for options **--header**, **--payload**, **--start-code**, **--avc-access-unit**. By default, the complete data section (payload, access unit, etc.) is displayed.

--max-payload-size *value*

Display PES packets with no payload or with a payload the size (in bytes) of which is not greater than the specified value.

--min-payload-size *value*

Display PES packets with a payload the size (in bytes) of which is equal to or greater than the specified value.

--multiple-files

With options **--save-pes** and **--save-es**, save each PES packet in a distinct file.

The specified file name in **--save-pes** or **--save-es** is considered as a template and a unique number is automatically added to the name part so that successive files receive distinct names. Example: if the specified file name is **base.pes**, the various files are named **base-000000.pes**, **base-000001.pes**, etc.

If the specified template already contains trailing digits, this unmodified name is used for the first file. Then, the integer part is incremented. Example: if the specified file name is **base-027.pes**, the various files are named **base-027.pes**, **base-028.pes**, etc.

--nal-unit-type *value*

AVC (H.264), HEVC (H.265) or VVC (H.266) NAL unit filter: with **--avc-access-unit**, select access units with this type (default: all access units).

Several **--nal-unit-type** options may be specified.

--negate-nal-unit-type

Negate the NAL unit filter: specified access units types are excluded.

-n
--negate-pid

Negate the PID filter: specified PID's are excluded.

--nibble

Same as **--binary** but add separator between 4-bit nibbles.

-o *filename*
--output-file *filename*

Specify the output file for the report (default: standard output).

--packet-index

Display the index of the first and last TS packet of each displayed PES packet.

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

PID filter: select packets with this PID value (default: all PID's containing PES packets). Several **--pid** options may be specified.

--payload

Dump all PES packets payload.

--save-es *filename*

Save the elementary stream in the specified file. The payloads of all PES packets are saved in a raw binary form without encapsulation. The PES headers are dropped.

When the specified output file is '**-**', the standard output is used. Thus, the binary content of an elementary stream can be pipelined to another command using the following command skeleton:

```
tsp -I ... -P pes --pid 100 --save-es - -O drop | ...
```

--save-pes *filename*

Save all PES packets, header and payload, in the specified file. All PES packets are saved in a raw binary form without encapsulation.

When the specified output file is '**-**', the standard output is used.

--sei-avc

Dump all SEI (Supplemental Enhancement Information) in AVC (H.264), HEVC (H.265) or VVC (H.266) access units.

--sei-type *value*

SEI type filter: with **--sei-avc**, select SEI access units with this type (default: all SEI access units).

Several **--sei-type** options may be specified.

-s
--start-code

Dump all start codes in PES packet payload.

-t
--trace-packets

Trace all PES packets (display a one-line description per packet).

--uuid-sei *value*

SEI filter: with **--sei-avc**, only select *user data unregistered* SEI access units with the specified UUID value. By default, with **--sei-avc**, all SEI are displayed.

Several **--uuid-sei** options may be specified.

The UUID value must be 16 bytes long. It must be either an ASCII string of exactly 16 characters or a hexadecimal value representing 16 bytes.

-v
--video-attributes

Display video attributes such as frame size, frame rate or profile in MPEG-1, MPEG-2 and AVC.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

∷ pidshift

Shift one or more PID's forward in the transport stream

This plugin considers a set of selected PID's and moves all their packets forward in the transport stream. Packets from all other (non-selected) PID's are not moved.

If all selected PID's globally have a constant bitrate (even if they individually have variable bitrates), shifting the packets keeps a consistent multiplexing: their offsets from non-selected non-moved packets remains constant.

Since a **tsp** plugin cannot go back in the past, the move can be forward only, buffering selected packets by a fixed amount of packets. The initial selected packets are replaced by null packets, until the shift buffer is full. The trailing buffered packets, at the end of the input stream, are lost.

To move a list of selected PID's "backward", the plugin moves all other PID's forward instead (see the option **--backward**). Again, the multiplexing remains consistent only if all other PID's globally have a constant bitrate.

This plugin is typically used to slightly move back and forth an audio PID. Since most audio PID's have a constant bitrate, it works well for forward moves. Backward moves work well if the entire transport stream also has a constant bitrate, which is the case for broadcast streams.

Forward vs. backward

To avoid any confusion between the terms "forward" and "backward", please note that moving the packets of a PID forward in the transport stream makes the time stamps of that PID moving backward relatively to the transport stream. So, depending on your standpoint, you may find the terms "forward" and "backward" either natural or counter-intuitive.

To illustrate this paradox, consider an audio PID which is shifted forward 1000 packets in the transport stream. The audio packets numbered 10, 20, 30 and 40 in the PID have a presentation time stamp (PTS). These packets are initially at positions 1000, 2000, 3000 and 4000 in the transport stream. The following table illustrates the forward vs. backward paradox after moving the PID 1000 packets forward in the transport stream.

Table 11: Moving packets forward means moving timestamps backward

Packet index in TS	Before shift		After shift	
	Index in PID	PTS	Index in PID	PTS
1000	10	PTS-1	null packet	
2000	20	PTS-2	10	PTS-1
3000	30	PTS-3	20	PTS-2
4000	40	PTS-4	30	PTS-3

The packet #10 in the audio PID is shifted *forward* in the TS, moving from the global position 1000 to 2000. But, if you are an observer at global position 2000 in the TS, you see that PTS-2 becomes PTS-1, giving the impression that the PID shifted *backward* in time.

Usage

```
tsp -P pidshift [options]
```

Options

-b
--backward

Revert the list of selected PID's, meaning that a shift forward is performed on all PID's except those in **-p** or **--pid** options.

In practice, this can be seen as shifting backward the selected PID's from the rest of the transport stream.

--directory path

Specify a directory where the temporary buffer file is created (if one is needed).

By default, the system-specific area for temporary files is used.

The temporary file is hidden and automatically deleted on termination. Specifying another location can be useful to redirect very large buffers on another disk.

If the reserved memory area is large enough to hold the buffer, no file is created.

--ignore-errors

Ignore shift buffer size evaluation errors or shift buffer write errors. Pass subsequent packets without shifting.

-i milliseconds
--initial-evaluation milliseconds

With **--time**, specify the duration of the initial evaluation phase in milliseconds. This is a transport stream playout duration, not a wall-clock duration.

The default is 1,000 milliseconds.

-m count
--memory-packets count

Specify the number of packets which are cached in memory. Having a larger memory cache improves the performances.

By default, the size of the memory cache is 128 packets.

--packets count

Specify the size of the shift buffer in packets.

The shift buffer contains packets from the selected PID's which are removed from the transport stream and reinserted later, replacing packets from the same set of selected PID's. Here, "removing" packets means replacing them with null packets in the initial phase. When the shift buffer is full, the "removed" packets are replaced from previous packets from the shifted PID's.

Using **--packets** is less intuitive than **--time** but allows starting the shift from the beginning of the transport stream, without initial evaluation period.

There is no default, the size of the buffer shall be specified either using **--packets** or **--time**.

-p pid1[-pid2]
--pid pid1[-pid2]

Specify a PID or range of PID's to shift forward.

Several **-p** or **--pid** options may be specified. At least one of them is required.

-t milliseconds
--time milliseconds

Specify the size of the shift buffer in milliseconds.

During an initial evaluation phase (see option **--initial-evaluation**), the global bitrate of all PID's to shift forward is evaluated. This global bitrate is then used to convert the specified **--time**

duration in a number of packets and this value is used as fixed-size for the shift buffer. Actual shifting the PID's starts at the end of this evaluation phase.

There is no default, the size of the buffer shall be specified either using **--packets** or **--time**.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ play (output)

Play output on a media player

This output plugin sends TS packets to a supported media player. It is typically used when one service was isolated on the transport stream and the resulting audio/video must be monitored.

The **play** plugin attempts to locate a media player application which can process MPEG-2 transport streams on its standard input. If one is found in the system, the plugin creates a process executing the media player (adding the required options if necessary) and sends the output stream to this process using a pipe.

This plugin is consequently is easier alternative to the **fork** plugin. The same operation could be achieved using the **fork** plugin but it requires to specify the complete media player command line with options.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Usage

```
tsp -O play [options]
```

Options

-m
--mplayer

Linux only: Use **mplayer** for rendering. The default is to look for **vlc**, **mplayer** and **xine**, in this order, and use the first available one.

-x
--xine

Linux only: Use **xine** for rendering. The default is to look for **vlc**, **mplayer** and **xine**, in this order, and use the first available one.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

Display plugin help text.

Supported media players

- Linux: Look for VLC, **mplayer** and **xine**. Use the **PATH** environment variable to locate the applications.

- macOS: Same a Linux but also search into **/usr/local/bin** (**/opt/homebrew/share/tsduck** on Arm) and **/Applications**.

- Windows: Look for VLC using the **Path** environment variable and various information that is normally filled in the registry by the VLC installation procedure. See [47] for downloading and installing VLC Media Player.

To use another media player or with specific options, use the **fork** plugin instead:

```
tsp ... –O fork [options] "media player command line"
```

▦ pmt

Perform various transformations on a PMT

This plugin performs various transformations on a PMT.

The PMT can be specified by PID, by service id or by service name.

Usage

```
tsp -P pmt [options]
```

Options

--ac3-atsc2dvb

Change the description of AC-3 (a.k.a. DD, Dolby Digital) audio streams from ATSC to DVB method. In details, this means that all components with stream_type **0x81** are modified with stream_type **0x06** (*PES private data*) and an *AC-3_descriptor* is added on this component (if none was already there).

--add-ca-descriptor *casid/pid[/private-data]*

Add a *CA_descriptor* at program-level in the PMT with the specified CA System Id and ECM PID. The optional private data must be a suite of hexadecimal digits.

Several --**add-ca-descriptor** options may be specified to add several descriptors.

-a *pid/type*
--add-pid *pid/type*

Add the specified PID / stream-type component in the PMT. Both *PID* and *type* must be integer values, either decimal or hexadecimal.

Several **--add-pid** options may be specified to add several components.

--add-pid-registration *pid/id*

Add a *registration_descriptor* in the descriptor list of the specified PID in the PMT.

The value is the *format_identifier* in the *registration_descriptor*, e.g. **0x43554549** for "CUEI".

--add-registration *id*

Add a *registration_descriptor* in the program-level descriptor list in the PMT.

The value is the *format_identifier* in the *registration_descriptor*, e.g. **0x43554549** for "CUEI".

--add-stream-identifier

Add a *stream_identifier_descriptor* on all components. The *component_tag* are uniquely allocated inside the service. Existing *stream_identifier_descriptor*s are left unmodified.

--audio-language *language-code*[:*audio-type*[:*location*]]

Specifies the language for an audio stream in the PMT. Several options can be specified to set the languages of several audio streams.

The *language-code* is a 3-character string.

The *audio-type* is optional, its default value is zero.

The *location* indicates how to locate the audio stream. Its format is either "**P***n*" or "**A***n*". In the first case, "*n*" designates a PID value and in the second case the audio stream number inside the PMT, starting with 1. The default location is "**A1**", ie. the first audio stream inside the PMT.

--bitrate *value*

Specifies the bitrate in bits / second of the PID containing the PMT if a new one is created.

See section 2.2 for more details on the representation of bitrates.

The default is 3,000 b/s.

--brazil

A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--cleanup-private-descriptors

Remove all private descriptors without preceding *private_data_specifier_descriptor*.

-c
--create

Create a new empty PMT if none was received after one second.

This is equivalent to **--create-after 1000**.

--create-after *milliseconds*

Create a new empty PMT if none was received after the specified number of milliseconds. If an actual PMT is received later, it will be used as the base for transformations instead of the empty one.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.

By default, standard DVB encoding is used. See section 2.5 for more details.

--eac3-atsc2dvb

Change the description of Enhanced-AC-3 (a.k.a. AC-3+, DD+, Dolby Digital+) audio streams from ATSC to DVB method. In details, this means that all components with stream_type **0x87** are modified with stream_type **0x06** (*PES private data*) and an *enhanced_AC-3_descriptor* is added on this component (if none was already there).

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--increment-version

Increment the version number of the PMT.

--inter-packet *value*

When a new PMT is created and **--bitrate** is not present, this option specifies the packet interval for the PMT PID, that is to say the number of TS packets in the transport between two packets of the PID.

Use instead of **--bitrate** if the global bitrate of the TS cannot be determined.

--japan

A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

-m *old-pid/new-pid*
--move-pid *old-pid/new-pid*

Change the PID value of a component in the PMT. Several **--move-pid** options may be specified to move several components.

-i *value*
--new-service-id *value*

Change the service id in the PMT.

-v *value*
--new-version *value*

Specify a new value for the version of the PMT.

--patch-xml *filename*

Specify an XML patch file which is applied to each PMT on the fly. The XML patches are applied first. The other options of this plugin are applied on the patched table.

If the specified name starts with "**<?xml**", it is considered as *inline XML content*, meaning that the string in the command line is directly the XML content and not a file name.

Several **--patch-xml** options can be specified. Patch files are sequentially applied on each table.

See section 2.6.4 for more details on XML patch files.

--pcr-pid *value*

Change the PCR PID value in the PMT.

--pds *value*

With option **--remove-descriptor**, specify the private data specifier which applies to the descriptor tag values above **0x80**.

-p *value*
--pmt-pid *value*

Specify the PID carrying the PMT to modify. All PMT's in this PID will be modified. Options **--pmt-pid** and **--service** are mutually exclusive. If neither are specified, the first service in the PAT is used.

--philippines

A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

--remove-descriptor *value*

Remove from the PMT all descriptors with the specified tag. Several **--remove-descriptor** options may be specified to remove several types of descriptors. See also option **--pds**.

-r pid1*[*-pid2*]*
--remove-pid pid1*[*-pid2*]*

Remove the component with the specified PID's from the PMT. Several **--remove-pid** options may be specified to remove several components.

--remove-stream-type *value[-value]*

Remove all components with a stream type matching the specified values. Several **--remove-stream-type** options may be specified.

-s *name-or-id*
--service *name-or-id*

Specify the service the PMT of which must be modified. If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id. Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored. Options **--pmt-pid** and **--service** are mutually exclusive. If neither are specified, the first service in the PAT is used.

--set-cue-type *pid/type*

In the component with the specified PID, add an SCTE 35 *cue_identifier_descriptor* with the specified *cue_stream_type*. Several **--set-cue-type** options may be specified.

--set-data-broadcast-id *pid/id[/selector]*

In the component with the specified PID, add a *data_broadcast_id_descriptor* with the specified *data_broadcast_id*. The optional selector is a suite of hexadecimal characters representing the content of the selector bytes.

Several **--set-data-broadcast-id** options may be specified.

--set-stream-identifier *pid/id*

In the component with the specified PID, add a *stream_identifier_descriptor* with the specified id as *component_tag*.

Several **--set-stream-identifier** options may be specified.

--sort-languages *lang1,lang2,...*

Sort the elementary streams carrying audio and subtitles in the specified order of languages. The languages must be 3-letter ISO-639 codes.

--sort-pids *pid1,pid2,...*

Sort the elementary streams in the specified order of PID's. Non-existent PID's are ignored. Unlisted PID's, if any, are placed after the others.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⊞ psi

Collect PSI structure information

This plugin extracts all PSI tables (PAT, CAT, PMT, NIT, BAT, SDT) from a transport stream. It is equivalent to the **tspsi** utility. Actually, the following two commands produce the same result:

```
tspsi options filename
tsp –I file filename –P psi options –O drop
```

Usage

```
tsp -P psi [options]
```

General options

The plugin accepts exactly the same options as the **tspsi** utility.

Developers options

The following options are reserved to C++, Java or Python developers. They are useful only when the plugin is used inside a custom application.

--event-code *value*

Signal a plugin event with the specified code for each section.

The event data is an instance of **PluginEventData** pointing to the section content.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ **psimerge**

Merge PSI/SI from mixed streams

This plugin assumes that the PSI/SI for two independent streams are multiplexed in the same transport streams but the packets from each original stream are independently labelled. This plugin merges the PSI/SI from these two streams into one.

Usage

```
tsp -P psimerge [options]
```

Options

--main-label *value*

> Specify the label which is set on packets from the *main* stream. The maximum label value is 31.
>
> By default, the main stream is made of packets without label.
>
> At least one of **--main-label** and **--merge-label** must be specified.

--merge-label *value*

> Specify the label which is set on packets from the *merge* stream. The maximum label value is 31.
>
> By default, the merge stream is made of packets without label.
>
> At least one of **--main-label** and **--merge-label** must be specified.

--no-bat

> Do not merge the BAT.

--no-cat

> Do not merge the CAT.

--no-eit

> Do not merge the EIT's.

--no-nit

> Do not merge the NIT Actual.

--no-pat

> Do not merge the PAT.

--no-sdt

> Do not merge the SDT Actual.

--time-from-merge

> Use the TDT/TOT time reference from the *merge* stream.
>
> By default, use the TDT/TOT time reference from the *main* stream.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⁘ reduce

Reduce the bitrate by removing stuffing (null packets)

This plugin reduces the bitrate of the transport stream by removing stuffing packets.

Usage

```
tsp -P reduce [options] [rempkt inpkt]
```

Parameters

Legacy syntax: For compatibility, two integer parameters can be used to specify *rempkt* and *inpkt*, the removal of packets in fixed proportion. Now preferably use option **--fixed-proportion**.

The parameters specify that *rempkt* TS packets must be automatically removed after every *inpkt* input TS packets in the transport stream. Only stuffing packets can be removed. Both *rempkt* and *inpkt* must be non-zero integer values.

Options

-f *rempkt/inpkt*
--fixed-proportion *rempkt/inpkt*

> Reduce the bitrate in fixed proportion: *rempkt* TS packets are automatically removed after every *inpkt* input TS packets in the transport stream.

> Only stuffing packets can be removed. Both *rempkt* and *inpkt* must be non-zero integer values.

> Exactly one of **--target-bitrate** or **--fixed-proportion** must be specified.

-i *value*
--input-bitrate *value*

> Specify the input bitrate in bits/second.

> See section 2.2 for more details on the representation of bitrates.

> By default, the input bitrate is permanently evaluated by previous plugins.

--packet-window *packet-count*

> With **--target-bitrate**, define the number of packets over which they are analyzed and extra packets are removed.

> The default is 10,000 packets.

> Options **--time-window** and **--packet-window** are mutually exclusive.

-p
--pcr-based

> With **--target-bitrate**, use PCR's in each packet window to determine how many packets should be removed in each window.

> By default, the input bitrate is used. In the case of highly variable bitrate (VBR), using PCR's on each time window gives better results but PCR's must be present and accurate and the window size must be large enough to contain more than one PCR on at least one PID.

-r *pid1*[*-pid2*]
--reference-pcr-pid *pid1*[*-pid2*]

> With **--pcr-based**, use PCR's from the specified reference PID's only.

> The option **--reference-pcr-pid** can be present multiple time.

> By default, PCR's are used from any PID.

-t *value*

--target-bitrate *value*

Reduce the bitrate to this target value in bits/second.

See section 2.2 for more details on the representation of bitrates.

Only stuffing packets can be removed.

Exactly one of **--target-bitrate** or **--fixed-proportion** must be specified.

Using the target bitrate method introduces an uncompressable latency in the stream, see options **--time-window** and **--packet-window**.

--time-window *milli-seconds*

With **--target-bitrate**, define the latency period over which packets are analyzed and extra packets are removed. To use this method, the bitrate must be known during the starting phase so that it can be turned into a number of packets.

Options **--time-window** and **--packet-window** are mutually exclusive.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[*-label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ regulate

Regulate packets flow according to a bitrate or PCR's

This plugin regulates the TS packets flow according to a specified bitrate or based on the Program Clock Reference from the transport stream.

It is useful to play a non-regulated input (such as a TS file) to a non-regulated output (such as IP multicast). Without this plugin, in this example, the IP packets will be sent as fast as the TS packets are read from the file, that is to say at a very much higher bitrate than expected. When inserted between the input and the output plugins, the **regulate** plugin regularly suspends the **tsp** process to slow down the output.

Note that this plugin can only slow down the stream but not accelerate it (if the input is not fast enough, there is nothing that a plugin can do!)

By default, the plugin uses a bitrate value. The plugin suspends the execution at regular intervals to ensure that its output does not exceed the target bitrate. A fixed bitrate can be specified. Otherwise, the plugin uses the bitrate information coming from the previous plugins in the chain. In the latter case, the bitrate can be variable.

When the option **--pcr-synchronous** is specified, the plugin does not use any bitrate information. It regulates the flow to be synchronous with the Program Clock Reference (PCR) in the transport stream.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp***)*.

Usage

```
tsp -P regulate [options]
```

Options

-b *value*
--bitrate *value*

> Specify the bitrate in bits/second.

> See section 2.2 for more details on the representation of bitrates.

> By default, use the input bitrate, typically resulting from the PCR analysis of the input stream. Note that this default is the bitrate which is presented by **tsp** at the input of the **regulate** plugin. This is not necessarily the bitrate at the input plugin if another plugin (such as **pcrbitrate**) has altered the bitrate between the input plugin and **regulate**.

-p *value*
--packet-burst *value*

> Number of packets to burst at a time. Does not modify the average output bitrate but influence smoothing and CPU load. The default is 16 packets.

> It is inefficient, and most of the time impossible, to suspend a process too often and for a too short time. To regulate a stream at 38 Mb/s, for instance, the process must be suspended 40 micro-seconds between each TS packets. This is not possible in practice on most Linux or Windows kernels with the default configuration. If the packet burst is set to 64, the wait time is 2.5 milli-seconds, which becomes feasible.

--pcr-synchronous

> Regulate the flow based on the Program Clock Reference from the transport stream.

> By default, use a bitrate, not PCR's.

--pid-pcr *value*

> With **--pcr-synchronous**, specify the reference PID for the Program Clock Reference.
>
> By default, use the first PID containing PCR's.

--wait-min *value*

> With **--pcr-synchronous**, specify the minimum wait time in milli-seconds.
>
> The default is 50 ms.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

⊞ remap

Generic PID remapping

This plugin modifies the PID value in selected packets. By default, the PSI are modified accordingly to preserve the consistency of the transport stream.

Usage

```
tsp -P remap [options] [pid[-pid]=newpid ...]
```

Specifying PID remapping

Each remapping is specified as "*pid=newpid*" or "*pid1-pid2=newpid*". All PID's can be specified as decimal or hexadecimal values. More than one PID remapping can be specified.

In the first form, the PID *pid* is remapped to *newpid*.

In the latter form, all PID's within the range *pid1* to *pid2* (inclusive) are respectively remapped to *newpid*, *newpid*+1, etc. (this behaviour is changed using option **--single**).

The null PID **0x1FFF** cannot be remapped.

Options

-n
--no-psi

> Do not modify the PSI.

> By default, the PAT, CAT and PMT's are modified so that previous references to the remapped PID's will point to the new PID values.

--reset-label *label1*[*-label2*]

> Clear the specified labels on the remapped packets.

> Several **--reset-label** options may be specified.

--set-label *label1*[*-label2*]

> Set the specified labels on the remapped packets.

> Several **--set-label** options may be specified.

-s
--single

> When a remapping is in the form "*pid1-pid2=newpid*", remap all input PID's within the range *pid1* to *pid2* to the same *newpid* value, not *newpid*, *newpid*+1, etc.

> This option forces **--unchecked** since distinct PID's are remapped to the same one.

-u
--unchecked

> Do not perform any consistency checking while remapping PID's:
>
> o   Remapping to or from a predefined PID is accepted.
>
> o   Remapping two PID's to the same PID or to a PID which is already present in the input is accepted.

> Note that this option should be used with care since the resulting stream can be illegal or inconsistent.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▦ rist (input)

Receive TS packets from Reliable Internet Stream Transport (RIST)

This input plugin receives TS packets using the Reliable Internet Stream Transport (RIST) protocol.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Restrictions

> This plugin is provided only when **librist** is officially supported on the target platform. As of this writing, in the TSDuck prebuilt binary packages, the **rist** plugin is available on Windows and macOS only. Although **librist** can be compiled on Linux, providing TSDuck pre-built binaries is impossible if dependencies on **librist** cannot be satisfied using the standard repositories of the distro. See [51] for more details on how to build TSDuck with RIST support on Linux.

Usage

```
tsp -I rist [options] url [url...]
```

URL parameters

> Specify RIST URL's as parameters to specify the location of the sending peer. More than one URL can be specified to receive from multiple paths at the same time.
>
> A RIST URL starts with **rist://**. It usually starts with **rist://remote-ip:port** (to connect to a peer) or **rist://@local-ip:port** (to listen for incoming connections from a peer).
>
> A **rist://** URL may also include tuning parameters in addition to the address and port. This is the reason why the **rist** plugin has so few options. Most options are in the URL.
>
> See [49] for more details on the syntax of **rist://** URL's.

Options

> **-a** *ip-address*[:*port*]
> **--allow** *ip-address*[:*port*]
>
>> In listener mode (**rist://@...**), allow the specified IP address (and optional port) to connect.
>>
>> More than one **--allow** option can be used to specify several allowed addresses. If at least one **--allow** option is specified, any client which is not explicitly allowed is denied.
>
> **-b** *milliseconds*
> **--buffer-size** *milliseconds*
>
>> Default buffer size in milliseconds for packet retransmissions.
>>
>> This value overrides the '**buffer=**' parameter in the URL.
>
> **-d** *ip-address*[:*port*]
> **--deny** *ip-address*[:*port*]
>
>> In listener mode (**rist://@...**), deny the specified IP address (and optional port) to connect.
>>
>> More than one **--deny** option can be used to specify several denied addresses.
>
> **-e** *name*
> **--encryption-type** *name*
>
>> Specify the encryption type (none by default).
>>
>> This value is used when the '**aes-type=**' parameter is not present in the URL.
>>
>> Must be one of **AES-128** or **AES-256**.

--ignore-rist-timestamps

> Ignore source timestamps, use reception time as packet timestamps.
>
> By default, use the source timestamps from the sender as packet timestamp.

-p *name*
--profile *name*

> Specify the RIST profile to use.
>
> The name must be one of **advanced**, **main**, **simple**. The default profile is **main**.

-s '*string*'
--secret '*string*'

> Default pre-shared encryption secret.
>
> If a pre-shared secret is specified without **--encryption-type**, AES-128 is used by default.
>
> This value is used when the '**secret=**' parameter is not present in the URL.

--stats-interval *milliseconds*

> Periodically report a line of statistics.
>
> The interval is in milliseconds. The statistics are in JSON format, on one line.

--stats-prefix '*prefix*'

> With **--stats-interval**, specify a prefix to prepend on the statistics line before the JSON text to locate the appropriate line in the logs.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

> Display plugin help text.

⚏ rist (output)

Send TS packets to Reliable Internet Stream Transport (RIST)

This output plugin sends TS packets using the Reliable Internet Stream Transport (RIST) protocol.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Restrictions

This plugin is provided only when **librist** is officially supported on the target platform. As of this writing, in the TSDuck prebuilt binary packages, the **rist** plugin is available on Windows and macOS only. Although **librist** can be compiled on Linux, providing TSDuck pre-built binaries is impossible if dependencies on **librist** cannot be satisfied using the standard repositories of the distro. See [51] for more details on how to build TSDuck with RIST support on Linux.

Usage

```
tsp -O rist [options] url [url...]
```

URL parameters

Specify RIST URL's as parameters to specify the location of the receiving peer. More than one URL can be specified to send through multiple paths at the same time.

A RIST URL starts with **rist://**. It usually starts with **rist://remote-ip:port** (to connect to a peer) or **rist://@local-ip:port** (to listen for incoming connections from a peer).

A **rist://** URL may also include tuning parameters in addition to the address and port. This is the reason why the **rist** plugin has so few options. Most options are in the URL.

See [49] for more details on the syntax of **rist://** URL's.

Options

-a *ip-address*[:*port*]
--allow *ip-address*[:*port*]

> In listener mode (**rist://@...**), allow the specified IP address (and optional port) to connect.

> More than one **--allow** option can be used to specify several allowed addresses. If at least one **--allow** option is specified, any client which is not explicitly allowed is denied.

-b *milliseconds*
--buffer-size *milliseconds*

> Default buffer size in milliseconds for packet retransmissions.

> This value overrides the '**buffer=**' parameter in the URL.

-d *ip-address*[:*port*]
--deny *ip-address*[:*port*]

> In listener mode (**rist://@...**), deny the specified IP address (and optional port) to connect.

> More than one **--deny** option can be used to specify several denied addresses.

-e *name*
--encryption-type *name*

> Specify the encryption type (none by default).

> This value is used when the '**aes-type=**' parameter is not present in the URL.

> Must be one of **AES-128** or **AES-256**.

--enforce-burst

Enforce that the number of TS packets per send operation is exactly what is specified in option **--packet-burst**. By default, this is only a maximum value.

-n
--null-packet-deletion

Enable null packet deletion. The receiver needs to support this.

--packet-burst *value*

Specifies the maximum number of TS packets to be grouped into each send operation.

The default is 7, the maximum is 128.

-p *name*
--profile *name*

Specify the RIST profile to use.

The name must be one of **advanced**, **main**, **simple**. The default profile is **main**.^

-s '*string*'
--secret '*string*'

Default pre-shared encryption secret.

If a pre-shared secret is specified without **--encryption-type**, AES-128 is used by default.

This value is used when the '**secret=**' parameter is not present in the URL.

--stats-interval *milliseconds*

Periodically report a line of statistics.

The interval is in milliseconds. The statistics are in JSON format, on one line.

--stats-prefix '*prefix*'

With **--stats-interval**, specify a prefix to prepend on the statistics line before the JSON text to locate the appropriate line in the logs.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

Display plugin help text.

▪ rmorphan

Remove unreferenced PID's

This plugin removes unreferenced (aka *orphan*) PID's from the transport stream. The plugin analyzes the complete TS structure, starting from the PAT and the CAT. Any packet which neither belongs to a predefined PID's nor to a referenced PID in the TS structure is removed.

Usage

```
tsp -P rmorphan [options]
```

Options

--abnt

Assume that the transport stream is an ISDB one with ABNT-defined variants. See section 2.4.2 for more details.

--atsc

Assume that the transport stream is an ATSC one. See section 2.4.2 for more details.

--brazil

A synonym for **--isdb --abnt**. See sections 2.4.2 for more details.

--isdb

Assume that the transport stream is an ISDB one. See section 2.4.2 for more details.

--japan

A synonym for **--isdb**. See sections 2.4.2 for more details.

--philippines

A synonym for **--isdb --abnt**. See sections 2.4.2 for more details.

-s
--stuffing

Replace excluded packets with stuffing (null packets) instead of removing them.

Useful to preserve the TS bitrate.

--usa

A synonym for **--atsc**. See section 2.4.2 for more details.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

rmsplice

Remove ads insertions using SCTE 35 splice information

This plugin removes part of a program (typically ads insertions) based on SCTE 35 splice cueing information.

According to the SCTE 35 standard (see [22]), a dedicated stream is declared in the PMT of a service, carrying private tables. These private tables describe upcoming *splice points*. They define specific points in the program where the audio and video can be "cut" and replaced by some alternate content, typically local ads sequences. *Splice out* points define places where the main program can be left to switch to local content. *Splice in* points define places where the content should return back to the original program.

The plugin **rmsplice** uses the specific SCTE 35 splice information stream to locate what could be uninteresting sequences of ads and simply removes the program content, audio, video, subtitles, during these sequences. The content of the program is not replaced, as originally intended by the SCTE 35 standard, it is simply removed. Consequently, using this plugin makes sense on SPTS only (see the plugin **zap** for instance).

The removal is based on Presentation Time Stamps (PTS) in the various content PID's of the program. The PTS of the starting (*splice out*) and ending (*splice in*) points are defined be the SCTE 35 commands in the dedicated stream. Currently, **rmsplice** removes entire PES packets and does not dig into the video encoding.

If the original video encoding is carefully performed to resist to identified splice points, the transition should be smooth. However, it has been observed transient glitches and macro blocks in the resulting stream after removing ads sequences, even though the PTS of the splice points exactly match the signalled PTS values. VLC reports one "*unref short failure*" at that point. It is currently unknown if this is due to a non-splice-resistant video encoding or if the cutting method of **rmsplice** is too harsh.

Usage

```
tsp -P rmsplice [options] [service]
```

Parameter

The optional parameter specifies the service to modify.

If this is an integer value (either decimal or hexadecimal), it is interpreted as a service id. Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored. If the input TS does not contain an SDT, use a service id.

When the parameter is omitted, the first service which is found in the PAT is selected.

Options

-a
--adjust-time

Adjust all time stamps (PCR, OPCR, PTS and DTS) after removing splice-out / splice-in sequences. This can be necessary to improve the video transition.

--brazil

A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

-c
--continue

> Continue stream processing even if no *splice information stream* is found for the service. Without this information stream, ads cannot be located and consequently not removed. By default, **tsp** aborts when the splice information stream is not found in the PMT of the service.

--default-charset *name*

> Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.

> By default, standard DVB encoding is used. See section 2.5 for more details.

-n
--dry-run

> Perform a dry run, report what operations would be performed. Use with **--verbose**.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--event-id *pid1*[-*pid2*]

> Only remove splices associated with the specified event ID's.

> Several **--event-id** options may be specified.

-f
--fix-cc

> Fix continuity counters after removing splice-out / splice-in sequences.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

--philippines

> A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-s
--stuffing

> Replace excluded packets with stuffing (null packets) instead of removing them. Useful to preserve bitrate.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

▪ scrambler

DVB scrambler

This plugin is a DVB scrambler, either using a static control word or using an external ECMG. In the latter case, the plugin generates the control words, schedules crypto-periods and inserts ECM's.

The control words are generated using the default pseudo-random number generator of the operating system with additional security improvements. Although these values are reasonably random, there is no security commitment and this scrambler should be used for test purpose only, not for production.

When inserting ECM's, the plugin uses the **delay_start** parameter, as returned by the ECMG, to synchronize the start of the crypto-period with the first insertion of an ECM. Both positive and negative **delay_start** values are supported.

Usage

```
tsp -P scrambler [options] [service]
```

Parameter

The optional parameter specifies the service to scramble.

If no service is specified, a list of PID's to scramble must be provided using **--pid** options. When specific PID's are provided, fixed control words must be specified as well.

If no fixed CW is specified, a random CW is generated for each crypto-period and ECM's containing the current and next CW's are created and inserted in the stream. ECM's can be created only when a service is specified.

If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id.

If it is an empty string or "**-**", the first service in the PAT is scrambled.

Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored. If the input TS does not contain an SDT, use service ids only.

General options

-b value
--bitrate-ecm value

> Specifies the bitrate for ECM PID's in bits / second.
>
> See section 2.2 for more details on the representation of bitrates.
>
> The default is 30,000 b/s.

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--clear-period seconds

> Set the size of the initial clear period, in seconds.
>
> The default value is 0, meaning that all packets are scrambled.

-d seconds
--cp-duration seconds

> Specifies the crypto-period duration in seconds (default: 10 seconds).

--default-charset name

> Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.
>
> By default, standard DVB encoding is used. See section 2.5 for more details.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--ignore-scrambled

> Ignore packets which are already scrambled. Since these packets are likely scrambled with a different control word, descrambling will not be possible the usual way.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

--no-audio

> Do not scramble audio components in the selected service. By default, all audio components are scrambled.

--no-video

> Do not scramble video components in the selected service. By default, all video components are scrambled.

--partial-scrambling *count*

> Do not scramble all packets, only one packet every `count` packets. The default value is 1, meaning that all packets are scrambled. Specifying higher values is a way to reduce the scrambling CPU load while keeping the service "mostly" scrambled.

--philippines

> A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

> Scramble packets with these PID values. Several **--pid** options may be specified. By default, scramble the specified service.

--pid-ecm *value*

> Specifies the new ECM PID for the service. By defaut, use the first unused PID immediately following the PMT PID. Using the default, there is a risk to later discover that this PID is already used. In that case, specify **--pid-ecm** with a notoriously unused PID value.

--subtitles

> Scramble subtitles components in the selected service. By default, the subtitles components are not scrambled.

--synchronous

> Specify to synchronously generate the ECM's.
>
> In real-time mode, the processing of packets continues in parallel while ECM's are generated in the ECMG. Use this option to force the stream processing to wait for ECM's.
>
> In offline mode, this option is always on. This is usually the right thing to do. Otherwise, if an ECM takes too long to be generated, the stream processing may reach the first insertion point of the ECM before it is available.

DVB SimulCrypt options

-a *hexa-digits*
--access-criteria *hexa-digits*

> Specifies the access criteria for the service as sent to the ECMG. The value must be a suite of hexadecimal digits.

--channel-id *value*

Specifies the DVB SimulCrypt *ECM_channel_id* for the ECMG (default: 1).

--component-level

Add *CA_descriptors* at component level in the PMT. By default, one *CA_descriptor* is added at program level.

-i *value*
--ecm-id *value*

Specifies the DVB SimulCrypt *ECM_id* for the ECMG (default: 1).

-e *host:port*
--ecmg *host:port*

Specify an ECM Generator host name (or IP address) and TCP port. Without ECMG, a fixed control word must be specified using **--control-word**.

-v *value*
--ecmg-scs-version *value*

Specifies the version of the ECMG <=> SCS DVB SimulCrypt protocol. Valid values are 2 and 3. The default is 2.

--log-data[=*level*]

Same as **--log-protocol** but applies to *CW_provision* and *ECM_response* messages only.

To debug the session management without being flooded by data messages, use **--log-protocol=info --log-data=debug**.

--log-protocol[=*level*]

Log all ECMG ⇔ SCS protocol messages using the specified level. If the option is not present, the messages are logged at debug level only. If the option is present without value, the messages are logged at info level. A level can be a numerical debug level or any of the following: **fatal**, **severe**, **error**, **warning**, **info**, **verbose**, **debug**.

--private-data *hexa-digits*

Specifies the private data to insert in the *CA_descriptor* in the PMT. The value must be a suite of hexadecimal digits.

--stream-id *value*

Specifies the DVB SimulCrypt *ECM_stream_id* for the ECMG (default: 1).

-s *value*
--super-cas-id *value*

Specify the DVB SimulCrypt *Super_CAS_Id*. This is required when **--ecmg** is specified.

Transport stream scrambling options

--aes-cbc

Use AES-CBC scrambling instead of DVB-CSA2 (the default).

The control words are 16-byte long instead of 8-byte. The residue is left clear. Specify a fixed initialization vector using the **--iv** option.

Note that this is a non-standard TS scrambling mode. The only standard AES-based scrambling modes are ATIS-IDSA and DVB-CISSA (DVB-CISSA is the same as AES-CBC with a DVB-defined IV).

A *scrambling_descriptor* is automatically added to the PMT of the service to indicate the use of AES-CBC scrambling. Since there is no standard value for AES-CBC, the user-defined *scrambling_mode* value **0xF0** is used.

--aes-ctr

Use AES-CTR scrambling instead of DVB-CSA2 (the default).

The control words are 16-byte long instead of 8-byte. The residue is included in the scrambling. Specify a fixed initialization vector using the **--iv** option. See the option **--ctr-counter-bits** for the size of the counter part in the IV.

Note that this is a non-standard TS scrambling mode. The only standard AES-based scrambling modes are ATIS-IDSA and DVB-CISSA.

A *scrambling_descriptor* is automatically added to the PMT of the service to indicate the use of AES-CTR scrambling. Since there is no standard value for AES-CTR, the user-defined *scrambling_mode* value **0xF1** is used.

--atis-idsa

Use ATIS-IDSA scrambling (ATIS-0800006) instead of DVB-CSA2 (the default).

The control words are 16-byte long instead of 8-byte.

A *scrambling_descriptor* is automatically added to the PMT of the service to indicate the use of ATIS-IDSA scrambling.

--ctr-counter-bits *value*

With **--aes-ctr**, specifies the size in bits of the counter part.

In the initialization vector, the fixed nounce part uses the first 128-N bits and the counter part uses the last N bits.

By default, the counter part uses the second half of the IV (64 bits).

-c *hexa-digits*
--cw *hexa-digits*

Specifies a fixed and constant control word (no crypto-period scheduling, no ECM insertion). The value must be a string of 16 hexadecimal digits (32 digits with **--atis-idsa** or **--dvb-cissa**).

When using this option, no Conditional Access System is used, meaning that no ECM or ECM PID is generated, no ECMG is allowed, all DVB SimulCrypt parameters are ignored and no CA_descriptor is inserted in the PMT.

--dvb-cissa

Use DVB-CISSA descrambling (see [16]) instead of DVB-CSA2 (the default).

The control words are 16-byte long instead of 8-byte.

A *scrambling_descriptor* is automatically added to the PMT of the service to indicate the use of DVB-CISSA scrambling.

--dvb-csa2

Use DVB-CSA2 scrambling. This is the default.

-f *name*
--cw-file *name*

Specifies a text file containing the list of control words to apply. Each line of the file must contain exactly 16 hexadecimal digits (32 digits with **--atis-idsa** or **--dvb-cissa**).

The next control word is used each time a new crypto-period is started. At the end of the list of control words, restart with the first one.

As with option **--cw**, no Conditional Access System is used, meaning that no ECM or ECM PID is generated, no ECMG is allowed, all DVB SimulCrypt parameters are ignored and no CA_descriptor is inserted in the PMT.

--iv *hexa-digits*

> With **--aes-cbc** or **--aes-ctr**, specifies a fixed initialization vector for all TS packets.
>
> The value must be a string of 32 hexadecimal digits. The default IV is all zeroes.

-n
--no-entropy-reduction

> With DVB-CSA2, do not perform control word entropy reduction to 48 bits, keep full 64-bit control words. This option is ignored with other scrambling modes.

--output-cw-file *name*

> Specifies a text file to create with all control words. Each line of the file will contain a control word with 16 or 32 hexadecimal digits, depending on the scrambling algorithm. Each time a new control word is used to scramble packets, it is logged in the file.
>
> This option is specifically useful when the control words are dynamically and randomly generated for insertion into ECM's. The created file can be used later to perform a direct descrambling test using the option **--cw-file** of the plugin **descrambler**.

--pre-reduce-cw

> With DVB-CSA2, when entropy reduction is on (the default), make sure that control words are reduced from the beginning, including when transmitted to an ECMG.
>
> By default, entropy reduction is applied just before encryption only, and the ECMG receives a full random CW, without entropy reduction. The default behavior is suitable to test if the CAS correctly handles entropy reduction without implicitly reduced control words.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[*-label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

⁙ **sdt**

Perform various transformations on an SDT

This plugin performs various transformations on an SDT, either the SDT-Actual or some specific SDT-Other. The other SDT's, if present, are left unchanged.

Usage

```
tsp -P sdt [options]
```

Options

--bitrate *value*

> Specifies the bitrate in bits / second of the PID containing the SDT if a new one is created.
>
> See section 2.2 for more details on the representation of bitrates.
>
> The default is 3,000 b/s.

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--cleanup-private-descriptors

> Remove all private descriptors without preceding *private_data_specifier_descriptor*.

-c
--create

> Create a new empty SDT if none was received after one second.
>
> This is equivalent to **--create-after 1000**.

--create-after *milliseconds*

> Create a new empty SDT if none was received after the specified number of milliseconds. If an actual SDT is received later, it will be used as the base for transformations instead of the empty one.

--default-charset *name*

> Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.
>
> By default, standard DVB encoding is used. See section 2.5 for more details.

--eit-pf *value*

> Specify a new *EIT_present_following_flag* value (0 or 1) for the added or modified service. For new services, the default is 0.

--eit-schedule *value*

> Specify a new *EIT_schedule_flag* value (0 or 1) for the added or modified service. For new services, the default is 0.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

-f *value*
--free-ca-mode *value*

> Specify a new *free_CA_mode* value (0 or 1) for the added or modified service. For new services, the default is 0.

-i
--increment-version

> Increment the version number of the SDT.

--inter-packet *value*

> When a new SDT is created and **--bitrate** is not present, this option specifies the packet interval for the SDT PID, that is to say the number of TS packets in the transport between two packets of the PID.

> Use instead of -**-bitrate** if the global bitrate of the TS cannot be determined.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

-n *value*
--name *value*

> Specify a new service name for the added or modified service. For new services, the default is an empty string.

-v *value*
--new-version *value*

> Specify a new value for the version of the SDT.

--original-network-id *id*

> Modify the original network id in the SDT with the specified value.

-o *id*
--other *id*

> Modify the SDT-Other with the specified TS id. By default, modify the SDT-Actual.

--patch-xml *filename*

> Specify an XML patch file which is applied to each SDT on the fly. The XML patches are applied first. The other options of this plugin are applied on the patched table.

> If the specified name starts with "**<?xml**", it is considered as *inline XML content*, meaning that the string in the command line is directly the XML content and not a file name.

> Several **--patch-xml** options can be specified. Patch files are sequentially applied on each table.

> See section 2.6.4 for more details on XML patch files.

--philippines

> A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *value*
--provider *value*

> Specify a new provider name for the added or modified service. For new services, the default is an empty string.

--remove-service *sid*

> Remove the specified service-id from the SDT. Several **--remove-service** options may be specified to remove several services.

-r *value*
--running-status *value*

> Specify a new *running_status* value (0 to 7) for the added or modified service. For new services, the default is 4 ("*running*").

-s *value*
--service-id *value*

>   Add a new service or modify the existing service with the specified service-id.

--ts-id *id*

>   Modify the transport stream id in the SDT with the specified value.

-t *value*
--type *value*

>   Specify a new service type for the added or modified service. For new services, the default is
>   **0x01** ("*digital television service*").

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

>   Display this help text.

--only-label *label1*[-*label2*]

>   Invoke this plugin only for packets with any of the specified labels. Other packets are
>   transparently passed to the next plugin, without going through this one.
>
>   Several **--only-label** options may be specified.

⁝⁝ sections

Remove, keep or merge sections from various PID's

This plugin extracts sections from one or more PID's and merges them inside an output PID.

Various filtering options can be used to selectively keep or remove sections. By default, the selected sections are removed. Using the option **--keep**, the selected sections are kept and all others are removed. Without selection option, the sections are simply merged from the various input PID's into the output PID.

Usage

```
tsp -P sections [options]
```

General options

-a
--and

> Remove or keep a section when all conditions are true ("and" on conditions).
>
> By default, a section is removed or kept as soon as one remove condition is true ("or" on conditions).
>
> Examples: The options **--tid 2 --version 6** remove all PMT sections (table id 2) and all sections with version 6 (any table id). On the other hand, **--and --tid 2 --version 6** remove only PMT sections with version 6.

-k
--keep

> Keep selected sections and remove others. The selection options are **--tid**, **--etid**, **--version**, etc.
>
> By default, when selection options are present, the selected sections are removed. If no selection option is present, the sections are simply merged from the various input PID's.

-n
--null-pid-reuse

> With this option, null packets can be replaced by packets for the output PID.
>
> By default, only packets from input PID's are replaced by output packets. This option may need to be used when **--stuffing** is specified and the input PID's contained packed sections. In that case, the output payload can be larger than the input and additional packets must be used.

--patch-xml *filename*

> Specify an XML patch file which is applied to each section on the fly.
>
> Here, the behavior of **--patch-xml** is slightly different, compared to other commands or plugins. While XML representation and patch normally apply to a complete table, they process one single section here. This means that the result of the patch must fit into one single section. Otherwise, only the first section of the result is kept (with the original section number of the input section).
>
> If the specified name starts with "**<?xml**", it is considered as *inline XML content*, meaning that the string in the command line is directly the XML content and not a file name.
>
> Several **--patch-xml** options can be specified. Patch files are sequentially applied on each section.
>
> See section 2.6.4 for more details on XML patch files.

-o *value*
--output-pid *value*

>   Specify the output PID. By default, the first input PID on the command line is used as output PID.

>   If the output PID is different from all input PID's and this output PID already exists in the transport stream, an error is generated.

-p *pid1*[*-pid2*]
--pid *pid1*[*-pid2*]

>   Specify input PID's. More than one input PID can be specified. All sections from all input PID's are merged into the output PID. At least one input PID must be specified.

-r
--reverse-etid

>   With option **--etid**, reverse the table id and the table id extension parts in the *extended table id* values. With this option, the values in **--etid** are of the form **0x*EEEETT*** instead of **0x*TTEEEE*** where *TT* is the table id part and *EEEE* the table id extension part.

>   This option can be useful when specifying ranges of values. For instance, the option **--etid 0x4A1234-0x4A1250** removes BAT sections (table id **0x4A**) for all service ids in the range **0x1234** to **0x1250**. On the other hand, the options **--etid 0x12344E-0x12346F --reverse-etid** remove all EIT sections (table ids **0x4E** to **0x6F**) for the service id **0x1234**.

-s
--stuffing

>   Insert stuffing at end of each section, up to the next TS packet boundary. By default, sections are packed and start in the middle of a TS packet, after the previous section. Note, however, that section headers are never scattered over a packet boundary.

Section selection options

--etid *id1*[*-id2*]

>   Remove or keep all sections with the corresponding *extended table id* values. The value is a combination of the table id and the table id extension.

>   For example, the option **-e 0x4A1234** removes all BAT sections (table id **0x4A**) for bouquet id **0x1234** (table id extension).

>   Several options **--etid** can be specified.

>   This option is now considered legacy. The option "**--etid 0x*TTEEEE***" where *TT* is the table id part and *EEEE* the table id extension part can now be more clearly specified as **--and --tid 0x*TT* --tid-ext 0x*EEEE***.

--section-content *hexa-data*

>   Remove or keep all sections the binary content of which starts with the specified binary data.

>   The value must be a string of hexadecimal digits specifying any number of bytes.

>   See also option **--section-mask** to specify selected bits or bytes only.

>   Several options **--section-content** can be specified.

--section-mask *hexa-data*

>   With **--section-content**, specify a mask of meaningful bits in the binary data that must match the beginning of the section.

>   The value must be a string of hexadecimal digits specifying any number of bytes.

>   If omitted or shorter than the **--section-content** parameter, the mask is implicitly padded with **FF** bytes. If several options **--section-content** are specified, several options **--section-mask** can

be specified. The first mask applies to the first content, the second mask to the second content, etc. If there are less masks than contents, the last mask is implicitly repeated.

--section-number *num1*[-*num2*]

Remove/keep all sections with the corresponding section number.

Several options **--section-number** can be specified.

-t *id1*[-*id2*]
--tid *id1*[-*id2*]

Remove or keep all sections with the corresponding table ids.

Several options **--tid** can be specified.

-e *id1*[-*id2*]
--tid-ext *id1*[-*id2*]

Remove or keep all sections with the corresponding table id extensions.

Several options **--tid-ext** can be specified.

-v *v1*[-v*2*]
--version *v1*[-v*2*]

Remove or keep all sections with the corresponding versions.

Several options **--version** can be specified.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ sifilter

Extract PSI/SI PID's

This plugin filters PID's containing the specified PSI/SI. Other PID's are removed.

Extracting PSI/SI on predefined PID's (such as PAT or SDT) can also be performed using the plugin **filter --pid**. For these types of PSI/SI, the plugin **sifilter** is simply more user-friendly (**sifilter --sdt** instead of **filter --pid 0x0011**). But the plugin **sifilter** can also detect PSI/SI on non-predefined PID's (such as PMT, ECM or EMM). It can also filter CA-related SI according to the CA System Id or CA Operator (a vendor-dependent concept).

If you want to extract the PMT or ECM for one particular service, use the plugin **zap** before **sifilter** in the plugin chain.

Usage

```
tsp -P sifilter [options]
```

Options

--bat

Extract PID **0x0011** (SDT/BAT). Same as **--sdt**.

--cat

Extract PID **0x0001** (CAT).

--eit

Extract PID **0x0012** (EIT).

--nit

Extract PID **0x0010** (NIT).

--pat

Extract PID **0x0000** (PAT).

-p
--pmt

Extract all PMT PID's.

--rst

Extract PID **0x0013** (RST).

--sdt

Extract PID **0x0011** (SDT/BAT). Same as **--bat**.

-s
--stuffing

Replace excluded packets with stuffing (null packets) instead of removing them. Useful to preserve bitrate.

--tdt

Extract PID **0x0014** (TDT/TOT). Same as **--tot**.

--tot

Extract PID **0x0014** (TDT/TOT). Same as **--tdt**.

--tsdt

Extract PID **0x0002** (TSDT).

CAS selection options

--cas *value*

> With options **--ecm** or **--emm**, select only ECM's or EMM's for the specified CA system id value. Equivalent to **--min-cas *value* --max-cas *value***.

--conax

> Equivalent to **--min-cas 0x0B00 --max-cas 0x0BFF**.

--ecm

> Extract PID's containing ECM.

--emm

> Extract PID's containing EMM.

--irdeto

> Equivalent to **--min-cas 0x0600 --max-cas 0x06FF**.

--max-cas *value*

> With options **--ecm** or **--emm**, select only ECM's or EMM's for the CA system id values in the range **--min-cas** to **--max-cas**.

--mediaguard

> Equivalent to **--min-cas 0x0100 --max-cas 0x01FF**.

--min-cas *value*

> With options **--ecm** or **--emm**, select only ECM's or EMM's for the CA system id values in the range **--min-cas** to **--max-cas**.

--nagravision

> Equivalent to **--min-cas 0x1800 --max-cas 0x18FF**.

--nds

> Equivalent to **--min-cas 0x0900 --max-cas 0x09FF**.

--operator *value*

> When a CAS is specified, select only ECM's or EMM's for the specified CAS operator. The "*CAS operator*" is a non-standard vendor-dependent concept and is recognized for some CAS only.

--safeaccess

> Equivalent to **--cas 0x4ADC**.

--viaccess

> Equivalent to **--min-cas 0x0500 --max-cas 0x05FF**.

--widevine

> Equivalent to **--min-cas 0x4AD4 --max-cas 0x4AD5**.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[*-label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

∷ skip

Skip leading packets in a TS

The plugin skips leading TS packets of a stream. The specified number of initial TS packets are dropped and not transmitted to the next plugin in the chain. After that, all packets are transparently passed.

Usage

```
tsp -P skip [options] count
```

Parameter

Number of leading TS packets to skip.

Options

-s
--stuffing

Replace excluded leading packets with stuffing (null packets) instead of removing them.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ **slice**

Pass or drop packets based on packet numbers

This plugin passes or drops packets based on packet numbers or relative transport stream time. It can be used to extract selected portions of a TS and group them into one single output.

Usage

```
tsp -P slice [options]
```

Options

-d *value*
--drop *value*

> All packets are dropped after the specified packet number.
>
> Several **--drop** options may be specified.

-i
--ignore-pcr

> When **--seconds** or **--milli-seconds** is used, do not use PCR's to compute time values. Only rely on bitrate as determined by previous plugins in the chain.

-m
--milli-seconds

> With options **--drop**, **--null**, **--pass** and **--stop**, interpret the integer values as milli-seconds from the beginning, not as packet numbers. Time is measured based on bitrate and packet count, not on real time.

-n *value*
--null *value*

> All packets are replaced by null packets after the specified packet number.
>
> Several **--null** options may be specified.

-p *value*
--pass *value*

> All packets are passed unmodified after the specified packet number.
>
> Several **--pass** options may be specified. This is the default for the initial packets.

--seconds

> With options **--drop**, **--null**, **--pass** and **--stop**, interpret the integer values as seconds from the beginning, not as packet numbers. Time is measured based on bitrate and packet count, not on real time.

-s *value*
--stop *value*

> Packet transmission stops after the specified packet number and **tsp** terminates.

Generic packet processing plugin options

> The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[*-label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⬛ spliceinject

Inject SCTE 35 splice commands in a transport stream

This plugin injects splice commands as *splice information sections*, as defined by the SCTE 35 standard [22]. All forms of splice information sections can be injected. The sections shall be provided by some external equipment, in real time.

The format of the sections can be binary, XML or JSON (see section 2.3). The reference source format for sections is XML. JSON files are first translated to XML using the "automated XML-to-JSON conversion" (see 2.7.3) rules of TSDuck and then compiled to binary.

All sections or tables shall be *splice information sections* (table id **0xFC**).

Injection principles

The whole point about splice information is synchronization with video. There are roughly two classes of splice events:

- Non-immediate **splice_insert()** and **time_signal()** commands. These commands contain a specific PTS value for the event. This PTS refers to a time stamp in the video and audio PID's of the service.
- Everything else.

Any splice command in the "everything else" category is injected as soon as possible after reception.

A non-immediate **splice_insert()** or **time_signal()** command is injected a specific number of times (2 by default) within a short period of time (2 seconds by default) preceding the specified PTS timestamp in the video stream.

When such a command is received in the plugin, the PTS of the event is compared with the current (or latest) PTS in the service. If the command is late and the PTS of the event is already in the past, the command is dropped. Otherwise, the command is placed in a waiting queue until the event time minus some predefined duration (see option **--start-delay**). At this time, the command is sent for the first time. It is later re-sent zero or more times. When the event time occurs, the command is no longer needed and is dropped.

Providing splice information tables

There are two possible mechanisms to provide the sections: files or UDP. The two options may be used simultaneously.

Files shall be specified as one single specification with optional wildcards. Example:

```
tsp ... –P spliceinject --files '/path/to/dir/splice*.xml' ...
```

All files named **splice*.xml** which are copied or updated into this directory are automatically loaded and injected. It is possible to automatically delete all files after being loaded.

UDP datagrams shall contain exactly one XML document or several binary sections. The XML document may contain several tables. The sections are injected upon reception. UDP reception is enabled by specifying a local port number. Example, listening on UDP port number 4444:

```
tsp ... –P spliceinject --udp 4444 ...
```

Using UDP usually provides a better reactivity than files. UDP messages are processed immediately after reception while files are detected on polling sequences only.

On a usability standpoint, remember that the bash[7] shell provides an easy way to send data or a file in an UDP message. So, sending a file though UDP is not more difficult than copying it to a directory. The following first command sends an XML file as one single UDP message on port 4444 to system 127.0.0.1 (the local host). The second command illustrates the file option.

```
cat splice_12.xml >/dev/udp/127.0.0.1/4444
cp splice_12.xml /path/to/dir
```

Usage

```
tsp -P spliceinject [options]
```

General options

--brazil

A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.

By default, standard DVB encoding is used. See section 2.5 for more details.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--inject-count *value*

For non-immediate *splice_insert()* and *time_signal()* commands, specifies the number of times the same splice information section is injected. The default is 2. Other splice commands are injected once only.

--inject-interval *value*

For non-immediate *splice_insert()* and *time_signal()* commands, specifies the interval in milliseconds between two insertions of the same splice information section. The default is 800 ms.

--japan

A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

--min-bitrate *value*

The minimum bitrate to maintain in the PID carrying the splice information tables.

See section 2.2 for more details on the representation of bitrates.

By default, the PID remains inactive when there is no splice information. If this is a problem for monitoring tools, an artificial minimum bitrate can be maintained for that PID using *splice_null()* commands.

--min-inter-packet *value*

This option can be used instead of **--min-bitrate** when the bitrate of the transport stream is unknown or unreliable. The specified value is the number of TS packets between two splice commands to insert, using *splice_null()* commands when necessary.

--pcr-pid *value*

Specifies the PID carrying the PCR reference clock. By default, use the PCR PID as declared in the PMT of the service.

---

[7] This is a feature of *bash*, not a Linux feature. It is available on all platforms, including macOS or Cygwin.

--philippines

A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *value*
--pid *value*

Specifies the PID for the injection of the splice information tables. By default, the injection of splice commands is done in the component of the service with a stream type equal to **0x86** in the PMT, as specified by SCTE 35 standard.

--pts-pid *value*

Specifies the PID carrying PTS reference clock. By default, use the video PID as declared in the PMT of the service.

--queue-size *value*

Specifies the maximum number of sections in the internal queue, sections which are received from files or UDP but not yet inserted into the TS. The default is 100.

-s *value*
--service *value*

Specifies the service for the insertion of the splice information tables.

If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id.

If it is an empty string or "**-**", the first service in the PAT is used.

Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored. If the input TS does not contain an SDT, use service ids only.

If no service is specified, the options **--pid** and **--pts-pid** must be specified (**--pcr-pid** is optional).

--start-delay *value*

For non-immediate *splice_insert()* and *time_signal()* commands, start to insert the first section this number of milliseconds before the specified splice PTS value. The default is 2000 ms.

-w
--wait-first-batch

When this option is specified, the start of the plugin is suspended until the first batch of splice commands is loaded and queued. Without this option, the input files or messages are loaded and queued asynchronously.

This option is typically useful when inserting splice commands from an XML file into a transport stream file. Since files are read much faster than the normal playout speed, it is possible that the splice points are already passed in the transport stream processing when the XML file is loaded. With this option, we have the guarantee that the XML file is loaded before the transport stream processing starts.

On the other hand, this option should not be used on live transport streams. In that case, the transport stream processing must be allowed to start without splice information tables to inject. These tables may be sent much later.

File input options

-d
--delete-files

Specifies that the files should be deleted after being loaded. By default, the files are left unmodified after being loaded. When a loaded file is modified later, it is reloaded and re-injected.

-f '*file-wildcard*'
--files '*file-wildcard*'

> A file specification with optional wildcards indicating which files should be polled. When such a file is created or updated, it is loaded and its content is interpreted as binary, XML or JSON tables. All tables shall be splice information tables.

--max-file-size *value*

> Files larger than the specified size are ignored. This avoids loading large spurious files which could clutter memory. The default is 2048 bytes.

--min-stable-delay *value*

> A file size needs to be stable during that duration, in milliseconds, for the file to be reported as added or modified. This prevents too frequent poll notifications when a file is being written and his size modified at each poll. The default is 500 ms.

--poll-interval *value*

> Specifies the interval in milliseconds between two poll operations. The default is 500 ms.

UDP input options

--buffer-size *value*

> Specifies the UDP socket receive buffer size in bytes (socket option).

--no-reuse-port

> Disable the reuse port socket option. Do not use unless completely necessary.

-r
--reuse-port

> Set the reuse port socket option. This is now enabled by default, the option is present for legacy only.

-u [*address*:]*port*
--udp [*address*:]*port*

> Specifies the local UDP port on which the plugin listens for incoming binary or XML splice information tables. When present, the optional address shall specify a local IP address or host name (by default, the plugin accepts connections on any local IP interface).

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

▪ splicemonitor

Monitor SCTE 35 splice information

This plugin monitors *splice information sections*, as defined by the SCTE 35 standard [22]. The event reference, the number of occurrences of each command and the time between the command and the event itself (sometimes called *pre-roll time*) are displayed.

Usage

```
tsp -P splicemonitor [options]
```

Options

--alarm-command "*command***"**

   Command to run when a splice event is outside the nominal range as specified by other **--min** and **--max** options.

   The command receives seven additional parameters:

   5. A human-readable message, the same as logged by the plugin.

   6. The PID of the splice command.

   7. The event id.

   8. The string "**in**" or "**out**" for splice in / splice out command.

   9. The adjusted PTS value in the splice command.

   10. Pre-roll time in milliseconds. This is the time between the first occurrence of a splice command and the corresponding event.

   11. Number of occurences of the command before the event.

   These parameters can be used or ignored by the alarm command.

-a
--all-commands

   Same as **--display-commands** but display all SCTE-35 splice information commands.

   This is equivalent to **--select-commands 0-255**.

   By default, only display splice insert commands.

-d
--display-commands

   Display the content of SCTE-35 splice insert commands.

   By default, only log a short event description.

-j
--json

   Build a JSON report into the specified file. Using '**-**' as file name means standard output.

   When **--all-commands** is specified, each SCTE-35 table is initially formatted as XML and an automated XML-to-JSON conversion is applied. See section 2.7.3 for more details on XML-to-JSON conversion.

--json-buffer-size *value*

   With **--json-tcp** or **--json-udp**, specify the network socket send buffer size.

--json-line[='*prefix*']

   Same as **--json** but log each event or table as one single JSON line in the message logger instead of an output file.

The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--json-tcp *address:port*

Same as **--json** but report the JSON text as one single line in a TCP connection instead of the output file.

The *address* specifies an IP address or a host name that translates to an IP address. The *port* specifies the destination TCP port.

By default, a new TCP connection is established each time a JSON message is produced (see also option **--json-tcp-keep**). Be aware that a complete TCP connection cycle may introduce some latency in the processing. If latency is an issue, consider using **--json-udp**.

--json-tcp-keep

With --json-tcp, keep the TCP connection open for all JSON messages. By default, a new TCP connection is established each time a JSON message is produced.

--json-udp *address:port*

Same as **--json** but report the JSON text as one single line in a UDP datagram instead of the output file.

The *address* specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The *port* specifies the destination UDP port.

Be aware that the size of UDP datagrams is limited by design to 64 kB. If larger JSON contents are expected, consider using **--json-tcp**.

--json-udp-local *address*

With **--json-udp**, when the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--json-udp-ttl *value*

With **--json-udp**, specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address. Remember that the default Multicast TTL is 1 on most systems.

--max-pre-roll-time *value*

Specify a maximum pre-roll time in milliseconds for splice commands.

See option **--alarm-command** for the processing of non-nominal cases.

--max-repetition *value*

Specify a maximum number of repetitions for each splice command.

See option **--alarm-command** for the processing of non-nominal cases.

--meta-sections

Add an hexadecimal dump of each section in the XML and JSON metadata.

--min-pre-roll-time *value*

Specify a minimum pre-roll time in milliseconds for splice commands.

See option **--alarm-command** for the processing of non-nominal cases.

--min-repetition *value*

Specify a minimum number of repetitions for each splice command.

See option **--alarm-command** for the processing of non-nominal cases.

-n

--no-adjustment

> When computing the anticipated pre-roll time at reception of a splice command, do not try to adjust the time using the distance between the last PTS and the splice command.
>
> By default, use the bitrate to adjust the supposed PTS of the splice command itself.

-o *file-name*

--output-file *file-name*

> Specify an output text file. With **--json**, this will be a JSON file.
>
> By default, use the message logging system for short messages and the standard output with **--display-commands**.

-i

--packet-index

> Display the current TS packet index for each message or event.

--select-commands *value1*[*–value2*]

> Same as **--display-commands** but display the specified SCTE-35 command types only.
>
> By default, only display splice insert commands.
>
> Several **--select-commands** can be specified.

-s *value*

--splice-pid *value*

> Specify one single PID carrying SCTE-35 sections to monitor.
>
> By default, all SCTE-35 PID's are monitored, based in their signalization in the PMT's.

-t *value*

--time-pid value

> Specify one video or audio PID containing PTS time stamps to link with SCTE-35 sections to monitor.
>
> By default, the PMT's are used to link between PTS PID's and SCTE-35 PID's.

--time-stamp

> Add a time stamp (current local time) inside each JSON structure (tables and events).

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[*-label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

▪ srt (input)

Receive TS packets from Secure Reliable Transport (SRT)

This input plugin receives TS packets from Secure Reliable Transport (SRT).

The received UDP datagrams are analyzed and all TS packets are extracted. Optional extra data at the beginning of the datagram are discarded.

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Restrictions

> This plugin is not available on all platforms. It is provided only when **libsrt** is available during the compilation of TSDuck. Typically, this plugin is available on macOS, Windows, Fedora 31 onwards, Ubuntu 19.04 onwards.

Acknowledgement

> This plugin is a contribution from Anthony Delannoy.

Input timestamps

> The SRT source time value of each measage is used as input timestamp by **tsp** for all TS packets in this message.

Usage

```
tsp -I srt [options]
```

General options

-d *value*
--display-interval *value*

> Specify the interval in seconds between two displays of the evaluated real-time input bitrate. The default is to never display the bitrate. This option is ignored if `--evaluation-interval` is not specified.

-e *value*
--evaluation-interval *value*

> Specify that the real-time input bitrate shall be evaluated on a regular basis. The value specifies the number of seconds between two evaluations. By default, the real-time input bitrate is never evaluated and the input bitrate is evaluated from the PCR in the input packets.

--timestamp-priority *name*

> Specify how the input timestamp of each packet is computed.
>
> The name specifies an ordered list of timestamp sources. The first available timestamp value is used as input timestamp. The name must be one of "**rtp-srt-tsp**", "**srt-rtp-tsp**", "**srt-tsp**", "**rtp-tsp**", "**tsp**".
>
> The possible timestamp sources are:
>
> - **rtp** : The RTP time stamp, when the UDP packet is an RTP packet.
> - **srt** : SRT source time stamp.
> - **tsp** : A software timestamp, provided by tsp when the input plugin returns a chunk of packets. The tsp-provided timestamp is always available, always comes last and is less precise.
>
> The default is **rtp-srt-tsp**.

Common SRT options

--backlog *value*

> With **--listener**, specify the number of allowed waiting incoming clients.
>
> The default is one.

--bufferapi

> When set, this socket uses the Buffer API. The default is Message API.

-c *address:port*
--caller *address:port*

> Use SRT in caller (or rendezvous) mode. The parameter specifies the IPv4 remote address (or host name) and UDP port.
>
> If **--listener** is also specified, the SRT socket works in rendezvous mode.

--conn-timeout *value*

> Connect timeout. SRT cannot connect for RTT > 1500 msec (2 handshake exchanges) with the default connect timeout of 3 seconds.
>
> This option applies to the caller and rendezvous connection modes. The connect timeout is 10 times the value set for the rendezvous mode (which can be used as a workaround for this connection problem with earlier versions.

--enforce-encryption

> This option enforces that both connection parties have the same passphrase set (including empty, that is, with no encryption), or the connection is rejected.

--ffs *value*

> Flight Flag Size (maximum number of bytes that can be sent without being acknowledged).

--final-statistics

> Report SRT usage statistics when the SRT socket is closed.
>
> This option is implicit with **--statistics-interval**.

--input-bw *value*

> This option is effective only if **SRTO_MAXBW** is set to **0** (relative).
>
> It controls the maximum bandwidth together with **SRTO_OHEADBW** option according to the formula: **MAXBW = INPUTBW * (100 + OHEADBW) / 100**.
>
> When this option is set to **0** (automatic) then the real **INPUTBW** value will be estimated from the rate of the input (cases when the application calls the *srt_send* function) during transmission.
>
> Recommended: set this option to the predicted bitrate of your live stream and keep default 25% value for **SRTO_OHEADBW**.

--iptos *value*

> IPv4 Type of Service (see **IP_TOS** option for IP) or IPv6 Traffic Class (see **IPV6_TCLASS** of IPv6) depending on socket address family.
>
> Applies to sender only. Sender: user configurable, default: **0xB8**.

--ipttl *value*

> IPv4 Time To Live (see **IP_TTL** option for IP) or IPv6 unicast hops (see **IPV6_UNICAST_HOPS** for IPV6) depending on socket address family.
>
> Applies to sender only, default: 64.

--json-line[='*prefix*']

> With **--statistics-interval** or **--final-statistics**, report the statistics as one single line in JSON format.
>
> The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--kmpreannounce *value*

> The interval (defined in packets) between when a new Stream Encrypting Key (SEK) is sent and when switchover occurs. This value also applies to the subsequent interval between when switchover occurs and when the old SEK is decommissioned.
>
> Note: The allowed range for this value is between 1 and half of the current value of **SRTO_KMREFRESHRATE**. The minimum value should never be less than the flight window (i.e. the number of packets that have already left the sender but have not yet arrived at the receiver).

--kmrefreshrate *value*

> The number of packets to be transmitted after which the Stream Encryption Key (SEK), used to encrypt packets, will be switched to the new one.
>
> Note that the old and new keys live in parallel for a certain period of time (see **SRTO_KMPREANNOUNCE**) before and after the switchover.

--latency *value*

> This flag sets both **SRTO_RCVLATENCY** and **SRTO_PEERLATENCY** to the same value.
>
> Note that prior to version 1.3.0 this is the only flag to set the latency, however this is effectively equivalent to setting **SRTO_PEERLATENCY**, when the side is sender (see **SRTO_SENDER**) and **SRTO_RCVLATENCY** when the side is receiver, and the bidirectional stream sending in version 1.2.0 is not supported.

--linger *value*

> Linger time on close.
>
> Recommended value: 0

-l [*address:*]*port*
--listener [*address:*]*port*

> Use SRT in listener (or rendezvous) mode. The parameter specifies the IPv4 local address and UDP port on which the SRT socket listens. The address is optional, the port is mandatory.
>
> If **--caller** is also specified, the SRT socket works in rendezvous mode.

--local-interface *address*

> In caller mode, use the specified local IP interface for outgoing connections.
>
> This option is incompatible with **--listener**.

--lossmaxttl *value*

> The value up to which the Reorder Tolerance may grow.
>
> When Reorder Tolerance is > 0, then packet loss report is delayed until that number of packets come in. Reorder Tolerance increases every time a "belated" packet has come, but it wasn't due to retransmission (that is, when UDP packets tend to come out of order), with the difference between the latest sequence and this packet's sequence, and not more than the value of this option.
>
> By default it's 0, which means that this mechanism is turned off, and the loss report is always sent immediately upon experiencing a "gap" in sequences.

--max-bw *value*

Maximum send bandwidth.

Note: This option has a default value of -1. Although in case when the stream rate is mostly constant it is recommended to use value 0 here and shape the bandwidth limit using **SRTO_INPUTBW** and **SRTO_OHEADBW** options.

--messageapi

Use the Message API. This is now the default. Specify **--bufferapi** to use the Buffer API.

--min-version *value*

The minimum SRT version that is required from the peer. A connection to a peer that does not satisfy the minimum version requirement will be rejected.

--mss *value*

Maximum Segment Size. Used for buffer allocation and rate calculation using packet counter assuming fully filled packets.

The smallest MSS between the peers is used. This is 1500 by default in the overall internet. This is the maximum size of the UDP packet and can be only decreased, unless you have some unusual dedicated network settings.

Not to be mistaken with the size of the UDP payload or SRT payload - this size is the size of the IP packet, including the UDP and SRT headers.

--nakreport *value*

When this option is specified, the receiver will send **UMSG_LOSSREPORT** messages periodically until the lost packet is retransmitted or intentionally dropped.

--no-reuse-port

With **--listener**, disable the reuse port socket option.

Do not use unless completely necessary.

--ohead-bw *value*

Recovery bandwidth overhead above input rate (see **SRTO_INPUTBW**). It is effective only if **SRTO_MAXBW** is set to 0.

--packet-filter *value*

Set up the packet filter. The string must match appropriate syntax for packet filter setup.

See: https://github.com/Haivision/srt/blob/master/docs/packet-filtering-and-fec.md

--passphrase *value*

Sets the passphrase for encryption. This turns encryption on on this side (or turns it off, if empty passphrase is passed). The passphrase must be 10 to 64 characters long.

--payload-size *value*

Sets the maximum declared size of a single call to sending function in Live mode. Use 0 if this value isn't used (which is default in file mode).

This value shall not be exceeded for a single data sending instruction in Live mode.

--pbkeylen *value*

Sender encryption key length, can be 0, 16 (AES-128), 24 (AES-192), 32 (AES-256).

--peer-idle-timeout *value*

The maximum time in milliseconds to wait until any packet is received from peer since the last such packet reception. If this time is passed, connection is considered broken on timeout.

--peer-latency *value*

The latency value (as described in **SRTO_RCVLATENCY**) that is set by the sender side as a minimum value for the receiver.

--polling-time *value*

Epoll timeout value in milliseconds for non-blocking mode.

--rcv-latency *value*

The time that should elapse since the moment when the packet was sent and the moment when it's delivered to the receiver application in the receiving function.

--rcvbuf *value*

Receive Buffer Size.

--sndbuf *value*

Send Buffer Size.

Warning: configured in bytes, converted in packets, when set, based on MSS value.

For desired result, configure MSS first.

--statistics-interval *milliseconds*

Report SRT usage statistics at regular intervals, in milliseconds.

The specified interval is a minimum value, actual reporting can occur only when data are exchanged over the SRT socket.

--streamid *value*

A string limited to 512 characters that can be set on the socket prior to connecting. This stream ID will be able to be retrieved by the listener side from the socket that is returned from srt_accept and was connected by a socket with that set stream ID (so you usually use SET on the socket used for srt_connect and GET on the socket retrieved from srt_accept). This string can be used completely free-form, however it's highly recommended to follow the SRT Access Control guidlines.

--tlpktdrop

Too-late Packet Drop. When enabled on receiver, it skips missing packets that have not been delivered in time and delivers the subsequent packets to the application when their time-to-play has come. It also sends a fake ACK to the sender. When enabled on sender and enabled on the receiving peer, sender drops the older packets that have no chance to be delivered in time. It is automatically enabled in sender if receiver supports it.

--transtype *value*

Sets the transmission type for the socket, in particular, setting this option sets multiple other parameters to their default values as required for a particular transmission type.

--udp-rcvbuf *value*

UDP socket receive buffer size in bytes.

--udp-sndbuf *value*

UDP socket send buffer size in bytes.

Generic common input plugin options

The following options are implicitly defined in all input plugins.

--help

Display plugin help text.

▪ srt (output)

Send TS packets using Secure Reliable Transport (SRT)

This output plugin sends TS packets using Secure Reliable Transport (SRT).

Using this plugin forces **tsp** and all plugins to use their real-time defaults (see the reference documentation for **tsp**).

Restrictions

This plugin is not available on all platforms. It is provided only when **libsrt** is available during the compilation of TSDuck. Typically, this plugin is available on macOS, Windows, Fedora 31 onwards, Ubuntu 19.04 onwards.

Acknowledgement

This plugin is a contribution from Anthony Delannoy.

Usage

```
tsp -O srt [options]
```

General options

-e
--enforce-burst

Enforce that the number of TS packets per message is exactly what is specified in option **--packet-burst**. By default, this is only a maximum value.

For instance, without **--enforce-burst** and the default **--packet-burst** value (7 packets), if the output plugin receives 16 TS packets, it immediately sends 3 messages containing 7, 7 and 2 TS packets respectively.

With option **--enforce-burst**, only the first 14 TS packets would be sent, using 2 messages. The remaining 2 TS packets are buffered, delaying their departure until 5 more TS packets are available.

-m
--multiple

When the receiver peer disconnects, wait for another one and continue.

-p *value*
--packet-burst *value*

Specifies the maximum number of TS packets to be grouped into each message.

The default is 7, the maximum is 128.

--restart-delay *milliseconds*

With **--multiple**, wait the specified number of milliseconds before restarting.

Common SRT options

--backlog *value*

With **--listener**, specify the number of allowed waiting incoming clients.

The default is one.

--bufferapi

When set, this socket uses the Buffer API. The default is Message API.

-c *address:port*
--caller *address:port*

> Use SRT in caller (or rendezvous) mode. The parameter specifies the IPv4 remote address (or host name) and UDP port.
>
> If **--listener** is also specified, the SRT socket works in rendezvous mode.

--conn-timeout *value*

> Connect timeout. SRT cannot connect for RTT > 1500 msec (2 handshake exchanges) with the default connect timeout of 3 seconds.
>
> This option applies to the caller and rendezvous connection modes. The connect timeout is 10 times the value set for the rendezvous mode (which can be used as a workaround for this connection problem with earlier versions.

--enforce-encryption

> This option enforces that both connection parties have the same passphrase set (including empty, that is, with no encryption), or the connection is rejected.

--ffs *value*

> Flight Flag Size (maximum number of bytes that can be sent without being acknowledged).

--final-statistics

> Report SRT usage statistics when the SRT socket is closed.
>
> This option is implicit with **--statistics-interval**.

--input-bw *value*

> This option is effective only if **SRTO_MAXBW** is set to **0** (relative).
>
> It controls the maximum bandwidth together with **SRTO_OHEADBW** option according to the formula: **MAXBW = INPUTBW * (100 + OHEADBW) / 100**.
>
> When this option is set to **0** (automatic) then the real **INPUTBW** value will be estimated from the rate of the input (cases when the application calls the *srt_send* function) during transmission.
>
> Recommended: set this option to the predicted bitrate of your live stream and keep default 25% value for **SRTO_OHEADBW**.

--iptos *value*

> IPv4 Type of Service (see **IP_TOS** option for IP) or IPv6 Traffic Class (see **IPV6_TCLASS** of IPv6) depending on socket address family.
>
> Applies to sender only. Sender: user configurable, default: **0xB8**.

--ipttl *value*

> IPv4 Time To Live (see **IP_TTL** option for IP) or IPv6 unicast hops (see **IPV6_UNICAST_HOPS** for IPV6) depending on socket address family.
>
> Applies to sender only, default: 64.

--json-line[='*prefix*']

> With **--statistics-interval** or **--final-statistics**, report the statistics as one single line in JSON format.
>
> The optional string parameter specifies a prefix to prepend on the log line before the JSON text to facilitate the filtering of the appropriate line in the logs.

--kmpreannounce *value*

> The interval (defined in packets) between when a new Stream Encrypting Key (SEK) is sent and when switchover occurs. This value also applies to the subsequent interval between when switchover occurs and when the old SEK is decommissioned.

Note: The allowed range for this value is between 1 and half of the current value of **SRTO_KMREFRESHRATE**. The minimum value should never be less than the flight window (i.e. the number of packets that have already left the sender but have not yet arrived at the receiver).

--kmrefreshrate *value*

The number of packets to be transmitted after which the Stream Encryption Key (SEK), used to encrypt packets, will be switched to the new one.

Note that the old and new keys live in parallel for a certain period of time (see **SRTO_KMPREANNOUNCE**) before and after the switchover.

--latency *value*

This flag sets both **SRTO_RCVLATENCY** and **SRTO_PEERLATENCY** to the same value.

Note that prior to version 1.3.0 this is the only flag to set the latency, however this is effectively equivalent to setting **SRTO_PEERLATENCY**, when the side is sender (see **SRTO_SENDER**) and **SRTO_RCVLATENCY** when the side is receiver, and the bidirectional stream sending in version 1.2.0 is not supported.

--linger *value*

Linger time on close.

Recommended value: 0

-l [*address:*]*port*
--listener [*address:*]*port*

Use SRT in listener (or rendezvous) mode. The parameter specifies the IPv4 local address and UDP port on which the SRT socket listens. The address is optional, the port is mandatory.

If **--caller** is also specified, the SRT socket works in rendezvous mode.

--local-interface *address*

In caller mode, use the specified local IP interface for outgoing connections.

This option is incompatible with **--listener**.

--lossmaxttl *value*

The value up to which the Reorder Tolerance may grow.

When Reorder Tolerance is > 0, then packet loss report is delayed until that number of packets come in. Reorder Tolerance increases every time a "belated" packet has come, but it wasn't due to retransmission (that is, when UDP packets tend to come out of order), with the difference between the latest sequence and this packet's sequence, and not more than the value of this option.

By default it's 0, which means that this mechanism is turned off, and the loss report is always sent immediately upon experiencing a "gap" in sequences.

--max-bw *value*

Maximum send bandwidth.

Note: This option has a default value of -1. Although in case when the stream rate is mostly constant it is recommended to use value 0 here and shape the bandwidth limit using **SRTO_INPUTBW** and **SRTO_OHEADBW** options.

--messageapi

Use the Message API. This is now the default. Specify **--bufferapi** to use the Buffer API.

--min-version *value*

The minimum SRT version that is required from the peer. A connection to a peer that does not satisfy the minimum version requirement will be rejected.

--mss *value*

Maximum Segment Size. Used for buffer allocation and rate calculation using packet counter assuming fully filled packets.

The smallest MSS between the peers is used. This is 1500 by default in the overall internet. This is the maximum size of the UDP packet and can be only decreased, unless you have some unusual dedicated network settings.

Not to be mistaken with the size of the UDP payload or SRT payload - this size is the size of the IP packet, including the UDP and SRT headers.

--nakreport

When this option is specified, the receiver will send **UMSG_LOSSREPORT** messages periodically until the lost packet is retransmitted or intentionally dropped.

--no-reuse-port

With **--listener**, disable the reuse port socket option.

Do not use unless completely necessary.

--ohead-bw *value*

Recovery bandwidth overhead above input rate (see **SRTO_INPUTBW**). It is effective only if **SRTO_MAXBW** is set to 0.

--packet-filter *value*

Set up the packet filter. The string must match appropriate syntax for packet filter setup.

See: https://github.com/Haivision/srt/blob/master/docs/packet-filtering-and-fec.md

--passphrase *value*

Sets the passphrase for encryption. This turns encryption on on this side (or turns it off, if empty passphrase is passed). The passphrase must be 10 to 64 characters long.

--payload-size *value*

Sets the maximum declared size of a single call to sending function in Live mode. Use 0 if this value isn't used (which is default in file mode).

This value shall not be exceeded for a single data sending instruction in Live mode.

--pbkeylen *value*

Sender encryption key length, can be 0, 16 (AES-128), 24 (AES-192), 32 (AES-256).

--peer-idle-timeout *value*

The maximum time in milliseconds to wait until any packet is received from peer since the last such packet reception. If this time is passed, connection is considered broken on timeout.

--peer-latency *value*

The latency value (as described in **SRTO_RCVLATENCY**) that is set by the sender side as a minimum value for the receiver.

--polling-time *value*

Epoll timeout value in milliseconds for non-blocking mode.

--rcv-latency *value*

The time that should elapse since the moment when the packet was sent and the moment when it's delivered to the receiver application in the receiving function.

--rcvbuf *value*

Receive Buffer Size.

--sndbuf *value*

   Send Buffer Size.

   Warning: configured in bytes, converted in packets, when set, based on MSS value.

   For desired result, configure MSS first.

--statistics-interval *milliseconds*

   Report SRT usage statistics at regular intervals, in milliseconds.

   The specified interval is a minimum value, actual reporting can occur only when data are exchanged over the SRT socket.

--streamid *value*

   A string limited to 512 characters that can be set on the socket prior to connecting. This stream ID will be able to be retrieved by the listener side from the socket that is returned from srt_accept and was connected by a socket with that set stream ID (so you usually use SET on the socket used for srt_connect and GET on the socket retrieved from srt_accept). This string can be used completely free-form, however it's highly recommended to follow the SRT Access Control guidlines.

--tlpktdrop

   Too-late Packet Drop. When enabled on receiver, it skips missing packets that have not been delivered in time and delivers the subsequent packets to the application when their time-to-play has come. It also sends a fake ACK to the sender. When enabled on sender and enabled on the receiving peer, sender drops the older packets that have no chance to be delivered in time. It is automatically enabled in sender if receiver supports it.

--transtype *value*

   Sets the transmission type for the socket, in particular, setting this option sets multiple other parameters to their default values as required for a particular transmission type.

--udp-rcvbuf *value*

   UDP socket receive buffer size in bytes.

--udp-sndbuf *value*

   UDP socket send buffer size in bytes.

Generic common output plugin options

The following options are implicitly defined in all output plugins.

--help

   Display plugin help text.

▦ stats

Report various statistics on PID's and labels

This plugin analyzes the selected PID's or labels and reports statistics. It currently focuses on inter-packet distances, the number of packets in the TS between two packets of the same PID or label.

Usage

```
tsp -P stats [options]
```

Options

-c
--csv

> Report the statistics in CSV (*comma-separated values*) format. All values are reported in decimal. It is suitable for later analysis using tools such as Microsoft Excel.

-i *seconds*
--interval *seconds*

> Produce a new output file at regular intervals. The interval value is in seconds. After outputting a file, the statistics are reset, i.e. each output file contains a fully independent analysis.

-l *label1*[-*label2*]
--label *label1*[-*label2*]

> Analyze packets with the specified labels or range of labels. Several -l or --label options may be specified.

> By default, PID's are analyzed. The options **--label** and **--pid** are mutually exclusive.

--log

> Report the statistics in the common transport stream logger, not in a file.

-m
--multiple-files

> When used with **--interval** and **--output-file**, create a new file for each statistics report instead of rewriting the previous file. Assuming that the specified output file name has the form **base.ext**, each file is created with a time stamp in its name as **base-*YYYYMMDD-hhmmss*.ext**.

-n
--noheader

> Do not output initial header line in CSV and text format.

-o *filename*
--output-file *filename*

> Specify the output text file for the analysis result.

> By default, use the standard output.

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

> Analyze the specified PID or range of PID's. Several -p or --pid options may be specified.

> By default, all PID's are analyzed.

-s '*string*'
--separator '*string*'

> Field separator string in CSV output (default: '**,**').

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⦚ stuffanalyze

Analyze the level of stuffing in sections

This plugin analyzes the level of "stuffing" in sections in a list of selected PID's. A section is considered as "stuffing" when its payload is larger than 2 bytes and filled with the same byte value (all **0x00** or all **0xFF** for instance).

The PID's to analyze can be selected manually or using CAS criteria.

Usage

```
tsp -P stuffanalyze [options]
```

Options

-o *file-name*
--output-file *file-name*

> Specify the output text file for the analysis result. By default, use the standard output.

> Warning: if you do not specify this option, be sure to redirect the output plugin to something different from the default. Otherwise, the text output of the analysis will be mixed with the binary output of the TS packets!

-p *pid1*[-*pid2*]
--pid *pid1*[-*pid2*]

> Analyze all sections from these PID values. Several –p or --pid options may be specified.

CAS selection options

--cas *value*

> With options --**ecm** or --**emm**, select only ECM's or EMM's for the specified CA system id value. Equivalent to **--min-cas value --max-cas value**.

--conax

> Equivalent to **--min-cas 0x0B00 --max-cas 0x0BFF**.

--ecm

> Extract PID's containing ECM.

--emm

> Extract PID's containing EMM.

--irdeto

> Equivalent to **--min-cas 0x0600 --max-cas 0x06FF**.

--max-cas *value*

> With options --**ecm** or --**emm**, select only ECM's or EMM's for the CA system id values in the range **--min-cas** to **--max-cas**.

--mediaguard

> Equivalent to **--min-cas 0x0100 --max-cas 0x01FF**.

--min-cas *value*

> With options **--ecm** or **--emm**, select only ECM's or EMM's for the CA system id values in the range **--min-cas** to **--max-cas**.

--nagravision

> Equivalent to **--min-cas 0x1800 --max-cas 0x18FF**.

--nds

　　Equivalent to **--min-cas 0x0900 --max-cas 0x09FF**.

--operator *value*

　　When a CAS is specified, select only ECM's or EMM's for the specified CAS operator. The "*CAS operator*" is a non-standard vendor-dependent concept and is recognized for some CAS only.

--safeaccess

　　Equivalent to **--cas 0x4ADC**.

--viaccess

　　Equivalent to **--min-cas 0x0500 --max-cas 0x05FF**.

--widevine

　　Equivalent to **--min-cas 0x4AD4 --max-cas 0x4AD5**.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

　　Display this help text.

--only-label *label1*[-*label2*]

　　Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

　　Several **--only-label** options may be specified.

▪ **svremove**

Remove a service

This plugin removes a service from the transport stream. The PAT, SDT Actual, NIT Actual and BAT are modified. The PMT and all components, including ECM streams, of the removed service are either removed or replaced by stuffing.

Usage

```
tsp -P svremove [options] service
```

Parameter

Specifies the service to remove. If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id. Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored. If the input TS does not contain an SDT, use a service id.

Options

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--default-charset *name*

> Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.

> By default, standard DVB encoding is used. See section 2.5 for more details.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

-a
--ignore-absent

> Ignore service if not present in the transport stream.

> By default, **tsp** fails if the service is not found.

-b
--ignore-bat

> Do not modify the BAT.

-e
--ignore-eit

> Do not remove the EIT's for this service.

-n
--ignore-nit

> Do not modify the NIT.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

--philippines

> A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-s
--stuffing

> Replace excluded packets with stuffing (null packets) instead of removing them. Useful to preserve bitrate.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[*-label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

▪ **svrename**

Rename a service

This plugin renames a service. It assigns a new service name and/or a new service id.

The PAT, PMT of the service, SDT Actual, NIT Actual and BAT are modified.

The service id is modified in the PAT, PMT and SDT Actual. It is modified in the **service_list_descriptor** and **logical_channel_number_descriptor** (EACEM/EICTA private descriptor) of the NIT Actual and the BAT. The service name is modified in the SDT Actual.

Usage

```
tsp -P svrename [options] [service]
```

Parameter

Specifies the service to rename.

If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id. Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored. If the input TS does not contain an SDT, use a service id.

When the service is omitted, the first service in the PAT is used. This is especially convenient when the transport stream is an SPTS.

Options

--brazil

A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--default-charset *name*

Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.

By default, standard DVB encoding is used. See section 2.5 for more details.

--europe

A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

-f *value*
--free-ca-mode *value*

Specify a new *free_CA_mode* to set in the SDT (0 or 1).

-i *value*
--id *value*

Specify a new service id value.

--ignore-bat

Do not modify the BAT.

--ignore-eit

Do not modify the EIT's for this service.

--ignore-nit

Do not modify the NIT.

--japan

A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

-l *value*
--lcn *value*

    Specify a new logical channel number (LCN).

-n *name*
--name *name*

    Specify a new service name.

--philippines

    A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *name*
--provider *name*

    Specify a new provider name.

-r *value*
--running-status *value*

    Specify a new *running_status* to set in the SDT (0 to 7).

-t *value*
--type *value*

    Specify a new service type.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

    Display this help text.

--only-label *label1*[-*label2*]

    Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

    Several **--only-label** options may be specified.

▦ svresync

Resynchronize the clock of a service based on another service

This plugin resynchronizes time stamps (PCR, PTS, DTS) of a target service based on the reference clock of another service. The two services then share the same time reference and it is possible, for instance, to migrate a component from one service to the other using subsequent manipulations of the two PMT's.

Resynchronization principles:

- The PCR values from the reference service are directly copied into the target service, with respect to the packet distance between reference and target PCR.
- When a target PCR is replaced, the applied time offset is recorded and uniformly applied to all subsequent PTS and DTS, until the next target PCR where a slightly different time offset may be computed if the stream does not have a constant bitrate.

Warning: this plugin won't work well if the target service is scrambled. The PCR will be replaced but not the PTS and DTS since they are in the scrambled part of the TS packet.

Usage

```
tsp -P svresync [options] service
```

Parameter

Specifies the target service to resynchronize to the reference clock.

If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id. Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored. If the input TS does not contain an SDT, use a service id.

Options

--brazil

   A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

--default-charset *name*

   Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.

   By default, standard DVB encoding is used. See section 2.5 for more details.

--europe

   A synonym for **--default-charset ISO-8859-15**. See section 2.5.2 for more details.

--japan

   A synonym for **--default-charset ARIB-STD-B24**. See section 2.5.2 for more details.

--philippines

   A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *value*
--pid-reference *value*

   Specifies the PID containing the reference PCR clock. This option can be used instead of a reference service if the reference PCR PID is known.

   Exactly one of **--service-reference** and **--pid-reference** must be specified.

-s *value*
--service-reference *value*

> Specifies the service containing the reference clock. Only the PCR PID is used in this service. Other components are ignored.

> If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id. Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored.

> Exactly one of **--service-reference** and **--pid-reference** must be specified.

--set-label *label1*[-*label2*]

> Set the specified labels on the modified PID's. On each PID, the label is first set on the first modified packet, and then on all packets of the PID.

> Several **--set-label** options may be specified.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

⸬ t2mi

Extract T2-MI (DVB-T2 Modulator Interface) packets

This plugin extracts (or simply logs) T2-MI packets. T2-MI is the DVB-T2 Modulator Interface. This is a protocol which encapsulates DVT-T2 modulator commands (including TS packets) into one PID of a transport stream. See [10] and [11] for more details.

This plugin selects one PID from the input transport stream. This PID shall contain an encapsulated T2-MI stream. This plugin extracts the embedded transport stream from one PLP (Physical Layer Pipe) of the original PID. By default, the input transport stream is completely replaced with the extracted stream. Using the option **--output-file**, the extracted encapsulated transport stream is saved in a file and, in that case, the input transport stream is passed unmodified.

Alternatively, the **t2mi** plugin can simply log all T2-MI packets without replacing the input transport stream. This is typically useful for debug only.

Warning: This plugin is currently experimental and has some limitations. DVB-T2 is complex and this complexity has an impact on the encapsulation of TS packets inside a T2-MI stream. This plugin may not work with all mode or stream adaptations (see [11]). If you encounter problems with some T2-MI streams, please report an issue (see [52]) and provide a sample transport stream which exhibits the problem.

Usage

```
tsp -P t2mi [options]
```

Options

-a
--append

> With **--output-file**, if the file already exists, append to the end of the file.
>
> By default, existing files are overwritten.

-e
--extract

> Extract encapsulated TS packets from one PLP of a T2-MI stream. The transport stream is completely replaced by the extracted stream.
>
> This is the default if neither **--extract** nor **--t2mi-file** nor **--log** nor **--identify** is specified.

-i
--identify

> Identify all T2-MI PID's and PLP's.
>
> If **--pid** is specified, only identify PLP's in this PID. If **--pid** is not specified, identify all PID's carrying T2-MI and their PLP's (require a fully compliant T2-MI signalization).

-k
--keep

> With **--output-file**, keep existing file (abort if the specified file already exists).
>
> By default, existing files are overwritten.

-l
--log

> Log all T2-MI packets using one single summary line per packet. This is typically useful for debug only.

If **--log** is specified without **--extract**, the input transport stream is passed unmodified. If both **--extract** and **--log** are specified, the T2-MI packets are logged and the encapsulated stream replaces the input stream.

-o *filename*
--output-file *filename*

Specify that the extracted transport stream is saved in this file. In that case, the main transport stream is passed unchanged to the next plugin.

-p *value*
--pid *value*

Specify the PID carrying the T2-MI encapsulated stream. By default, the plugin automatically locates and uses the first component with a *T2MI_descriptor* in the PMT of its service.

--plp *value*

Specify the PLP (Physical Layer Pipe) to extract from the T2-MI encapsulation. By default, use the first PLP which is found. This option is ignored if **--extract** is not used.

To determine which PID's carry T2-MI streams and what are the PLP's inside each stream, use the command **tsanalyze** or the plugin **analyze**.

-t *filename*
--t2mi-file *filename*

Save all complete raw T2-MI packets in the specified binary file.

If **--plp** is specified, only save T2-MI packets for that PLP. Otherwise, save all T2-MI packets from the selected PID.

The created binary file contains all T2-MI packets, contiguously, without any encapsulation. Each T2-MI packet contains enough information to determine its size. Therefore, it possible to read T2-MI packets one by one.

In short, a T2-MI packet is composed of a 6-byte header, a payload, and a 4-byte trailing CRC32. The size of the payload in bits is stored on 16 bits, starting at byte 4 in the header. This size is in bits, not bytes. The size of the payload in bytes is computed from the size in bits, rounded up to the next byte boundary. The total size of the T2-MI packet is consequently this payload size in bytes, plus 10.

See [10] for more details on the format of T2-MI packets.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ **tables**

Collect tables or sections

This plugin collects tables or sections from a transport stream. The tables can be displayed or saved in a human readable format, saved in binary or XML files or sent over UDP/IP to some collecting server. It is equivalent to the **tstables** utility. Actually, the following two commands produce the same result:

```
tstables options filename
tsp –I file filename –P tables options –O drop
```

Usage

```
tsp -P tables [options]
```

General options

The plugin accepts exactly the same options as the **tstables** utility.

Developers options

The following options are reserved to C++, Java or Python developers. They are useful only when the plugin is used inside a custom application.

--event-code *value*

Signal a plugin event with the specified code for each section.

The event data is an instance of **PluginEventData** pointing to the section content.

With **--all-sections**, an event is signaled for each section. Without **--all-sections**, an event is signaled for each section of each complete new table.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[-*label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⠿ **teletext**

Extract Teletext subtitles in SRT format

This plugin extracts a Teletext subtitle stream from a service and exports it in SRT format, also known as SubRip format. SRT is a text format which can be manipulated by many video processing tools.

Teletext subtitles are contained in a PID which is signalled in the PMT of the service. Unlike DVB subtitles, a single Teletext PID can contain more than one subtitle stream. Typically, one PID can contain a multiplex of the standard and *for hard of hearing* subtitles. Each subtitle stream is defined by its *Teletext Page* number. All page numbers inside a single Teletext PID are normally listed in a Teletext descriptor in the PMT of the service.

Usage

```
tsp -P teletext [options]
```

Options

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

-c
--colors

> Add font color tags in the subtitles. By default, no color is specified.

--default-charset *name*

> Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.
>
> By default, standard DVB encoding is used. See section 2.5 for more details.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

-l *name*
--language *name*

> Specify the language of the subtitles to select. This option is useful only with **--service**, when the PMT of the service declares Teletext subtitles in different languages.

-m *value*
--max-frames *value*

> Specifies the maximum number of Teletext frames to extract. The processing is then stopped.
>
> By default, all frames are extracted.

-o *filename*
--output-file *filename*

> Specify the SRT output file name. This is a text file. By default, the SRT subtitles are displayed on the standard output.

--page *value*

> Specify the Teletext page to extract. This option is useful only when the Teletext PID contains several pages. By default, the first Teletext frame defines the page to use.

--philippines

A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-p *value*
--pid *value*

Specify the PID carrying Teletext subtitles.

Alternatively, if the Teletext PID is properly signalled in the PMT of its service, the option **--service** can be used instead.

-s *value*
--service *value*

Specify the service with Teletext subtitles. If the argument is an integer value (either decimal or hexadecimal), it is interpreted as a service id. Otherwise, it is interpreted as a service name, as specified in the SDT. The name is not case sensitive and blanks are ignored.

The first *teletext_descriptor* in the PMT of the service is used to identify the PID carrying Teletext subtitles.

If neither **--service** nor **--pid** is specified, the first service in the PAT is used.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

Display this help text.

--only-label *label1*[*-label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

⧉ **time**

Schedule packets pass or drop

This plugin schedules in time the processing of packets (drop packets, pass packets or replace them by null packets). This plugin may be used to schedule the recording of a program at a specified time, for instance.

Usage

```
tsp -P time [options]
```

Specifying time values

A time value must be in the format "year/month/day:hour:minute:second".

If **--relative** is specified, the time value is a number of seconds from the start of execution. It may contain a decimal part if milliseconds are required (e.g., --relative

An empty value ("") means *from the beginning*, that is to say when **tsp** starts.

By default, packets are passed when **tsp** starts.

Options

-d *time*
--drop *time*

> All packets are dropped after the specified time.
>
> Several **--drop** options may be specified.

-n *time*
--null *time*

> All packets are replaced by null packets after the specified time.
>
> Several **--null** options may be specified.

-p *time*
--pass *time*

> All packets are passed unmodified after the specified time.
>
> Several **--pass** options may be specified.

-r
--relative

> All time values are interpreted as a number of seconds relative to the **tsp** start time.
>
> By default, all time values are interpreted as an absolute time in the format "*year/month/day:hour:minute:second*". Option **--relative** is incompatible with **--tdt** or **--utc**.

-s *time*
--stop *time*

> Packet transmission stops after the specified time and **tsp** terminates.

-t
--tdt

> Use the Time & Date Table (TDT) from the transport stream as time reference instead of the system clock. Since the TDT contains UTC time, all time values in the command line must be UTC also.

-u
--utc

> Specifies that all time values in the command line are in UTC. By default, the time values are interpreted as system local time.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

■ timeref

Update TDT and TOT with a new time reference

This plugin updates all TDT and TOT (and optionally EIT) in the transport stream according to a new time reference. This new reference can be completely new or an offset from the original TS.

Usage

```
tsp -P timeref [options]
```

Options

-a *seconds*
--add *seconds*

> Add the specified number of seconds to all UTC time.

> Specify a negative value to make the time reference go backward.

--eit

> Update events start time in EIT's. By default, EIT's are not modified.

> When **--add** is used, the specified offset is applied to all events start time.

> When **--start** is used, EIT's are dropped until the first TDT or TOT is encountered. Then, the difference between the first TDT or TOT time and the new time reference at this point is applied.

--eit-date-only

> Same as **--eit** but update the date field only in the event start dates in EIT's. The hour, minute and second fields of the event start dates are left unchanged.

-l *minutes*
--local-time-offset *minutes*

> Specify a new local time offset in minutes to set in the TOT. The allowed range is -720 to 720 (from -12 hours to +12 hours).

> By default, the local time offset is unchanged.

--next-change *value*

> Specify a new UTC date & time for the next DST change, to set in the TOT.

> The time value must be in the format "*year/month/day:hour:minute:second*".

> By default, the time of next DST change is unmodified.

--next-time-offset *minutes*

> Specify a new local time offset to be applied after the next DST change, to set in the TOT. The value is in minutes, similar to **--local-time-offset**.

> By default, the next time offset is unchanged.

--notdt

> Do not update TDT.

--notot

> Do not update TOT.

--only-country *name*

> Restrict the modification of **--local-time-offset**, **--next-change** and **--next-time-offset** to the specified 3-letter country code.

> Several **--only-country** options are allowed.

--only-region *id1*[*-id2*]

> Restrict the modification of **--local-time-offset**, **--next-change** and **--next-time-offset** to the specified region id inside a country.
>
> Several **--only-region** options are allowed.

-s *time*

--start *time*

> Specify a new UTC date & time reference for the first packet in the stream. Then, the time reference is updated according to the number of packets and the bitrate.
>
> A time value must be in the format "*year/month/day:hour:minute:second*".
>
> The predefined name "system" can be used to specify the current UTC time from the system clock (use **--start system**).

--system-synchronous

> Keep the TDT and TOT time synchronous with the system clock. Each time a TDT or TOT is updated, the system clock value is used.
>
> It implicitely uses **--start system** but is immune to the jitter which may happen on the long run without system clock synchronization. If **--start** is specified with a specific date, the difference between that date and the initial UTC system clock is stored. This offset is then consistently applied to the current system clock in all TDT and TOT.
>
> Note: this option is meaningful on live streams only. It is useless on offline file processing.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[*-label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

■ **timeshift**

Delay transmission by a fixed amount of packets

This plugin implements the *time shift* feature, as commonly found on set-top boxes or some TV sets.

The packet transmission is initially suspended for a given duration and packets are buffered in the meantime. At the end of the initial duration, packets transmission restarts at the point it was suspended. Packet buffering continues. All packets are transmitted without loss but with a time delay.

Usage

```
tsp -P timeshift [options]
```

Options

--directory *path*

> Specify a directory where the temporary buffer file is created.
>
> By default, the system-specific area for temporary files is used.
>
> The temporary file is hidden and automatically deleted on termination. Specifying another location can be useful to redirect very large buffers on another disk.
>
> If the reserved memory area is large enough to hold the buffer, no file is created.

-d
--drop-initial

> Drop output packets during the initial phase, while the time-shift buffer is filling.
>
> By default, initial packets are replaced by null packets.

-m *value*
--memory-packets *value*

> Specify the number of packets which are cached in memory. Having a larger memory cache improves the performances.
>
> By default, the size of the memory cache is 128 packets.

-p *value*
--packets *value*

> Specify the size of the time-shift buffer in packets.
>
> There is no default, the size of the buffer shall be specified either using **--packets** or **--time**.

-t *milliseconds*
--time *milliseconds*

> Specify the size of the time-shift buffer in milliseconds.
>
> The initial bitrate is used to convert this duration in number of packets and this value is used as fixed-size for the buffer. This is convenient for constant bitrate (CBR) streams only.
>
> There is no default, the size of the buffer shall be specified either using **--packets** or **--time**.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

▪ **trigger**

Trigger actions on selected TS packets

This plugin triggers an action (running an external command, sending an UDP packet) each time a TS packet is marked with a given label. Labels are typically set on packets by a previous plugin in the chain, such as the **filter** plugin.

By default, without option **--label**, **--start** or **--stop**, the actions are triggered on all packets in the stream. To avoid "avalanche effects" of too many triggers, the options **--min-inter-packet** and **--min-inter-time** can be used.

Usage

```
tsp -P trigger [options]
```

Options

-a
--all-labels

> All labels from options **--label** shall be set on a packet to be selected (logical *and*).

> By default, a packet is selected if any label is set (logical *or*).

-e '*command*'
--execute '*command*'

> Run the specified command when the current packet triggers the actions.

-l *label1*[-*label2*]
--label *label1*[-*label2*]

> Trigger the actions on packets with any of the specified labels. Labels should have typically be set by a previous plugin in the chain.

> Several **--label** options may be specified.

> Note that the option **--label** is different from the generic option **--only-label**. The generic option **--only-label** acts at *tsp* level and controls which packets are passed to the plugin. All other packets are directly passed to the next plugin without going through this plugin. The option **--label**, on the other hand, is specific to the *trigger* plugin and selects packets with specific labels among the packets which are passed to this plugin.

--local-address *address*

> With **--udp**, when the destination is a multicast address, specify the IP address of the outgoing local interface. It can be also a host name that translates to a local address.

--min-inter-packet *count*

> Specify the minimum number of packets between two triggered actions.

> Actions which should be triggered in the meantime are ignored.

--min-inter-time *milliseconds*

> Specify the minimum time, in milliseconds, between two triggered actions.

> Actions which should be triggered in the meantime are ignored.

--start

> Trigger the actions on **tsp** start.

--stop

> Trigger the actions on **tsp** stop.

--ttl *value*

> With **--udp**, specifies the TTL (Time-To-Live) socket option. The actual option is either "Unicast TTL" or "Multicast TTL", depending on the destination address. Remember that the default Multicast TTL is 1 on most systems.

-u *address:port*
--udp *address:port*

> Send a UDP/IP message to the specified destination when the current packet triggers the actions. The *address* specifies an IP address which can be either unicast or multicast. It can be also a host name that translates to an IP address. The *port* specifies the destination UDP port.

--udp-message *hexa-string*

> With **--udp**, specifies the binary message to send as UDP datagram. The value must be a string of hexadecimal digits specifying any number of bytes.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

▦ tsrename

Rename a transport stream

This plugin renames the transport stream. It assigns a new transport stream id and/or an original network id.

The PAT, SDT-Actual, NIT-Actual and BAT are modified.

Usage

```
tsp -P tsrename [options]
```

Options

-a
--add

> Equivalent to **--add-bat --add-nit**.

--add-bat

> Add a new entry for the renamed TS in the BAT and keep the previous entry. By default, the TS entry is renamed. Note that if no previous entry existed for this TS in the BAT, none is created.

--add-nit

> Add a new entry for the renamed TS in the NIT and keep the previous entry. By default, the TS entry is renamed. Note that if no previous entry existed for this TS in the NIT, none is created.

--ignore-bat

> Do not modify the BAT.

--ignore-eit

> Do not modify the EIT's for this transport stream.

--ignore-nit

> Do not modify the NIT.

-o *value*
--original-network-id *value*

> Modify the original network id. By default, it is unchanged.

-t *value*
--ts-id *value*

> Modify the transport stream id. By default, it is unchanged.

Generic packet processing plugin options

> The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.
>
> Several **--only-label** options may be specified.

⁞ until

Pass packets until some specified condition

This plugin passes all TS packets to the next plugin in the chain, until one of the specified conditions is met. At this point, the plugin simulates an end of input stream and all subsequent packets are dropped. The previous plugins in the chain are notified to stop. When the next plugins in the chain finish the processing of the passed packet, **tsp** terminates.

Usage

```
tsp -P until [options]
```

Options

-b *value*
--bytes *value*

> Stop after processing the specified number of bytes.

-e
--exclude-last

> Exclude the last packet (the one which triggers the final condition).

-j
--joint-termination

> When the final condition is triggered, perform a *joint termination* instead of unconditional termination. See the description of the **tsp** command for more details on *joint termination*.

-m *value*
--milli-seconds *value*

> Stop the specified number of milli-seconds after receiving the first packet.

-n *value*
--null-sequence-count *value*

> Stop when the specified number of sequences of consecutive null packets is encountered.

-p *value*
--packets *value*

> Stop after the specified number of packets.

-s *value*
--seconds *value*

> Stop the specified number of seconds after receiving the first packet.

-u *value*
--unit-start-count *value*

> Stop when the specified number of packets containing a payload unit start indicator is encountered.

Generic packet processing plugin options

> The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[-*label2*]

> Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

> Several **--only-label** options may be specified.

▋ vatek (output)

Send the transport stream to a VATek-based modulator device

This plugin sends the output transport stream to a modulator device which is based on chips from Vision Advance Technology Inc. (VATek). The final modulator device product can be from a different manufacturer.

Note

> Unlike Dektec and HiDes devices which are available on Linux and Windows only, VATek-based devices are available on all operating systems, including macOS, because VATek chips do not need a dedicated device driver. They are accessed through the portable **libusb** library which is available on all operating systems.

Usage

```
tsp -O vatek [options]
```

Options

--bandwidth *value*

> DVB-T, DVB-T2, DMB-T (DTMB): indicate bandwidth in MHz.
>
> Must be one of **1.7**, **10**, **5**, **6**, **7**, **8**. The bandwidth values 1.7 and 10 MHz are valid for DVB-T2 only. The default is 8 MHz.

--bandwidth-extension

> DVB-T2: indicate that the extended carrier mode is used.
>
> By default, use normal carrier mode.

--constellation *value*

> DVB-T, ISDB-T: indicate the constellation type.
>
> Must be one of **16-QAM**, **64-QAM**, **QPSK**. The default is **64-QAM**.

-r *value*
--convolutional-rate *value*

> Indicate the convolutional rate. The specified value depends on the modulation type.
>
> Must be one of **1/2**, **2/3**, **3/4**, **5/6**, **7/8**. The default is **5/6**.

-d *value*
--device *value*

> Device index, from 0 to N-1 (with N being the number of VATek-based devices in the system).
>
> Use the command **tsvatek --all** to have a complete list of devices in the system.
>
> By default, use the first VATek-based device (index 0).

--dmb-carrier *value*

> DMB-T (DTMB): indicate the carrier mode.
>
> Must be one of **1**, **3780**. The default is **3780**.

--dmb-constellation *value*

> DMB-T (DTMB): indicate the constellation type.
>
> Must be one of **4-QAM**, **4-QAM-NR**, **16-QAM**, **32-QAM**, **64-QAM**. The default is **64-QAM**.
>
> **4-QAM-NR** and **32-QAM** can be used only with **--dmb-fec 0.8**.

--dmb-fec *value*

> DMB-T (DTMB): indicate the FEC code rate.

Must be one of **0.4**, **0.6**, **0.8**. The default is **0.8**.

--dmb-frame-numbering

DMB-T/H, ADTB-T: indicate to use frame numbering.

The default is to use no frame numbering.

--dmb-header *value*

DMB-T/H, ADTB-T: indicate the FEC frame header mode.

Must be one of **PN420**, **PN595**, **PN945**. The default is **PN945**.

--dmb-interleaver *value*

DMB-T (DTMB): indicate the interleaver mode.

Must be one of **1** (B=54, M=240) or **2** (B=54, M=720). The default is **1**.

--fft-mode *value*

DVB-T2: indicate the FFT mode.

Must be one of **1K**, **2K**, **4K**, **8K**, **16K**. The default is **8K**.

-f *value*
--frequency *value*

Indicate the frequency, in Hz, of the output carrier. The valid range is 50,000,000 Hz to 1,000,000,000 Hz.

The default is 473,000,000 Hz.

-g *value*
--guard-interval *value*

DVB-T and ISDB-T modulators: indicate the guard interval.

Must be one of **1/16**, **1/32**, **1/4**, **1/8**. The default is **1/16**.

--j83-qam *value*

Indicate J83 the modulation type.

Must be one of **16-QAM**, **32-QAM**, **64-QAM**, **128-QAM**, **256-QAM**.

The specified value and default depend on the modulation type.

J83A : **16-QAM**, **32-QAM**, **64-QAM**, **128-QAM**, **256-QAM**. Default: **64-QAM**.

J83B : **64-QAM**, **256-QAM**. Default: **256-QAM**.

J83C : **64-QAM**, **256-QAM**. Default: **256-QAM**.

-m *value*
--modulation *value*

Indicate the modulation type. The supported modulation types depend on the device model.

Must be one of **ATSC-VSB**, **DMB-T**, **DTMB**, **DVB-T**, **DVB-T2**, **ISDB-T**, **J83A**, **J83B**, **J83C**. The default is **DVB-T**.

--pcradjust *name*

Adjust the buffer transmission speed according to different application.

Must be one of **adjust**, **disable** (default).

-p *value*
--pilot-pattern *value*

DVB-T2: indicate the pilot pattern to use, a value in the range 1 to 8.

Must be one of 1, 2, 3, 4, 5, 6, 7, 8. The default is 7.

--pilots

DVB-S2 and ADTB-T: enable pilots; Default: no pilot.

--plp0-code-rate *value*

DVB-T2: indicate the convolutional coding rate used by the PLP #0.

Must be one of **1/2**, **2/3**, **3/4**, **3/5**, **4/5**, **5/6**. The default is **2/3**.

--plp0-fec-type *value*

DVB-T2: indicate the FEC type used by the PLP #0.

Must be one of **16K**, **64K**. The default is **64K**.

--plp0-high-efficiency

DVB-T2: indicate that the PLP #0 uses High Efficiency Mode (HEM).

Otherwise, normal Mode (NM) is used.

--plp0-issy *value*

DVB-T2: type of ISSY field to compute and insert in PLP #0.

Must be one of **LONG**, **NONE**, **SHORT**. The default is **NONE**.

--plp0-modulation *value*

DVB-T2: indicate the modulation used by PLP #0.

Must be one of **16-QAM**, **256-QAM**, **64-QAM**, **QPSK**. The default is **256-QAM**.

--plp0-null-packet-deletion

DVB-T2: indicate that null-packet deletion is active in PLP #0.

Otherwise, it is not active.

--plp0-rotation

DVB-T2: indicate that constellation rotation is used for PLP #0.

Otherwise, it is not used.

--remux *value*

Must be one of:

- **remux**: Lock the first PCR to keep USB transfer TS stable, TS must contain some PCR to operate. This is the default.
- **passthrough**: Bypass TS without padding null packets (input bitrate = output bitrate).

--symbol-rate *value*

J83a: Specify the symbol rate in symbols/second.

The default is 5,120,000 symbols/second

--t2-guard-interval *value*

DVB-T2: indicates the guard interval.

Must be one of **1/128**, **1/16**, **1/32**, **1/4**, **1/8**, **19/128**, **19/256**. The default is **1/128**.

--t2-l1-modulation *value*

DVB-T2: indicate the modulation type used for the L1-post signalling block.

Must be one of **16-QAM**, **64-QAM**, **BPSK**, **QPSK**. The default is **16-QAM**.

--t2-network-id *value*

DVB-T2: indicate the DVB-T2 network identification.

The default is 0.

--t2-system-id *value*

> DVB-T2: indicate the DVB-T2 system identification.
>
> The default is 0.

--t2-version *value*

> DVB-T2: version tag.
>
> Must be one of **ver131**, **ver131_lite**. The default is **ver131**.

-t *value*
--transmission-mode *value*

> DVB-T, ISDB-T: indicate the transmission mode.
>
> Must be one of **2K**, **4K**, **8K**. The default is **8K**.

Generic output plugin options

The following options are implicitly defined in all output plugins.

--help

> Display this help text.

▪ **zap**

Zap on one or more services, remove all other services

This plugin keeps one or more services in the transport stream and remove all others. If only one service is specified, this plugin produces a Single Program Transport Stream (SPTS) containing only the specified service.

The PAT and SDT are modified in order to contain only the specified services. Unless specified otherwise (see the relevant options), the PMT and all elementary streams of the services are passed transparently. All other PID's in the transport streams are removed. If some elementary streams (audio, subtitles) must be removed from the service, the PMT is modified accordingly.

For ATSC transport streams, the service is extracted as with any MPEG-compliant transport stream but the PSIP signalization (PID **0x1FFB**) is not modified. The TVCT or CVCT still contains the description of all previous (and now removed) services in the transport stream.

Usage

```
tsp -P zap [options] service ...
```

Parameter

The parameters specify the services to keep.

If a parameter is an integer value (either decimal or hexadecimal), it is interpreted as a service id. If its format is "*integer.integer*", it is interpreted as major and minor ids on ATSC streams. Otherwise, the parameter is interpreted as a service name, as specified in the SDT (DVB, ISDB) or VCT (ATSC).

Service names are not case sensitive and blanks are ignored.

If the input TS does not contain an SDT (DVB, ISDB) or VCT (ATSC), use a service id.

Options

-a *name*
--audio *name*

> Specify a three-letter audio language code to keep. All other audio components are removed (unless specified in an **--audio-pid** option).

> Several **--audio** options can be specified.

> By default, keep all audio components.

--audio-pid *value*

> Specify an audio PID to keep. All other audio components are removed (unless specified in an **--audio** option).

> Several **–audio-pid** options can be specified.

> By default, keep all audio components.

--brazil

> A synonym for **--default-charset RAW-ISO-8859-15**. See section 2.5.2 for more details.

-c
--cas

> Keep Conditional Access System sections (CAT and EMM's). Remove them by default. Note that the ECM's for the specified services are always kept (unless **--no-ecm** is specified).

--default-charset *name*

> Default character set to use when interpreting strings from tables and descriptors. This is is used, for instance, to control the way service names are extracted from the signalization.
>
> By default, standard DVB encoding is used. See section 2.5 for more details.

--eit

> Keep EIT sections for the specified services. EIT sections for other services are removed. By default, all EIT's are removed.

--europe

> A synonym for **--default-charset ISO-8859-15**. See section 2.5 for more details.

--japan

> A synonym for **--default-charset ARIB-STD-B24**. See section 2.5 for more details.

-e
--no-ecm

> Remove all ECM PID's. By default, keep all ECM PID's for the selected services.

-n
--no-subtitles

> Remove all subtitles. By default, keep all subtitles for the selected services.

-p
--pes-only

> Keep only the PES elementary streams (audio, video, subtitles) for the selected services. Remove all PSI/SI and CAS information.

--philippines

> A synonym for **--default-charset RAW-UTF-8**. See section 2.5.2 for more details.

-s
--stuffing

> Replace excluded packets with stuffing (null packets) instead of removing them. Useful to preserve bitrate.

-t *name*
--subtitles *name*

> Specify a three-letter subtitles language code to keep. All other subtitles components are removed (unless specified in a **--subtitles-pid** option).
>
> Several **--subtitles** options can be specified.
>
> By default, keep all subtitles components.

--subtitles-pid *value*

> Specify a subtitles PID to keep. All other subtitles components are removed (unless specified in a **--subtitles** option).
>
> Several **--subtitles-pid** options can be specified.
>
> By default, keep all subtitles components.

Generic packet processing plugin options

The following options are implicitly defined in all packet processing plugins.

--help

> Display this help text.

--only-label *label1*[*-label2*]

Invoke this plugin only for packets with any of the specified labels. Other packets are transparently passed to the next plugin, without going through this one.

Several **--only-label** options may be specified.

5 Usage Examples

5.1 TSDuck utilities

5.1.1 tsdektec examples

Listing all (**-a**) Dektec devices:

```
$ tsdektec -a
0: DTA-110 (DTA-110T Modulator with UHF Upconverter)
1: DTA-140 (DTA-140 DVB/ASI Input+Output)
$
```

Listing all (**-a**) Dektec devices in verbose format (**-v**):

```
$ tsdektec -av

DTAPI version: 4.1.1.108
PCI device driver: 2.2.0.124
USB device driver: unknown

* Device 0: DTA-110 (DTA-110T Modulator with UHF Upconverter)
  Physical ports: 1
  Channels: input: 0, output: 1
  Output 0: Port 1, Modulator, Failsafe, ATSC/VSB, DVB-T/DVB-H, DVB-C,
      QAM-B (USA), QAM-C (Japan), UHF
  Subsystem id: 0xD10A (DTA-110)
  Subsystem vendor id: 0x14B4
  Device id: 0x9056
  Vendor id: 0x10B5
  Serial number: 00000000F50268FF
  Firmware version: 4 (0x00000004)
  Firmware variant: 4 (0x00000004)
  PCI bus: 5, slot: 5
  Customer id: 301819
  Engineering change level: Rev 3
  Manufacture id: 03
  Production date: 2002.07
  Part number: DTA-110T
  Serial number: 4110575871
  Crystal stability: RF:1ppm;Sym:25ppm

* Device 1: DTA-140 (DTA-140 DVB/ASI Input+Output)
  Physical ports: 2
  Channels: input: 1, output: 1
  Input 0: Port 1, top socket, ASI/SDI, ASI
  Output 0: Port 2, ASI/SDI, ASI
  Subsystem id: 0xD128 (DTA-140)
  Subsystem vendor id: 0x14B4
  Device id: 0x9056
  Vendor id: 0x10B5
  Serial number: 00000000F6C458E8
  Firmware version: 2 (0x00000002)
  Firmware variant: 0 (0x00000000)
  PCI bus: 5, slot: 6
  Customer id: 301819
  Engineering change level: Rev 1A
  Manufacture id: 03
  Production date: 2003.05
  Part number: DTA-140
  Serial number: 4140062952
  Crystal stability: 10ppm
```

```
$
```

5.1.2   tslsdvb examples

Listing all DVB receiver devices on a Linux system with a dual-tuner Hauppauge Nova-T 500. Each tuner of the single PCI board is seen as one DVB receiver device:

```
$ tslsdvb
/dev/dvb/adapter0 (DiBcom 3000MC/P, DVB-T)
/dev/dvb/adapter1 (DiBcom 3000MC/P, DVB-T)
$
```

The DVB receiver device name is **/dev/dvb/adapter0** but it can also be specified using the option **--adapter** (**-a**) in all TSDuck commands: the options "**--device-name /dev/dvb/adapter1**" and "**-a 1**" are equivalent.

Listing all DVB receiver devices on a Windows system with one USB receiver:

```
C:\> tslsdvb
0: "Nova-T Stick DVB-T Tuner (Dev1 Path0)" (DVB-T)
C:\>
```

The DVB receiver device name is "**Nova-T Stick DVB-T Tuner (Dev1 Path0)**". This is the name of the DirectShow tuner filter supplied by the hardware vendor.

Listing all DVB receiver devices on a Windows system with two other USB receivers:

```
C:\> tslsdvb
0: "Cinergy T USB XE (MKII) Tuner" (DVB-T)
1: "PCTV DiBcom BDA Digital Tuner (Dev1 Path0)" (DVB-T)
C:\>
```

Listing all DVB receiver devices on a Linux system in verbose (**-v**) format. Note that the current modulation parameters are usually accessible on Linux systems only. On Windows systems, most tuner drivers do not return them and **tslsdvb** cannot display the characteristics of the current transponder.

```
$ tslsdvb -v

/dev/dvb/adapter0 (DiBcom 3000MC/P, DVB-T)

  Status: has signal, has carrier, has viterbi, has sync, has lock

  Bit error rate .................................. 0 (0%)
  Signal/noise ratio ............................. 0 (0%)
  Signal strength ........................... 39,586 (60%)
  Uncorrected blocks ............................. 0
  Frequencies:
    Current ........................... 562,000,000 Hz
    UHF channel ................................. 32
    Min ............................... 48,000,000 Hz
    Max .............................. 860,000,000 Hz
    Step ................................. 62,500 Hz
    Tolerance .................................. 0 Hz
  Spectral inversion ......................... auto
  Bandwidth .................................. 8-MHz
  FEC (high priority) .......................... 2/3
  FEC (low priority) ........................... 1/2
  Constellation ............................ 64-QAM
  Transmission mode ............................ 8K
  Guard interval ............................. 1/32
  Hierarchy ................................. none

  Capabilities: inversion auto, FEC 1/2, FEC 2/3, FEC 3/4, FEC 5/6, FEC 7/8,
     FEC auto, QPSK, 16-QAM, 64-QAM, QAM auto, transmission mode auto,
     guard interval auto, hierarchy auto, recover
```

```
/dev/dvb/adapter1 (DiBcom 3000MC/P, DVB-T)

  Status: has signal, has carrier, has viterbi, has sync, has lock

  Bit error rate ................................ 0 (0%)
  Signal/noise ratio ............................ 0 (0%)
  Signal strength ........................... 40,690 (62%)
  Uncorrected blocks ............................ 0
  Frequencies:
    Current ........................... 490,000,000 Hz
    UHF channel ............................... 23
    Min ............................... 48,000,000 Hz
    Max .............................. 860,000,000 Hz
    Step .................................. 62,500 Hz
    Tolerance ................................. 0 Hz
  Spectral inversion ......................... auto
  Bandwidth ................................. 8-MHz
  FEC (high priority) ......................... 2/3
  FEC (low priority) .......................... 1/2
  Constellation ........................... 16-QAM
  Transmission mode ............................ 8K
  Guard interval ............................. 1/32
  Hierarchy ................................. none

  Capabilities: inversion auto, FEC 1/2, FEC 2/3, FEC 3/4, FEC 5/6, FEC 7/8,
    FEC auto, QPSK, 16-QAM, 64-QAM, QAM auto, transmission mode auto,
    guard interval auto, hierarchy auto, recover

$
```

5.1.3   tsscan examples

UHF-band scanning, including a global service list at end of network scanning:

```
$ tsscan -g
* UHF channel 21, offset +1 (474.166 MHz), strength: 59%
  Transport stream id: 2, 0x0002
* UHF channel 23, offset +1 (490.166 MHz), strength: 62%
  Transport stream id: 8, 0x0008
* UHF channel 24, offset +1 (498.166 MHz), strength: 62%
  Transport stream id: 4, 0x0004
* UHF channel 27, offset +1 (522.166 MHz), strength: 63%
  Transport stream id: 3, 0x0003
* UHF channel 32, offset +1 (562.166 MHz), strength: 61%
  Transport stream id: 6, 0x0006
* UHF channel 35, offset +1 (586.166 MHz), strength: 63%
  Transport stream id: 1, 0x0001

LCN Name             Provider ServId TSId   ONetId Type PMTPID
--- ---------------- -------- ------ ------ ------ ---- ------
  1 TF1              SMR6     0x0601 0x0006 0x20FA 0x01 0x0064
  2 France 2         GR1      0x0101 0x0001 0x20FA 0x01 0x006E
  3 France 3         GR1      0x0111 0x0001 0x20FA 0x01 0x00D2
  4 CANAL+           CNH      0x0301 0x0003 0x20FA 0x01 0x0500
  5 France 5         GR1      0x0104 0x0001 0x20FA 0x01 0x0136
  6 M6               MULTI4   0x0401 0x0004 0x20FA 0x01 0x006E
  7 ARTE             GR1      0x0105 0x0001 0x20FA 0x01 0x01FE
  8 Direct 8         NTN      0x0201 0x0002 0x20FA 0x01 0x0500
  9 W9               MULTI4   0x0402 0x0004 0x20FA 0x01 0x00D2
 10 TMC              SMR6     0x0606 0x0006 0x20FA 0x01 0x0258
 11 NT1              MULTI4   0x0403 0x0004 0x20FA 0x01 0x0136
 12 NRJ12            SMR6     0x0602 0x0006 0x20FA 0x01 0x00C8
 13 LCP              GR1      0x0106 0x0001 0x20FA 0x01 0x0262
 14 France 4         NTN      0x0207 0x0002 0x20FA 0x01 0x0506
 15 BFM TV           NTN      0x0203 0x0002 0x20FA 0x01 0x0502
 16 i>TELE           NTN      0x0204 0x0002 0x20FA 0x01 0x0503
```

```
17 Virgin 17        NTN      0x0205 0x0002 0x20FA 0x01 0x0504
18 Gulli            NTN      0x0206 0x0002 0x20FA 0x01 0x0505
20 France Ô         GR1      0x0176 0x0001 0x20FA 0x01 0x02C6
21 Canal 21         Multi-7  0x0802 0x0008 0x20FA 0x01 0x10E1
22 IDF1             Multi-7  0x0803 0x0008 0x20FA 0x01 0x10E2
23 NRJ Paris        Multi-7  0x0804 0x0008 0x20FA 0x01 0x10E3
24 CAP 24           Multi-7  0x0805 0x0008 0x20FA 0x01 0x10E4
30 TPS STAR         CNH      0x0306 0x0003 0x20FA 0x01 0x0505
31 PARIS PREMIERE   MULTI4   0x0404 0x0004 0x20FA 0x01 0x019A
32 CANAL+ SPORT     CNH      0x0303 0x0003 0x20FA 0x01 0x0502
33 CANAL+ CINEMA    CNH      0x0302 0x0003 0x20FA 0x01 0x0501
34 AB1              MULTI4   0x0406 0x0004 0x20FA 0x01 0x0262
35 PLANETE          CNH      0x0304 0x0003 0x20FA 0x01 0x0503
36 TF6              MULTI4   0x0405 0x0004 0x20FA 0x01 0x01FE
37 CANAL J          CNH      0x0305 0x0003 0x20FA 0x01 0x0504
38 LCI              SMR6     0x0603 0x0006 0x20FA 0x01 0x012C
39 Eurosport France SMR6     0x0604 0x0006 0x20FA 0x01 0x0190
                             0x01FF 0x0001 0x20FA      0x03F2
                             0x02FF 0x0002 0x20FA      0x050A
                    CNH      0x03F0 0x0003 0x20FA 0x0C 0x050A
                    CNH      0x03F1 0x0003 0x20FA 0x0C 0x050B
                             0x04FF 0x0004 0x20FA 0x0C 0x03F2
   $
```

UHF-band scanning, including modulation parameters information (usually unavailable on Windows, depending on the tuner driver):

```
$ tsscan -m
* UHF channel 21, offset +1 (474.166 MHz), strength: 59%
  Transport stream id: 2, 0x0002
  Carrier frequency: 474,166,666 Hz
  Constellation: 64-QAM
  HP streams FEC: 2/3
  LP streams FEC: 1/2
  Guard interval: 1/32
  Transmission mode: 8K
  Hierarchy: none
* UHF channel 23, offset +1 (490.166 MHz), strength: 62%
  Transport stream id: 8, 0x0008
  Carrier frequency: 490,166,666 Hz
  Constellation: 16-QAM
  HP streams FEC: 2/3
  LP streams FEC: 1/2
  Guard interval: 1/32
  Transmission mode: 8K
  Hierarchy: none
* UHF channel 24, offset +1 (498.166 MHz), strength: 62%
  Transport stream id: 4, 0x0004
  Carrier frequency: 498,166,666 Hz
  Constellation: 64-QAM
  HP streams FEC: 2/3
  LP streams FEC: 1/2
  Guard interval: 1/32
  Transmission mode: 8K
  Hierarchy: none
* UHF channel 27, offset +1 (522.166 MHz), strength: 63%
  Transport stream id: 3, 0x0003
  Carrier frequency: 522,166,666 Hz
  Constellation: 64-QAM
  HP streams FEC: 2/3
  LP streams FEC: 1/2
  Guard interval: 1/32
  Transmission mode: 8K
  Hierarchy: none
* UHF channel 32, offset +1 (562.166 MHz), strength: 61%
  Transport stream id: 6, 0x0006
```

```
      Carrier frequency: 562,166,666 Hz
      Constellation: 64-QAM
      HP streams FEC: 2/3
      LP streams FEC: 1/2
      Guard interval: 1/32
      Transmission mode: 8K
      Hierarchy: none
  * UHF channel 35, offset +1 (586.166 MHz), strength: 63%
      Transport stream id: 1, 0x0001
      Carrier frequency: 586,166,666 Hz
      Constellation: 64-QAM
      HP streams FEC: 3/4
      LP streams FEC: 1/2
      Guard interval: 1/8
      Transmission mode: 8K
      Hierarchy: none
  $
```

5.1.4   tssmartcard examples

Listing all smartcard readers in the system:

```
$ tssmartcard
OmniKey CardMan 3121 00 00
OmniKey CardMan 3121 01 00
OmniKey CardMan 3121 02 00
OmniKey CardMan 3121 03 00
$
```

Listing all smartcard readers in the system, in verbose (**-v**) format:

```
$ tssmartcard -v
OmniKey CardMan 3121 00 00: empty
OmniKey CardMan 3121 01 00: smartcard present
    ATR: 3B DE 18 00 40 11 90 28 43 29 4C 6F 67 69 77 61 79 73 AA 55
OmniKey CardMan 3121 02 00: empty
OmniKey CardMan 3121 03 00: smartcard present
    ATR: 3B DE 18 00 40 11 90 28 43 29 4C 6F 67 69 77 61 79 73 AA 55
$
```

Perform a warm (**-w**) reset on the second smartcard then list all readers in verbose format again: the smartcard now returns its "warm reset" ATR.

```
$ tssmartcard "OmniKey CardMan 3121 01 00" -w
$ tssmartcard -v
OmniKey CardMan 3121 00 00: empty
OmniKey CardMan 3121 01 00: smartcard present
    ATR: 3B D3 18 00 40 11 90 AA 55
OmniKey CardMan 3121 02 00: empty
OmniKey CardMan 3121 03 00: smartcard present
    ATR: 3B DE 18 00 40 11 90 28 43 29 4C 6F 67 69 77 61 79 73 AA 55
$
```

5.1.5   tsterinfo examples

Converting UHF channels to frequencies:

```
$ tsterinfo -u 21
Carrier Frequency: 474,000,000 Hz
$
$ tsterinfo -u 21 -o 1
Carrier Frequency: 474,166,666 Hz
$
$ tsterinfo -u 21 -o 1 -s
474166666
$
```

Converting frequencies to UHF channels:

```
$ tsterinfo -f 474166666
UHF channel: 21, offset: 1
$
$ tsterinfo -f 474166000
UHF channel: 21, offset: 1
Warning: exact frequency for channel 21, offset 1 is 474,166,666 Hz, differ by -666 Hz
$
```

Computing transport stream bitrate from OFDM modulation parameters:

```
$ tsterinfo -h 2/3 -g 1/32
Transport stream bitrate: 24,128,342 b/s
$
$ tsterinfo -h 2/3 -g 1/32 -c QPSK
Transport stream bitrate: 8,042,780 b/s
$
$ tsterinfo -h 2/3 -g 1/32 -c QPSK -s
8042780
$
```

Retrieving OFDM modulation parameters from the transport stream bitrate. Note that the second example gives two possible sets of parameters with the same bitrate difference.

```
$ tsterinfo -b 24128300
  Nominal bitrate .......... 24,128,342 b/s
  Bitrate difference .............. -42 b/s
  Bandwidth ..................... 8-MHz
  FEC (high priority) ............. 2/3
  Constellation ................ 64-QAM
  Guard interval ................. 1/32
$
$ tsterinfo -b 24882000
  Nominal bitrate .......... 24,882,352 b/s
  Bitrate difference ............. -352 b/s
  Bandwidth ..................... 8-MHz
  FEC (high priority) ............. 3/4
  Constellation ................ 64-QAM
  Guard interval .................. 1/8

  Nominal bitrate .......... 24,882,352 b/s
  Bitrate difference ............. -352 b/s
  Bandwidth ..................... 8-MHz
  FEC (high priority) ............. 5/6
  Constellation ................ 64-QAM
  Guard interval .................. 1/4
$
```

5.1.6 tshides examples

The command **tshides** lists the HiDes devices, typically cheap modulators. Since these devices are simple encapsulations around chips from ITE Technologies, using device drivers from ITE, they usually appear as ITE 950x, from the model name of the main chip in the HiDes device.

Using **tshides** on Windows:

```
C:\> tshides
0: "IT9507 TX Filter"

C:\> tshides -v
Found 1 HiDes device

Index ........... 0
Name ............ "IT9507 TX Filter"
```

```
Device .......... \\?\usb#vid_048d&pid_9507#ut100cv4201504240422#{fbf6f530-07b9-11d2-
a71e-0000f8004788}\{9963cc0e-ee70-11e0-ba8f-92d34824019b}
USB mode ........ 0x0200
Vendor id ....... 0x048D
Product id ...... 0x9507
Chip type ....... 0x9507
Device type ..... 11
Driver version .. 21.17.39.1
Link firmware ... 255.39.2.0
OFDM firmware ... 255.9.11.0
```

The option **--gain-range** is used to display the adjustable gain range for a given frequency and a given bandwidth. Sample usage on Windows, using the default values for frequency and bandwidth:

```
C:\> tshides --gain-range
Device: 0: "IT9507 TX Filter"
Frequency: 474,000,000 Hz
Bandwidth: 8-MHz
Min. gain: -52 dB
Max. gain: 6 dB
>
```

Using **tshides** on Linux with the same HiDes device. Notice the naming difference.

```
$ tshides
0: "usb-it950x0" (/dev/usb-it950x0)
$
$ tshides -v
Found 1 HiDes device

Index ........... 0
Name ............ "usb-it950x0"
Device .......... /dev/usb-it950x0
Chip type ....... 0x9507
Device type ..... 11
Driver version .. v16.11.10.1
API version ..... 1.3.20160929.0
Link firmware ... 255.39.2.0
OFDM firmware ... 255.9.11.0
Company ......... ITEtech
Hardware info ... Eagle DVBT

$
```

5.1.7 tsswitch examples

The following diagram illustrates a sample usage of the **tsswitch** command:
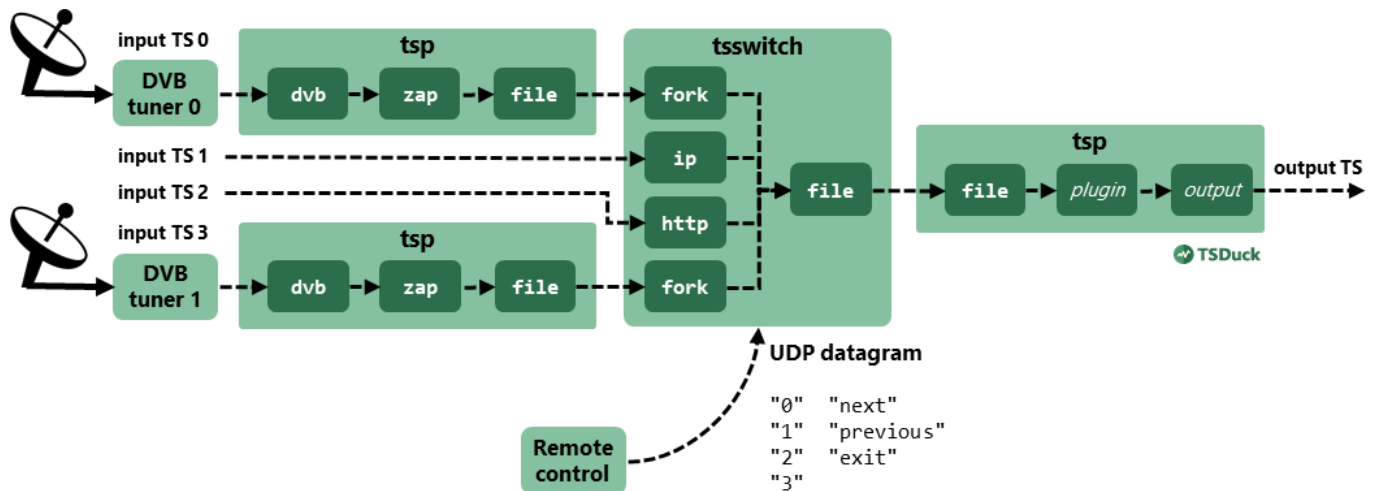
Figure 4: Sample input switching configuration

In the example above, four inputs are used. Each input contains an SPTS (single-program transport stream).

Two of these inputs are network streams already containing an SPTS. They can be directly received by an input plugin in **tsswitch** (the plugin **ip** is used to receive an UDP/IP multicast stream and the plugin **http** is used to receive an HTTP unicast stream).

The two other inputs are taken from broadcast transport streams which contain multiple services. The target service must be extracted before input to **tsswitch**. To achieve that, we run two **tsp** commands which extract the target services and we inject the output into an input of **tsswitch**.

The complete command skeleton is the following:

```
$ tsswitch --remote 4444 \
         -I fork 'tsp –I dvb ... –P zap service0' \
         -I ip 226.2.2.2:1234 \
         -I http --infinite http://server.foo.com/service2/ \
         -I fork 'tsp –I dvb ... –P zap service3' \
   | tsp –P ... –O ...
```

In this command, the remote control will send commands to UDP port 4444. For instance:

```
$ echo >/dev/udp/127.0.0.1/4444 2
$ echo >/dev/udp/127.0.0.1/4444 0
$ echo >/dev/udp/127.0.0.1/4444 next
$ echo >/dev/udp/127.0.0.1/4444 prev
```

5.1.8   tsxml examples

The **tsxml** utility is mainly used to test the effect of XML patch files, as used with option **--patch-xml** in various plugins.

In this example, we want to patch PAT's, the simplest form of table.

Consider the following patch file:

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>

  <!-- The following transformations are applied on all PAT's -->
  <PAT>
    <!-- Add this service in all PAT's -->
    <service service_id="123" program_map_PID="7777" x-node="add"/>
    <!-- Change PMT PID of service 102 in any PAT -->
    <service service_id="102" x-update-program_map_PID="2121"/>
```

```
        <!-- Delete service 202 in any PAT -->
        <service service_id="202" x-node="delete"/>
      </PAT>

      <!-- The following transformations are applied only on PAT's with TS id 2 -->
      <PAT transport_stream_id="2">
        <!-- Add this service in all PAT's with TS id 2 -->
        <service service_id="456" program_map_PID="8888" x-node="add"/>
      </PAT>

    </tsduck>
```

Consider the following input file:

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <PAT transport_stream_id="1">
    <service service_id="101" program_map_PID="1111"/>
    <service service_id="102" program_map_PID="1222"/>
    <service service_id="103" program_map_PID="1333"/>
  </PAT>
  <PAT transport_stream_id="2">
    <service service_id="201" program_map_PID="2111"/>
    <service service_id="202" program_map_PID="2222"/>
    <service service_id="203" program_map_PID="2333"/>
    <service service_id="204" program_map_PID="2444"/>
    <service service_id="205" program_map_PID="2555"/>
  </PAT>
</tsduck>
```

Let's apply the XML patch on it:

```
$ tsxml pat.xml --patch patch.xml
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <PAT transport_stream_id="1">
    <service service_id="101" program_map_PID="1111"/>
    <service service_id="102" program_map_pid="2121"/>
    <service service_id="103" program_map_PID="1333"/>
    <service service_id="123" program_map_PID="7777"/>
  </PAT>
  <PAT transport_stream_id="2">
    <service service_id="201" program_map_PID="2111"/>
    <service service_id="203" program_map_PID="2333"/>
    <service service_id="204" program_map_PID="2444"/>
    <service service_id="205" program_map_PID="2555"/>
    <service service_id="123" program_map_PID="7777"/>
    <service service_id="456" program_map_PID="8888"/>
  </PAT>
</tsduck>
```

5.1.9 tsscan using a tuner emulator

The command **tsscan** scans a broadcast network using a tuner. In case of problem analysis, the user must be present in the corresponding geographical area or have an easy access to a remote system with a reception equipment in that area. To simulate the environment elsewhere, it is possible to locally collect one capture file per frequency and use them to emulate the tuning operations.

See the section 7.1.4 for more details on tuner emulators.

The following file **tuner.xml** describes our tuner emulator:

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <defaults delivery="DVB-T" bandwidth="4,000,000" directory="../italy-sardinia-dttv"/>
  <channel frequency="474,000,000" file="mux1rai.ts"/>
```

```
            <channel frequency="482,000,000" file="mux2canaleitalia.ts"/>
            <channel frequency="490,000,000" file="mux3mediaset.ts"/>
            <channel frequency="498,000,000" file="mux4rai.ts"/>
            <channel frequency="506,000,000" file="muxsardegna1.ts"/>
            <channel frequency="514,000,000" file="muxtcs.ts"/>
            <channel frequency="522,000,000" file="muxtelesardegna.ts"/>
            <channel frequency="530,000,000" file="muxvideolina.ts"/>
        </tsduck>
```

The frequencies are chosen from UHF channels 21 to 28 in Western Europe (the default HF band region in TSDuck). The listed files were captured in a local area. The files are organized as follow:

```
test:
    tuner.xml
italy-sardinia-dttv:
    mux1rai.ts
    mux2canaleitalia.ts
    mux3mediaset.ts
    mux4rai.ts
    muxsardegna1.ts
    muxtcs.ts
    muxtelesardegna.ts
    muxvideolina.ts
```

The following command is a standard **tsscan** operation, except that the tuner device name is the XML file which describes the tuner emulator.

The option **--default-pds eacem** is required because the signalization of these streams is incorrect: the private data specifier descriptors are missing.

```
$ tsscan -d test/tuner.xml -u -l --last-channel 28 --default-pds eacem

* UHF channel 21 (474 MHz), strength: 100%, quality: 100%
  Transport stream id: 1, 0x0001

  LCN Name                Provider ServId TSId   ONetId Type PMTPID
  --- ----------------- -------- ------ ------ ------ ---- ------
    1 Rai 1               RAI      0x0D49 0x0001 0x013E 0x01 0x0102
    2 Rai 2               RAI      0x0D4A 0x0001 0x013E 0x01 0x0101
    3 Rai 3 TGR Sardegna  RAI      0x0D4B 0x0001 0x013E 0x01 0x0100
   48 Rai News 24         RAI      0x0D53 0x0001 0x013E 0x01 0x0118
  100 Test HEVC main10    Rai      0x0D52 0x0001 0x013E 0x1F 0x012C
      Rai Radio1          RAI      0x0D4C 0x0001 0x013E 0x02 0x0103
      Rai Radio2          RAI      0x0D4D 0x0001 0x013E 0x02 0x0104
      Rai Radio3          RAI      0x0D4E 0x0001 0x013E 0x02 0x0105

* UHF channel 22 (482 MHz), strength: 100%, quality: 100%
  Transport stream id: 18385, 0x47D1

  ServId TSId   ONetId PMTPID
  ------ ------ ------ ------
  0x0001 0x47D1 0x217C 0x0064
  0x0002 0x47D1 0x217C 0x0020
  0x0003 0x47D1 0x217C 0x0021
  0x0004 0x47D1 0x217C 0x0022
  0x0005 0x47D1 0x217C 0x0023
  0x0006 0x47D1 0x217C 0x0024
  0x0007 0x47D1 0x217C 0x0025
  0x0008 0x47D1 0x217C 0x0026
  0x0009 0x47D1 0x217C 0x0027
  0x000A 0x47D1 0x217C 0x0028
  0x000B 0x47D1 0x217C 0x0029
  0x000C 0x47D1 0x217C 0x002A
  0x000D 0x47D1 0x217C 0x002B
  0x000E 0x47D1 0x217C 0x002C
  0x000F 0x47D1 0x217C 0x002D
```

```
   0x0010 0x47D1 0x217C 0x002E
   0x0011 0x47D1 0x217C 0x002F
   0x0012 0x47D1 0x217C 0x0030
   0x0013 0x47D1 0x217C 0x0031
   0x0014 0x47D1 0x217C 0x0032
   0x0015 0x47D1 0x217C 0x0033
   0x0016 0x47D1 0x217C 0x0034
   0x0017 0x47D1 0x217C 0x0035
   0x0018 0x47D1 0x217C 0x0036
   0x0019 0x47D1 0x217C 0x0038
   0x001A 0x47D1 0x217C 0x0039
   0x001B 0x47D1 0x217C 0x003A
   0x001C 0x47D1 0x217C 0x003C
   0x001D 0x47D1 0x217C 0x003B
   0x001E 0x47D1 0x217C 0x003E
   0x001F 0x47D1 0x217C 0x003D
   0x0020 0x47D1 0x217C 0x0037


 * UHF channel 23 (490 MHz), strength: 100%, quality: 100%
   Transport stream id: 930, 0x03A2

   LCN Name               ServId TSId   ONetId Type PMTPID
   --- ------------------ ------ ------ ------ ---- ------
     4 Rete4 HD           0x0BBC 0x03A2 0x0110 0x19 0x00D6
     5 Canale5 HD         0x0BBD 0x03A2 0x0110 0x19 0x00D7
     6 Italia1 HD         0x0BBE 0x03A2 0x0110 0x19 0x0041
    55 Mediaset Extra     0x0BEF 0x03A2 0x0110 0x01 0x00FF
    66 Mediaset Italia Due 0x0BFA 0x03A2 0x0110 0x01 0x010A
   504 Rete4 HD           0x0C20 0x03A2 0x0110 0x19 0x00CC
   505 Canale5 HD         0x0C21 0x03A2 0x0110 0x19 0x00CD
   506 Italia1 HD         0x0C22 0x03A2 0x0110 0x19 0x00CE
   566 Mediaset Italia Due 0x0C5E 0x03A2 0x0110 0x01 0x010B
       Servizio 31        0x001F 0x03A2 0x0110      0x0065
       Servizio 32        0x0020 0x03A2 0x0110      0x0066
       Servizio 33        0x0021 0x03A2 0x0110      0x0067
       Servizio 34        0x0022 0x03A2 0x0110      0x0068
       Servizio 35        0x0023 0x03A2 0x0110      0x0069
       Servizio 36        0x0024 0x03A2 0x0110      0x006A
       Servizio 37        0x0025 0x03A2 0x0110      0x006B
       Servizio 38        0x0026 0x03A2 0x0110      0x006C
       Servizio 39        0x0027 0x03A2 0x0110      0x006D
       Ghost              0x0063 0x03A2 0x0110      0x0063

 * UHF channel 24 (498 MHz), strength: 100%, quality: 100%
   Transport stream id: 5, 0x0005

   LCN Name            Provider ServId TSId   ONetId Type PMTPID
   --- --------------- -------- ------ ------ ------ ---- ------
    57 Rai Sport + HD Rai      0x2197 0x0005 0x013E 0x01 0x0211
   502 Rai 2 HD       Rai      0x2190 0x0005 0x013E 0x01 0x020D
   503 Rai 3 HD       Rai      0x2191 0x0005 0x013E 0x01 0x0229

 * UHF channel 25 (506 MHz), strength: 100%, quality: 100%
   Transport stream id: 6001, 0x1771

   LCN Name               Provider     ServId TSId   ONetId Type PMTPID
   --- ------------------ ------------ ------ ------ ------ ---- ------
    19 Sardegna1          Sardegna1 TV 0x0001 0x1771 0x1F41 0x01 0x0100
   172 Sardegna2 - EjaTV  Sardegna1 TV 0x0002 0x1771 0x1F41 0x01 0x0200
   272 Sardegna3 - MATEX  Sardegna1 TV 0x0003 0x1771 0x1F41 0x01 0x0300
   607 Canale40 Regionale SARDEGNA TV  0x000B 0x1771 0x1F41 0x01 0x0BBE
   641 Sardegna4          Sardegna1 TV 0x0007 0x1771 0x1F41 0x01 0x010A
   642 Sardegna5          Sardegna1 TV 0x0008 0x1771 0x1F41 0x01 0x0114
   643 Sardegna6          Sardegna1 TV 0x0009 0x1771 0x1F41 0x01 0x011E
       Radio SuperSound   Sardegna1 TV 0x0006 0x1771 0x1F41 0x02 0x00E3
```

```
   * UHF channel 26 (514 MHz), strength: 100%, quality: 100%
     Transport stream id: 130, 0x0082

     LCN Name               Provider  ServId TSId   ONetId Type PMTPID
     --- ------------------ --------- ------ ------ ------ ---- ------
      13 Telecostasmeralda Harmonic  0x0001 0x0082 0x01CA 0x01 0x1029
     113 TCS 2             videolina 0x000D 0x0082 0x01CA 0x01 0x0110

   * UHF channel 27 (522 MHz), strength: 100%, quality: 100%
     Transport stream id: 43008, 0xA800

     LCN Name               Provider         ServId TSId   ONetId Type PMTPID
     --- ---------------- ---------------- ------ ------ ------ ---- ------
      14 Telesardegna     Telesardegna     0x0001 0xA800 0x3001 0x01 0x0820
     114 Telesardegna 1   Telesardegna     0x0002 0xA800 0x3001 0x01 0x0821
     214 Telesardegna 2   Telesardegna     0x0003 0xA800 0x3001 0x01 0x0822
     609 Telesardegna 3   Telesardegna     0x0004 0xA800 0x3001 0x01 0x0823

   * UHF channel 28 (530 MHz), strength: 100%, quality: 100%
     Transport stream id: 297, 0x0129

     LCN Name               Provider  ServId TSId   ONetId Type PMTPID
     --- ------------------ --------- ------ ------ ------ ---- ------
      10 Videolina         Videolina 0x0001 0x0129 0x217C 0x01 0x0405
      13 TeleCostaSmeralda Videolina 0x0005 0x0129 0x217C 0x01 0x0407
     110 Videolina 2       Videolina 0x0002 0x0129 0x217C 0x01 0x0402
     210 Videolina  3      Videolina 0x0003 0x0129 0x217C 0x01 0x0403
     510 Videolina HD Test Videolina 0x0006 0x0129 0x217C 0x01 0x0406
     601 Videolina 4       Videolina 0x0004 0x0129 0x217C 0x01 0x0404
         Radiolina         Videolina 0x000A 0x0129 0x217C 0x02 0x0210
         Rad1              Videolina 0x000B 0x0129 0x217C 0x0C 0x006F
         Radio Bonaria     Videolina 0x000C 0x0129 0x217C 0x02 0x0070
```

5.1.10 tspcap examples

The **tspcap** utility analyzes **.pcapng** files, as saved by Wireshark. While Wireshark remains the easiest and most useful tool to investigate network problems and analyze **.pcapng** files, let's see how **tspcap** can help in the analysis of a real-world problem.

A problem has been identified in the communication between an EMMG and a MUX. A network capture has been saved. When analyzing the capture using Wireshark, we can see that the EMMG/PDG ⇔ MUX protocol is implemented correctly but, by the end of the capture, the MUX reports a stream error with an exceed bandwidth message. Is there really an increase of EMM bandwidth and how much? Using Wireshark, it is not easy to precisely answer that question. So, let's use **tspcap**.

First, let's get a global summary of the file content:

```
$ tspcap test.pcapng

File summary:
  Total packets in file: 704
  Total IPv4 packets:    698
  File size:             707,960 bytes
  Total packets size:    684,150 bytes
  Total IPv4 size:       674,018 bytes

Filtered packets summary:
  Packets:               698
  Packets size:          674,018
  Payload data size:     646,098
  Start time:            2021/08/14 15:39:44.011 (+0 micro-seconds)
  End time:              2021/08/14 15:39:46.593 (+2,582,174 micro-seconds)
  Duration:              2,582,174 micro-seconds
  IP bitrate:            2,088,218 bits/second
```

```
    Data bitrate:            2,001,717 bits/second
```

Now, let's identify which streams are present in the file:

```
$ tspcap test.pcapng --list-streams

Source                  Destination            Protocol  Packets   Data bytes    Bitrate
192.168.201.18:5000     192.168.201.100:59054  TCP           208        1,572      4,870
192.168.201.100:59054   192.168.201.18:5000    TCP           490      644,526  1,996,847
```

The MUX accepts connections on the TCP port 5000. Let's list the statistics of the connection to that destination by intervals of 200 milliseconds (200,000 micro-seconds):

```
$ tspcap test.pcapng --destination 192.168.201.18:5000 --interval 200,000

Date                     Micro-seconds    Packets     Data bytes      Bitrate
2021/08/14 15:39:44.011            +13          4          3,368      134,720
2021/08/14 15:39:44.211       +200,013          3          3,032      121,280
2021/08/14 15:39:44.411       +400,013          2          2,882      115,280
2021/08/14 15:39:44.611       +600,013          3          3,144      125,760
2021/08/14 15:39:44.811       +800,013          4          3,256      130,240
2021/08/14 15:39:45.011     +1,000,013          2          2,882      115,280
2021/08/14 15:39:45.211     +1,200,013          3          3,144      125,760
2021/08/14 15:39:45.411     +1,400,013        136        165,210    6,608,400
2021/08/14 15:39:45.611     +1,600,013         60         84,568    3,382,720
2021/08/14 15:39:45.811     +1,800,013         61         84,300    3,372,000
2021/08/14 15:39:46.011     +2,000,013         57         77,872    3,114,880
2021/08/14 15:39:46.211     +2,200,013         60         83,696    3,347,840
2021/08/14 15:39:46.411     +2,400,013         95        127,172    5,086,880
```

Now we see the problem. The bitrate of the stream from the EMMG to the MUX is stable above 100 kb/s (the EMM bandwidth is 100 kb/s but the displayed bitrate includes the EMMG/PDG ⇔ MUX protocol overhead). And, at some point, the EMM bandwidth suddenly jumps to 6 Mb/s and then remains stable at 3 Mb/s. Now, we know that the problem is on the EMMG side.

5.2 TSP examples

This section demonstrates the usage of the transport stream processor on some typical examples. Refer to the documentation of each specific plugin for more details.

5.2.1 Capturing a TS from an external source

The following example captures 20 seconds of the satellite transponder containing the Canal+ service and saves it into a file. We assume that we have a DVB-S adapter and a dish which is pointed to the Astra satellite.

```
tsp –I dvb --channel canal+ \
    -P until --seconds 20 \
    -O file ts_capture.ts
```

Same example, using specific tuning information for the satellite transponder (carrier 11.856 GHz, vertical polarity, 27.5 mega-symbols / second):

```
tsp –I dvb --frequency 11,856,000,000 --polarity vertical --symbol-rate 27,500,000 \
    -P until --seconds 20 \
    -O file ts_capture.ts
```

Same example using short names for options, knowing that the default polarity is vertical:

```
tsp –I dvb –f 11856000000 -s 27500000 -P until –s 20 -O file ts_capture.ts
```

5.2.2   Routing a TS between several physical transports

The following example reads the same satellite transponder and redirects its content to the first Dektec DVB-ASI output device. The output bitrate of the ASI stream is locked to the input bitrate (from the satellite transponder).

```
tsp –I dvb –t 11856:v:0:27500 -O dektec
```

5.2.3   Using IP multicast

The following example reads a transport stream from the second Dektec DVB-ASI input device ("*device 1*"), extracts the service named "Arte", with French audio track only (identified as "fra" in the PMT) and broadcasts the resulting SPTS on the LAN using multicast IP (port 1000 on multicast address 224.10.11.12).

```
tsp –I dektec –d 1 \
    -P zap arte -a fra \
    -O ip 224.10.11.12:1000
```

Then, the service Arte can be received from any workstation on the LAN using, for instance, the free VLC media player.

As an alternative to VLC, the Linux receivers may use the following example to view the channel using the standard Linux media player:

```
tsp -I ip 224.10.11.12:1000 | mplayer -
```

5.2.4   Regulating the output speed

The following example reads a captured transport stream file, extracts the service Arte and broadcasts it on the LAN.

```
tsp –I file –i ts_capture.ts \
    -P zap arte \
    -P pcrbitrate \
    -P regulate \
    -O ip 224.10.11.12:1000
```

Since reading a file can be extremely fast, it is not reasonable to broadcast the TS packets without regulation. If the receivers wish to play the TV program, the TS packets arrive too fast. The **pcrbitrate** plugin re-computes the expected TS bitrate after extraction of the selected service. Then, the **regulate** plugin introduces wait periods to slow down the stream to the previously computed bitrate.

On the contrary, when the input source is a live transponder, this kind of regulation may be useless since the input source is already regulated at the appropriate speed.

Unfortunately, this is not completely true in all cases. The *average* bitrate is regulated by the source (the live transponder) but there is a potential burst problem. If the broadcaster system and all receivers use the same type in connection to the LAN (100 Mb/s for instance) and if the LAN backbone does not slow down the bandwidth, this is fine. However, there is a problem if the broadcaster has a faster connection to the LAN than the receivers (say 100 Mb/s vs. 10 Mb/s). Of course, 10 Mb/s is enough to receive one service which usually needs around 4 Mb/s. However, there is a potential burst problem.

To avoid burst in case of non-homogeneous access speed to the LAN, the broadcaster should smooth the flow at all stages, as illustrated in the following command

```
tsp --max-input-packets 128 \
    –I dvb –c arte \
    -P zap arte \
    -P pcrbitrate --min-pcr 256 \
    -P regulate --packet-burst 128 \
    -O ip 224.10.11.12:1000 --packet-burst 128
```

5.2.5 Scheduling the recording of a program

The following example records the contents of the channel named "France 2" between 17:15 and 17:30 the 6th of July 2006.

```
tsp -I dvb -c france2 \
    -P time -d "" -p "2006/07/06:17:15:00" -s "2006/07/06:17:30:00" \
    -P zap france2 \
    -O file program.ts
```

The **–I** option selects the first DVB input device, tuning on the transponder containing the channel named "France 2".

The first **–P** option specifies to:

- Initially drop packets (-d "")

- Start passing packets at 17:15 the 6th of July 2006.

- Stop packet processing (and make tsp terminate) at 17:30 the 6th of July 2006.

The second **–P** option extracts only the service named "France 2" and the **–O** option finally saves the resulting SPTS in the file **program.ts**.

5.2.6 Extracting selected packets

The following silly example dumps the content of the 20th TS packet with the *payload unit start indicator* set in PID 0x0208:

```
tsp -I file /data1/mpeg/test/frtv_tnt.mpg \
    -P filter --pid 0x208 \
    -P filter --unit-start \
    -P skip 19 \
    -P until --packets 1 | \
    tsdump
```

Note that the **filter** plugin selects packets matching any of the specified conditions (an "*or*" selection). Here, to select packets matching two conditions (an "*and*" selection), we chain two **filter** plugins.

5.2.7 Monitoring selected MPEG tables (here, EMM's)

The following example demonstrates how to monitor the EMM's for a given operator. The first command determines on which PID are sent the EMMs. This command analyzes the satellite transponder which carries the channel Canal+ during 2 seconds. Instead of the full human-readable analysis report, we ask for a *normalized* output format and we filter the conditions we need: a line starting with "**pid:**" for description of a PID, "**:emm:**" for a PID carrying EMM's, "**:cas=256:**" to filter EMM's for CA System Id 256 (0x100, ie. MediaGuard).

```
tsp -I dvb -c canal+ \
    -P until -s 2 \
    -P analyze --normalized \
    -O drop | \
    grep ^pid: | grep :emm: | grep :cas=256:
```

The output of this command is:

```
pid:pid=193:emm:cas=256:access=clear: […]
pid:pid=196:emm:cas=256:operator=129:access=clear: […]
```

We now know that PID 193 carries the MediaGuard individual EMM's and PID 196 carries the MediaGuard group EMM's for operator 129 (OPI of Canal+).

The second command, below, filters the contents of those two PID's and formats the contents of the MPEG tables that are carried in those PID's:

```
tsp -I dvb -c canal+ -P filter -p 193 -p 196 | tstables | less
```

Of course, since EMM's are ciphered, their contents are obscure to the user and the display looks like:

```
* EMM (0x82), TID 130 (0x82), PID 193 (0x00C1)
  Version: 0, sections: 1, total size: 117 bytes
  - Section 0:
    0000:  00 00 09 F3 87 00 00 80 00 B0 10 01 5E E7 07 85   ...ó.....°..^ç..
    0010:  22 C3 DB 13 75 43 3B 5C 1E 08 DC 4A 05 35 AD 54   "ÃÛ.uC;\..ÜJ.5-T
    0020:  B5 52 35 B1 61 FB 37 BB EC 6D 55 F5 21 B6 4C 58   µR5±aû7»ìmUõ!¶LX
    0030:  80 F4 FA FB D9 C5 D0 A2 C7 22 BA 77 51 B9 C8 96   .ôúûÙÅÐ¢Ç"ºwQ¹È.
    0040:  A3 79 9E 5A 24 74 2A 01 7D 00 62 A3 EC D4 AF DF   £y.Z$t*.}.b£ìÔ¯ß
    0050:  F2 43 B1 3A 72 B5 B3 E0 C9 22 68 2D 50 F0 FE 82   òC±:rµ³àÉ"h-Pðþ.
    0060:  47 1F AC 95 5F D2 59 E6 C8 C6 78 BE F3 C5 A9 CF   G.¬._ÒYæÈÆx¾óÅ©Ï
    0070:  05 90                                            ..

* EMM (0x82), TID 130 (0x82), PID 193 (0x00C1)
  Version: 0, sections: 1, total size: 105 bytes
  - Section 0:
    0000:  00 00 F1 F2 F3 F4 00 00 00 B0 10 01 98 3E EF 81   ..ñòóô...°...>ï.
    0010:  45 E1 A1 D3 76 B9 B0 21 D6 F9 5F AB 4B 07 9D 13   Eá¡Óv¹°!Öù_«K...
    ...
```

5.2.8   Scanning all services by CAS operator

The following complex example scans a complete satellite network, looking for the list of services which are scrambled for an operator.

We assume that we have a DVB-S adapter and a dish which is pointed to the Astra satellite.

The first command scans the NIT (Network Information Table) of a known transponder. The output is the list of all transponders in the network. This list is sorted and duplicate lines are removed ("sort –u").

Then, each transponder is analyzed during 3 seconds ("-P until -s 3") and the result of the analysis in normalized format is saved in a temporary file. From this analysis file, we extract the PID's carrying ECM's with CA system id 256 (MediaGuard) and MediaGuard OPI 128 (CanalSat). For each ECM PID, we extract the list of services this PID belongs to.

Thus, for each transponder, we get a list of services (actually, a list of *service ids*) which are scrambled for the CanalSat MediaGuard operator. Finally, we use again the transponder analysis in normalized format to get the service name for each of these service id.

```
inittune='-f 11856000000'  # Initial transponder to scan the NIT
cas=256                    # MediaGuard CA system id
opi=128                    # MediaGuard OPI for CanalSat

tsp -I dvb $inittune -P nitscan -t -O drop | \
sort -u | \
while read tune; do
    tsp -I dvb -t $tune \
        -P until -s 3 \
        -P analyze --normalized -o tmp.tmp \
        -O drop
    grep "^pid:" tmp.tmp | \
    grep ":ecm:" | \
    grep ":cas=$cas:" | \
    grep ":operator=$opi:" | \
    sed -e 's/^.*:servlist=//' -e 's/:.*$//' -e 's/,/\n/' | \
    while read serv; do
        grep "^service:" tmp.tmp | \
        grep ":id=$serv:" | \
        sed -e "s/^.*:name=/Transponder: $tune  Service: /"
    done
    rm -f tmp.tmp
done
```

The output of this script gives the following output (107 lines):

```
    Transponder: 11739:v:0:27500  Service: MTV F
    Transponder: 11739:v:0:27500  Service: MTV HITS.
    Transponder: 11739:v:0:27500  Service: MTV Base.
    ...
    Transponder: 12640:v:0:22000  Service: TOON DISNEY
    Transponder: 12640:v:0:22000  Service: MOTORS TV
    Transponder: 12640:v:0:22000  Service: E! ENTERTAINMENT
```

5.2.9   On-the-fly replacement of an SI table

The following example tests an updated version of a *Bouquet Association Table* (BAT) on a live transport stream.

We assume to have a DVB-T tuner card to capture live streams and a Dektec DTA-110T DVB-T modulator (PCI card) to send the modified stream into a local distribution network (or even to one single directly-connected STB).

We capture one transport stream (the "R4" from the French DTTV network, on UHF channel 24). We remove the BAT of the *Tv Numéric* operator and we replace it with a new one, the table we wish to test. The new table is stored in binary section format into a file named **BAT_TvNumeric_V3.si**.

First, we capture all tables from the PID **0x0011** (the one which carries the SDT's and the BAT's).

```
    rm -f r4_p0011_*.si  # remove previous files if any
    tsp -I dvb --uhf 24 -P until -s 10 -P filter -p 0x011 | tstables -m -b r4.si
    rm -f r4_p0011_t4A_e0086_*.si # remove current Tv Numeric BAT
```

These commands capture and save all tables (SDT's and BAT's) in binary files named **r4_p0011_*.psi** during 10 seconds. Each section is stored in a separate file (option **–m** in **tstables**). The current TV Numeric BAT is removed. Note the file name **r4_p0011_t4A_e0086_*.si** which means all sections from PID **0x0011** with TID **0x4A** (BAT) and TID extension **0x0086** (bouquet identifier for operator TV Numeric).

The following command now performs the live replacement. The **inject** plugin is used to replace the content of PID **0x0011** with the sections in all the specified files. These files are all the previously captured sections from this PID (minus the previous BAT which was deleted) and the new BAT.

```
    tsp -I dvb –u 24 \
        -P inject --replace 0x0011 r4_p0011_*.si BAT_TvNumeric_V3.si \
        -O dektec –u 24 --convolution 2/3 --guard 1/32
```

5.2.10 Performing the global analysis of a transponder

The following command receives a DVB-T transport stream from UHF channel 35 during 100 seconds and produces an analysis report in the text file **R1.analysis**. The first 5000 packets are ignored since the signal may not be quite stable right after the tuning operation.

```
    tsp -I dvb --uhf-channel 35 \
        -P skip 5000 \
        -P until -s 100 \
        -P analyze --title "R1 (Channel 35)" -o R1.analysis \
        -O drop
```

The report file is quite large:

```
    ================================================================================
    |  TRANSPORT STREAM ANALYSIS REPORT                        R1 (Channel 35)  |
    |==============================================================================|
    |  Transport Stream Id: .......... 1 (0x0001)  |  PID's: Total: ......... 35  |
    |  Bytes: ...................... 317,825,468  |        Clear: ......... 35  |
    |  TS packets: .................. 1,690,561  |        Scrambled: ...... 0  |
    |  Invalid TS packets: .................... 0  |        With PCR's: ..... 6  |
    |  Services: ............................ 7  |        Unreferenced: ... 0  |
    |------------------------------------------------------------------------------|
```

```
| Transport stream bitrate, based on ....... 188 bytes/pkt   204 bytes/pkt |
| User-specified: ........................ 24,882,352 b/s   26,999,998 b/s |
| Estimated based on PCR's: .............. 24,882,351 b/s   26,999,998 b/s |
|-------------------------------------------------------------------------|
| Broadcast time: .................................. 102 sec (1 mn 42 sec) |
| First TDT time stamp: ............................... 2008/06/11 09:34:25 |
| Last TDT time stamp: ................................ 2008/06/11 09:35:37 |
| TOT country code: ............................................... FRA |
|-------------------------------------------------------------------------|
| Serv.Id  Service Name                          Access         Bitrate |
| 0x0101  France 2 ................................... C     3,637,078 b/s |
| 0x0104  France 5 ................................... C     4,567,443 b/s |
| 0x0105  ARTE ....................................... C     3,688,018 b/s |
| 0x0106  LCP ........................................ C     3,554,581 b/s |
| 0x0111  France 3 ................................... C     4,828,238 b/s |
| 0x0176  .France Ô ................................... C     3,286,441 b/s |
| 0x01FF  (System Software Update) ................... C        35,015 b/s |
|                                                                         |
| Note 1: C=Clear, S=Scrambled                                            |
| Note 2: Unless explicitly specified otherwise, all bitrates are based on |
| 188 bytes per packet.                                                   |
===========================================================================


===========================================================================
| SERVICES ANALYSIS REPORT                                R1 (Channel 35) |
|=========================================================================|
| Global PID's                                                            |
| TS packets: 87,342, PID's: 7 (clear: 7, scrambled: 0)                   |
|-------------------------------------------------------------------------|
|    PID  Usage                                    Access         Bitrate |
|  Total  Global PID's ............................. C     1,285,534 b/s |
| 0x0000  PAT ....................................... C        15,027 b/s |
| 0x0010  DVB-NIT ................................... C         4,503 b/s |
| 0x0011  SDT/BAT ................................... C           750 b/s |
| 0x0012  EIT ....................................... C        37,075 b/s |
| 0x0014  TDT/TOT ................................... C           132 b/s |
| 0x0015  Network Synchronization ................... C         2,737 b/s |
| 0x1FFF  Stuffing .................................. C     1,225,306 b/s |
|=========================================================================|
| Service: 257 (0x0101), TS: 1 (0x0001), Original Netw: 8442 (0x20FA)     |
| Service name: France 2, provider: GR1                                   |
| Service type: 1 (0x01), Digital television service                      |
| TS packets: 247,111, PID's: 4 (clear: 4, scrambled: 0)                  |
| PMT PID: 110 (0x006E), PCR PID: 120 (0x0078)                            |
|-------------------------------------------------------------------------|
|    PID  Usage                                    Access         Bitrate |
|  Total  Digital television service ................ C     3,637,078 b/s |
| 0x006E  PMT ....................................... C        15,042 b/s |
| 0x0078  MPEG-2 Video .............................. C     3,404,836 b/s |
| 0x0082  MPEG-1 Audio (fra) ........................ C       198,433 b/s |
| 0x008C  Subtitles (fra, DVB subtitles, no aspect rati C        18,765 b/s |
|         (C=Clear, S=Scrambled, +=Shared)                                |
|=========================================================================|
| Service: 260 (0x0104), TS: 1 (0x0001), Original Netw: 8442 (0x20FA)     |
```

… more services skipped …

```
|=========================================================================|
| Service: 511 (0x01FF), TS: 1 (0x0001), Original Netw: 8442 (0x20FA)     |
| Service name: (System Software Update), provider: (unknown)             |
| Service type: 0 (0x00), Reserved service type 0x00                      |
| TS packets: 2,379, PID's: 2 (clear: 2, scrambled: 0)                    |
| PMT PID: 1010 (0x03F2), PCR PID: None                                   |
|-------------------------------------------------------------------------|
|    PID  Usage                                    Access         Bitrate |
```

```
|    Total  Reserved service type 0x00  ................ C      35,015 b/s  |
|  0x0294  DSM-CC U-N (SSU Sagem Communication) ....... C      19,987 b/s  |
|  0x03F2  PMT  ...................................... C      15,027 b/s  |
|          (C=Clear, S=Scrambled, +=Shared)                                |
============================================================================
```

```
============================================================================
|  PIDS ANALYSIS REPORT                                   R1 (Channel 35)  |
|==========================================================================|
|  PID: 0 (0x0000)                                                    PAT  |
|--------------------------------------------------------------------------|
|  Global PID            Transport:              Discontinuities:           |
|  Bitrate: .... 15,027 b/s Packets: ......... 1,021 Expected: ......... 0  |
|  Access: Clear           Adapt.F.: ............ 0 Unexpect: ........ 0    |
|                          Duplicated: ......... 0 Sections:                |
|                          PCR: ................ 0 Unit start: ... 1,021    |
|                                                                          |
|==========================================================================|
|  PID: 16 (0x0010)                                               DVB-NIT  |
```

… more PID's skipped …

```
|==========================================================================|
|  PID: 8191 (0x1FFF)                                             Stuffing  |
|--------------------------------------------------------------------------|
|  Global PID            Transport:              Discontinuities:           |
|  Bitrate: . 1,225,306 b/s Packets: ........ 83,250 Expected: ......... 0  |
|  Access: Clear           Adapt.F.: ............ 0 Unexpect: ......... 0   |
|                          Duplicated: ......... 0 Sections:                |
|                          PCR: ................ 0 Unit start: ....... 0    |
|                                                                          |
============================================================================
```

5.2.11 Performing the global analysis of a network

This section presents an automated way to analyze a network (here, the French terrestrial network) using a GNU makefile.

Using the simple command "**make**", each known transport stream (designated by its UHF channel number) is analyzed. For each TS, for instance the one named R1, the following text files are created:

- **R1.analysis**: Global analysis of the TS in human-readable format, as in 5.2.10.
- **R1.anl**: Global analysis of the TS in normalized format, for use by other scripts.
- **R1.psi**: Analysis of the main PSI/SI tables (PAT, CAT, PMT, SDT, NIT, BAT).

Individual targets, such as "**make R1**" can be used to analyze only one TS. Use the make option **-B** to force the analysis again when the files already exist.

The command "**make capture**" captures 120 seconds of each TS in files named **R1.ts**, **R2.ts**, etc. Similarly, commands like "**make R1.ts**" capture only one TS.

The content of the makefile follows:

```
# === This is a GNU makefile ===

# List of UHF channels:

ALL_CHAN = R1 R2 R3 R4 R5 R6 L8

R1_CHAN = 35
R2_CHAN = 21
R3_CHAN = 27
R4_CHAN = 24
R5_CHAN = 29
```

```
R6_CHAN = 32
L8_CHAN = 23

# Channel full names:

$(foreach R,$(ALL_CHAN),$(eval $R_NAME=$R (Channel $($R_CHAN))))

# Default target is analysis of all TS

all: $(ALL_CHAN)

$(ALL_CHAN): %: %.analysis %.anl %.psi

%.analysis %.services %.anl %.psi:
    tsp -I dvb $(DEVICE) --uhf $($(*F)_CHAN) \
        -P skip 5000 \
        -P until -s 100 \
        -P analyze --title "$($(*F)_NAME)" -o $*.analysis \
        -P analyze --title "$($(*F)_NAME)" -o $*.anl --normalized \
        -P psi -a -o $*.psi \
        -O drop

# Capture TS content:

capture: $(foreach R,$(ALL_CHAN),$R.ts)

%.ts:
    tsp -I dvb $(DEVICE) --uhf $($(*F)_CHAN) \
        -P skip 5000 \
        -P until -s 120 \
        -O file $@
```

5.2.12 Monitoring the stuffing rate of all transponders in a network

The following script monitors the stuffing bitrate of a list of selected transport streams. The output is suitable for importation into Excel so that further analysis can be performed. It can be executed on Linux or Windows (using the Cygwin shell).

In this script, the transport streams are designated by a list of UHF channels, meaning DVB-T only. Here, the UHF channels represent the 5 main MUX of the French DTTV in the Paris area.

```
# List of UHF channels
UHF_CHANNELS="35 21 27 24 32"

# Analysis time per TS, in seconds
ANALYSIS_TIME=20

# Sample interval, in seconds
SAMPLE_INTERVAL=300

# Excel separator character for "csv" files (depends on Excel locale)
EXCEL_SEPARATOR=';'

# Main loop
while true; do

    # Current date in seconds since epoch
    curtime=$(date "+%s")

    # Loop on all TS
    outline=
    for uhf in $UHF_CHANNELS; do
        stuffing=$(
            tsp -I dvb --uhf-channel $uhf \
                -P until -s $ANALYSIS_TIME \
```

```
                     -P analyze --normalized \
                     -O drop | \
                     grep '^pid:' | \
                     grep ':pid=8191:' | \
                     sed -e 's/^.*:bitrate=//' -e 's/:.*//')
            outline="${outline}${EXCEL_SEPARATOR}${stuffing}"
        done

        # Current date and stuffing rates in Excel format
        echo "$(date -d @$curtime '+%d/%m/%Y %H:%M')${outline}"

        # Sleep until next sample time
        sleeptime=$(( $curtime + $SAMPLE_INTERVAL - $(date "+%s") ))
        [[ $sleeptime -le 0 ]] || sleep $sleeptime
    done
```

The script runs infinitely and produces the following output:

```
    12/06/2008 14:01;1208706;4501497;3762828;626932;1145037
    12/06/2008 14:06;1232543;4505620;3782431;621524;1172479
    12/06/2008 14:11;1225293;4505553;3487315;613616;1151119
    12/06/2008 14:16;1231288;4505958;3415868;665393;1156933
    ....
```

It may be imported into Microsoft Excel to produce the following graph:
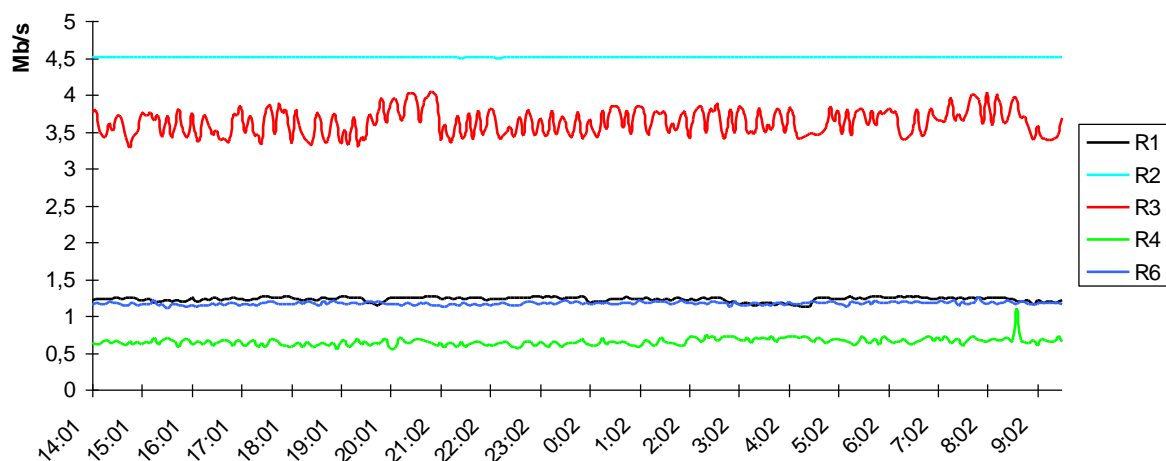
Figure 5: Stuffing bitrate sample diagram

5.2.13 Analyzing the bitrate of all services in a network

The following script demonstrates a way to produce a report of the bitrate of all services in a network. First, you need to analyze all TS in the network and get the result in *normalized format* (see 5.2.11 for an example). Then run the following script on all normalized analysis files.

```
    echo "MUX  Service                  Bitrate     Video bitrate  Access"
    echo "---  ------------------  --------------  --------------  ---------"

    for f in $*; do
        tsid=$(grep '^ts:' $f | sed -e 's/.*:id=//' -e 's/:.*//')
        grep '^service:' $f | grep ':servtype=1:' | \
        while read line; do
            name=$(sed <<<"$line" -e 's/.*:name=//')
            bitrate=$(sed <<<"$line" -e 's/.*:bitrate=//' -e 's/:.*//')
            access=$(sed <<<"$line" -e 's/.*:access=//' -e 's/:.*//')
            pidgrep=$(sed <<<"$line" -e 's/.*:pidlist=//' -e 's/:.*//' \
                             -e 's/^/-e :pid=/' \
                             -e 's/,/: -e :pid=/g' -e 's/$/:/')
```

```
            vbitrate=0
            for br in $(grep '^pid:' $f | grep $pidgrep | grep ':video:' | \
                        sed -e 's/.*:bitrate=//' -e 's/:.*//')
            do
                vbitrate=$(( $vbitrate + $br ))
            done
            printf "R%d   %-18s  %'10d b/s  %'10d b/s  %s\n" \
                $tsid "$name" $bitrate $vbitrate $access
        done
    done
```

When used in conjunction with the makefile from 5.2.11, you get:

```
make –f Makefile.tnt
...
bitrate-summary *.anl
MUX  Service                  Bitrate   Video bitrate  Access
---  -----------------    --------------  --------------  ---------
R8   Canal 21             2,803,938 b/s   2,588,374 b/s  clear
R8   IDF1                 3,502,350 b/s   3,254,550 b/s  clear
R8   NRJ Paris            6,462,333 b/s   6,214,518 b/s  clear
R8   CAP 24               2,929,000 b/s   2,681,200 b/s  clear
R1   France 2             3,655,962 b/s   3,419,466 b/s  clear
R1   France 5             4,600,309 b/s   4,379,003 b/s  clear
R1   ARTE                 5,052,002 b/s   4,627,464 b/s  clear
R1   LCP                  2,867,453 b/s   2,649,782 b/s  clear
R1   France 3             3,510,985 b/s   3,293,801 b/s  clear
R1   .France Ô            3,857,456 b/s   3,643,981 b/s  clear
R2   Direct 8             2,740,873 b/s   2,432,179 b/s  clear
R2   BFM TV               3,120,068 b/s   2,913,715 b/s  clear
R2   i>TELE               2,699,497 b/s   2,493,143 b/s  clear
R2   Virgin 17            4,947,397 b/s   4,676,283 b/s  clear
R2   Gulli                3,280,344 b/s   3,036,397 b/s  clear
R2   France 4             2,748,753 b/s   2,477,639 b/s  clear
R3   CANAL+               8,369,816 b/s   7,477,442 b/s  scrambled
R3   CANAL+ CINEMA        2,975,779 b/s   2,531,416 b/s  scrambled
R3   CANAL+ SPORT         2,930,938 b/s   2,493,595 b/s  scrambled
R3   PLANETE              2,340,974 b/s   2,095,053 b/s  scrambled
R3   CANAL J              2,609,858 b/s   2,371,848 b/s  scrambled
R3   TPS STAR             3,203,408 b/s   2,779,778 b/s  scrambled
R4   M6                   4,628,819 b/s   3,834,868 b/s  clear
R4   W9                   3,231,344 b/s   2,694,826 b/s  clear
R4   NT1                  3,278,883 b/s   2,887,844 b/s  clear
R4   PARIS PREMIERE       4,009,594 b/s   3,404,277 b/s  scrambled
R4   ARTE HD              7,725,247 b/s   7,171,310 b/s  clear
R5   TF1 HD               9,032,166 b/s   8,635,108 b/s  clear
R5   France 2 HD          7,593,045 b/s   7,080,227 b/s  clear
R5   M6HD                 7,301,165 b/s   6,714,945 b/s  clear
R6   TF1                  5,022,465 b/s   3,951,056 b/s  clear
R6   NRJ12                6,883,049 b/s   6,026,657 b/s  clear
R6   LCI                  1,379,288 b/s   1,224,422 b/s  scrambled
R6   Eurosport            3,535,155 b/s   3,380,304 b/s  scrambled
R6   TF6                  1,701,739 b/s   1,543,181 b/s  scrambled
R6   TMC                  4,103,693 b/s   3,890,212 b/s  clear
```

5.2.14 Analyzing the number of PCR per second

It is sometimes useful to get a complete overview of the number of PCR per second in each service of a network. The following script illustrates this. First, you need to analyze all TS in the network and get the result in *normalized format* (see 5.2.11 for an example). Then run the following script on all normalized analysis files.

```
for file in $*; do
    sec=$(grep '^ts:' $file | grep ':duration=' | \
            sed -e 's/.*:duration=//' -e 's/:.*//')
```

```
        if [[ "$sec" -gt 1 ]]; then
            grep '^service:' $file | grep ':pcrpid=' | grep ':name=' |
            while read line; do
                pid=$(sed <<<$line -e 's/.*:pcrpid=//' -e 's/:.*//')
                name=$(sed <<<$line -e 's/.*:name=//')
                count=$(grep '^pid:' $file | grep ":pid=$pid:" | grep ':pcr=' | \
                    sed -e 's/.*:pcr=//' -e 's/:.*//')
                if [[ "$count" -ne 0 ]]; then
                    printf "%4d PCR/s - %s\n" \
                        $((($count + ($sec / 2)) / $sec)) "$name"
                fi
            done
        fi
    fi
  done | sort
```

When used in conjunction with the makefile from 5.2.11, you get:

```
make –f Makefile.tnt
...
pcrrate *.anl
  29 PCR/s - France 2 HD
  29 PCR/s - TF1 HD
  30 PCR/s - ARTE
  30 PCR/s - ARTE HD
  30 PCR/s - BFM TV
  30 PCR/s - Canal 21
  30 PCR/s - CAP 24
  30 PCR/s - Direct 8
  30 PCR/s - France 2
  30 PCR/s - France 3
  30 PCR/s - France 4
  30 PCR/s - France 5
  30 PCR/s - .France Ô
  30 PCR/s - Gulli
  30 PCR/s - IDF1
  30 PCR/s - i>TELE
  30 PCR/s - LCP
  30 PCR/s - M6
  30 PCR/s - M6HD
  30 PCR/s - NRJ12
  30 PCR/s - NRJ Paris
  30 PCR/s - NT1
  30 PCR/s - Virgin 17
  30 PCR/s - W9
  31 PCR/s - CANAL+
  31 PCR/s - TF1
  31 PCR/s - TMC
  50 PCR/s - CANAL+ CINEMA
  50 PCR/s - CANAL J
  50 PCR/s - CANAL+ SPORT
  50 PCR/s - Eurosport
  50 PCR/s - LCI
  50 PCR/s - PARIS PREMIERE
  50 PCR/s - PLANETE
  50 PCR/s - TF6
  50 PCR/s - TPS STAR
```

5.2.15 Injecting a System Software Update (SSU) service

This example illustrates how to inject a new System Software Update (SSU) service into a transport stream as defined in [8]. This type of procedure can be used to test the SSU capabilities of a Set Top Box in real conditions, using a live transport stream.

The test is the following:

- A DVB-T transport stream is received on UHF channel 24.

- This transport stream has at least 56 kb/s of stuffing packets (much more actually). Our *tsp* command steals 56 kb/s of stuffing and replaces them with a new service (16 kb/s for the new service's PMT and 40 kb/s for the SSU data PID).

- The STB software provider delivers three types of SSU tables: a DSI, a DII and a lot of DDB's. The tables are provided as binary files containing the sections. There is one file `dsi.bin` containing the DSI section, one file `dii.bin` containing the DII section and one file `ddb.bin` containing all DDB sections.

- These tables are multiplexed in the same SSU data PID but have different repetition rates constraints. Here, we use 14 seconds for the DSI and 60 seconds for the DII. The DDB use the rest of the available bitrate in the SSU data PID.

- After analysis of the transport stream, the new SSU service will use the service id `0x04F0` and PID values `0x1F00` (SSU data) and `0x1F01` (PMT). These values are chosen since they are not used in the original transport stream.

- The resulting transport stream with the added SSU service in sent to an embedded Dektec OFDM modulator on the same frequency as the original service. The output of the modulator can be directly connected to a STB.

The PMT of the service is defined as follow in file **pmt.xml**:

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <PMT service_id="0x04F0">
    <component elementary_PID="0x1F00" stream_type="0x0B">
      <data_broadcast_id_descriptor data_broadcast_id="0x000A">
        <selector_bytes>
          0C 00 12 22 F1 DF 06 FF FF FF FF F0 F0
        </selector_bytes>
      </data_broadcast_id_descriptor>
    </component>
  </PMT>

</tsduck>
```

In this example, the specified OUI value and selector bytes are those which are used by Logiways SSU on Skardin-based STB.

The binary version of the PMT is generated in file **pmt.bin** by the table compiler:

```
tstabcomp pmt.xml
```

The files **pmt.bin**, **dsi.bin**, **dii.bin** and **ddb.bin** are injected in the transport stream using the following command:

```
tsp -I dvb -u 24 \
    -P pat -v 31 -a 0x04F0/0x1F01 \
    -P inject -b 16000 -p 0x1F01 -s pmt.bin \
    -P inject -b 40000 -p 0x1F00 -s dsi.bin=14000 dii.bin=60000 ddb.bin \
    -O dektec -u 24 --convolution 2/3 --guard 1/32
```

Notes: We have previously checked in the TS that the PAT version was not 31. By assigning the new version 31 to the PAT, we state that the content of the PAT has changed. Thus, the STB will analyze it again and will discover the new service.

In the case were the transport stream does not initially contain enough stuffing to inject the SSU service, it is possible to remove a service and replace it with stuffing. In the following command, the service named AB1 is first replaced by stuffing, representing a stuffing increase of 4 Mb/s.

```
tsp -I dvb -u 24 \
    -P svremove –s AB1 \
    -P pat -v 31 -a 0x04F0/0x1F01 \
    -P inject -b 16000 -p 0x1F01 -s pmt.bin \
    -P inject -b 40000 -p 0x1F00 -s dsi.bin=14000 dii.bin=60000 ddb.bin \
```

```
        -O dektec -u 24 --convolution 2/3 --guard 1/32
```

5.2.16 Analyzing EPG data

This example illustrates how to analyze EIT sections and report which service supports EPG data (EIT schedule) and for how many days. The command analyzes the content of UHF channel 27 (DVB-T) during 30 seconds and reports a summary of EIT analysis.

```
$ tsp -I dvb -u 27 -P until -s 30 -P eit -O drop
Summary
-------
TS id:          3 (0x0003)
Last UTC:       2008/08/13 14:19:28
EITp/f actual: 186
EITp/f other:  435
EITs actual:   461
EITs other:    0

TS      Services  With EITp/f  With EITs  EPG days
------  --------  -----------  ---------  --------
Actual      8           6          6          3
Other      66          66          0          0

A/O  TS Id   Srv Id  Name          EITp/f  EITs  EPG days
---  ------  ------  ------------- ------  ----  --------
Oth  0x0001  0x0101                Yes     No           0
Oth  0x0001  0x0104                Yes     No           0
Oth  0x0001  0x0105                Yes     No           0
Oth  0x0001  0x0106                Yes     No           0
Oth  0x0001  0x0110                Yes     No           0
Oth  0x0001  0x0111                Yes     No           0
Oth  0x0001  0x0112                Yes     No           0
Oth  0x0001  0x0113                Yes     No           0
Oth  0x0001  0x0114                Yes     No           0
Oth  0x0001  0x0115                Yes     No           0
Oth  0x0001  0x0116                Yes     No           0
Oth  0x0001  0x0117                Yes     No           0
Oth  0x0001  0x0118                Yes     No           0
Oth  0x0001  0x0119                Yes     No           0
Oth  0x0001  0x011A                Yes     No           0
Oth  0x0001  0x011B                Yes     No           0
Oth  0x0001  0x011C                Yes     No           0
Oth  0x0001  0x011D                Yes     No           0
Oth  0x0001  0x011E                Yes     No           0
Oth  0x0001  0x011F                Yes     No           0
Oth  0x0001  0x0120                Yes     No           0
Oth  0x0001  0x0121                Yes     No           0
Oth  0x0001  0x0122                Yes     No           0
Oth  0x0001  0x0123                Yes     No           0
Oth  0x0001  0x0124                Yes     No           0
Oth  0x0001  0x0125                Yes     No           0
Oth  0x0001  0x0126                Yes     No           0
Oth  0x0001  0x0127                Yes     No           0
Oth  0x0001  0x0128                Yes     No           0
Oth  0x0001  0x0129                Yes     No           0
Oth  0x0001  0x012A                Yes     No           0
Oth  0x0001  0x012B                Yes     No           0
Oth  0x0001  0x012C                Yes     No           0
Oth  0x0001  0x012D                Yes     No           0
Oth  0x0001  0x012E                Yes     No           0
Oth  0x0001  0x012F                Yes     No           0
Oth  0x0001  0x0130                Yes     No           0
Oth  0x0001  0x0131                Yes     No           0
Oth  0x0001  0x0132                Yes     No           0
Oth  0x0001  0x0133                Yes     No           0
```

```
Oth  0x0001  0x0134                      Yes     No          0
Oth  0x0001  0x0135                      Yes     No          0
Oth  0x0001  0x0136                      Yes     No          0
Oth  0x0001  0x0137                      Yes     No          0
Oth  0x0001  0x0138                      Yes     No          0
Oth  0x0001  0x0139                      Yes     No          0
Oth  0x0001  0x013A                      Yes     No          0
Oth  0x0001  0x013B                      Yes     No          0
Oth  0x0001  0x0176                      Yes     No          0
Oth  0x0002  0x0201                      Yes     No          0
Oth  0x0002  0x0203                      Yes     No          0
Oth  0x0002  0x0204                      Yes     No          0
Oth  0x0002  0x0205                      Yes     No          0
Oth  0x0002  0x0206                      Yes     No          0
Oth  0x0002  0x0207                      Yes     No          0
Act  0x0003  0x0301  CANAL+              Yes     Yes         3
Act  0x0003  0x0302  CANAL+ CINEMA       Yes     Yes         3
Act  0x0003  0x0303  CANAL+ SPORT        Yes     Yes         3
Act  0x0003  0x0304  PLANETE             Yes     Yes         3
Act  0x0003  0x0305  CANAL J             Yes     Yes         3
Act  0x0003  0x0306  TPS STAR            Yes     Yes         3
Act  0x0003  0x03F0                      No      No          0
Act  0x0003  0x03F1                      No      No          0
Oth  0x0004  0x0401                      Yes     No          0
Oth  0x0004  0x0402                      Yes     No          0
Oth  0x0004  0x0403                      Yes     No          0
Oth  0x0004  0x0404                      Yes     No          0
Oth  0x0004  0x0405                      Yes     No          0
Oth  0x0004  0x0406                      Yes     No          0
Oth  0x0006  0x0601                      Yes     No          0
Oth  0x0006  0x0602                      Yes     No          0
Oth  0x0006  0x0603                      Yes     No          0
Oth  0x0006  0x0604                      Yes     No          0
Oth  0x0006  0x0606                      Yes     No          0
$
```

5.2.17 Analyzing audio and video attributes

This example illustrates how to display the audio and video attributes from a captured transport stream file.

```
$ tsp -I file cap.ts -P pes -a -v -O drop
* PID 0x0083, stream_id 0xC0 (Audio 0), audio attributes:
  Audio layer II, 160 kb/s, sampled at 48,000 Hz, stereo
* PID 0x014A, stream_id 0xC0 (Audio 0), audio attributes:
  Audio layer II, 192 kb/s, sampled at 48,000 Hz, stereo
* PID 0x0085, stream_id 0xC0 (Audio 0), audio attributes:
  Audio layer II, 64 kb/s, sampled at 48,000 Hz, single channel
* PID 0x0082, stream_id 0xC0 (Audio 0), audio attributes:
  Audio layer II, 192 kb/s, sampled at 48,000 Hz, stereo
* PID 0x0276, stream_id 0xC0 (Audio 0), audio attributes:
  Audio layer II, 192 kb/s, sampled at 48,000 Hz, stereo
* PID 0x01AE, stream_id 0xC0 (Audio 0), audio attributes:
  Audio layer II, 256 kb/s, sampled at 48,000 Hz, stereo
* PID 0x00E6, stream_id 0xC0 (Audio 0), audio attributes:
  Audio layer II, 256 kb/s, sampled at 48,000 Hz, stereo
* PID 0x0078, stream_id 0xE0 (Video 0), video attributes:
  720x576i, 25 Hz, 16/9, 4:2:0
  Maximum bitrate: 15,000,000 b/s, VBV buffer size: 1,835,008 bits
* PID 0x01A4, stream_id 0xE0 (Video 0), AVC video attributes:
  720x576, AVC main profile (77), level 30
* PID 0x00DC, stream_id 0xE0 (Video 0), video attributes:
  720x576i, 25 Hz, 16/9, 4:2:0
  Maximum bitrate: 15,000,000 b/s, VBV buffer size: 1,835,008 bits
* PID 0x026C, stream_id 0xE0 (Video 0), video attributes:
```

```
    720x576i, 24 Hz, 4/3, 4:2:0
    Maximum bitrate: 15,000,000 b/s, VBV buffer size: 1,835,008 bits
  * PID 0x0140, stream_id 0xE0 (Video 0), AVC video attributes:
    704x576, AVC main profile (77), level 30
  $
```

5.2.18 Conditional Access System scrambling and ECM functional tests

The following command receives a DVB-T live stream on UHF channel 21 and remodulates it on the same frequency using a Dektec modulator. In the middle, the service named BFM TV is scrambled. An external ECMG is used (host name **ecmg1** on TCP port 10000). The crypto-periods are scheduled using the default duration of 10 seconds. A new control word is generated for each crypto-period. The corresponding ECM's are generated using the specified ECMG (**Super_CAS_Id** and access criteria specified by options **–s** and **-a**) and inserted in the TS. The PMT of the service is modified to include a **CA_descriptor**. The private part of this descriptor is specified using option **–p**.

```
tsp -I dvb –u 21 \
    -P scrambler bfmtv \
        -e ecmg1:10000 \
        -s 0x4ADC0001 \
-a 6B0A01010000000000000006B0A0102000000000000000006105000000500066040000002 \
        -p FE \
    -O dektec –u 21 --conv 2/3 --guard 1/32
```

5.2.19 Complete Conditional Access System test bed

The following command implements a complete Conditional Access System test bed in one single **tsp** process. It emulates all functions of a MUX system for testing a CAS.

The command uses the French DVB-T network, but it can be easily adapted to any environment.
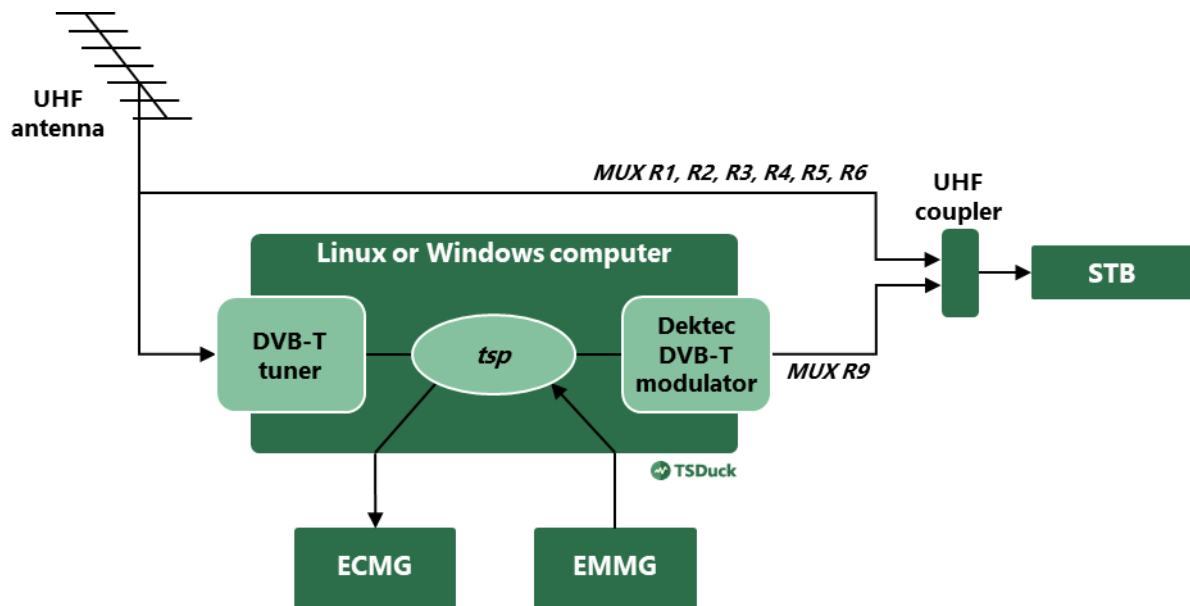
Figure 6: Conditional Access System sample test bed

The command transforms the R2 MUX into a new R9 MUX with new services (actually renamed services from R2) and outputs the resulting TS to a modulator on a different UHF channel. In the meantime, the service named "*Gulli Test*" is scrambled using an external ECMG and EMM injection is allowed from an external EMMG.

The modulated output stream can be used alone (direct connection to STB) or mixed with the public antenna signals using a UHF coupler.

For the sake of clarity of this example, all significant parameters are first assigned into environment variables, then the tsp command references these variables.

```
# Transmission parameters:
UHF_INPUT=21
UHF_OUTPUT=60

# EMM parameters
MUX_SERVER_PORT=32000
CAS_ID=0x4ADC
EMM_PID=0x01F0
EMM_MAX_BITRATE=50000
CAT_CADESC_PRIVATE=FF0001

# ECM parameters
ECMG=ecmg1:10000
SUPER_CAS_ID=0x4ADC0001
ECM_PID=0x01F1
ECM_BITRATE=30000
PMT_CADESC_PRIVATE=FE
AC=6B0A0101000000000000000006B0A01020000000000000000006105000000500066040000002

# One single command implementing the CAS test bed:
tsp -v \
    -I dvb -u $UHF_INPUT \
    -P tsrename -t 9 -a \
    -P svrename direct8  -i 0x0901 -l 41 -n "Direct 8 Test" \
    -P svrename bfmtv     -i 0x0903 -l 42 -n "BFM TV Test" \
    -P svrename 'i>tele' -i 0x0904 -l 43 -n "i>TELE Test" \
    -P svrename virgin17 -i 0x0905 -l 44 -n "Virgin 17 Test" \
    -P svrename gulli     -i 0x0906 -l 45 -n "Gulli Test" \
    -P svrename france4  -i 0x0907 -l 46 -n "France 4 Test" \
    -P svrename 0x02FF    -i 0x09FF \
    -P scrambler GulliTest -e $ECMG -s $SUPER_CAS_ID -p $PMT_CADESC_PRIVATE \
                -a $AC -b $ECM_BITRATE --pid $ECM_PID \
    -P cat -c -a $CAS_ID/$EMM_PID/$CAT_CADESC_PRIVATE \
    -P datainject -r -s $MUX_SERVER_PORT -b $EMM_MAX_BITRATE -p $EMM_PID \
    -O dektec --uhf $UHF_OUTPUT --convolution 2/3 --guard 1/32
```

5.2.20 Emulation of a Conditional Access head-end

This example is a variant of the previous one. Instead of using a real ECMG from a real Conditional Access System, we use the command **tsecmg**.

The utility **tsecmg** implements the DVB SimulCrypt ECMG⇔SCS protocol and behaves like a real ECMG. All ECM generation requests are accepted but, instead of generating robust ciphered proprietary ECM's, **tsecmg** returns pseudo ECM's which contain the control words and the access criteria in the clear.

The utility **tsecmg** can be used anywhere a DVB SimulCrypt ECMG can be used. Consequently, it can be used from any real MUX or from the **tsp** plugin **scrambler**. Used from a real MUX, **tsecmg** becomes a useful debugging tool. All ECMG⇔SCS messages are displayed (using option **--verbose**). The returned ECM's are inserted in the stream like any real ECM. Since these ECM's contain the access criteria in the clear, this is also a useful debug tool for the EIS or ACG or both.

Important: Note that the control words are also inserted in the clear. It is consequently obvious that **tsecmg** shall never be used on a production system, alone or in addition to any real operational CAS.

The **tsp** plugin **descrambler** is normally a static descrambler using fixed control words. But, to facilitate the prototyping of end-to-end systems, the plugin **descrambler** can also recognize the clear ECM's which are generated by **tsecmg** and use their control words to descramble the stream.

Thus, it is easy to build a complete end-to-end Conditional Access System using TSDuck components only. This kind of configuration is mainly useless in itself (except maybe as a tutorial for DVB SimulCrypt). But because all components are replaceable, this can become a very useful integration framework. First, start with a complete configuration using TSDuck components only. Verify that the system works as expected. Then, replace the TSDuck components one by one with the real components which shall be tested.

Sample configurations:

- Testing a MUX: Replace the plugin **scrambler** with the real MUX. Use **tsecmg** to generate ECM's. Use the plugin **analyze** to analyze the output of the MUX. Use the plugin **descrambler** to verify the insertion and synchronization of ECM's.
- Testing a CAS: Replace **tsecmg** with the real ECMG. Replace the plugin **descrambler** with a real set-top box. Use plugin **scrambler** to make the link between to two end-points of the CAS (ECMG and STB).

Let's have a look at a real demo.

First, run the utility **tsecmg**. Without option, it simply creates a TCP server on port 2222. The option **--verbose** (or simply **–v**) is useful to dump all protocol exchanges.

```
tsecmg -v
* TCP server listening on 0.0.0.0:2222, using ECMG <=> SCS protocol version 2
```

Then, the following command performs a complete end-to-end CAS demo in one single process, using a live satellite stream as input:

```
tsp -v \
    -I dvb --freq 12,012,000,000 --symbol 29,700,000 --fec 5/6 --polarity vertical \
        --delivery DVB-S2 --modulation QPSK \
    -P scrambler cnews --ecmg localhost:2222 --super-cas-id 0xDEADBEEF \
        --access-criteria 0123456789 \
    -P analyze --interval 30 -o cas_scrambled.txt \
    -P descrambler cnews \
    -P analyze --interval 30 -o cas_descrambled.txt \
    -P zap cnews \
    -O play
```

The first plugin receives a live transport stream from a DVB-S2 satellite. In this TS, there is a clear service named "CNEWS". We are going to use this clear channel as a test.

The next plugin scrambles the service using our instance of **tsecmg** on the same system. The Super CAS Id is here a fake value (**tsecmg**, unlike a real ECMG, accepts to serve any Super CAS Id). The access criteria are also fake values.

The next plugin permanently analyzes the stream at this point in the chain and produces a report every 30 seconds in a text file named **cas_scrambled.txt.** Looking at this text file, we can see that the service CNEWS is now scrambled and there is an ECM stream in its PMT with CA_system_id **0xDEAD** (the MSB part of the Super CAS Id). The bitrate of the ECM stream is reported as 30 kb/s, the default ECM bitrate for the plugin **scrambler**.

The next plugin is a **descrambler**. Only the service name is required. The plugin automatically locates the ECM stream in the PMT (there is only one here), collects the ECM's and uses the clear control words from these fake ECM's to descramble the stream.

The next plugin performs the same periodic analysis as the previous one. This time, the report demonstrates that the service CNEWS is back in the clear.

Finally, the plugin **zap** extracts the service CNEWS and the output plugin **play** sends the output to a media player (VLC by default).

We can see that the service is in the clear and plays correctly. If we restart the command without the plugin **descrambler**, the player stays with a black screen because the service stays scrambled.

If we are interested in the DVB SimulCrypt ECMG⇔SCS protocol, the option **--verbose** of **tsecmg** displays all exchanges, as listed below. This can be useful to debug an ECMG⇔SCS integration.

```
  * 127.0.0.1:1302: 2018/04/10 23:11:58: session started
  * 127.0.0.1:1302: 2018/04/10 23:11:58: received message:
      channel_setup (ECMG<=>SCS)
      protocol_version = 0x02
      message_type = 0x0001
      ECM_channel_id = 0x0001
      Super_CAS_id = 0xDEADBEEF

  * 127.0.0.1:1302: 2018/04/10 23:11:58: sending message:
      channel_status (ECMG<=>SCS)
      protocol_version = 0x02
      message_type = 0x0003
      ECM_channel_id = 0x0001
      section_TSpkt_flag = 1
      AC_delay_start = 200
      AC_delay_stop = 200
      delay_start = 200
      delay_stop = 200
      transition_delay_start = -500
      transition_delay_stop = 0
      ECM_rep_period = 100
      max_streams = 0
      min_CP_duration = 10
      lead_CW = 1
      CW_per_msg = 2
      max_comp_time = 100

  * 127.0.0.1:1302: 2018/04/10 23:11:58: received message:
      stream_setup (ECMG<=>SCS)
      protocol_version = 0x02
      message_type = 0x0101
      ECM_channel_id = 0x0001
      ECM_stream_id = 0x0001
      ECM_id = 0x0001
      nominal_CP_duration = 100

  * 127.0.0.1:1302: 2018/04/10 23:11:58: sending message:
      stream_status (ECMG<=>SCS)
      protocol_version = 0x02
      message_type = 0x0103
      ECM_channel_id = 0x0001
      ECM_stream_id = 0x0001
      ECM_id = 0x0001
      access_criteria_transfer_mode = 0

  * 127.0.0.1:1302: 2018/04/10 23:11:58: received message:
      CW_provision (ECMG<=>SCS)
      protocol_version = 0x02
      message_type = 0x0201
      ECM_channel_id = 0x0001
      ECM_stream_id = 0x0001
      CP_number = 0
      CP_duration = 100
      access_criteria (5 bytes) =
          01 23 45 67 89
      CP = 0
      CW (8 bytes) = 26 E9 2C D9 C8 96 06 B2
      CP = 1
      CW (8 bytes) = 8B 37 0B 94 69 64 93 CE
```

```
* 127.0.0.1:1302: 2018/04/10 23:11:58: sending message:
    ECM_response (ECMG<=>SCS)
    protocol_version = 0x02
    message_type = 0x0202
    ECM_channel_id = 0x0001
    ECM_stream_id = 0x0001
    CP_number = 0
    ECM_datagram (188 bytes) =
        47 5F FF 10 00 80 70 26 80 AA 03 00 21 00 10 00 08 26 E9 2C D9 C8
        96 06 B2 00 11 00 08 8B 37 0B 94 69 64 93 CE 00 12 00 05 01 23 45
        67 89 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
        FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
        FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
        FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
        FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
        FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
        FF FF FF FF FF FF FF FF FF FF FF FF
```

The returned ECM is a TS packet containing a section with *table_id* **0x80** (an ECM). The payload of the ECM is a TLV structure following the same syntax as DVB SimulCrypt protocols. The command and parameter tags are private to TSDuck and documented in its development documentation (Doxygen-generated, available online).

To create a more realistic environment, we can split the big command into two parts, a "head-end part" which can be replaced by a real MUX and a "set-top box part" which can be replaced by a real STB. The communication between the two parts can be done using a modulator-tuner pair, an ASI link or UDP/IP. All these interconnections are supported by TSDuck and can be driven directly from **tsp**.

Let's have a look at the head-end emulation command, using an UDP/IP output link:

```
tsp -v \
    -I dvb --freq 12,012,000,000 --symbol 29,700,000 --fec 5/6 --polarity vertical \
        --delivery DVB-S2 --modulation QPSK \
    -P scrambler cnews --ecmg localhost:2222 --super-cas-id 0xDEADBEEF \
        --access-criteria 0123456789 --atis-idsa \
    -P zap cnews \
    -O ip 224.10.11.12:9999
```

The output is a multicast address.

Also note that we used the option **--atis-idsa** in the plugin **scrambler**. This means that we use the ATIS IIF Default Scrambling Algorithm (IDSA) instead of the default DVB Common Scrambling Algorithm (CSA2). ATIS being based on AES-128, we can see in the ECMG⇔SCS exchanges that the control words are now 16-byte long. There is no particular reason to use ATIS in this demo (except that ATIS is typically used in IP-TV while DVB-CSA2 is mainly used in broadcast).

The set-top box emulation command is simply:

```
tsp -v \
    -I ip 224.10.11.12:9999 \
    -P descrambler cnews \
    -O play
```

Note that we do not need to specify **--atis-idsa** in the plugin **descrambler**. During the scrambling, the plugin **scrambler** has inserted a *scrambling_descriptor* in the PMT of the service to indicate the non-default scrambling type. This descriptor is automatically recognized by the plugin **descrambler** and the right descrambling algorithm is used, just like any properly integrated set-top box would do.

5.2.21 Multi-Protocol Encapsulation (MPE)

These examples describe a test bed or demo infrastructure for MPE injection and MPE extraction. See [14] for more details on MPE.

5.2.21.1 MPE insertion in an existing transport stream

In this example, we insert MPE in an existing transport stream. The input TS is read from a tuner, the MPE stream is inserted on the fly and the resulting TS is output on a modulator.

The network infrastructure is illustrated in the diagram below.
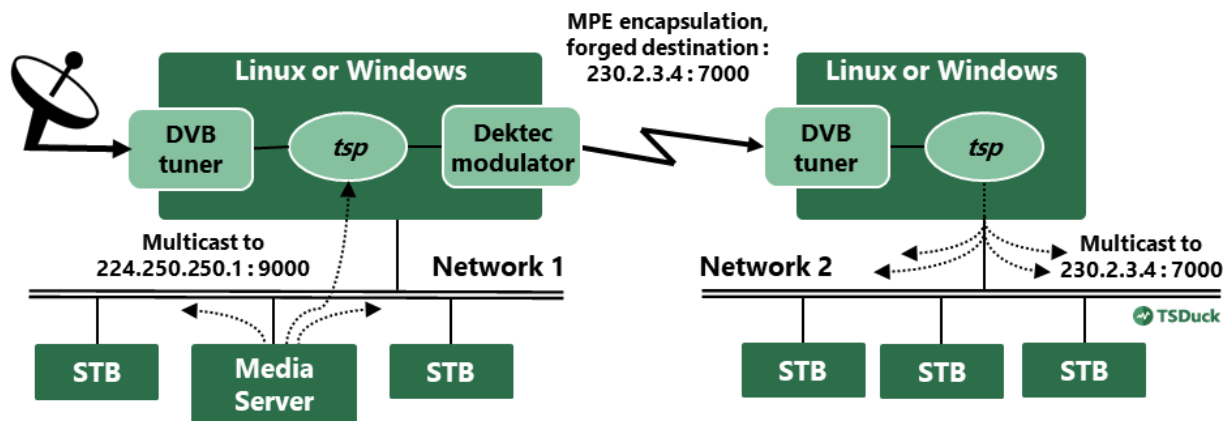
Figure 7: Multi-Protocol Encapsulation (MPE) sample test bed

In network 1, a media server multicasts a transport stream on address 224.250.250.1, port 9000.

We want to encapsulate this UDP multicast stream in an existing transport stream using MPE. We do this using **tsp**. We also change the multicast destination address for the UDP stream to 230.2.3.4, port 7000, in the MPE-encapsulated datagrams. There is no particular reason for this, we just illustrate the feasibility.

The resulting transport stream with embedded MPE is then broadcast. Here, the broadcast network is a Dektec modulator, followed by another computer using a DVB tuner.

This computer is connected to a second network. Another instance of **tsp** extracts the datagrams from the MPE stream and multicasts them on its network using the modified destination address.

Let's review the various steps and commands in detail.

The existing transport stream is here a live satellite TS which is received on a Linux or Windows computer using a DVB tuner. The insertion of the MPE stream adds two new services. We carefully select service ids and PID's which are not used in the existing transport stream.

- A service carrying the IP/MAC Notification Table (INT).
  - Service id: 700
  - Service name: "Demo INT"
  - PMT PID: 5000
  - PID of the component carrying the INT: 5001
- A service carrying the MPE stream. Such a service may carry many MPE streams. Here, we use only one.
  - Service id: 701
  - Service name: "Demo MPE"
  - PMT PID: 5002
  - PID of the component carrying the MPE stream: 5003

We need to create three tables from scratch, the PMT's of the two new services and the INT. We create them using XML files.

PMT of the service carrying the INT (file **pmt-int.xml**):

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <!-- See ETSI EN 301 192, section 8.3 -->
  <PMT service_id="700">
    <component elementary_PID="5001" stream_type="0x05">
      <data_broadcast_id_descriptor data_broadcast_id="0x000B"/>
    </component>
  </PMT>
</tsduck>
```

PMT of the service carrying the MPE stream (file **pmt-mpe.xml**):

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <!-- See ETSI EN 301 192, section 7.2 -->
  <PMT service_id="701">
    <component elementary_PID="5003" stream_type="0x0D">
      <stream_identifier_descriptor component_tag="1"/>
      <data_broadcast_id_descriptor data_broadcast_id="0x0005"/>
    </component>
  </PMT>
</tsduck>
```

IP/MAC Notification Table (file **int.xml**):

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <!-- See ETSI EN 301 192, section 8.4 -->
  <INT platform_id="0x123456">
    <IPMAC_platform_name_descriptor language_code="eng" text="Demo"/>
    <IPMAC_platform_provider_name_descriptor language_code="eng" text="TSDuck"/>
    <device>
      <target>
        <target_IP_slash_descriptor>
          <address IPv4_addr="230.2.3.4" IPv4_slash_mask="32"/>
        </target_IP_slash_descriptor>
      </target>
      <operational>
        <IPMAC_stream_location_descriptor
            network_id="1"
            original_network_id="1"
            transport_stream_id="1080"
            service_id="701"
            component_tag="1"/>
      </operational>
    </device>
  </INT>
</tsduck>
```

On the first system, the following command is used to insert the MPE stream:

```
tsp -I dvb --frequency ... \
    -P svremove Service1 --stuffing \
    -P pat --add-service 700/5000 --add-service 701/5002 \
    -P inject pmt-int.xml --pid 5000 --bitrate 15000 \
    -P inject int.xml --pid 5001 --bitrate 15000 \
    -P inject pmt-mpe.xml --pid 5002 --bitrate 15000 \
    -P sdt --service-id 700 --name "Demo INT" --provider "TSDuck" --type 0x0C \
    -P sdt --service-id 701 --name "Demo MPE" --provider "TSDuck" --type 0x0C \
    -P mpeinject 224.250.250.1:9000 --max-queue 512 \
                 --new-destination 230.2.3.4:7000 --pid 5003 \
    -O dektec --frequency ...
```

The following chain of plugins is used:

- The input plugin **dvb** receives an existing satellite stream.

- The plugin **svremove** removes one service from the TS and replaces it with stuffing. We are going to insert an MPE stream and we need bandwidth for it. If the existing TS does not have enough stuffing bandwidth, we need to create some. Depending on the target MPE bandwidth, we may need to remove several existing services.
- The plugin **pat** adds the two new services in the PAT.
- The three plugin **inject** insert the three XML tables we created, each one on its own PID.
- The two plugins **sdt** add the descriptions of the two new services in the SDT.
- The plugin **mpeinject** inserts the MPE stream. It receives the UDP multicast datagrams for address 224.250.250.1, port 9000. In each datagram, the destination address is modified as 230.2.3.4, port 7000. The UDP datagrams are encapsulated into MPE sections which are injected in PID 5003. The option **--max-queue** is a tuning parameter. It specifies the number of UDP datagrams which can be buffered before insertion in the MPE stream. The parameter shall be tuned according to the receiving multicast rate and bursts and the placement of stuffing packets in the exiting TS. We need to tune it when we get "*UDP overflow*" messages.
- Finally, the plugin **dektec** sends the resulting TS on a modulator.

On the second system, the following command is used to extract the MPE stream and to re-multicast it on the network 2:

```
tsp -I dvb --frequency ... -P mpe --udp-forward -O drop
```

Here, the command is simple since we assume that there is only one MPE stream in the TS and it is properly signaled in the PSI/SI. If there are several MPE streams in the TS, more options are required in the plugin **mpe**.

The option **--udp-forward** specifies that the UDP datagrams shall be forwarded on the local network. Note that when the UDP packets are multicast and the system running **tsp** has several network interfaces, it may be necessary to specify the **--local-address** option to select through which local interface the multicast packets shall be sent.

We may want to use **tsanalyze** on the intermediate transport stream. The two services we created are described as follow:

```
|==============================================================================|
|  Service: 0x02BC (700), TS: 0x0438 (1080), Original Netw: 0x0001 (1)          |
|  Service name: Demo INT, provider: TSDuck                                     |
|  Service type: 0x0C (Data broadcast service)                                 |
|  TS packets: 600, PID's: 2 (clear: 2, scrambled: 0)                          |
|  PMT PID: 0x1388 (5000), PCR PID: None                                        |
|------------------------------------------------------------------------------|
|    PID  Usage                                    Access         Bitrate       |
|  Total  Data broadcast service ..................... C       29,938 b/s       |
|  0x1388  PMT ........................................ C       14,969 b/s       |
|  0x1389  MPEG-2 Private sections (INT, IP/MAC Notifica  C     14,969 b/s       |
|          (C=Clear, S=Scrambled, +=Shared)                                     |
|==============================================================================|
|  Service: 0x02BD (701), TS: 0x0438 (1080), Original Netw: 0x0001 (1)          |
|  Service name: Demo MPE, provider: TSDuck                                     |
|  Service type: 0x0C (Data broadcast service)                                 |
|  TS packets: 154,507, PID's: 2 (clear: 2, scrambled: 0)                      |
|  PMT PID: 0x138A (5002), PCR PID: None                                        |
|------------------------------------------------------------------------------|
|    PID  Usage                                    Access         Bitrate       |
|  Total  Data broadcast service ..................... C    7,709,471 b/s       |
|  0x138A  PMT ........................................ C       14,969 b/s       |
|  0x138B  DSM-CC Sections (MPE) ..................... C    7,694,502 b/s       |
|          (C=Clear, S=Scrambled, +=Shared)                                     |
|==============================================================================|
```

5.2.21.2 Creating a transport stream from scratch

This example is a variant of the previous one. This time, we do not have access to an existing transport stream. Instead, a new transport stream is created from scratch by TSDuck and MPE is inserted on the fly. The resulting stream is an SPTS (single program transport stream) which is output on UDP/IP. This UDP/IP stream is then typically collected by a MUX for insertion in an MPTS (multiple programs transport stream).

Note: The generated TS is not really an SPTS because it contains two services, one for the INT and one for the MPE sections. This is how MPE is structured. But, logically, the two services serve a common function: an MPE stream. So, by extension, we will call it an SPTS.

Creating a TS from scratch using TSDuck is usually done using the input plugin **null**, a plugin which generates an endless stream of null packets. Then, all tables and elementary streams are inserted using appropriate plugins. Remember that *inserting* packets means replacing null packets.

The TS will contain the same two services which were created in the previous example. We already have XML files for their PMT. To create a minimal TS, we also need a PAT and an SDT. For the sake of consistency, we reuse the same PID's as the previous example.

PAT of the new TS (file **pat.xml**):

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <PAT transport_stream_id="1">
    <service service_id="700" program_map_PID="5000"/>
    <service service_id="701" program_map_PID="5002"/>
  </PAT>
</tsduck>
```

SDT of the new TS (file **sdt.xml**):

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <SDT transport_stream_id="1" original_network_id="1">
    <service service_id="700" running_status="running">
      <service_descriptor service_type="0x0C"
                          service_name="MPE Demo (INT)"
                          service_provider_name="TSDuck"/>
    </service>
    <service service_id="701" running_status="running">
      <service_descriptor service_type="0x0C"
                          service_name="MPE Demo"
                          service_provider_name="TSDuck"/>
    </service>
  </SDT>
</tsduck>
```

The **tsp** command which generates the TS and inserts MPE is the following:

```
tsp --verbose --bitrate 30000000 --max-flushed-packets 70 \
    -I null \
    -P regulate --packet-burst 14 \
    -P inject pat.xml --pid 0 --bitrate 15000 \
    -P inject sdt.xml --pid 17 --bitrate 15000 \
    -P inject pmt-int.xml --pid 5000 --bitrate 15000 \
    -P inject int.xml --pid 5001 --bitrate 15000 \
    -P inject pmt-mpe.xml --pid 5002 --bitrate 15000 \
    -P mpeinject 230.2.3.4:4000 --pid 5003 --max-queue 512 \
    -O ip 230.5.6.7:4500 --packet-burst 7 --enforce-burst
```

The following chain of plugins is used:

- The input plugin **null** generates null packets.

- The plugin **regulate** slows down the playout speed at the target TS bitrate. Unlike the previous example where the playout speed was naturally regulated at the input speed of the tuner, here the input plugin generates null packets at full speed (CPU-bound). Note that the bitrate is specified here at **tsp** level and is propagated to all plugins. We have chosen an arbitrary value of 30 Mb/s.
- The subsequent plugins are similar to the previous example, except that the PAT and SDT are inserted from XML file because they did not exist in the input TS.
- The output plugin **ip** sends the resulting SPTS to multicast IP address 230.5.6.7, port 4500.

5.2.21.3 Creating a transport stream from scratch with PCR

Most the time, the command in the previous example will do the job. The generated SPTS is perfectly valid and can be multiplexed in an MPTS when necessary.

However, this SPTS contains only section data (basic signalization, INT and DSM-CC sections for MPE). It does not contain any clock reference. There is no PCR. Usually, this is not a problem since there is no need for a clock in the absence of video or audio streams. However, some MUX or monitoring equipment may generate errors in the absence of PCR.

Additionally, TSDuck will not be able to determine the bitrate of this MPTS (not important in practice, but annoying for us).

Let's see how to modify the previous **tsp** command to generate a valid PCR stream.

We will create a dedicated PCR PID and attach it to the service carrying the MPE stream. We need to modify the XML file for its PMT to reference the new PCR PID.

PMT of the service carrying the MPE stream (file **pmt-mpe-with-pcr.xml**) with highlighted modified fields:

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <!-- See ETSI EN 301 192, section 7.2 -->
  <PMT service_id="701" PCR_PID="5004">
    <component elementary_PID="5003" stream_type="0x0D">
      <stream_identifier_descriptor component_tag="1"/>
      <data_broadcast_id_descriptor data_broadcast_id="0x0005"/>
    </component>
  </PMT>
</tsduck>
```

The new **tsp** command is the following, with highlighted modifications:

```
BITRATE=30000000
PCR_PER_SEC=5
PCR_DISTANCE=$(( $BITRATE / $(( $PCR_PER_SEC * 188 * 8 )) ))
PCR_PID=5004

tsp --verbose --bitrate $BITRATE --max-flushed-packets 70 \
    -I null \
    -P regulate --packet-burst 14 \
    -P filter --every $PCR_DISTANCE --set-label 1 \
    -P craft --only-label 1 --pid $PCR_PID --no-payload --pcr 0 \
    -P continuity --pid $PCR_PID --fix \
    -P pcradjust --pid $PCR_PID \
    -P inject pat.xml --pid 0 --bitrate 15000 \
    -P inject sdt.xml --pid 17 --bitrate 15000 \
    -P inject pmt-int.xml --pid 5000 --bitrate 15000 \
    -P inject int.xml --pid 5001 --bitrate 15000 \
    -P inject pmt-mpe-with-pcr.xml --pid 5002 --bitrate 15000 \
    -P mpeinject 230.2.3.4:4000 --pid 5003 --max-queue 512 \
    -O ip 230.5.6.7:4500 --packet-burst 7 --enforce-burst
```

Note the initial shell variables. We decide that the number of PCR's per second shall be 5 (**PCR_PER_SEC**). From the bitrate (30 Mb/s, now in variable **BITRATE**), we compute the interval between two PCR packets (**PCR_DISTANCE**). This is the number of TS packets between two packets containing a PCR.

To generate a PCR PID in the TS, the following chain of plugins was added:

- The plugin **filter** selects one packet every **PCR_DISTANCE** packets. The selected packets will become the PCR packets. Note that we use the option **--set-label 1** which means that the selected packets are flagged with label 1. No modification is applied to the TS, only flagging some packets.
- The plugin **craft** is applied only on the previously selected packets (option **--only-label 1**). The plugin **craft** performs low-level modifications on the packets. Here, we modify the PID value, we remove the payload and we insert a PCR (with value zero for now).
- The plugin **continuity** fixes the continuity counters on the PCR PID.
- The plugin **pcradjust** fixes the PCR values based on the bitrate.

We now have a valid PCR PID in the MPE service. Let's see how **tsanalyze** evaluates the generated SPTS:

```
=================================================================================
|  TRANSPORT STREAM ANALYSIS REPORT                                             |
|===============================================================================|
|  Transport Stream Id: .......... 1 (0x0001)  |  Services: .............. 2    |
|  Bytes: ..................... 112,355,004    |  PID's: Total: .......... 8    |
|  TS packets: ..................... 597,633   |      Clear: .......... 8       |
|     With invalid sync: .................. 0  |      Scrambled: ...... 0       |
|     With transport error: ............... 0  |      With PCR's: ..... 1       |
|     Suspect and ignored: ................ 0  |      Unreferenced: ... 0       |
|-------------------------------------------------------------------------------|
|  Transport stream bitrate, based on ....... 188 bytes/pkt    204 bytes/pkt    |
|  User-specified: ......................... 29,996,462 b/s   32,549,352 b/s    |
|  Estimated based on PCR's: ............... 29,934,196 b/s   32,481,787 b/s    |
|-------------------------------------------------------------------------------|
|  Broadcast time: ................................. 29 sec (0 min 29 sec)      |
|-------------------------------------------------------------------------------|
|  Srv Id  Service Name                          Access        Bitrate          |
|  0x02BC  MPE Demo (INT) .............................. C       30,115 b/s      |
|  0x02BD  MPE Demo .................................... C    6,638,107 b/s      |
|                                                                               |
|  Note 1: C=Clear, S=Scrambled                                                 |
|  Note 2: Unless specified otherwise, bitrates are based on 188 bytes/pkt      |
=================================================================================


=================================================================================
|  SERVICES ANALYSIS REPORT                                                     |
|===============================================================================|
|  Global PID's                                                                 |
|  TS packets: 464,779, PID's: 3 (clear: 3, scrambled: 0)                       |
|-------------------------------------------------------------------------------|
|    PID  Usage                                   Access        Bitrate         |
|   Total Global PID's ................................. C   23,328,239 b/s     |
|   Subt. Global PSI/SI PID's (0x00-0x1F) .............. C       30,115 b/s     |
|  0x0000 PAT .......................................... C       15,057 b/s     |
|  0x0011 SDT/BAT ...................................... C       15,057 b/s     |
|  0x1FFF Stuffing ..................................... C   23,298,123 b/s     |
|===============================================================================|
|  Service: 0x02BC (700), TS: 0x0001 (1), Original Netw: 0x0001 (1)             |
|  Service name: MPE Demo (INT), provider: TSDuck                               |
|  Service type: 0x0C (Data broadcast service)                                  |
|  TS packets: 600, PID's: 2 (clear: 2, scrambled: 0)                           |
|  PMT PID: 0x1388 (5000), PCR PID: None                                        |
|-------------------------------------------------------------------------------|
|    PID  Usage                                   Access        Bitrate         |
```

```
|   Total   Data broadcast service ....................... C        30,115 b/s |
|   0x1388  PMT ......................................... C        15,057 b/s |
|   0x1389  MPEG-2 Private sections (INT) ............... C        15,057 b/s |
|           (C=Clear, S=Scrambled, +=Shared)                                  |
|=============================================================================|
|   Service: 0x02BD (701), TS: 0x0001 (1), Original Netw: 0x0001 (1)          |
|   Service name: MPE Demo, provider: TSDuck                                  |
|   Service type: 0x0C (Data broadcast service)                              |
|   TS packets: 132,254, PID's: 3 (clear: 3, scrambled: 0)                   |
|   PMT PID: 0x138A (5002), PCR PID: 0x138C (5004)                           |
|-----------------------------------------------------------------------------|
|     PID  Usage                                     Access       Bitrate |
|   Total   Data broadcast service ....................... C     6,638,107 b/s |
|   0x138A  PMT ......................................... C        15,057 b/s |
|   0x138B  DSM-CC Sections (MPE) ....................... C     6,615,571 b/s |
|   0x138C  PCR (not otherwise referenced) .............. C         7,478 b/s |
|           (C=Clear, S=Scrambled, +=Shared)                                  |
|=============================================================================|
```

5.2.22 DVB-T2 Modulator Interface (T2-MI)

A DVB T2-MI stream is encapsulated into one PID of a TS. A DVB-T2 stream may contain several Physical Layer Pipes (PLP). Each PLP contains a complete TS. The plugin **t2mi** is designed to extract the TS from a PLP of a T2-MI stream.

With a fully DVB-compliant signalization, the PID carrying T2-MI is signaled in the PMT of its service using a T2-MI descriptor.

Sample PMT using **tstables**:

```
* PMT, TID 2 (0x02), PID 33 (0x0021)
  Version: 11, sections: 1, total size: 27 bytes
  - Section 0:
    Program: 800 (0x0320), PCR PID: none
    Elementary stream: type 0x06 (MPEG-2 PES private data), PID: 64 (0x0040)
    - Descriptor 0: Extension Descriptor (0x7F, 127), 4 bytes
      Extended descriptor: T2MI (0x11, 17)
      T2-MI stream id: 0, T2-MI stream count: 1, PCR/ISCR common clock: no
```

Excerpt from **tsanalyze** for the service containing the T2-MI stream:

```
|=============================================================================|
|   Service: 0x0320 (800), TS: 0x03A2 (930), Original Netw: 0x0000 (0)        |
|   Service name: (T2-MI), provider: (unknown)                               |
|   Service type: 0x00 (unknown)                                             |
|   TS packets: 145,024, PID's: 2 (clear: 2, scrambled: 0)                   |
|   PMT PID: 0x0021 (33), PCR PID: None                                      |
|-----------------------------------------------------------------------------|
|     PID  Usage                                     Access       Bitrate |
|   Total   unknown (0x00) .............................. C         Unknown |
|   0x0021  PMT ......................................... C         Unknown |
|   0x0040  T2-MI (PLP: 0x66 (102)) ..................... C         Unknown |
|           (C=Clear, S=Scrambled, +=Shared)                                  |
|=============================================================================|
```

The option **--identify** of the plugin **t2mi** lists the same information. With this option, the plugin does not modify the stream, it only identify T2-MI PID's and PLP's.

```
$ tsp -I dvb ... -P t2mi --identify -O drop
* t2mi: found T2-MI PID 0x0040 (64)
* t2mi: PID 0x0040 (64), found PLP 102
^C
* tsp: user interrupt, terminating...
* t2mi: summary: found 1 PID's with T2-MI
* t2mi: PID 0x0040 (64): PLP 102
$
```

But since T2-MI streams are received by designated professional equipment, many operators do not setup the required signalization and it is necessary to guess which PID in which service may carry T2-MI.

Example service which is a good candidate for T2-MI:

```
|===============================================================================|
|   Service: 0x0320 (800), TS: 0x03A2 (930), Original Netw: 0x0000 (0)           |
|   Service name: (unknown), provider: (unknown)                                 |
|   Service type: 0x00 (unknown)                                                 |
|   TS packets: 27,805,661, PID's: 2 (clear: 2, scrambled: 0)                    |
|   PMT PID: 0x0100 (256), PCR PID: None                                         |
|-------------------------------------------------------------------------------|
|     PID  Usage                                        Access        Bitrate    |
|   Total  unknown (0x00) ............................. C            Unknown     |
|  0x0100  PMT ........................................ C            Unknown     |
|  0x1000  MPEG-2 PES private data .................... C            Unknown     |
|          (C=Clear, S=Scrambled, +=Shared)                                      |
|===============================================================================|
```

In this example, the TS contains only one service. This service contains only one component and it carries private sections. Since there is no video PID, there is no PCR and **tsanalyze** is not able to compute bitrates. If we know, from other sources, that the TS contains T2-MI, it must be there. In this case, we need to explicitly provide the PID number to the plugin **t2mi**:

```
$ tsp -I dvb ... -P t2mi --pid 0x1000 --identify -O drop
* t2mi: PID 0x1000 (4096), found PLP 0
* t2mi: PID 0x1000 (4096), found PLP 2
* t2mi: PID 0x1000 (4096), found PLP 1
^C
* tsp: user interrupt, terminating...
* t2mi: summary: found 1 PID's with T2-MI
* t2mi: PID 0x1000 (4096): PLP 0, 1, 2
$
```

If we want to redistribute on a local DVB network one of these PLP's, the command is the following:

```
$ tsp -I dvb ... -P t2mi --pid 0x1000 --plp 1 -O dektec ...
```

Without the option **--identify**, the plugin **t2mi** extracts the TS from the specified PLP and completely replaces the TS with the extracted one. The output of the plugin is the extracted TS, the original TS carrying T2-MI has disappeared. The final output is a Dektec modulator (or ASI board) which broadcasts the extracted TS.

The plugin **t2mi** can extract only one PLP because this is the basic principle of **tsp**: end-to-end processing of one single TS. Even if one plugin produces a radical transformation such as completely replacing the TS with another one (here, the extracted PLP), there is only one TS at all points in the chain.

If we want to process all PLP's at the same time, we must re-route the original TS in parallel instances of **tsp** using the plugin **fork**. Each instance of **tsp** extracts one PLP.

This is illustrated by the following command:

```
tsp -I dvb ... \
    -P until –seconds 30 \
    -P fork 'tsp -P t2mi --pid 0x1000 --plp 0 -P analyze -o plp0.txt -O drop' \
    -P fork 'tsp -P t2mi --pid 0x1000 --plp 1 -P analyze -o plp1.txt -O drop' \
    -P fork 'tsp -P t2mi --pid 0x1000 --plp 2 -P analyze -o plp2.txt -O drop' \
    -P analyze -o main.txt -O drop
```

This command analyzes the enclosing stream and the three different PLP's in parallel during 30 seconds. Each plugin **fork** creates a process and passes the complete TS to this process. Each created process runs another instance of **tsp** which extracts one PLP. Note that the default input plugin of **tsp** is the plugin **file** which, by default, reads the standard input.

5.2.23 Merging transport streams

The plugin **merge** can be used to merge a transport stream into another one. The service references are correctly merged into the final transport stream.

Let's illustrate this using two live transport streams from satellite Astra 19.2 E. We use one transport stream as base. We remove one service from this stream and we replace it with another live service coming from another transport stream.

We use the transport stream with id 1028 as base. Using the plugin **dvb**, the tuning options are:

```
--freq 11,626,500,000 --symbol 22,000,000 --fec 5/6 --polarity vertical --delivery DVB-S
```

To simplify the command lines, we save these options, one per line, in a text file named **ts1028.txt** to be used by partial command line redirection (see 3.1.5).

The structure of this transport stream can be seen using the plugin **analyze**. Here is the list of services from the analyze output:

```
|----------------------------------------------------------------------|
| Srv Id  Service Name                       Access        Bitrate     |
| 0x1131  TVE INTERNACIONAL EUROPA ..................... C   3,572,410 b/s |
| 0x1132  CANAL 24 HORAS ............................... C   3,423,043 b/s |
| 0x113B  RNE RADIO 1 .................................. C     140,998 b/s |
| 0x113C  RNE RADIO 3 .................................. C     278,941 b/s |
| 0x113D  RNE RADIO 4 .................................. C     141,045 b/s |
| 0x113E  RNE RADIO 5 TODO NOTICIAS .................... C     141,092 b/s |
| 0x113F  RNE RADIO CLASICA ............................ C     347,819 b/s |
| 0x1140  RNE RADIO EXTERIOR DE ESPAÑA ................. C     141,139 b/s |
| 0x1146  CNN Int. ..................................... C   4,008,806 b/s |
| 0x114E  DW (English) ................................. C   3,488,065 b/s |
| 0x1158  Al Jazeera English ........................... C   3,803,631 b/s |
|----------------------------------------------------------------------|
```

We use the transport stream with id 1022 to extract a service and inject it into the previous transport stream. The **dvb** tuning options are:

```
--freq 11,538,000,000 --symbol 22,000,000 --fec 5/6 --polarity vertical --delivery DVB-S
```

Again, we save them, one by line, in a text file named **ts1022.txt**.

The list of services from transport stream 1022 is shown below. Note that we use transport streams with clear channels only to be able to watch the result.

```
|----------------------------------------------------------------------|
| Srv Id  Service Name                       Access        Bitrate     |
| 0x1AF4  DATASYSTEM .................................. C      44,884 b/s |
| 0x1AF8  Russia Today ................................ C   4,038,071 b/s |
| 0x1AF9  France 24 (en Français) ..................... C   2,703,659 b/s |
| 0x1AFA  France 24 (in English) ...................... C   2,700,842 b/s |
| 0x1AFE  France 24 (in Arabic) ....................... C   2,465,576 b/s |
| 0x1B00  CGTN Documentary ............................ C   2,504,263 b/s |
| 0x1B01  CGTN F ...................................... C   2,247,071 b/s |
| 0x1B02  CGTN ........................................ C   2,443,463 b/s |
| 0x1B03  TV5MONDE EUROPE ............................. C   3,619,747 b/s |
| 0x1B06  TRT World HD ................................ C   5,984,240 b/s |
|----------------------------------------------------------------------|
```

We assume that we have two satellite tuners in the system. Adapter 0 will be used to receive TS 1022 and adapter 1 will be used to receive TS 1028.

We also have a Dektec modulator to redistribute the resulting transport stream. Again, to shorten the command line, we place all modulation options into one text file named **modulation.txt**.

In our example, we extract the service **TV5MONDE EUROPE** from TS 1022 and we merge it into TS 1028. To make sure that the transport stream has enough free space, we remove the service **Al Jazeera English** from TS 1028 before the merge[8].

The merging command is the following:

```
tsp -I dvb -a 1 @ts1028.txt \
    -P svremove -s AlJazeeraEnglish \
    -P merge "tsp -I dvb -a 0 @ts1022.txt -P zap TV5MondeEurope" \
    -P analyze -i 30 -o merged.txt \
    -O dektec @modulation.txt
```

Note that the service **Al Jazeera English** is replaced by stuffing (option **-s**) in TS 1028.

In the created command, everything is removed from TS 1022, except service **TV5MONDE EUROPE** (the service names are not case-sensitive and spaces are ignored).

The final plugin **analyze** continuously analyzes the output stream and produces a report file every 30 seconds. Here is the merged list of services from this report:

```
|---------------------------------------------------------------------------|
| Srv Id   Service Name                          Access         Bitrate     |
| 0x1131   TVE INTERNACIONAL EUROPA ..................... C    3,529,507 b/s |
| 0x1132   CANAL 24 HORAS .............................. C    3,382,237 b/s |
| 0x113B   RNE RADIO 1 ................................. C      139,475 b/s |
| 0x113C   RNE RADIO 3 ................................. C      275,915 b/s |
| 0x113D   RNE RADIO 4 ................................. C      139,425 b/s |
| 0x113E   RNE RADIO 5 TODO NOTICIAS ................... C      139,374 b/s |
| 0x113F   RNE RADIO CLASICA ........................... C      343,831 b/s |
| 0x1140   RNE RADIO EXTERIOR DE ESPAÑA ................ C      139,425 b/s |
| 0x1146   CNN Int. ................................... C    3,963,218 b/s |
| 0x114E   DW (English) ................................ C    3,448,180 b/s |
| 0x1B03   TV5MONDE EUROPE ............................. C    3,566,805 b/s |
|---------------------------------------------------------------------------|
```

We can see that the service **Al Jazeera English** has been replaced with **TV5MONDE EUROPE**.

Luckily, there was no PID or service id conflict between the two transport streams. If the same service id or PID had existed in the two streams, the plugin **merge** would have reported an error and the component from the merged stream would have been dropped. In case of conflict, we use the plugin **remap** to modify PID's or the plugin **svrename** to rename a service (including modifying its service id).

5.2.24 Injecting SCTE 35 cue information

SCTE 35 cue information are single-section tables which are sent in one dedicated PID in a service. These commands are used to signal *video splicing points* where alternate content (typically ads) can replace the original video content. The video splicing points are defined by PTS (presentation time stamp) values in the video PID of the service.

Inserting SCTE 35 cue information is consequently different from traditional signalization. Each section defines one specific splicing event. It is not cycled. It is inserted once or twice only in the PID. The traffic on this PID is very low and not regular (it depends on the occurrences of the splicing events).

The splicing points are usually defined on the fly, with the cooperation of the video encoder. The exact PTS values of the splicing points are defined in real time. It is usually impossible to define in advance the list of all splicing events in the life of a service. Moreover, inserting cue information section needs

---

[8] In practice, on the day of this experiment, the service TS 1028 had more than enough stuffing to insert one or two services without removing any other. However, in the general case, we need to make some room first. So, let's do it anyway.

to be synchronized with the associated video PID. Typically, a splice event is signaled twice, once two seconds before the event and once one second before.

Because of this dynamics, there are two distinct use cases: real-time live streams and offline test files.

5.2.24.1 Real-time live stream

This example illustrates the insertion of cue information in a real-time live transport stream. We receive a DTTV stream from a DVB-T tuner, we insert cue information for one service and we restream the result through a DVB-T modulator.

The transmission chain is processed by a **tsp** command. The generation of the cue information is externally performed by some real-time system, cooperating with the content management system and the video encoder. The format of the splice commands is defined by SCTE 35 [22]. Splice information sections can be provided in binary or XML format (see 2.3).

Here is an XML example of a pair of splice commands, a *splice out* event, followed 20 seconds later by a *splice in* event. This is typically an ads replacement opportunity. Here, the sections are minimal. You may want to add *break duration* information or additional descriptors.

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>

  <splice_information_table>
    <splice_insert splice_event_id="100" unique_program_id="1"
                   out_of_network="true" pts_time="0x078CA4459"/>
  </splice_information_table>

  <splice_information_table>
    <splice_insert splice_event_id="100" unique_program_id="1"
                   out_of_network="false" pts_time="0x78E5BB99"/>
  </splice_information_table>

</tsduck>
```

The PTS timestamps are synchronized with the video PID. Moreover, these timestamp shall correspond to *video splice points*, i.e. frames where the binary replacement of the encoded video content is smooth. This is why splicing shall be done with the cooperation of the video encoder.

The following command performs the real-time processing.

```
tsp -I dvb –u 24 \
    -P pmt --service 1010 --add-programinfo-id 0x43554549 --add-pid 600/0x86 \
    -P spliceinject --service 1010 --files 'splice-*.xml' --udp 4444 \
    -O dektec –u 24 --convolution 2/3 --guard 1/32
```

The input plugin **dvb** reads a DVB-T live stream from UHF channel 24. At the end of the processing, the output plugin **dektec** sends the stream to a Dektec DVB-T modulator on the same frequency.

The transport stream contains several services. We will add cue information on service id 1010. We could process multiple services using successive instances of the plugin **spliceinject** in the same command.

The plugin **pmt** modifies the PMT of the target service on the fly. To comply with the SCTE 35 standard, we add a *registration_descriptor* with id 0x43554549 and we add the declaration of the PID 600 with stream type 0x86 (meaning SCTE 35 cue information).

The plugin **spliceinject** performs the injection. The service id is sufficient to locate the target PID: the plugin searches the service and then searches a component with stream type 0x86 in its PMT.

The splice information sections can be supplied in real time using two methods: file (binary or XML) and UDP datagrams. Here, for the sake of the example, we use both. We can also use only one. The file specification is a wildcard because different files can be provided. It is also possible to rewrite the same

file. Each time a file is modified, it is reloaded. We can also receive UDP datagrams (here on port number 4444). The datagram can contain binary or XML sections.

See the reference documentation of the plugin **spliceinject** for more details.

5.2.24.2 Cue insertion in offline files

Sometimes, it is necessary to prepare a transport stream file for demo or test. Usually, the same **tsp** command can be used indifferently on live streams and offline files. For SCTE 35 cue information, this is a bit different because of the dynamics.

The plugin **spliceinject** processes a transport stream and, on the other hand, it asynchronously receives splice information sections. On a real time stream, the events are received slightly in advance but in a timely fashion. The plugin does not expect any section file to be present at the time the processing starts. It does not wait for the section files.

With an offline transport stream file, the processing is very fast, running at the speed of the disk storage. So, even if the splice information section files are already present, they are read asynchronously from the transport stream processing. Specifically, they can be read *after* the processing the target event in the stream. In that case, no section would be injected. To avoid this problem, we use the option **--wait-first-batch** which forces the transport stream processing to wait for at least the first batch of splice section files. Thus, if the section files are present at the time the command is run, it is guaranteed that they are loaded and injected.

Additionally, in the following example, we use an SPTS file (containing only one service). These files usually contain no stuffing. However, **tsp** cannot insert new packets in a transport stream. It can only replace stuffing packets. So, unlike broadcast transport streams which always contain some stuffing, nothing can be injected in such a stream. To make room for insertion, we use the **tsp** option **--add-input-stuffing** which artificially injects null packets at input level (here one null packet every 10 input packets). This artificial stuffing will be used by **spliceinject** to insert its sections. Note that we remove the extra unused stuffing before the output plugin using the plugin **filter**.

The rest of the command is similar to the previous example.

```
tsp --add-input-stuffing 1/10 \
    -I file spts.ts \
    -P pmt --service 1010 --add-programinfo-id 0x43554549 --add-pid 600/0x86 \
    -P spliceinject --service 1010 --files splice.xml --wait-first-batch \
    -P filter --negate --pid 0x1FFF \
    -O file spts-out.ts
```

5.2.25 Encapsulating PID's into a private tunnel

In this example, we start from a transport stream containing two services, **CANAL+ DECALE** (id 0x2262) and **CNEWS** (id 0x226A). We want to process the first service through some external equipment (transcoder, transrater, etc.) However, this equipment can only process SPTS (single-program transport stream).

To preserve the structure of the transport stream while crossing this equipment, we use the following trick. We encapsulate the second service into one single "tunnel" PID and then we erase this service from the structure of the TS. This tunnel PID is added as a private component of the first service. Now, we have a true SPTS which can be processed by external equipment.

The structure of the service CNEWS is reported as follow by **tsanalyze**:

```
|==============================================================================|
|  Service: 0x226A (8810), TS: 0x0438 (1080), Original Netw: 0x0001 (1)        |
|  Service name: CNEWS, provider: CSAT                                         |
|  Service type: 0x19 (Advanced codec HD digital television service)          |
|  TS packets: 9,298, PID's: 4 (clear: 4, scrambled: 0)                       |
```

```
|  PMT PID: 0x03E8 (1000), PCR PID: 0x03F2 (1010)                            |
|----------------------------------------------------------------------------|
|     PID  Usage                                          Access     Bitrate |
|   Total  Advanced codec HD digital television service . C    3,983,427 b/s |
|  0x03E8  PMT ......................................... C       14,994 b/s |
|  0x03F2  AVC video (1920x1080, high profile, level 4.0 C    3,771,361 b/s |
|  0x03FD  AC-3 Audio (fra, AC-3, stereo (L,R), @48,000   C      197,072 b/s |
|  0x0413  Subtitles (fra, DVB subtitles for hard of hea  C            0 b/s |
|          (C=Clear, S=Scrambled, +=Shared)                                  |
|============================================================================|
```

The first step is performed using the following command.

```
tsp -I ... \
    -P encap -o 0x1000 -p 0x03E8 -p 0x03F2 -p 0x03FD -p 0x0413 \
    -P pat --remove-service 0x226A \
    -P sdt --remove-service 0x226A \
    -P pmt -s 0x2262 -a 0x1000/0x99 \
    -O ...
```

The plugin **encap** creates a tunnel PID **0x1000**. This tunnel contains the 4 PID's of the service **CNEWS**, PMT, video, audio and subtitles. The plugins **pat** and **sdt** remove the service from the PAT and SDT, respectively. At this point, the service CNEWS has disappeared but the new PID **0x1000** is orphan. To preserve this PID through the processing of the service CANAL+ DECALE, we add it to the PMT of the service using the plugin **pmt**. We use the reserve stream type **0x99** for this PID to indicate some private type (any other reserved stream type should be OK).

After processing the SPTS through the external equipment (and hoping that the equipment has preserved the private components of the service), we restore the structure of the transport stream using the following command:

```
tsp -I ... \
    -P decap -p 0x1000 \
    -P pat -a 0x226A/0x03E8 \
    -P sdt -s 0x226A -n CNEWS -p CSAT \
    -P pmt -s 0x2262 -r 0x1000 \
    -O ...
```

The plugin **decap** decapsulates the content of the tunnel PID 0x1000. It is replaced by all original PID's of the service CNEWS. Then, we need to restore the reference to the service in the PAT and SDT using the plugins **pat** and **sdt**. Finally, since the private component 0x1000 no longer exists, we remove it from the PMT of the service **CANAL+ DECALE** using the plugin **pmt**.

Note: in a real-life example, the MPTS would probably contain more than two services. In that case, we would encapsulate all other services in the private tunnel PID as well. The principle remains the same. The command is only a bit longer.

5.2.26 Interleaving input files and merging their PSI

This example command reads two input files **file1.ts** and **file2.ts**. We assume here that the two files have no conflicting allocation of service ids and no conflicting PID's into services. Only the PSI/SI PID's are common.

Using the option **--interleave** in the **file** input plugin, we read one packet of **file1.ts**, then one packet of **file2.ts**, then one packet of **file1.ts** *again*, and so on. So, the two input files are multiplexed one by one.

Using the option **--label-base**, we assign the label 1 to all packets from **file1.ts** and label 2 to all packets from **file2.ts**.

```
tsp -I file --interleave file1.ts file2.ts --label-base 1 \
    -P psimerge --main-label 1 --merge-label 2 \
    ...
```

The plugin **psimerge** uses all packets with label 1 as a *main* stream and all packets with label 2 as a *merge* stream. It merges the PSI/SI from the two streams, creating a PAT and SDT-Actual containing all services from the two streams, creating a CAT containing all EMM PID's from the two streams. All EIT sections are multiplexed into the EIT PID.

5.2.27 Using Secure Reliable Transport (SRT) transmission

The input and output plugins **srt** can be used to send and receive a transport stream using the Secure Reliable Transport (SRT) protocol. These plugins are not available everywhere, the **libsrt** (SRT library, see [48]) must be present during the compilation of TSDuck.

First example: On a system named **vmfedora**, a **tsp** command sends a stream (here, a simple file playback) using SRT. The system is the SRT listener. It waits for an incoming connection on port 12345

```
tsp -v \
    -I file input.ts --infinite \
    -P regulate \
    -O srt --listener 12345 --transtype live --messageapi
```

On a receiver system, a **tsp** command connects to **vmfedora** on port 12345 and receives the stream over SRT. Here, the processing of the stream is simply an analysis during 30 seconds.

```
tsp -v \
    -I srt --caller vmfedora:12345 --transtype live --messageapi --conn-timeout 100000 \
    -P until --seconds 30 \
    -P analyze \
    -O drop
```

Second example with encrypted transmission: The passphrase is used to derive the encryption key. The passphrase must be 10 to 64 characters long. The option **--pbkeylen** selects the actual derived encryption key length. The option **--min-version** rejects connection with a **libsrt** version lower than 1.4.0 in this case

```
tsp -v \
    -I file input.ts --infinite \
    -P regulate \
    -O srt --listener 12345 --transtype live --messageapi \
        --passphrase baguettess --pbkeylen 16 \
        --enforce-encryption --min-version 0x010400
```

On the receiver system:

```
tsp -v \
    -I srt --caller vmfedora:12345 --transtype live --messageapi \
        --passphrase baguettess --pbkeylen 16 \
    -P until --seconds 30 \
    -P analyze \
    -O drop
```

Third example using **--transtype file** and buffer API (equivalent to not setting **--messageapi**).

```
tsp -v \
    -I file input.ts --infinite \
    -P regulate \
    -O srt --listener 12345 --transtype file
```

On the receiver system:

```
tsp -v \
    -I srt --caller vmfedora:12345 --transtype file --conn-timeout 100000 \
    -P until --seconds 30 \
    -P analyze \
    -O drop
```

5.2.28 Preserving EIT's through ffmpeg processing

TSDuck is often used in combination with **ffmpeg**. The former processes the system layer and the latter processes the video and audio. However, **ffmpeg** removes the TS signalization, system or data PID's. So, while **ffmpeg** is extremely useful to transcode video and audio, it is inconvenient to process a complete TS. In this example, we demonstrate how to process an SPTS through **ffmpeg** while preserving EIT's. It can be easily adapted to preserve any other data PID.

The plugin **encap** encapsulates one or more PID's into one *tunnel* PID. There are several encapsulation modes, include a "PES mode" which builds a PES stream containing the encapsulated data (see the **encap** documentation in chapter 4). We use this trick to preserve EIT's through ffmpeg.

```
tsp --add-input-stuffing 1/10 \
    -I dvb --uhf-channel 30 \
    -P zap arte --audio fra --no-subtitles --eit --stuffing \
    -P encap --pes-mode fixed --pid 0x12 --output-pid 0x900 \
    -P pmt --add-pid 0x900/0x06 --add-pid-registration 0x900/0x4B4C5641 \
    -P filter --negate --pid 0x1FFF | \
ffmpeg -f mpegts -i - \
    -map 0:d -codec:d copy \
    -map 0:v -codec:v ... \
    -map 0:a -codec:a ... \
    -mpegts_start_pid 0x900 \
    -mpegts_transport_stream_id 0x0004 \
    -mpegts_original_network_id 0x20FA \
    -mpegts_service_id 0x0407 \
    -metadata service_name="Arte" \
    -f mpegts - | \
tsp -P decap --pid 0x900 \
    -P pmt --remove-pid 0x900 \
    -P filter --negate --pid 0x1FFF \
    -O ...
```

In this example, we extract one service named **Arte** from a DVB-T transport stream on UHF channel 30.

Analysis of this command:

- Initial **tsp** command:
    - Add one null packet every 10 input packets (**--add-input-stuffing 1/10**) to accomodate the encapsulation overhead. In this specific example, this is useless because a broadcast TS always contain some stuffing. But it would be required if you read an IP stream without stuffing, for instance.
    - Receive a DVB-T transport stream from a tuner on UHF channel 30.
    - Extract the service named **Arte**, using the French audio track, no subtitles and keep all EIT's for this service.
    - Encapsulate the PID **0x12** (EIT's) in PES mode, creating a *tunnel* PID **0x900**. Make sure that this PID number is not already used in your stream.
    - Reference this PID in the PMT of the service with stream type **0x06** (PES private data) and registration type **KLVA** (**0x4B4C5641**). Thus, the encapsulated EIT's become a data component of the service.
    - Remove remaining null packets.
- Intermediate **ffmpeg** command:
    - Map the first "data" stream "**0:d**" to output and use **copy** codec (ie. no transformation of the PES stream). Thus, the PES stream containing the encapsulated EIT's will pass unmodified.
    - Then, map video and audio PID's "**0:v**" and "**0:a**" with their respective codecs (unspecified here, select your favorite codecs).

- o Important: Be sure to map the data stream first to enforce it as first output PID. This way, you can specify exactly the first PID using the **ffmpeg** option **-mpegts_start_pid** afterwards.
  - o Respecify the original TS id, original network id and service id using dedicated **ffmpeg** options. This is important to preserve the references of the EIT's. By default, **ffmpeg** would generate TS id 1 and service id 1 which would not match with the EIT's. We also respecify the orginal service name (**ffmpeg** generates a dummy name by default). All these values shall be adapted according to the input stream.
- • Final **tsp** command:
  - o Decapsulate the *tunnel* PID. We have forced it in **ffmpeg** as PID **0x900** using **-mpegts_start_pid**. The PID **0x12** (EIT's) reappears in the stream.
  - o Dereference the PID **0x900** from the PMT. The tunnel PID disappears after decapsulation and it is cleaner to dereference it.
  - o Remove spurious null packets which were created from encapsulation overhead.

5.2.29 JSON analysis of a transport stream

The option **--json** is used with **tsanalyze** or the pugin **analyze** to produce a JSON output. Such output can be used with many tools. In shell scripts, the open source tool **jq** (for "JSON Query") is extremely powerful.

Getting a JSON analysis of a transport stream from the TSDuck repository:

```
$ tsp -I http https://tsduck.io/streams/france-dttv/tnt-uhf30-546MHz-2019-01-22.ts \
    -P analyze --json -o ts.json \
    -O drop
```

First sample commands using **jq** to get the number of services and their names:

```
$ jq <ts.json -r '.services | length'
5
$ jq <ts.json -r '.services[].name'
M6
W9
Arte
France 5
6ter
$
```

Now, let's write a shell script to display all services and a description of each of their PID's. This illustrates the power of **jq**, including field selection and array lookup based on the value of a property.

```
JSON=ts.json
SRVCOUNT=$(jq <$JSON -r ".services | length")

for ((i=0; i<$SRVCOUNT; i++)); do
    SRVNAME=$(jq <$JSON -r ".services[$i].name")
    PIDCOUNT=$(jq <$JSON -r ".services[$i].pids | length")
    echo "Service $SRVNAME, $PIDCOUNT PID's"
    for ((p=0; p<$PIDCOUNT; p++)); do
        PID=$(jq <$JSON -r ".services[$i].pids[$p]")
        DESC=$(jq <$JSON -r ".pids[] | select(.id==$PID) | .description")
        printf "  PID 0x%04X, %s\n" "$PID" "$DESC"
    done
done
```

The output of this script is the following (truncated for clarity):

```
Service M6, 9 PID's
  PID 0x0064, PMT
  PID 0x0078, AVC video (1920x1080, high profile, level 4.0, 4:2:0)
  PID 0x0082, E-AC-3 Audio (fra, E-AC-3, 3/2 (L,C,R,SL,SR), @48,000 Hz, complete m...
  PID 0x0083, E-AC-3 Audio (qad, E-AC-3, stereo (L,R), @48,000 Hz, visually impair...
```

```
      PID 0x0084, E-AC-3 Audio (qaa, E-AC-3, stereo (L,R), @48,000 Hz, complete main, ...
      PID 0x008C, Subtitles (fra, DVB subtitles for hard of hearing, high definition)
      PID 0x008D, Subtitles (fra, DVB subtitles, high definition)
      PID 0x00AA, MPEG-2 Private sections (AIT)
      PID 0x00AB, DSM-CC U-N (HbbTV)
  Service W9, 9 PID's
      PID 0x00C8, PMT
      PID 0x00DC, AVC video (1920x1080, high profile, level 4.0, 4:2:0)
      PID 0x00E6, E-AC-3 Audio (fra, E-AC-3, 3/2 (L,C,R,SL,SR), @48,000 Hz, complete m...
      PID 0x00E7, E-AC-3 Audio (qad, E-AC-3, stereo (L,R), @48,000 Hz, visually impair...
      PID 0x00E8, E-AC-3 Audio (qaa, E-AC-3, stereo (L,R), @48,000 Hz, complete main, ...
      PID 0x00F0, Subtitles (fra, DVB subtitles for hard of hearing, high definition)
      PID 0x00F1, Subtitles (fra, DVB subtitles, high definition)
      PID 0x010E, MPEG-2 Private sections (AIT)
      PID 0x010F, DSM-CC U-N (HbbTV)
  Service Arte, 11 PID's
      PID 0x012C, PMT
      PID 0x0140, AVC video (1920x1080, high profile, level 4.0, 4:2:0)
      ...
```

5.2.30 Monitoring the bitrate of a PID

This example demonstrates how to monitor the bitrate of a PID and raise alarms when the bitrate of that PID goes out of range or back to normal.

Here, we want to make sure that the bitrate of the PID 100 of a transport stream remains in the 1 to 2 Mb/s range. Assuming that the input is a UDP/IP stream on local UDP port 12345, the monitoring command is the following:

```
tsp --timed-log \
    -I ip 12345 \
    -P bitrate_monitor --pid 100 --min 1,000,000 --max 2,000,000 \
                       --time-interval 1 --alarm-command './alarm.sh' \
    -O drop
```

This command analyzes the bitrate of PID 100 by periods of 1 second. Each time the bitrate goes out of range or back to normal, the script **alarm.sh** is run. The sample **alarm.sh** script contains:

```
#!/usr/bin/env bash
(
    echo -n "Date: "; date '+%Y/%m/%d %H:%M:%S'
    echo "Message: $1"
    echo "Target PID: $2"
    echo "Alarm state: $3"
    echo "Current bitrate: $4"
    echo "Minimum bitrate: $5"
    echo "Maximum bitrate: $6"
    echo
) >>monitor.log
```

This script simply accumulates the alarms in a log file. See the reference description of the **bitrate_monitor** plugin for a description of the six parameters which are passed to the alarm command.

To exercise the script, we run the following source command:

```
for bitrate in 1,500,000 500,000 1,500,000 2,500,000 1,500,000; do
    tsp -I craft --pid 100 \
        -P regulate --bitrate $bitrate \
        -P until --seconds 10 \
        -O ip localhost:12345
done
```

This command simply generates a transport stream full of PID 100 packets. By sequences of 10 seconds, the stream has a bitrate of 1.5, 0.5, 1.5, 2.5, 1.5 Mb/s. Thus, the bitrate of the monitored PID is first in range, then too low, back in range, to high, back in range and finally zero.

The test scenario is the following:

- Run the source command from one terminal.
- Immediately after, run the monitoring command from another terminal.
- Once the source command completes, we may interrupt the monitoring command.

The monitoring command generates warning messages each time an alarm is raised:

```
* 2020/12/30 15:01:17 - Warning: bitrate_monitor: PID 0x0064 (100) bitrate (964,064
bits/s) is lower than allowed minimum (1,000,000 bits/s)
* 2020/12/30 15:01:28 - Warning: bitrate_monitor: PID 0x0064 (100) bitrate (1,516,032
bits/s) is back in allowed range (1,000,000-2,000,000 bits/s)
* 2020/12/30 15:01:38 - Warning: bitrate_monitor: PID 0x0064 (100) bitrate (2,496,640
bits/s) is greater than allowed maximum (2,000,000 bits/s)
* 2020/12/30 15:01:48 - Warning: bitrate_monitor: PID 0x0064 (100) bitrate (1,491,968
bits/s) is back in allowed range (1,000,000-2,000,000 bits/s)
* 2020/12/30 15:01:58 - Warning: bitrate_monitor: PID 0x0064 (100) bitrate (0 bits/s) is
lower than allowed minimum (1,000,000 bits/s)
```

The file **monitor.log** is filled with the various alarms and contains the following:

```
Date: 2020/12/30 15:01:17
Message: PID 0x0064 (100) bitrate (964,064 bits/s) is lower than allowed minimum
(1,000,000 bits/s)
Target PID: 100
Alarm state: lower
Current bitrate: 964064
Minimum bitrate: 1000000
Maximum bitrate: 2000000

Date: 2020/12/30 15:01:28
Message: PID 0x0064 (100) bitrate (1,516,032 bits/s) is back in allowed range
(1,000,000-2,000,000 bits/s)
Target PID: 100
Alarm state: normal
Current bitrate: 1516032
Minimum bitrate: 1000000
Maximum bitrate: 2000000

Date: 2020/12/30 15:01:38
Message: PID 0x0064 (100) bitrate (2,496,640 bits/s) is greater than allowed maximum
(2,000,000 bits/s)
Target PID: 100
Alarm state: greater
Current bitrate: 2496640
Minimum bitrate: 1000000
Maximum bitrate: 2000000

Date: 2020/12/30 15:01:48
Message: PID 0x0064 (100) bitrate (1,491,968 bits/s) is back in allowed range
(1,000,000-2,000,000 bits/s)
Target PID: 100
Alarm state: normal
Current bitrate: 1491968
Minimum bitrate: 1000000
Maximum bitrate: 2000000

Date: 2020/12/30 15:01:58
Message: PID 0x0064 (100) bitrate (0 bits/s) is lower than allowed minimum (1,000,000
bits/s)
Target PID: 100
Alarm state: lower
Current bitrate: 0
Minimum bitrate: 1000000
Maximum bitrate: 2000000
```

Note: The same example can be used to monitor the global bitrate of the transport stream. Just remove the **--pid** option in the **bitrate_monitor** plugin.

6 Troubleshooting

This chapter provides some troubleshooting guidelines when encountering problems when using TSDuck.

6.1 Environment variables

The following environment variables affect the behavior of TSDuck.

Table 12: Environment variables

Variable name	Description
APPDATA	On Windows systems, used to locate user-specific TSDuck configuration files (see A.1 and B.1).
GITHUB_API_TOKEN	Used instead of **TSDUCK_GITHUB_API_TOKEN** when the latter is not defined.
HOME	On Unix systems (Linux, macOS, BSD), used to locate user-specific TSDuck configuration files (see A.1 and B.1).
HOMEBREW_GITHUB_API_TOKEN	On macOS, used instead of **TSDUCK_GITHUB_API_TOKEN** and **GITHUB_API_TOKEN** when none of them is defined.
http_proxy	Define a default proxy URL for commands and plugins which access the Internet. The syntax is "http://[*username*[:*password*]@]*server*[:*port*]/".
https_proxy	Same as **http_proxy**.
LD_LIBRARY_PATH	On Unix systems (Linux, macOS, BSD), used to locate shareable libraries such as **tsp** plugins or TSDuck extensions.
PAGER	Defined to a *pager* command to output commands such as **tstables**, **tsdump** or **--help** option. The default is "**less -QFX**" or "**more**" when the **less** command is not available.
Path	On Windows systems, the system-defined search path of executables is also used to search **tsp** plugins, TSDuck extensions and global configuration files.
PATH	On Unix systems (Linux, macOS, BSD), the system-defined search path of executables is also used to search TSDuck extensions and global configuration files.
TS_CERR_DEBUG_LEVEL	A debug level to initially set to the standard error device (same values as specified with **--debug** command line, see 3.1.3). This can be used to troubleshoot initialization steps such as loading plugins or extensions.
TS_CURL_RETRY	On Unix systems (Linux, macOS, BSD), define a retry policy for Web requests (HTTP, HLS, etc.) See 6.1.2 below.
TS_DEBUG_OPENSSL	On Unix systems (Linux, macOS, BSD), display OpenSSL error messages on standard error.
TS_NO_CRC32_INSTRUCTIONS	Do not use CRC32 accelerated instructions even when available on the current CPU. Currently, this applies to Arm64 CPU only.
TS_NO_HARDWARE_ACCELERATION	Do not use any form of accelerated instructions even when available on the current CPU.

Variable name	Description
TS_FORCED_VERSION	When it contains a string in the form "**x.y-z**", it is used as a *fake* version number for TSDuck. This is only useful to test the detection of new versions. Avoid playing with this otherwise.
TSDUCK_GITHUB_API_TOKEN	Used with **tsversion** to authenticate to GitHub when checking or downloading the TSDuck latest versions from GitHub. This is not required but it enhances the access to the GitHub API. See GitHub documentation for details.
TSDUCK_NO_USER_CONFIG	When defined to any non-empty value, do not load the TSDuck user's configuration file. See Appendix A.
TSDUCK_NO_VERSION_CHECK	When defined to any non-empty value, do not check new versions. By default, **tsp** checks the availability of a new version at most once a day (unless TSDuck was built without version check).
TSLIBEXT_IGNORE	A comma-separated list of extension names to ignore. This can be used to prevent loading a specific list of extensions.
TSLIBEXT_NONE	When defined to any non-empty value, do not load any extension.
TSPLUGINS_PATH	A search path of additional directories containing **tsp** plugins.
TSPLUGINS_STACK_SIZE	When defined to an integer value, it specifies the stack size in bytes of all **tsp** plugin threads. By default, an "appropriate" stack size is used. This is a debug tool, use with care.

6.1.1 Search paths

The directory search paths such as the system-defined **PATH** and the TSDuck-defined **TSPLUGINS_PATH** use a system-specific syntax. On Unix systems (Linux, macOS), the directory names are separated with colons '**:**'. On Windows systems, they are separated with semi-colons '**;**'.

6.1.2 Web requests retry policy

On Unix systems (Linux, macOS, BSD), TSDuck uses **libcurl** to perform Web requests. In rare cases, it has been noted that **curl** fails with "connection reset by peer" right after sending the SSL/TLS client hello message. Retrying usually succeeds after of a couple of times. This is typically seen on some specific servers. The reason for this issue is currently unknown.

All other Web clients, including all browsers and the Windows WinInet library, perform the same request without error. Only the **curl** command and **libcurl** fail.

As a dirty workaround, the environment variable **TS_CURL_RETRY** can be set to specify a per-site retry policy. The value must be a comma-separated list of directives:

- RETRY=value : number of retries for following hosts.
- INTERVAL=value : milliseconds between retries for following hosts.
- HOST=name : host name, as used in Web URL's.

Example:

```
export TS_CURL_RETRY="RETRY=5,INTERVAL=100,HOST=foo1.com,RETRY=2,HOST=foo2.com"
```

Web requests on host foo1.com are retried 5 times after an initial failure, waiting 100 milliseconds between retries. Web requests on host foo2.com are retried 2 times only and the waiting interval remains 100 milliseconds.

6.2 Typical issues with tsp

This section lists a few typical issues when using **tsp** and provides some troubleshooting recipes.

The screen is garbled with strange characters

This is typically observed when no output plugin is specified. The default output plugin is **file** and the default output file for this plugin is the standard output. This is quite useful to pipe transport streams between commands. But if the binary transport stream is sent to the console, the screen is garbled.

Solution: If you don't need the output transport stream, use **-O drop** as output plugin.

A plugin which is supposed to insert some data in the stream does not insert anything

The **tsp** command processes a transport stream. It can modify or delete existing packets but it cannot create new packets. *Inserting packets* essentially means replacing null packets (aka. stuffing) from the transport stream with new data. When there is not enough or no null packets, no data can be inserted.

Solution: Make sure that enough input stuffing exist. The more appropriate way to do this depends on the context. See the **tsp** reference documentation in chapter 3, especially the section named "modifying, inserting and deleting packets".

7 Hardware Device Support

7.1 Tuner receiver devices (DVB, ATSC, ISDB)

7.1.1 Overview

The tuner receiver devices are specialized hardware devices which receive DVB-T, DVB-S, DVB-C, ATSC, ISDB-T, ISDB-S signals and transmit the demodulated binary transport stream to the computer system.

The input of a tuner receiver device is the antenna cable. The receiver device has either an F-connector (satellite, cable) or a standard TV connector (terrestrial, cable).

Most terrestrial receivers come with a small linear antenna. The usage of such an antenna should be avoided when possible since the reception is usually very poor. Always use the signal coming from a classical roof TV antenna when available (wall TV socket).

The physical output of a tuner receiver is a standard PC bus, usually PCIe or USB. Legacy devices also included PCI, PCMCIA (PC Card) or Express Card. Some PCIe devices are actually composed of one or more USB receivers and a USB-to-PCI bridge.

Most receivers simply contain a tuner and a demodulator. They transmit the complete transport stream over the bus (PCIe, USB, etc.) The demultiplexing and MPEG audio / video decoding is performed by some software, either in the kernel of the operating system or in a user-space application. Since TSDuck works on transport streams, the embedded hardware demux are never used. So, the simplest and cheapest receivers are usually fine for TSDuck.

Some receivers contain two or more tuners in order to receive several independent transport streams. They usually appear as distinct devices in the operating system.

Some receivers support multiple protocols, for instance DVB-T/T2 and DVB-C. The way they appear on a system depends on the vendor driver. For instance, the same device may appear as one single tuner supporting DVB-T/T2/C on Linux and two distincts tuners on Windows (one for DVB-T/T2 and one for DVB-C).

7.1.2 Operating system integration

7.1.2.1 Linux platforms

The tuner receiver devices are managed by Linux under the common "LinuxTV" framework which is part of V4L ("Video for Linux").

Drivers:

The drivers for the DVB receiver devices come with the Linux kernel.

The drivers for recent devices may not be integrated yet into the mainstream Linux kernel, see [46] for details on how to install the latest Linux drivers for DVB devices.

Firmware:

Some devices need a firmware file in **/lib/firmware** which is loaded by the driver when the system boots or when the device is plugged-in (USB device for instance).

Some firmware files are packaged with the Linux kernel, but only when no copyright applies. Most firmware files are extracted from the proprietary Windows drivers of the device and are not free. Consequently, they are not included in the kernel distributions. Such proprietary firmware files must be fetched from various sites all over the Web. Some distros provide a package named **linux-firmware** which contains firmware for many devices, including some DVB devices. The OpenELEC community has collected a large number of tuner firmware files which can be downloaded as an archive.

To simplify the firmware downloading and installation, the command **tsconfig --install-dvb-firmware** collects all know DVB firmware online and installs them in **/lib/firmware**. See the documentation of the **tsconfig** command in chapter 3.

Device naming:

The DVB devices are identified as **/dev/dvb/adapter***N*, where *N* is a number between 0 and the number of DVB adapters in the system.

When several DVB devices are present in the system, the allocation of the adapter numbers depends on the kernel initialization sequence, the PCI slots, the way the USB devices are plugged and unplugged. It is possible to assign a specific adapter number to each device using the **adapter_nr** parameter in the relevant drivers (kernel modules) configuration.

For instance, let's take the example of a system with a Hauppauge WinTV Nova-T-500 (dual DVB-T tuner) and a Hauppauge WinTV Nova-HD-S2 (DVB-S/S2 tuner). The two tuners in the DVB-T PCI board are actually USB devices with an embedded USB hub and the numbering of the tuners is not deterministic. The adapter number for each tuner may vary after each boot. To always allocate adapter numbers 0 and 1 to the DVB-T dual tuner and adapter number 2 to the DVB-S tuner, add the following lines to a **modprobe** configuration file, for instance **/etc/modprobe.d/local.conf**:

```
options dvb-usb-dib0700 adapter_nr=0,1
options cx88-dvb adapter_nr=2
```

Then, the following allocation is always used:

```
$ tslsdvb
/dev/dvb/adapter0 (DiBcom 3000MC/P, DVB-T)
/dev/dvb/adapter1 (DiBcom 3000MC/P, DVB-T)
/dev/dvb/adapter2 (Conexant CX24116/CX24118, DVB-S)
```

7.1.2.2 Microsoft Windows platforms

DirectShow framework:

On Windows XP and higher, the DVB devices are managed by **DirectShow**, a Microsoft framework for multimedia. The specific subsystem of DirectShow for DVB receiver devices is BDA (Broadcast Device Architecture). Most of the time, the hardware vendors provide BDA drivers for their receivers. Windows does not include any predefined BDA driver.

On all Windows platforms, TSDuck uses basic DirectShow features to access the BDA drivers of the receiver devices.

Retrieving actual modulation parameters:

On Windows, it is not possible to retrieve the actual tuning parameters of a transport stream as detected by the tuner device.

This can be annoying in a DVB-T environment where many transmission parameters may be inaccurate but the tuner device will detect the actual parameters. For instance, you may tune on a transport specifying a FEC 2/3 and a guard interval 1/32. If the actual signal uses a FEC 3/4 and a guard interval 1/8, the tuner device will automatically adjust the parameters. On Linux, the command "**tslsdvb –v**" displays the actual parameters, as reported by the tuner device. Moreover, the **dvb** plugin can compute the exact theoretical bitrate of the transport stream based on the actual transmission parameters. On Windows, it is not possible to query the tuner device for the actual parameters. It is not possible to display the actual transmission parameters. The **dvb** plugin must use the analysis of PCR's to evaluate the bitrate.

7.1.2.3 MacOS platforms

There is no uniform or standard software framework to support tuners on macOS. Some tuners are officially supported on macOS but they are shipped with proprietary drivers and proprietary TV-watching applications. The driver API's are not documented.

As a result, TSDuck provides no support for hardware tuner devices on macOS.

7.1.3 Device naming

All TSDuck modules using DVB receivers (**tslsdvb**, **tsscan**, **dvb** plugin) use a *device name* to designate a DVB receiver device. The syntax of the device name depends on the operating system.

Use the **tslsdvb** utility to list all available DVB receiver devices. By default, when no device name is specified, the *first* DVB receiver device is used, that is the say the device which appears first when the command **tslsdvb** is invoked.

In all cases (**tslsdvb**, **tsscan**, **dvb** plugin), the option **--adapter** (or **–a**) can be used to simply designate the Nth receiver device in the system, the first index being zero. When the system has several receiver devices, **tslsdvb** also displays the corresponding device index.

7.1.3.1 Linux platforms

On Linux, a receiver device is named as **/dev/dvb/adapterA[:F[:M[:V]]]** where:

> `A` = adapter number
>
> `F` = frontend number (default: `0`).
>
> `M` = demux number (default: same as frontend number).
>
> `V` = dvr number (default: same as frontend number).

When unspecified, the demux and dvr numbers default to the same number as the frontend or, if the corresponding demux or dvr does not exist, to the highest existing demux or dvr number.

Usually, only the adapter number is important if there is more than one DVB receiver device in the system. The frontend number is useful only if a device adapter includes several tuners.

On most adapters, there are as many demux and dvr as frontends and the default demux and dvr numbers are appropriate. There are some adapters with less demux or dvr than frontends. In that case, all frontends cannot be used at the same time. It may also be impossible to list the characteristics of all tuner devices at the same time. With such tuners, the user needs to know exactly how the frontends are allocated and specify the right full device name with frontend, demux and dvr number.

Additionally, the full unique description of a tuner can be used instead of the classical device name. The full description, when available, includes some unique identification of a device such as the serial number ("SN").

Example:

```
$ tslsdvb
/dev/dvb/adapter0 ("Silicon Labs Si2168, AVerMedia TD310 Device 2.00 SN:202866000009",
DVB-T, DVB-T2, DVB-C)
/dev/dvb/adapter1 ("DiBcom 7000MA/MB/PA/PB/MC, Hauppauge Nova-T Stick 2.00
SN:4027216814", DVB-T)
```

The following commands are then equivalent:

```
$ tsp -I dvb -d "Silicon Labs Si2168, AVerMedia TD310 Device 2.00 SN:202866000009" ...
$ tsp -I dvb -d /dev/dvb/adapter0 ...
$ tsp -I dvb -a 0 ...
```

This type of identification can be useful when using several USB tuners of the same model. USB devices have no fixed **/dev/dvb/adapterN** identification. After unplugging and replugging the device or after

rebooting the system, the tuner ordering can change. Using a complete identification, including a unique serial number, provides a way to address a specific physical tuner without ambiguity.

7.1.3.2 Microsoft Windows platforms

On Windows, a receiver device name is the name of a DirectShow tuner filter. Since these names are usually complicated, with spaces and mixed cases ("Nova-T Stick DVB-T Tuner (Dev1 Path0)" for instance), the specified name is not case sensitive and spaces are ignored.

As an alternative, the name **:N** can be used to designate the Nth receiver device in the system, the first index being zero. So, the following commands are equivalent:

```
C:\> tsp -I dvb -d :0 ...
C:\> tsp -I dvb -a 0 ...
```

When several tuners of identical models are used, the DirectShow tuner filters will have identical names. To address a specific tuner, it is possible to use the adapter number. However, if the tuners are connected to distinct antenna sources, we must be sure to address a specific physical tuner. If the tuners are USB devices, they may be assigned different adapter numbers each time they are plugged in.

To solve this problem, it is possible to use the device path of a tuner as tuner name. The device path remains contant for a given physical tuner.

To get the device paths, use the following command:

```
C:\> tslsdvb -v

0: "AVerMedia TD310 BDA C Filter" (ATSC, DVB-C, DVB-C/C)
   Device: @device:pnp:\\?\usb#vid_07ca&pid_1871#202866000009#{71985f48-1ca1-11d3-9cc8-
00c04f7971e0}\{cacacefd-1b5f-49f4-af24-0ce559cc1e90}
....
1: "AVerMedia TD310 BDA Filter" (DVB-T, DVB-T2)
   Device: @device:pnp:\\?\usb#vid_07ca&pid_1871#202866000009#{71985f48-1ca1-11d3-9cc8-
00c04f7971e0}\{cacacefd-1b5f-49f4-af24-0ce559cc1f6d}
....
```

The following commands are then equivalent:

```
C:\> tsp -I dvb -d "AVerMedia TD310 BDA Filter" ...
C:\> tsp -I dvb -d "@@device:pnp:\\?\usb#vid_07ca&pid_1871#202866000009#{71985f48-1ca1-
11d3-9cc8-00c04f7971e0}\{cacacefd-1b5f-49f4-af24-0ce559cc1f6d}" ...
C:\> tsp -I dvb -d :1 ...
C:\> tsp -I dvb –a 1 ...
```

Note that, when the device path starts with **@**, we must double it (**@@**) to avoid the interpretation as partial command line redirection (see section 3.1.5 for more details).

7.1.4 Tuner emulator

For specific tasks such as troubleshooting scanning issues on a remote location, TSDuck includes a *tuner emulator* feature. The tuner emulator is not connected to a physical device. Instead, it emulates the behavior of a regular tuner using pure software and transport stream data files. Being pure software, the tuner emulator is available on all operating systems, including macOS.

7.1.4.1 Principles

A tuner emulator can be used anywhere a physical tuner is used, for instance with the **tsscan** command or the **dvb** input plugin.

The *device name* of a tuner is the path of an XML file. Using a name ending in **.xml** as tuner device name means that the corresponding command or plugin will automatically use the tuner emulator.

The XML file contains the characteristics of the tuner, namely its type and the list of frequencies (or *channels*) which are populated with a signal.

For each frequency, there is either an associated transport stream file or a shell command which generates a transport stream on its standard output. Receiving packets from that frequency means reading packets from the transport stream file, endlessly (at end of file, loop back at the beginning of the file) or reading packets from the output of the command.

Each channel has a *bandwidth* which is centered on the declared frequency. Reception is possible in all frequencies within that bandwidth. The reported signal quality and strength ranges from 100% at the center frequency to 50% at the edges of the bandwidth.

Note that the command **tslsdvb** does not list tuner emulators. Physical tuners are explicitly defined in the system while there is a potentially unlimited number of XML files which can be used as tuner emulators.

7.1.4.2 Tuner emulator XML file

An XML file which describes a tuner emulator has the following structure:

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>

  <!-- Default values for channel entries -->
  <defaults delivery="string, optional"
            bandwidth="uint64, optional"
            directory="string, optional"/>

  <!-- One channel entry per frequency -->
  <channel frequency="uint64, required"
           delivery="string, optional"
           bandwidth="uint64, optional"
           file="string, optional"
           pipe="string, optional"/>

</tsduck>
```

The **<default>** entry is optional. It contains default values for the **<channel>** entries. The **delivery** and **bandwidth** attributes values are used when missing in a **<channel>** entry.

The value of the **delivery** attribute shall be one of the names which are documented in the **dvb** plugin option **--delivery-system**.

The optional **directory** attribute indicates the root directory of transport stream file paths in the **<channel>** entries. If the directory path is not absolute, it is interpreted relatively to the XML file location, not the current directory of the command which uses the terminal emulator. This allows a more flexible and portable file structure.

Each **<channel>** entry describes a frequency. The **frequency** attribute describes the center frequency in Hz and the **bandwidth** attribute the width in Hz around the center frequency where reception is possible.

Exactly one of **file** or **pipe** attributes shall be present and not empty.

The **file** attribute points to a transport stream file which is read as "content of the frequency". If the file path is not absolute, it is interpreted relatively to the **directory** attribute of the **<default>** entry. If there is no default directory, it is interpreted relatively to the XML file location,

The **pipe** attribute contains a shell command which generates a transport stream on its standard output (a pipe in that case). The process is started when the tuner reception is started (after the tune operation). This command is expected to never complete until the pipe is closed. Receiving packets on the tuner emulator after the completion of the process generates an error.

See an example of tuner emulator usage in section 5.1.9.

7.1.5   Tested devices

On Linux, TSDuck works indifferently with any supported tuner device. If a driver exists (with optional firmware) for a given receiver, it should work with TSDuck.

On Windows, TSDuck should work with any receiver coming with a BDA driver but the integration is less straightforward than on Linux and additional testing should be performed. Typically, if the device comes with a "DVB Network Tuner" DirectShow filter and an optional "BDA Receiver Component" DirectShow filter, it should work with TSDuck. At least one device (one from TechniSat) has exhibited different software architecture and could not be used by TSDuck.

The following table summarizes the DVB receiver devices which have been tested with TSDuck.

Please note that this table is informational only. It was built from various users' feedback at some point in time. There is no exhaustive test suite using all these devices. Probably no one, neither the author of TSDuck nor any of its users, have all these devices. So, keep in mind that these devices are not tested for every new version of TSDuck.

Table 13: Tested DVB receiver devices

Brand	Model	Network	# [1]	Bus	Linux	Windows
Artek [2]	TV Tuner Stick USB Dongle	DVB-T2/C	2	USB	Tested OK	Not tested
AVerMedia	TD310	DVB-T2/C	1	USB	Tested OK[31]	Tested OK
BlackGold	BGT3620	DVB-T2/C	6	PCIe	Not tested	Tested OK
DVBSky	S960	DVB-S/S2	1	USB	Tested OK	Tested OK
DVBSky	S960C [4]	DVB-S/S2	1	USB	Tested OK	Tested OK
GoTView	MasterHD3	DVB-T2/C	2 [5]	USB	Tested OK [6]	Tested OK
Hauppauge	WinTV Nova-T-500 [7]	DVB-T	2	PCI	Tested OK [8]	Not tested
Hauppauge	WinTV Nova-TD-500 [9]	DVB-T	2	PCI	Tested OK [8, 10]	Not tested
Hauppauge	WinTV Nova-T-Stick [11]	DVB-T	1	USB	Tested OK [8, 12]	Tested OK [13]
Hauppauge	WinTV Nova-T-Stick SE	DVB-T	1	USB	Tested OK [8, 14]	Tested OK [14]
Hauppauge	WinTV Nova-S	DVB-S	1	PCI	Tested OK	Not tested
Hauppauge	WinTV Nova-HD-S2 [15]	DVB-S/S2	1	PCI	Tested OK [16]	Tested OK
Hauppauge	WinTV-soloHD [3]	DVB-T2/C	1	USB	Not tested	Tested OK [17]
Hauppauge	WinTV-dualHD [3]	DVB-T2/C	2	USB	Tested OK	Not tested
Hauppauge	WinTV-HVR-935	DVB-T2/C	1	USB	Tested OK	Not tested
MaxMedia	HU 372 [25]	DVB-T2/C	2 [5]	USB	Tested OK [6]	Tested OK
MyGica	T230C	DVB-T/T2	1	USB	Tested OK	Tested OK
MyGica	S270 [27]	ISDB-T	1	USB	Tested OK [28]	Tested OK
MyGica	S2870	ISDB-T	2	USB	Tested OK [29]	Tested OK
Pinnacle	PCTV DVB-T Stick 72e	DVB-T	1	USB	Tested OK [8]	Tested OK
Pinnacle	PCTV nanoStick T2 290e [3]	DVB-T2/C	2	USB	Tested OK [18]	Tested OK
Pinnacle	PCTV DVB-S2 Stick 461e [3]	DVB-S/S2	1	USB	Not working [19, 20]	Tested OK [21]
PLEX	PX-S1UD [27]	ISDB-T	1	USB	Tested OK [28]	Tested OK

Brand	Model	Network	# [1]	Bus	Linux	Windows
Raspberry	Raspberry Pi TV HAT	DVB-T/T2	1	Pi [32]	Tested OK	Not tested
TBS	TBS 6284	DVB-T/T2	4	PCIe	Not tested	Tested OK
TBS	TBS 6903	DVB-S/S2	2	PCIe	Not tested	Tested OK
TBS	TBS 5922	DVB-S/S2	1	USB	Not tested	Tested OK
TBS	TBS 5925	DVB-S/S2	1	USB	Not tested	Tested OK
TBS	TBS 5580	Multiple [30]	2	USB	Tested OK	Tested OK
TBS	TBS 5520-SE DVB-T2/T, DVB-S2X/S2/S, DVB-C2/C, ISDB-T	Multiple	1	USB	Not tested	Tested OK
TBS	TBS 5530 DVB-T2/T, DVB-S2X/S2/S, DVB-C2/C, ISDB-T, ISDB-C, J83B, ATSC1.0	Multiple	1	USB	Tested OK	Not tested
TBS	TBS 6704	ATSC	4	PCIe	Tested OK	Not tested
TBS	TBS 6904	DVB-S/S2	4	PCIe	Tested OK	Not tested
TechniSat	SkyStar USB HD	DVB-S/S2	1	USB	Not tested	Not working [22]
TechnoTrend	TT-connect CT-3650 CI	DVB-T/C	1	USB	Tested OK	Not tested
TechnoTrend	TT-connect S2-3600	DVB-S/S2	1	USB	Not tested	Tested OK [23]
TechnoTrend	TT-connect S2-4600	DVB-S/S2	1	USB	Not tested	Tested OK
TechnoTrend	TT-budget S2-4100	DVB-S/S2	1	PCIe	Not tested	Tested OK
Terratec	Cinergy T USB XE Rev 2 [24]	DVB-T	1	USB	Tested OK [25]	Tested OK
TeVii	H640 [25]	DVB-T2/C	2 [5]	USB	Tested OK [6]	Tested OK
TeVii	S482 DVB-S2	DVB-S/S2	2	PCIe	Not tested	Tested OK

Notes from the table:

1. Number of tuners. When more than one is present, they usually appear as different receiver devices in the operating system.

2. Also known as HanfTek or Astrometa. The first tuner supports DVB-T only. The second tuner supports DVB-T/T2 and DVB-C. The second tuner was tested on 64-QAM DVB-C cable in India.

3. This tuner discards null packets and cannot be used to modify a running TS on the fly and cannot compute reliable bitrates.

4. The DVBSky S960C has a DVB-CI CAM slot (not CI+).

5. The GoTView MasterHD3 has two demodulators, one for DVB-T and one for DVB-T2/C. On Windows, they appear as one single DVB-T tuner. On Linux, they appear as two frontends, one for DVB-T and one for DVB-T2/C.

6. With Linux kernels 4.2 up to 4.7, two frontends are available: frontend0 is DVB-T, frontend1 is DVB-T2/DVB-C. The support in kernels after version 4.7 is partial, something was broken. The device starts but only with the one (DVB-T) frontend. The second frontend (Si2168 demodulator for DVB-T2 and DVB-C) doesn't start due to i2c error.

7. The Hauppauge WinTV Nova-T-500 is a PCI board which embeds two USB tuners and a USB-to-PCI bridge.

8. Need the firmware file revision 1.20 for DiBcom-based DVB receiver devices on Linux, http://www.wi-bw.tfh-wildau.de/~pboettch/home/files/dvb-usb-dib0700-1.20.fw

9. The Nova-TD-500 is similar to the Nova-T-500 but has two aerial inputs instead of one.

10. Do not plug antenna cables in both aerial inputs, this leads to garbage reception. Use only the top aerial input and this feeds the two tuners. The bottom aerial input is not used. Also specify the following options in `/etc/modprobe.d/options`:

```
options dvb_usb_dib0700 force_lna_activation=1
options dvb_usb disable_rc_polling=1
```

11. Two different revisions exist: 70001 and 70009 (read the sticker).

12. Revision 70001 tested, works OK. Revision 70009 not tested.

13. Revision 70001 tested, works OK with the Hauppauge driver CD version 2.5E but does not work with recent drivers versions 3.x and 4.x. Revision 70009 not tested (requires drivers CD version 4.x).

14. Model 203, revision D1F4 70019 tested.

15. This is a "lite" version of the Hauppauge HVR-4000.

16. Need the `dvb-fe-cx24116.fw` firmware file. Known limitation: Some PCI DMA transfers are aborted without known reason, resulting in packet loss. The problem appears only on some hardware systems and may be related to PCI bus configuration. The problem is characterized by the following error messages from `dmesg`:

```
cx88[0]: irq mpeg  [0x80000] pci_abort*
cx88[0]/2-mpeg: general errors: 0x00080000
```

17. On Windows, the Hauppauge software installation is incomplete. After installing the drivers, the WinTV-soloHD initially appears as one single DVB-T tuner. DVB-C is not accessible. The bundled application WinTV must be run at least once and tuned to a DVB-C transport. Afterwards, a second tuner is installed for DVB-C. This tuner is persistent after reboots.

18. Need the firmware file `dvb-demod-si2168-b40-01.fw`.

19. Need the firmware file for Montage M88DS3103-based DVB receiver devices on Linux from the OpenELEC dvb-firmware package. https://github.com/OpenELEC/dvb-firmware/blob/master/firmware/dvb-demod-m88ds3103.fw

20. Documented to work on Linux. But the experience demonstrates that it is mostly unreliable. The first tuning operation after insertion of the USB device works. Subsequent tuning operations fail.

21. On Windows, it has been observed that the PCTV 461e discards all null packets (PID 0x1FFF). As a consequence, transport stream analyses are incorrect, bitrates are incorrect and all **tsp** plugins which use stuffing to insert new packets do not work correctly.

22. The TechniSat drivers for Windows have a proprietary and unusual interface. They cannot be integrated in a DirectShow reception graph and, consequently, cannot be used by TSDuck.

23. DVB tuners drivers for Windows: http://www.tt-pc.com/2959/PC_Products.html

24. Two different revisions exist: Rev 1 and Rev 2. They use different chipsets and need different drivers. Only the Rev 2 has been tested with TSDuck.

25. Reported as identical to GoTView Master HD3.

26. Need the firmware file for Afatech-based DVB receiver devices on Linux, http://www.otit.fi/~crope/v4l-dvb/af9015/af9015_firmware_cutter/firmware_files/4.95.0/dvb-usb-af9015.fw

27. The ISDB-T tuners MyGica S270 and PLEX PX-S1UD are internally identical.

28. Need the firmware file from http://plex-net.co.jp/plex/px-s1ud/PX-S1UD_driver_Ver.1.0.1.zip or https://www.linuxtv.org/downloads/firmware/isdbt_rio.inp

29. Need the firmware file https://linuxtv.org/downloads/firmware/dvb-usb-dib0700-1.20.fw

30. The TBS 5580 device has two tuners. The first one supports DVB-T/T2, DVB-C/C2 and ISDB-T. The second tuner supports DVB-S/S2/S2X with a CI interface.

31. Need the firmware files dvb-usb-it9303-01.fw, dvb-demod-si2168-b40-01.fw and dvb-demod-si2168-02.fw from https://github.com/OpenELEC/dvb-firmware/blob/master/firmware/

32. The Raspberry Pi TV HAT can be connected to Raspberry Pi boards only. It uses the 40-pin Raspberry Pi board connector. It is top-mounted using the *Raspberry HAT* form factor.

7.2 Dektec devices

7.2.1 Overview

The Dektec devices include a wide range of professional MPEG/DVB devices: ASI input or output, modulators (QPSK, QAM, OFDM, ATSC, DMB, ISDB, etc), demodulators and IP multicasting. The PCI devices are named DTA-1xx and the USB devices are named DTU-2xx. The ASI devices can perform either input, output or both. See [38] for more details.

The **tsp** plugin named **dektec** can perform input or output on any Dektec device, provided that the appropriate drivers are installed on the system. Dektec provides drivers and API for their devices on Windows and Linux (see [39]). For each operating system, there are two Dektec drivers: one for all PCI devices and one for all USB devices.

7.2.2 Linux platforms

The Dektec drivers are provided in source format. They must be compiled for each specific version of the Linux kernel.

For a better integration with the various distros, an independent project has been setup to create DKMS packages for Dektec drivers (see [40]). This project provides a script to build packages for RedHat, CentOS, AlmaLinux, Fedora and Ubuntu distros, using the source code from the Dektec site. Pre-built packages are also available from the *releases* section in [40].

7.2.3 Microsoft Windows platforms

The Dektec drivers are provided in binary format and can be directly installed. An installation guide is included in the zip file of each driver. See [39].

7.2.4 MacOS platforms

Dektec provides no support for macOS. All Dektec features of TSDuck are disabled on macOS.

7.2.5 Tested devices

The following Dektec devices have been successfully tested with TSDuck:

- DTA-140 : PCI ASI input and output.

- DTU-245   : USB ASI input and output.
- DTA-107   : PCI DVB-S modulator.
- DTA-107S2 : PCI DVB-S2 modulator.
- DTA-110T   : PCI DVB-T modulator.
- DTA-115   : PCI multi-standard modulator (some modulation types are subject to optional licences) with an additional bidirectional ASI port.
- DTU-315   : USB-3 multi-standard modulator (subject to optional licences).
- DTA-2137C : PCIe DVB-S/S2 demodulator with ASI outputs.
- DTA-2138B : PCIe DVB-T/T2, DVB-C/C2, ISDB-T demodulator.

Any other Dektec device should work with TSDuck. Not having a Dektec device listed above is usually not an issue. The Dektec software interface is stable and consistent between Linux and Windows. The experience has demonstrated that using new Dektec devices using recent builds of TSDuck (i.e. containing a recent version of the Dektec API library) has always worked.

It is possible that new Dektec devices introduce new features or protocols which are not yet supported by TSDuck. Please report this in the TSDuck issue tracker (see [52]) so that the new feature can be implemented.

7.3 HiDes Devices

7.3.1   Overview

HiDes is a company from Taiwan, a manufacturer of cheap DVB-T devices (see [41]). These devices are based on chips from ITE Technologies Inc., also from Taiwan.

The UT-100C model is a USB DVB-T modulator adaptor (transmission). This device is probably the cheapest modulator on Earth for Digital TV.

Other models from HiDes include reception, ISDB-T support or PCIe interface. Currently, only USB DVB-T modulators are supported by TSDuck.

The tsp plugin named **hides** can perform output on HiDes devices, provided that the appropriate drivers are installed on the system. These drivers are available at [42].

7.3.2   Linux platforms

The drivers for HiDes devices are provided in source format. It is unclear if these drivers were provided by HiDes or ITE. They must be compiled for each specific version of the Linux kernel.

For a better integration with the various distros, an independent project has been setup to create DKMS packages for HiDes drivers (see [42]). This project provides a script to build packages for RedHat, CentOS, AlmaLinux, Fedora and Ubuntu distros. Pre-built packages are also available from the *releases* section in [42].

The name of a HiDes device is illustrated below:

```
$ tshides -v
Found 1 HiDes device

Index ........... 0
Name ............ "usb-it950x0"
Device .......... /dev/usb-it950x0
Chip type ....... 0x9507
Device type ..... 11
Driver version .. v16.11.10.1w
API version ..... 1.3.20160929.0
Link firmware ... 255.39.2.0
```

```
OFDM firmware ... 255.9.11.0
Company ......... ITEtech
Hardware info ... Eagle DVBT
```

Note the '**w**' at the end of the driver version. This indicates a modified "waiting" version of the driver as provided in [42].

The original driver from HiDes or ITE has a "polling" design which is much less efficient. If you have a driver version without trailing '**w**', this is probably an original version of the driver. TSDuck will work but in a very inefficient way : each time packets shall be sent to the modulator, the **tsp** application has to actively wait (looping on very short timers) for the modulator to be ready, unnecessarily consuming CPU and lacking accuracy. With the modified '**w**' version, the output thread of the **tsp** application is simply suspended until the very precise moment where the modulator is ready.

7.3.3   Microsoft Windows platforms

The HiDes driver is provided in binary format and can be directly installed. The installer is in a zip file.

There is no known fixed reference URL for the latest version of the Windows driver. To make sure that TSDuck users can always find a working version of this driver, it is also available from the *releases* section in [42].

Unlike the Linux driver, the Windows driver has not been modified for TSDuck. The original driver is anyway delivered in binary form and cannot be easily modified. Note that the original Windows driver has a standard "waiting" design and does not suffer from the "polling" design of the original Linux driver.

The name of a HiDes device is a DirectShow filter name, as illustrated below:

```
C:\> tshides -v
Found 1 HiDes device

Index ........... 0
Name ........... "IT9507 TX Filter"
Device .......... \\?\usb#vid_048d&pid_9507#ut100cv4201504240422#{fbf6f530-07b9-11d2-
a71e-0000f8004788}\{9963cc0e-ee70-11e0-ba8f-92d34824019b}
USB mode ........ 0x0200
Vendor id ....... 0x048D
Product id ...... 0x9507
Chip type ....... 0x9507
Device type ..... 11
Driver version .. 21.17.39.1
Link firmware ... 255.39.2.0
OFDM firmware ... 255.9.11.0
```

Identical devices use the same DirectShow filter and have probably identical names. The device path is unique but is a complicated Windows device reference and is barely usable. So, when we have several identical HiDes devices on the same machine, it is probably easier to reference them by adapter index (0, 1, 2, etc.) using option **--adapter**.

Note that the verbose display (option **–v**) is different between Windows and Linux. This is due to the distinct API's of the HiDes drivers on distinct operating system. The command **tshides** displays what is available for the platform it is running on.

7.3.4   MacOS platforms

HiDes provides no support for macOS. All HiDes features of TSDuck are disabled on macOS.

7.3.5   Tested devices

The following HiDes devices have been successfully tested with TSDuck:

- UT-100C : USB DVB-T modulator.

- UT-100A : USB DVB-T receptor and modulator. Only the modulator is supported with TSDuck.

7.3.6 Power constraints

The HiDes devices have no external power. They are exclusively powered through the USB port. It has been reported that some USB ports did not provide sufficient power to the device, resulting in random corruptions in the output stream.

In case of problem, try to connect the HiDes device to a powered USB 3.0 hub.

In [41], the HiDes documentation states that the maximum required power is 390 mA. But it is currently unclear if the HiDes device requires more than the normalized maximum of 500 mA from the USB port or if some USB ports fail to provide the required 500 mA.

7.4 VATek-based modulators

7.4.1 Overview

Vision Advance Technology Inc. (aka. VATek, see [43]) is a company from Taiwan which designs modulator chips. The final modulator device products can be from different manufacturers.

Note that, unlike Dektec and HiDes devices which are available on Linux and Windows only, VATek-based devices are available on all operating systems, including macOS, because VATek chips do not need a dedicated device driver. They are accessed through the portable **libusb** library which is available on all operating systems.

There is no "device name" for VATek-based modulators, only device indexes, from 0 to N-1 (with N being the number of VATek-based devices in the system).

7.4.2 Tested devices

The tested devices were based on the A3 chip from VATek:

- A3 developer board from VATek.
- Suntechtv U3 USB modulator (see [45]).

Note that the software (the **tsvatek** command and the **vatek** output plugin) is developed and maintained by VATek and controls all devices using VATek chips. Thus, all modulator products based on the A3 chip should work identically.

Appendix A TSDuck User's Configuration File

The TSDuck user's configuration file is used to specify default command line options or alternate options for all or selected TSDuck commands. This configuration file is specific per user.

If the environment variable **TSDUCK_NO_USER_CONFIG** is defined to some non-empty value, the configuration file is ignored. This can be useful to bypass the defaults from this file or to troubleshoot problems and test if they come from the user's configuration file.

A.1 Configuration file location

The location of the user's TSDuck configuration file depends on the operating system.

- Unix :   **$HOME/.tsduck**
- Windows : **%APPDATA%\tsduck\tsduck.ini**

A.2 Configuration file format

The format of this file resembles the old **.ini** files on Windows systems. There is one main section, followed by several command-specific sections.

Here are the main rules for the configuration files:

- The main section comes first.
- A section starts with the section name enclosed in square brackets.
- The name of a section is the name of a TSDuck command (e.g. **[tsp]**, **[tsswitch]**, etc.)
- In a section, an entry has the syntax "***name = value***".
- An entry can be specified several times in a section when multiple values are allowed.
- When a TSDuck command searches for an entry in the configuration file, it searches first in the section with the name of the command. If the entry is not found here, it is searched in the top main section.
- Lines starting with a dieresis (**#**) are comments and are ignored.
- Lines ending with a back-slash are continued on the next text line.
- Quotes can be used to group command line arguments when necessary.
- Back-slashes in the middle of a line are used to escape characters.

The following table lists the supported entries in the configuration file.

Table 14: Configuration file entries

Entry name	Description	Apply to
default.options	Used as command line options when none are specified.	All commands
prepend.options	Options to prepend before the actual options.	All commands
append.options	Options to append after the actual options.	All commands
default.input	Default input plugin (with options) when none are specified.	**tsp**, **tsswitch**
default.plugin	Default packet processing plugin (with options) when none are specified.	**tsp**
default.output	Default output plugin (with options) when none are specified.	**tsp**, **tsswitch**
default.lnb	Default LNB type for satellite reception. See A.3 below.	All commands
default.region	Default region for UHF / VHF frequency layout. See A.4 below.	All commands
default.time	Default value for **--time-reference** option. See 2.4.2.	All commands

Entry name	Description	Apply to
`leap.seconds`	Use explicit leap seconds in time computations. The value shall be **true** or **false** (default is **true**). See 2.4.2.	All commands

A.3 LNB names

In the configuration file entry **default.lnb** and the command line option **--lnb**, the specified string is the name (or an alias for that name) of a preconfigured LNB in the configuration file named **tsduck.lnbs.xml.**

The location of this file depends on the operating system.

- Linux :   **/usr/share/tsduck/tsduck.lnbs.xml**
- macOS (Intel) : **/usr/local/share/tsduck/tsduck.lnbs.xml**
- macOS (Arm) : **/opt/hombrew/share/tsduck/tsduck.lnbs.xml**
- Windows :   **%TSDUCK%\bin\tsduck.lnbs.xml**
- NetBSD :   **/usr/pkg/share/tsduck/tsduck.lnbs.xml**
- Other BSD :   **/usr/local/share/tsduck/tsduck.lnbs.xml**

The default value describes a dual-band so-called *European Universal Ku (extended) LNB*.

The table below summarizes known LNB names and aliases. This list may be incomplete. See the file **tsduck.lnbs.xml** for a complete reference.

Table 15: Preconfigured LNB names and aliases

Name	Aliases		
European Universal Ku (extended)	Astra 19.2E	Extended	
European Universal (old)	Universal		
Astra	Enhanced		
Expressvu	DBS		
Standard			
L10700			
L10750			
L11300			
Invacom QPH-031	QPH031		
Big Dish Monopoint	C-Band		
Big Dish Multipoint	C-Multi		
DishPro			
Japan 110BS/CS	Japan	110BS	110CS
BrasilSat Stacked	Stacked-Brasilsat		
BrasilSat Oi	Oi-BrasilSat		
BrasilSat Amazonas 1/2, 3 Oscillators	Amazonas3		
BrasilSat Amazonas 1/2, 2 Oscillators	Amazonas2		
BrasilSat custom GVT	GVT-BrasilSat		
None	Null		

For compatibility, the legacy format "**low_freq[,high_freq,switch_freq]**" is also accepted as LNB name. The three frequencies are the low-band oscillator, the high-band oscillator and the switch frequency. All frequencies are in MHz. The last two values are used only with a dual-band LNB.

A.4   HF band region names

A list of all supported regions can be found in the file named **tsduck.hfbands.xml** the location of which depends on the operating system.

- Linux :   **/usr/share/tsduck/tsduck.hfbands.xml**
- macOS (Intel) : **/usr/local/share/tsduck/tsduck.hfbands.xml**
- macOS (Arm) : **/opt/hombrew/share/tsduck/tsduck.hfbands.xml**
- Windows :   **%TSDUCK%\bin\tsduck.hfbands.xml**
- NetBSD :   **/usr/pkg/share/tsduck/tsduck.hfbands.xml**
- Other BSD :   **/usr/local/share/tsduck/tsduck.hfbands.xml**

The table below summarizes known regions. This list may be incomplete. See the file **tsduck.hfbands.xml** for a complete reference.

Table 16: HF band region names

Region name	Aliases	UHF	VHF	BS	CS	Standards
europe	uk france	×	×			DVB
north-america	us usa	×	×			ATSC
japan		×	×	×	×	ISDB
south-america	abnt brazil	×	×			ISDB
paraguay		×	×			ISDB
argentina		×				ISDB
chile		×				ISDB
ecuador		×				ISDB
philippines		×				ISDB
botswana		×				ISDB

Note: the names BS and CS designate satellite frequency bands which are used in Japan only. In other regions, the frequency allocation inside satellite bands is not regulated and planned using channel numbers.

A.5   Sample configuration files

A.5.1   Generic example

The following example configuration file illustrates most entries.

```
# Sample configuration file
prepend.options = --verbose

[tsversion]
default.options = --all

[tsp]
default.input  = file '/home/john doe/name with spaces \' and quotes\'.ts'
default.plugin = until --packet 1,000,000
default.plugin = analyze
default.output = drop
```

In this case, when the command **tsp** is used alone without arguments, the actual command will be:

```
tsp --verbose \
    -I file '/home/john doe/name with spaces \' and quotes\'.ts' \
    -P until --packet 1,000,000 \
```

```
    -P analyze \
    -O drop
```

If one type of plugin is specified, the defaults no longer apply. For instance, the command:

```
tsp -P regulate
```

will become:

```
tsp --verbose \
    -I file '/home/john doe/name with spaces \' and quotes\'.ts' \
    -P regulate \
    -O drop
```

A.5.2   Using TSDuck on Japanese ISDB transport streams

A user who routinely analyzes Japanese transport streams only will have to use specific options in all TSDuck commands. It is consequently easier to setup a configuration file as follow:

```
default.region = japan
default.lnb = japan
default.time = jst

[tsp]
prepend.options = --japan

[tsanalyze]
prepend.options = --japan

[tsdate]
prepend.options = --japan

 [tscharset]
prepend.options = --japan

[tspacketize]
prepend.options = --japan

[tspsi]
prepend.options = --japan

[tsscan]
prepend.options = --japan

[tstabcomp]
prepend.options = --japan

[tstabdump]
prepend.options = --japan

[tstables]
prepend.options = --japan

[tsterinfo]
prepend.options = --japan
```

Appendix B Channel Configuration XML Reference Model

This appendix describes the XML reference format for the channel configuration file.

B.1   File usage

A channel configuration file is an XML file containing the description of TV channels (networks, transport streams, services). This file is typically used to simplify the specification of tuning parameters on the command line. Instead of specifying all tuning parameters, use the option **--channel-transponder** followed by a service name. The TSDuck command retrieves the characteristics of the transport stream which contains the specified service and automatically uses its tuning parameters.

If the same service appears in networks of different types (for instance a DVB-S and a DVB-T network), the TSDuck command will use the one in the same type of network as the hardware tuner in use.

There is one default file per user but any other file can be specified using the option **--tuning-file**. The location of the user's default file depends on the operating system.

- Unix :   **$HOME/.tsduck.channels.xml**
- Windows : **%APPDATA%\tsduck\channels.xml**

B.2   Channel configuration file format

The format which is used here is informal. See the section 2.6.3, page 37, about XML model files.

The **<tsduck>** root node contains any number of networks which, in turn contain transport streams and services.

The global structure of the XML channel configuration file is the following:

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>

  <!-- Several networks in an XML file -->
  <!-- The type attribute must match the tuner type to locate a service -->
  <network id="uint16, required" type="ATSC|DVB-C|DVB-S|DVB-T|ISDB-T, required">

    <!-- Several transport streams in a network -->
    <ts id="uint16, required" onid="uint16, optional">

      <!-- Tuning information: exactly one of atsc, dvbc, dvbs, dvbt -->
      <!-- Must match the network type -->

      <!-- Several services in the TS -->
      <service id="uint16, required"
               name="string, optional"
               provider="string, optional"
               LCN="uint16, optional"
               PMTPID="uint13, optional"
               type="uint8, optional"
               cas="bool, optional"
               atsc_type="uint6, optional"
               atsc_major_id="uint10, optional"
               atsc_minor_id="uint10, optional"/>
    </ts>
  </network>

</tsduck>
```

B.3   Tuning parameters

There must be exactly one tuning parameter structure per transport stream description (**<ts>** structure).

B.3.1   ATSC

To be used for ATSC tuners:

```
<atsc frequency="uint64, required"
      modulation="8-VSB|16-VSB, default=8-VSB"
      inversion="on|off|auto, default=auto"/>
```

B.3.2   DVB-C

To be used for DVB-C/C2 tuners:

```
<dvbc frequency="uint64, required"
      symbolrate="uint32, default=6,900,000"
      modulation="16-QAM|32-QAM|64-QAM|128-QAM|256-QAM|QAM, default=64-QAM"
      FEC="1/2|2/3|3/4|4/5|5/6|6/7|7/8|8/9|9/10|3/5|1/3|1/4|2/5|5/11|auto|none,
          default=auto"
      inversion="on|off|auto, default=auto"/>
```

B.3.3   DVB-S

To be used for DVB-S/S2 tuners:

```
<dvbs satellite="uint2, default=0"
      orbital="string, optional"
      frequency="uint64, required"
      symbolrate="uint32, default=27,500,000"
      modulation="QPSK|8-PSK|16-APSK|32-APSK, default=QPSK"
      system="DVB-S|DVB-S2, default=DVB-S"
      polarity="horizontal|vertical|left|right|auto|none, default=auto"
      inversion="on|off|auto, default=auto"
      FEC="1/2|2/3|3/4|4/5|5/6|6/7|7/8|8/9|9/10|3/5|1/3|1/4|2/5|5/11|auto|none,
          default=auto"
      pilots="on|off|auto, default=auto"
      rolloff="0.20|0.25|0.35|auto, default=auto"
      ISI="uint8, optional"
      PLS_code="uint18, optional"
      PLS_mode="ROOT|GOLD|COMBO, default=ROOT"/>
```

B.3.4   DVB-T

To be used for DVB-T/T2 tuners:

```
<dvbt frequency="uint64, required"
      modulation="QPSK|16-QAM|64-QAM|256-QAM, default=64-QAM"
      inversion="on|off|auto, default=auto"
      HPFEC="1/2|2/3|3/4|4/5|5/6|6/7|7/8|8/9|9/10|3/5|1/3|1/4|2/5|5/11|auto|none,
          default=auto"
      LPFEC="1/2|2/3|3/4|4/5|5/6|6/7|7/8|8/9|9/10|3/5|1/3|1/4|2/5|5/11|auto|none,
          default=auto"
      bandwidth="1.712-MHz|5-MHz|6-MHz|7-MHz|8-MHz|10-MHz|auto, default=auto"
      transmission="1K|2K|4K|8K|16K|32K|auto, default=auto"
      guard="1/4|1/8|1/16|1/32|1/128|19/128|19/256|auto, default=auto"
      hierarchy="1|2|4|auto|none, default=auto"
      PLP="uint8, optional"/>
```

B.3.5   ISDB-T

To be used for ISDB-T tuners:

```
<isdbt frequency="uint64, required"
       inversion="on|off|auto, default=auto"
       bandwidth="5-MHz|6-MHz|7-MHz|8-MHz|auto, default=auto"
       transmission="2K|4K|8K|auto, default=auto"
       guard="1/4|1/8|1/16|1/32|auto, default=auto"/>
```

B.3.6   ISDB-S

To be used for ISDB-S tuners:

```
<isdbs satellite="uint2, default=0"
       orbital="string, optional"
       frequency="uint64, required"
       symbolrate="uint32, default=27,500,000"
       polarity="horizontal|vertical|left|right|auto|none, default=auto"
       inversion="on|off|auto, default=auto"
       FEC="1/2|2/3|3/4|5/6|7/8|auto|none, default=auto"/>
```

Appendix C Resource monitoring configuration file

This appendix describes the usage and XML reference format for the resource monitoring configuration files as used with option **--monitor** in **tsp** and **tsswitch**.

C.1 Resource monitoring in TSDuck

When TSDuck is used in lab activities, most commands run a short time only. The stability of the application over time is not an issue. However, during very long tests or basic production activities, commands such as **tsp** or **tsswitch** can run during days, weeks or possibly forever.

In that case, there is always a risk that some system resource is exhausted, typically the virtual memory of the process in case of memory leak. TSDuck is carefully developed to avoid such leaks. However, nobody can guarantee that no mishap will ever appear.

To detect problems in resource usage, **tsp** or **tsswitch** define the **--monitor** option. Using this option, the application periodically logs messages such as the following:

```
* [MON] 2021/03/14 18:23, VM: 389 MB (stable), CPU:2.19% (average:2.17%)
```

Each message contains a summary of the memory and CPU usage, both at the time of the message and its evolution over time.

The monitoring strategy is flexible and defined in *resource monitoring configuration files* (they are XML files). Each command can use a dedicated resource monitoring configuration, although the default one is fine for most usages.

Since the resource usage of an application typically evolves over time, from rapid jumps at the beginning to stability on the long run, the monitoring strategy is divided into several periods. Each period can have a distinct monitoring strategy.

When anomalies are detected, it is possible to trigger external alarm commands in addition to log messages (although the default configuration doesn't).

C.2 Resource monitoring configuration file format

The XML format which is used here is informal. See the section 2.6.3, page 37, about XML model files.

The template structure of a resource monitoring configuration file is the following:

```
<tsduck>

  <!-- Default behaviour -->
  <defaults max_cpu="uint, 0-100, required"
            stable_memory="bool, required"
            log="bool, required">
    <alarm>shell command (optional)</alarm>
  </defaults>

  <!-- Time profile. All time values are in seconds. -->
  <profile>
    <!-- One entry per period. -->
    <period duration="uint64, optional"
            interval="uint64, required"
            max_cpu="uint, 0-100, optional"
            stable_memory="bool, optional"
            log="bool, optional">
      <alarm>shell command (optional)</alarm>
    </period>
  </profile>

</tsduck>
```

The **<tsduck>** root node shall contain exactly one **<defaults>** node and one **<profile>** node. The profile is made of at least one **<period>** node.

In the definition of a period, the **duration** attribute indicates the total duration of the period in seconds. If this attribute is missing, the period extends forever and is consequently the last one. The **interval** attribute indicates the interval between two probes of the resource usage during the period.

Other attributes and nodes are optional and their default values are read from the **<defaults>** node.

The **max_cpu** attribute indicates the maximum CPU percentage that the TSDuck application should use during a monitoring interval. If the application CPU usage exceeds this value, an alarm is triggered. Keep in mind that multi-threaded applications such as **tsp** or **tsswitch** running on multi-core systems may use more than 100% of a CPU.

The **stable_memory** attribute is a boolean which indicates if the amount of virtual memory which is used by the TSDuck application should remain stable during the period. Usually, the virtual memory size of a process takes some time to stabilize and then it should remain stable. It is therefore recommended to set the attribute to false in the initial monitoring periods and to set it to true in the last period at least. The idea is to detect potential memory leaks on the long term.

The **log** attribute is a Boolean which indicates if monitoring messages should be displayed in the log during the period. These messages are useful to understand the behavior of the application. But when the application is running 24 hours a day, it creates an infinitely large log file. To avoid this issue, it is recommended to set this attribute to true in all periods except the last one to keep a finite number of monitoring messages in the log file.

The **<alarm>** node contains a shell command to run when an alarm is triggered. This can be a user-defined shell script which notifies some larger monitoring infrastructure. If the **<alarm>** node is empty or omitted, no alarm is triggered and the resource monitoring is limited to messages in the log file.

In the **<alarm>** node, the leading and trailing spaces are ignored, as well as line breaks. Thus, if the command is very long, it is possible to freely format it in the XML file.

The alarm command automatically receives three additional parameters:

1. A human-readable message, the same as the monitoring message in the log file.
2. The type of alarm, either "**cpu**" or "**memory**".
3. The alarm value. In the case of a CPU alarm, this is the CPU percentage of the application during the last monitoring interval. In the case of a memory alarm, this is the size in bytes of the virtual memory space of the application.

C.3   Default resource monitoring configuration

The default resource monitoring configuration can be found in the file named **tsduck.monitor.xml** the location of which depends on the operating system.

- Linux :   **/usr/share/tsduck/tsduck.monitor.xml**
- macOS (Intel) : **/usr/local/share/tsduck/tsduck.monitor.xml**
- macOS (Arm) : **/opt/hombrew/share/tsduck/tsduck.monitor.xml**
- Windows :   **%TSDUCK%\bin\tsduck.monitor.xml**
- NetBSD :   **/usr/pkg/share/tsduck/tsduck.monitor.xml**
- Other BSD :   **/usr/local/share/tsduck/tsduck.monitor.xml**

It is recommended to never modify this default file. Any modification would be overwritten when TSDuck is upgraded to a new version. To use an alternative resource monitoring configuration, specify the XML file in the monitoring option, for instance **--monitor=myconfig.xml**.

The default configuration is defined as follow. It is relatively liberal, and no alarm command is defined.

```
<tsduck>
```

```
    <defaults max_cpu="80" stable_memory="false" log="true"/>
    <profile>
      <period duration="120" interval="10" max_cpu="100"/>
      <period duration="480" interval="60"/>
      <period duration="600" interval="120"/>
      <period duration="2400" interval="300"/>
      <period duration="32400" interval="1800"/>
      <period interval="1800" stable_memory="true" log="false"/>
    </profile>
  </tsduck>
```

It can be interpreted as follow:

- During the first 2 minutes, monitor every 10 seconds, no CPU limitation.
- During the next 8 minutes (up to start + 10 mn), monitor every minute.
- During the next 10 minutes (up to start + 20 mn), monitor every 2 minutes.
- During the next 40 minutes (up to start + 1 hour), monitor every 5 minutes.
- During the next 9 hours (up to start + 10 hours), monitor every 30 minutes.
- After 10 hours, monitor every 30 minutes, raise an alarm when the memory is not stable, stop logging messages to avoid flooding the log file.

Appendix D PSI/SI XML Reference Model

This appendix describes the XML reference format for all tables and descriptors.

D.1 PSI/SI file format

The format which is used here is informal. See the section 2.6.3, page 37, about XML model files.

Additionally:

- Hexadecimal content is a suite of hexadecimal digits. Spaces are ignored. Note that the name *hexadecimal content* is used for data blocks, usually private ones, of arbitrary length. This is different from integer values in attributes which can be represented as hexadecimal using the prefix **0x**. In *hexadecimal content* blocks, there is no **0x** prefix, everything is hexadecimal.

- The pseudo-node **<DESCRIPTOR_LIST>** is a place-holder for a sequence a descriptor nodes.

- Unsupported tables and descriptors can still be used. Their payloads must be specified as hexadecimal content. See tags **<generic_short_table>**, **<generic_long_table>** and **<generic_descriptor>** in section D.20, page 579.

D.1.1 XML file structure

The **<tsduck>** root node contains any number of tables:

```
<?xml version="1.0" encoding="UTF-8"?>
<tsduck>
  <!-- any number of table structures -->
</tsduck>
```

The table structures are documented in the following sections. Descriptors are documented right after. Tables and descriptors are grouped by standard bodies or private parties which defined them.

When a table or structure is not supported by TSDuck, it is still possible to represent it using the generic structures **<generic_long_table>**, **<generic_short_table>** and **<generic_descriptor>** (see section D.20 page 579).

D.1.2 Table metadata

Although not documented in the following reference sections and not actually part of the binary table, each table structure accepts the following metadata information.

This information is optional and typically generated by tools and plugins which extract tables from a stream. They are informational only. The <**metadata**> structure is ignored when an XML file is read.

```
<metadata PID="uint13, optional"
          time="YYYY-MM-DD hh:mm:ss, optional"
          first_ts_packet="uint64, optional"
          last_ts_packet="uint64, optional">
  <section>
    Hexadecimal content.
  </section>
</metadata>
```

The <**section**> structures are used to propagate a copy of the binary sections of the original table, one per section.

D.2 MPEG-defined tables

D.2.1 Conditional Access Table (CAT)

Defined by MPEG in [1]**.**

```
<CAT version="uint5, default=0" current="bool, default=true">
  <DESCRIPTOR_LIST>
</CAT>
```

D.2.2   DSM-CC Stream Descriptors Table

Defined by MPEG in [2].

```
<DSMCC_stream_descriptors_table
    version="uint5, default=0"
    current="bool, default=true"
    table_id_extension="uint16, default=0xFFFF">
  <DESCRIPTOR_LIST>
</DSMCC_stream_descriptors_table>
```

D.2.3   Program Association Table (PAT)

Defined by MPEG in [1].

```
<PAT version="uint5, default=0"
    current="bool, default=true"
    transport_stream_id="uint16, required"
    network_PID="uint13, optional">

  <!-- One per service -->
  <service service_id="uint16, required" program_map_PID="uint13, required"/>

</PAT>
```

D.2.4   Program Map Table (PMT)

Defined by MPEG in [1].

```
<PMT version="uint5, default=0"
    current="bool, default=true"
    service_id="uint16, required"
    PCR_PID="uint13, default=0x1FFF">

  <!-- Program-level descriptors -->
  <DESCRIPTOR_LIST>

  <!-- One per elementary stream -->
  <component stream_type="uint8, required" elementary_PID="uint13, required">
    <DESCRIPTOR_LIST>
  </component>

</PMT>
```

D.2.5   Transport Stream Description Table (TSDT)

Defined by MPEG in [1].

```
<TSDT version="uint5, default=0" current="bool, default=true">
  <DESCRIPTOR_LIST>
</TSDT>
```

D.3   DVB-defined tables

D.3.1   Application Information Table (AIT)

Defined by DVB in [12] and [15].

```
<AIT version="uint5, default=0"
    current="bool, default=true"
    test_application_flag="bool, default=true"
```

```
        application_type="uint15, required">

    <!-- Common descriptors loop -->
    <DESCRIPTOR_LIST>

    <!-- One per application -->
    <application control_code="uint8, required">
      <application_identifier
          organization_id="uint32, required"
          application_id="uint16, required"/>
      <DESCRIPTOR_LIST>
    </application>

  </AIT>
```

D.3.2   Bouquet Association Table (BAT)

Defined by DVB in [5].

The optional attribute **preferred_section** indicates in which section the description of a transport stream should be preferably serialized. When unspecified for a TS, the corresponding TS description is serialized in an arbitrary section.

```
  <BAT version="uint5, default=0"
       current="bool, default=true"
       bouquet_id="uint16, required">

    <!-- Bouquet-level descriptors -->
    <DESCRIPTOR_LIST>

    <!-- One per transport stream -->
    <transport_stream transport_stream_id="uint16, required"
                      original_network_id="uint16, required"
                      preferred_section="uint8, optional">
      <DESCRIPTOR_LIST>
    </transport_stream>

  </BAT>
```

D.3.3   Content Identifier Table (CIT)

Defined by DVB in [9].

```
  <CIT version="uint5, default=0"
       current="bool, default=true"
       service_id="uint16, required"
       transport_stream_id="uint16, required"
       original_network_id="uint16, required">

    <!-- One per prepend string -->
    <prepend_string value="string, required"/>

    <!-- One per CRID (Content Reference Identifier) -->
    <crid crid_ref="uint16, required"
          prepend_string_index="uint8, optional"
          unique_string="string, required"/>

  </CIT>
```

D.3.4   Discontinuity Information Table

Defined by DVB in [5].

```
  <discontinuity_information_table transition="bool, required"/>
```

D.3.5 Event Information Table (EIT)

Defined by DVB in [5]. This is the DVB version of an EIT. ATSC uses a different structure for EIT.

If **type="pf"**, this is an EITp/f (present/following).

If **type** is a 4-bit integer, this is an EITs (schedule) with TID **0x50** + type (EITs Actual) or **0x60** + type (EITs Other), depending on the **actual** attribute.

When an EIT is compiled by TSDuck (serialized as binary sections), the events are sorted in ascending order of start time and spread over sections as described in [6].

The attribute **last_table_id** is optional. By default, it is set to the same table id as the table. Upon serialization, the DVB rules are enforced to bind its value within the DVB-specified limits.

```
<EIT type="pf|uint4, default=pf"
     version="uint5, default=0"
     current="bool, default=true"
     actual="bool, default=true"
     service_id="uint16, required"
     transport_stream_id="uint16, required"
     original_network_id="uint16, required"
     last_table_id="uint8, default=same as table id">

  <!-- One per event -->
  <event event_id="uint16, required"
         start_time="YYYY-MM-DD hh:mm:ss, required"
         duration="hh:mm:ss, required"
         running_status="undefined|not-running|starting|pausing|running|off-air,
                         default=undefined"
         CA_mode="bool, default=false">
    <DESCRIPTOR_LIST>
  </event>

</EIT>
```

D.3.6 IP/MAC Notification Table (INT)

Defined by DVB in [14].

```
<INT version="uint5, default=0"
     current="bool, default=true"
     action_type="uint8, default=0x01"
     processing_order="uint8, default=0x00"
     platform_id="uint24, required">

  <!-- Plaform-level descriptors -->
  <DESCRIPTOR_LIST>

  <!-- One per device -->
  <device>
    <target>
      <DESCRIPTOR_LIST>
    </target>
    <operational>
      <DESCRIPTOR_LIST>
    </operational>
  </device>

</INT>
```

D.3.7 Network Information Table (NIT)

Defined by DVB in [5].

The optional attribute **preferred_section** indicates in which section the description of a transport stream should be preferably serialized. When unspecified for a TS, the corresponding TS description is serialized in an arbitrary section.

```
<NIT version="uint5, default=0"
     current="bool, default=true"
     network_id="uint16, required"
     actual="bool, default=true">

  <!-- Network-level descriptors -->
  <DESCRIPTOR_LIST>

  <!-- One per transport stream -->
  <transport_stream transport_stream_id="uint16, required"
                    original_network_id="uint16, required"
                    preferred_section="uint8, optional">
    <DESCRIPTOR_LIST>
  </transport_stream>

</NIT>
```

D.3.8   Resolution provider Notification Table (RNT)

Defined by DVB in [9].

```
<RNT version="uint5, default=0"
     current="bool, default=true"
     context_id="uint16, required"
     context_id_type="uint8, required">

  <DESCRIPTOR_LIST>

  <!-- One per resolution provider -->
  <resolution_provider name="string, required">

    <DESCRIPTOR_LIST>

    <!-- One per CRID authority -->
    <CRID_authority name="string, required" policy="uint2, required">
      <DESCRIPTOR_LIST>
    </CRID_authority>

  </resolution_provider>

</RNT>
```

D.3.9   Running Status Table (RST)

Defined by DVB in [5].

```
<RST>
  <!-- One per event -->
  <event transport_stream_id="uint16, required"
         original_network_id="uint16, required"
         service_id="uint16, required"
         event_id="uint16, required"
         running_status="undefined|not-running|starting|pausing|running|off-air,
                         required"/>
</RST>
```

D.3.10   Satellite Information Table (SAT)

Defined by DVB in [5].

```
<SAT version="uint5, default=0"
     current="bool, default=true"
```

```
        satellite_table_id="uint6, required"
        table_count="uint10, required">

    <!-- satellite_table_id=0 -> satellite_position_v2_info -->
    <satellite_position_v2_info>
      <!-- 1 or more satellite_position required -->
      <satellite_position satellite_id="uint24, required">
        <!-- position_system==0 -> geostationary -->
        <geostationary
            orbital_position="SatelliteOrbitalPosition, eg. 19.2, required"
            west_east_flag="east|west, required"/>
        <!-- position_system==1 -> earth_orbiting -->
        <earth_orbiting
            epoch_year="uint8, required"
            day_of_the_year="uint16, required"
            day_fraction="float, required"
            mean_motion_first_derivative="float, required"
            mean_motion_second_derivative="float, required"
            drag_term="float32, required"
            inclination="float32, required"
            right_ascension_of_the_ascending_node="float32, required"
            eccentricity="float32, required"
            argument_of_perigree="float32, required"
            mean_anomaly="float32, required"
            mean_motion="float32, required"/>
      </satellite_position>
    </satellite_position_v2_info>

    <!-- satellite_table_id=1 -> cell_fragment_info -->
    <cell_fragment_info>
      <!-- 1 or more cell_fragment required -->
      <cell_fragment
          cell_fragment_id="uint32, required"
          first_occurence="bool, required"
          last_occurence="bool, required"
          center_latitude="int18, optional"
          center_longitude="int19, optional"
          max_distance="uint24, optional">
        <!--
            center_latitude, center_longitude (tcimsbf) –
                two's complement integer, most significanr (sign) bit first
            center_latitude, center_longitude,
                max_distance only required when first_occurrence=true
        -->

        <!-- 0 or more delivery_system required -->
        <delivery_system id="uint32, required"/>

        <!-- 0 or more new_delivery_system required -->
        <new_delivery_system id="uint32, required">
          <time_of_application
              base="uint33, required"
              ext="uint9, required"/>
        </new_delivery_system>

        <!-- 0 or more obsolescent_delivery_system required -->
        <obsolescent_delivery_system id="uint32, required">
          <time_of_obsolescence
              base="uint33, required"
              ext="uint9, required"/>
        </obsolescent_delivery_system>

      </cell_fragment>
    </cell_fragment_info>

    <!-- satellite_table_id=2 -> time_association_info -->
```

```
<time_association_info
    association_type="uint4, required"
    leap59="bool, optional"
    leap61="bool, optional"
    past_leap59="bool, optional"
    past_leap61="bool, optional"
    association_timestamp_seconds="uint64, required"
    association_timestamp_nanoseconds="uint32, required">
  <!--
      association_type==0:  UTC without leab second signalling
      association_type==1:  UTC with leab second signalling
      leap59, leap61, pastleap59, pastleap61 only required when association_type==1
  -->
  <ncr base="uint33, required"
       ext="uint9, required"/>
</time_association_info>

<!-- satellite_table_id=3 -> beamhopping_timeplan_info -->
<beamhopping_timeplan_info>
  <beamhopping_timeplan id="uint32, required">

    <time_of_application
        base="uint33, required"
        ext="uint9, required"/>
    <cycle_duration
        base="uint33, required"
        ext="uint9, required"/>

    <time_plan_mode_0>
      <dwell_duration
          base="uint33, required"
          ext="uint9, required"/>
      <on_time
          base="uint33, required"
          ext="uint9, required"/>
    </time_plan_mode_0>

    <time_plan_mode_1 current_slot="uint15, required">
      <slot id="uint15, required" transmission_on="bool, required"/>
    </time_plan_mode_1>

    <time_plan_mode_2>
      <grid_size
          base="uint33, required"
          ext="uint9, required"/>
      <revisit_duration
          base="uint33, required"
          ext="uint9, required"/>
      <sleep_time
          base="uint33, required"
          ext="uint9, required"/>
      <sleep_duration
          base="uint33, required"
          ext="uint9, required"/>
    </time_plan_mode_2>

  </beamhopping_timeplan>
</beamhopping_timeplan_info>

</SAT>
```

D.3.11   Selection Information Table (SIT)

Defined by DVB in [5].

```
<selection_information_table version="uint5, default=0" current="bool, default=true">
```

```
    <!-- Common descriptors loop, for transmission parameters -->
    <DESCRIPTOR_LIST>

    <!-- One per service -->
    <service service_id="uint16, required"
             running_status="undefined|not-running|starting|pausing|running|off-air,
                            required">
      <DESCRIPTOR_LIST>
    </service>

  </selection_information_table>
```

D.3.12   Service Description Table (SDT)

Defined by DVB in [5].

```
<SDT version="uint5, default=0"
     current="bool, default=true"
     transport_stream_id="uint16, required"
     original_network_id="uint16, required"
     actual="bool, default=true">

  <!-- One per service -->
  <service service_id="uint16, required"
           EIT_schedule="bool, default=false"
           EIT_present_following="bool, default=false"
           running_status="undefined|not-running|starting|pausing|running|
                           off-air, default=undefined"
           CA_mode="bool, default=false">
    <DESCRIPTOR_LIST>
  </service>

</SDT>
```

D.3.13   Time and Date Table (TDT)

Defined by DVB in [5].

```
<TDT UTC_time="YYYY-MM-DD hh:mm:ss, required"/>
```

D.3.14   Time Offset Table (TOT)

Defined by DVB in [5].

```
<TOT UTC_time="YYYY-MM-DD hh:mm:ss, required">
  <DESCRIPTOR_LIST>
</TOT>
```

D.3.15   Update Notification Table (UNT)

Defined by DVB in [8].

```
<UNT version="uint5, default=0"
     current="bool, default=true"
     action_type="uint8, default=0x01"
     OUI="uint24, required"
     processing_order="uint8, default=0x00">

  <!-- Common descriptors, apply to all SSU -->
  <DESCRIPTOR_LIST>

  <!-- One per set of devices -->
  <devices>

    <!-- More than one allowed, each one is an individual descriptor -->
    <!-- inside compatibilityDescriptor() -->
```

```
    <compatibilityDescriptor
        descriptorType="uint8, required"
        specifierType="uint8, default=0x01"
        specifierData="uint24, required"
        model="uint16, default=0x00"
        version="uint16, default=0x00">
      <!-- Several subdescriptors -->
      <subDescriptor subDescriptorType="uint8, required">
        Hexadecimal content
      </subDescriptor>
    </compatibilityDescriptor>

    <!-- One per platform -->
    <platform>
      <target>
        <DESCRIPTOR_LIST>
      </target>
      <operational>
        <DESCRIPTOR_LIST>
      </operational>
    </platform>
  </devices>

</UNT>
```

D.4 SCTE-defined tables

D.4.1   Cable Emergency Alert Table (SCTE 18)

Defined by ANSI/SCTE in [21].

```
<cable_emergency_alert_table
    sequence_number="uint5, required"
    protocol_version="uint8, default=0"
    EAS_event_ID="uint16, required"
    EAS_originator_code="char3, required"
    EAS_event_code="string, required"
    alert_message_time_remaining="uint8, optional"
    event_start_time="YYYY-MM-DD hh:mm:ss, optional"
    event_duration="uint16, optional"
    alert_priority="uint4, required"
    details_OOB_source_ID="uint16, optional"
    details_major_channel_number="uint10, optional"
    details_minor_channel_number="uint10, optional"
    audio_OOB_source_ID="uint16, optional">

  <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
  <nature_of_activation_text>
    <string language="char3, required" text="string, required"/>
  </nature_of_activation_text>

  <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
  <alert_text>
    <string language="char3, required" text="string, required"/>
  </alert_text>

  <!-- From 1 to 31 location structures -->
  <location
      state_code="uint8, required"
      county_subdivision="uint4, required"
      county_code="uint10, required"/>

  <!-- Up to 255 exception structures -->
  <!-- Specify either exception_major_channel_number+exception_minor_channel_number -->
  <!-- or exception_OOB_source_ID -->
```

```
    <exception
        exception_major_channel_number="uint10, optional"
        exception_minor_channel_number="uint10, optional"
        exception_OOB_source_ID="uint16, optional"/>

    <DESCRIPTOR_LIST>

</cable_emergency_alert_table>
```

D.4.2 Splice Information Table (SCTE 35)

Defined by ANSI/SCTE in [22].

Exactly one of the following tags is allowed. This is the splice command in this table.

```
<splice_null>
<splice_schedule>
<splice_insert>
<time_signal>
<bandwidth_reservation>
<private_command>
```

Table definition:

```
<splice_information_table
    protocol_version="uint8, default=0"
    pts_adjustment="uint33, default=0"
    tier="uint12, default=0xFFF">

  <!-- Splice commands, only one of them is allowed -->

  <splice_null/>

  <splice_schedule>
    <!-- One per splice event -->
    <splice_event
        splice_event_id="uint32, required"
        splice_event_cancel="bool, default=false"
        out_of_network="bool, required when splice_event_cancel is false"
        utc_splice_time="uint32 or YYYY-MM-DD hh:mm:ss,
                         required when splice_event_cancel is false and
                         program_splice_flag is to be set"
        unique_program_id="uint16, required when splice_event_cancel is false"
        avail_num="uint8, default=0"
        avails_expected="uint8, default=0">
      <!-- Optional -->
      <break_duration
          auto_return="bool, required"
          duration="uint33, required"/>
      <!-- One per component when splice_event_cancel is false and
           utc_splice_time is not specified -->
      <component
          component_tag="uint8, required"
          utc_splice_time="uint32 or YYYY-MM-DD hh:mm:ss, required"/>
    </splice_event>
  </splice_schedule>

  <splice_insert
      splice_event_id="uint32, required"
      splice_event_cancel="bool, default=false"
      out_of_network="bool, required when splice_event_cancel is false"
      splice_immediate="bool, default=false"
      pts_time="uint33, required when splice_event_cancel is false and
                splice_immediate is false and program_splice_flag is to be set"
      unique_program_id="uint16, required when splice_event_cancel is false"
      avail_num="uint8, default=0"
      avails_expected="uint8, default=0">
```

```
    <!-- Optional -->
    <break_duration
        auto_return="bool, required"
        duration="uint33, required"/>
    <!-- One per component when splice_event_cancel is false and
         pts_time is not specified -->
    <component
        component_tag="uint8, required"
        pts_time="uint33, required when splice_immediate is false"/>
  </splice_insert>

  <time_signal pts_time="uint33, optional"/>

  <bandwidth_reservation/>

  <private_command identifier="uint32, required">
    Hexadecimal digits.
  </private_command>

  <DESCRIPTOR_LIST>

</splice_information_table>
```

D.5 ATSC-defined tables

D.5.1   Cable Virtual Channel Table (CVCT)

Defined by ATSC in [25].

```
<CVCT version="uint5, default=0"
      current="bool, default=true"
      protocol_version="uint8, default=0"
      transport_stream_id="uint16, required">

  <!-- Common descriptors loop -->
  <DESCRIPTOR_LIST>

  <!-- One per channel -->
  <channel short_name="string, required"
           major_channel_number="uint10, required"
           minor_channel_number="uint10, required"
           modulation_mode="analog|64-QAM|256-QAM|8-VSB|16-VSB|uint8, required"
           carrier_frequency="uint32, default=0"
           channel_TSID="uint16, required"
           program_number="uint16, required"
           ETM_location="uint2, default=0"
           access_controlled="bool, default=false"
           hidden="bool, default=false"
           path_select="uint1, default=0"
           out_of_band="bool, default=0"
           hide_guide="bool, default=false"
           service_type="analog|dtv|audio|data|software|uint6, default=dtv"
           source_id="uint16, required">
    <DESCRIPTOR_LIST>
  </channel>

</CVCT>
```

D.5.2   Directed Channel Change Table (DCCT)

Defined by ATSC in [25].

```
<DCCT version="uint5, default=0"
      protocol_version="uint8, default=0"
      dcc_subtype="uint8, default=0"
```

```
        dcc_id="uint8, required">

    <!-- Common descriptors loop -->
    <DESCRIPTOR_LIST>

    <!-- One per channel change test -->
    <dcc_test dcc_context="temporary_retune|channel_redirect|uint1, required"
            dcc_from_major_channel_number="uint10, required"
            dcc_from_minor_channel_number="uint10, required"
            dcc_to_major_channel_number="uint10, required"
            dcc_to_minor_channel_number="uint10, required"
            dcc_start_time="YYYY-MM-DD hh:mm:ss, required"
            dcc_end_time="YYYY-MM-DD hh:mm:ss, required">

      <!-- DCC test descriptors loop -->
      <DESCRIPTOR_LIST>

      <!-- One per channel change test -->
      <dcc_term dcc_selection_type="uint8, required"
            dcc_selection_id="uint64, required">
        <!-- DCC term descriptors loop -->
        <DESCRIPTOR_LIST>
      </dcc_term>

    </dcc_test>

  </DCCT>
```

D.5.3 Directed Channel Change Selection Code Table (DCCSCT)

Defined by ATSC in [25].

```
    <DCCSCT version="uint5, default=0"
            protocol_version="uint8, default=0"
            dccsct_type="uint16, default=0">

    <!-- Common descriptors loop -->
    <DESCRIPTOR_LIST>

    <!-- One per update -->
    <update update_type="new_genre_category|new_state|new_county|uint8, required"
            genre_category_code="uint8, required when update_type == new_genre_category"
            dcc_state_location_code="uint8, required when update_type == new_state"
            state_code="uint8, required when update_type == new_county"
            dcc_county_location_code="uint10, required when update_type == new_county">

      <!-- Update descriptors loop -->
      <DESCRIPTOR_LIST>

      <!-- multiple_string_structure(), required when update_type==new_genre_category -->
      <genre_category_name_text>
        <string language="char3, required" text="string, required"/>
      </genre_category_name_text>

      <!-- ATSC multiple_string_structure(), required when update_type == new_state -->
      <dcc_state_location_code_text>
        <string language="char3, required" text="string, required"/>
      </dcc_state_location_code_text>

      <!-- ATSC multiple_string_structure(), required when update_type == new_county -->
      <dcc_county_location_code_text>
        <string language="char3, required" text="string, required"/>
      </dcc_county_location_code_text>

    </update>
```

```
      </DCCSCT>
```

D.5.4   Event Information Table (EIT)

Defined by ATSC in [25].

To avoid conflicts with the DVB version of an EIT, the XML structure is named <ATSC_EIT>. The tag <EIT> designates a DVB EIT.

```
<ATSC_EIT version="uint5, default=0"
          source_id="uint16, required"
          protocol_version="uint8, default=0">

  <!-- One per event -->
  <event event_id="uint16, required"
         start_time="YYYY-MM-DD hh:mm:ss, required"
         ETM_location="uint2, required"
         length_in_seconds="uint20, required">

    <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
    <title_text>
      <string language="char3, required" text="string, required"/>
    </title_text>

    <!-- Event descriptors loop -->
    <DESCRIPTOR_LIST>

  </event>

</ATSC_EIT>
```

D.5.5   Extended Text Table (ETT)

Defined by ATSC in [25].

```
<ETT version="uint5, default=0"
     protocol_version="uint8, default=0"
     ETT_table_id_extension="uint16, required"
     ETM_id="uint32, required">

  <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
  <extended_text_message>
    <string language="char3, required" text="string, required"/>
  </extended_text_message>

</ETT>
```

D.5.6   Master Guide Table (MGT)

Defined by ATSC in [25].

```
<MGT version="uint5, default=0" protocol_version="uint8, default=0">

  <!-- Common descriptors loop -->
  <DESCRIPTOR_LIST>

  <!-- One per table type -->
  <table type="TVCT-current|TVCT-next|CVCT-current|CVCT-next|ETT|DCCSCT|
               EIT-0..EIT-127|ETT-0..ETT-127|RRT-1..RRT-255|DCCT-0DCCT-255|
               uint16, required"
         PID="uint13, required"
         version_number="uint5, required"
         number_bytes="uint32, required">
    <DESCRIPTOR_LIST>
  </table>
```

```
    </MGT>
```

D.5.7   Rating Region Table (RRT)

Defined by ATSC in [25].

```
    <RRT version="uint5, default=0"
        protocol_version="uint8, default=0"
        rating_region="uint8, required">

      <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
      <rating_region_name>
        <string language="char3, required" text="string, required"/>
      </rating_region_name>

      <!-- One per dimension -->
      <dimension graduated_scale="bool, required">

        <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
        <dimension_name>
          <string language="char3, required" text="string, required"/>
        </dimension_name>

        <!-- One per rating value -->
        <value>

          <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
          <abbrev_rating_value>
            <string language="char3, required" text="string, required"/>
          </abbrev_rating_value>

          <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
          <rating_value>
            <string language="char3, required" text="string, required"/>
          </rating_value>

        </value>

      </dimension>

      <DESCRIPTOR_LIST>

    </RRT>
```

D.5.8   System Time Table (STT)

Defined by ATSC in [25].

```
    <STT protocol_version="uint8, default=0"
        system_time="uint32, required"
        GPS_UTC_offset="uint8, required"
        DS_status="bool, required"
        DS_day_of_month="uint5, default=0"
        DS_hour="uint8, default=0">

      <DESCRIPTOR_LIST>

    </STT>
```

D.5.9   Terrestrial Virtual Channel Table (TVCT)

Defined by ATSC in [25].

```
    <TVCT version="uint5, default=0"
        current="bool, default=true"
        protocol_version="uint8, default=0"
```

```
        transport_stream_id="uint16, required">

    <!-- Common descriptors loop -->
    <DESCRIPTOR_LIST>

    <!-- One per channel -->
    <channel short_name="string, required"
             major_channel_number="uint10, required"
             minor_channel_number="uint10, required"
             modulation_mode="analog|64-QAM|256-QAM|8-VSB|16-VSB|uint8, required"
             carrier_frequency="uint32, default=0"
             channel_TSID="uint16, required"
             program_number="uint16, required"
             ETM_location="uint2, default=0"
             access_controlled="bool, default=false"
             hidden="bool, default=false"
             hide_guide="bool, default=false"
             service_type="analog|dtv|audio|data|software|uint6, default=dtv"
             source_id="uint16, required">
      <DESCRIPTOR_LIST>
    </channel>

</TVCT>
```

D.6 ISDB-defined tables

D.6.1   Broadcaster Information Table (BIT)

Defined by ARIB in [28].

```
<BIT version="uint5, default=0"
     current="bool, default=true"
     original_network_id="uint16, required"
     broadcast_view_propriety="bool, required">

    <!-- Common descriptors loop -->
    <DESCRIPTOR_LIST>

    <!-- One per broadcaster -->
    <broadcaster broadcaster_id="uint8, required">
      <DESCRIPTOR_LIST>
    </broadcaster>

</BIT>
```

D.6.2   Common Data Table (CDT)

Defined by ARIB in [29].

```
<CDT version="uint5, default=0"
     current="bool, default=true"
     download_data_id="uint16, required"
     original_network_id="uint16, required"
     data_type="uint8, required">

    <!-- Common descriptors loop -->
    <DESCRIPTOR_LIST>

    <data_module>
      Hexadecimal content
    </data_module>

</CDT>
```

D.6.3 Event Relation Table (ERT)

Defined by ARIB in [28].

```
<ERT version="uint5, default=0"
    current="bool, default=true"
    event_relation_id="uint16, required"
    information_provider_id="uint16, required"
    relation_type="uint4, required">

  <!-- One per event relation -->
  <relation
      node_id="uint16, required"
      collection_mode="uint4, required"
      parent_node_id="uint16, required"
      reference_number="uint8, required">
    <DESCRIPTOR_LIST>
  </relation>

</ERT>
```

D.6.4 Index Transmission information Table (ITT)

Defined by ARIB in [28].

```
<ITT version="uint5, default=0"
    current="bool, default=true"
    event_id="uint16, required">

  <DESCRIPTOR_LIST>

</ITT>
```

D.6.5 Linked Description Table (LDT)

Defined by ARIB in [28].

```
<LDT version="uint5, default=0"
    current="bool, default=true"
    original_service_id="uint16, required"
    transport_stream_id="uint16, required"
    original_network_id="uint16, required">

  <!-- One per description -->
  <description description_id="uint16, required">
    <DESCRIPTOR_LIST>
  </description>

</LDT>
```

D.6.6 Local event Information Table (LIT)

Defined by ARIB in [28].

```
<LIT version="uint5, default=0"
    current="bool, default=true"
    event_id="uint16, required"
    service_id="uint16, required"
    transport_stream_id="uint16, required"
    original_network_id="uint16, required">

  <!-- One per local event -->
  <event local_event_id="uint16, required">
    <DESCRIPTOR_LIST>
  </event>

</LIT>
```

D.6.7   Network Board Information Table (NBIT)

Defined by ARIB in [28].

```
<NBIT version="uint5, default=0"
      current="bool, default=true"
      original_network_id="uint16, required"
      body="bool, default=true">

  <!-- One per information set -->
  <information
      information_id="uint16, required"
      information_type="uint4, required"
      description_body_location="uint2, required"
      user_defined="uint8, default=0xFF">

    <!-- One per key_id entry -->
    <key id="uint16, required"/>
    <DESCRIPTOR_LIST>

  </information>

</NBIT>
```

The attribute *body* indicates if the NBIT carries actual information body (table id **0xC5** when true) or reference to information (table id **0xC6** when false).

D.6.8   Partial Content Announcement Table (PCAT)

Defined by ARIB in [28].

```
<PCAT version="uint5, default=0"
      current="bool, default=true"
      service_id="uint16, required"
      transport_stream_id="uint16, required"
      original_network_id="uint16, required"
      content_id="uint32, required">

  <!-- One per content version -->
  <version content_version="uint16, required"
           content_minor_version="uint16, required"
           version_indicator="uint2, required">

    <!-- One per schedule entry -->
    <schedule start_time="YYYY-MM-DD hh:mm:ss, required"
              duration="hh:mm:ss, required"/>

    <DESCRIPTOR_LIST>

  </version>

</PCAT>
```

D.7   MPEG-defined descriptors

D.7.1   af_extensions_descriptor

Defined by MPEG in [1].

```
<af_extensions_descriptor/>
```

D.7.2   association_tag_descriptor

Defined by MPEG in [2].

```
<association_tag_descriptor
```

```
        association_tag="uint16, required"
        use="uint16, required">
    <selector_bytes>
      Hexadecimal content
    </selector_bytes>
    <private_data>
      Hexadecimal content
    </private_data>
  </association_tag_descriptor>
```

D.7.3   audio_stream_descriptor

Defined by MPEG in [1].

```
<audio_stream_descriptor
    free_format="bool, required"
    ID="uint1, required"
    layer="uint2, required"
    variable_rate_audio="bool, required"/>
```

D.7.4   auxiliary_video_stream_descriptor

Defined by MPEG in [1].

```
<auxiliary_video_stream_descriptor aux_video_codestreamtype="uint8, required">

  <si_message payload_type="uint32, required">
    <generic_params
      aux_is_bottom_field="bool, optional"
      aux_is_interlaced="bool, optional"
      position_offset_h="uint8, required"
      position_offset_v="uint8, required"/>
    <depth_params
      kfar_numerator="uint8, required"
      knear_numerator="uint8, required"/>
    <parallax_params
      parallax_zero="uint16, required"
      parallax_scale="uint16, required"
      dref="uint16, required"
      wref="uint16, required"/>
    <reserved_si_message>
      Hexadecimal content
    </reserved_si_message>
  </si_message>

</auxiliary_video_stream_descriptor>
```

D.7.5   AVC_timing_and_HRD_descriptor

Defined by MPEG in [1].

```
<AVC_timing_and_HRD_descriptor
    hrd_management_valid="bool, required"
    N_90khz="uint32, optional"
    K_90khz="uint32, optional"
    num_units_in_tick="uint32, optional"
    fixed_frame_rate="bool, required"
    temporal_poc="bool, required"
    picture_to_display_conversion="bool, required"/>
```

D.7.6   AVC_video_descriptor

Defined by MPEG in [1].

```
<AVC_video_descriptor
    profile_idc="uint8, required"
    constraint_set0="bool, required"
```

```
     constraint_set1="bool, required"
     constraint_set2="bool, required"
     constraint_set3="bool, default=false"
     constraint_set4="bool, default=false"
     constraint_set5="bool, default=false"
     AVC_compatible_flags="uint2, required"
     level_idc="uint8, required"
     AVC_still_present="bool, required"
     AVC_24_hour_picture="bool, required"
     frame_packing_SEI_not_present="bool, default=false"/>
```

D.7.7   CA_descriptor

Defined by MPEG in [1].

```
<CA_descriptor CA_system_id="uint16, required" CA_PID="uint13, required">
  <private_data>
    Hexadecimal content
  </private_data>
</CA_descriptor>
```

D.7.8   carousel_identifier_descriptor

Defined by MPEG in [2].

```
<carousel_identifier_descriptor carousel_id="uint32, required">
  <private_data>
    Hexadecimal content
  </private_data>
</carousel_identifier_descriptor>
```

D.7.9   content_labelling_descriptor

Defined by MPEG in [1].

```
<content_labelling_descriptor
    metadata_application_format="uint16, required"
    metadata_application_format_identifier="uint32, optional"
    content_time_base_indicator="uint4, required"
    content_time_base_value="uint33, optional"
    metadata_time_base_value="uint33, optional"
    content_id="uint7, optional">

  <content_reference_id>
    Hexadecimal content
  </content_reference_id>

  <time_base_association_data>
    Hexadecimal content
  </time_base_association_data>

  <private_data>
    Hexadecimal content
  </private_data>

</content_labelling_descriptor>
```

D.7.10   copyright_descriptor

Defined by MPEG in [1].

```
<copyright_descriptor copyright_identifier="uint32, required">
  <additional_copyright_info>
    Hexadecimal content (optional element)
  </additional_copyright_info>
</copyright_descriptor>
```

D.7.11 data_stream_alignment_descriptor

Defined by MPEG in [1].

```
<data_stream_alignment_descriptor alignment_type="uint8, required"/>
```

D.7.12 deferred_association_tags_descriptor

Defined by MPEG in [2].

```
<deferred_association_tags_descriptor
    transport_stream_id="uint16, required"
    program_number="uint16, required">
  <!-- One per association tag -->
  <association tag="uint16, required"/>
  <private_data>
    Hexadecimal content
  </private_data>
</deferred_association_tags_descriptor>
```

D.7.13 external_ES_ID_descriptor

Defined by MPEG in [1].

```
<external_ES_ID_descriptor external_ES_ID="uint16, required"/>
```

D.7.14 EVC_timing_and_HRD_descriptor

Defined by MPEG in [1].

```
<EVC_timing_and_HRD_descriptor
    hrd_management_valid="bool, required"
    N_90khz="uint32, optional"
    K_90khz="uint32, optional"
    num_units_in_tick="uint32, optional"/>
```

D.7.15 EVC_video_descriptor

Defined by MPEG in [1].

```
<EVC_video_descriptor
    profile_idc="uint8, required"
    level_idc="uint8, required"
    toolset_idc_h="uint32, required"
    toolset_idc_l="uint32, required"
    progressive_source_flag="bool, required"
    interlaced_source_flag="bool, required"
    non_packed_constraint_flag="bool, required"
    frame_only_constraint_flag="bool, required"
    EVC_still_present_flag="bool, required"
    EVC_24hr_picture_present_flag="bool, required"
    HDR_WCG_idc="uint2, default=3"
    video_properties_tag="uint4, default=0"
    temporal_id_min="uint3, optional, specify both min and max or none"
    temporal_id_max="uint3, optional, specify both min and max or none"/>
```

D.7.16 FMC_descriptor

Defined by MPEG in [1].

```
<FMC_descriptor>
  <!-- One per SL_packetized stream -->
  <stream ES_ID="uint16, required" M4MuxChannel="uint8, required"/>
</FMC_descriptor>
```

D.7.17   green_extension_descriptor>

Defined by MPEG in [1].

```
<green_extension_descriptor>

  <!-- One per time interval -->
  <constant_backlight_voltage_time_interval value="uint16, required"/>

  <!-- One per variation -->
  <max_variation value="uint16, required"/>

</green_extension_descriptor>
```

D.7.18   HEVC_hierarchy_extension_descriptor

Defined by MPEG in [1].

```
<HEVC_hierarchy_extension_descriptor
    extension_dimension_bits="uint16, required"
    hierarchy_layer_index="uint6, required"
    temporal_id="uint3, required"
    nuh_layer_id="uint6, required"
    tref_present="bool, required"
    hierarchy_channel="uint6, required">

  <!-- One per embedded layer -->
  <embedded_layer hierarchy_layer_index="uint6, required"/>

</HEVC_hierarchy_extension_descriptor>
```

D.7.19   HEVC_operation_point_descriptor

Defined by MPEG in [1].

```
<HEVC_operation_point_descriptor>

  <profile_tier_level_info>
    Hexadecimal Content
  </profile_tier_level_info>

  <operation_point
      target_ols="uint8, required"
      constant_frame_rate_info_idc="uint2, required"
      applicable_temporal_id="uint3, required"
      frame_rate_indicator="uint12, default=0"
      avg_bit_rate="uint24, default=0"
      max_bit_rate="uint24, default=0">
    <ES
        prepend_dependencies="bool, required"
        ES_reference="uint6, required"/>
    <ESinOP
        necessary_layer="bool, required"
        output_layer="bool, required"
        ptl_ref_idx="uint6, required"/>
  </operation_point>

</HEVC_operation_point_descriptor>
```

D.7.20   HEVC_subregion_descriptor

Defined by MPEG in [1].

```
<HEVC_subregion_descriptor
    SubstreamIDsPerLine="uint7, required"
    TotalSubstreamIDs="uint8, required"
    LevelFullPanorama="uint8, required">
```

```
        <SubregionLayout
            PreambleSubstreamID="uint7, optional"
            Level="uint8, required"
            PictureSizeHor="uint16, required"
            PictureSizeVer="uint16, required">

          <Pattern>
            <Substream offset="int8, required"/>
          </Pattern>

        </SubregionLayout>

    </HEVC_subregion_descriptor>
```

D.7.21 HEVC_tile_substream_descriptor

Defined by MPEG in [1].

Ether a single **Reference** element or multiple **Substream** elements can be present (or none).

```
    <HEVC_tile_substream_descriptor
        SubstreamID="uint7, required">

      <Reference
          PreambleFlag="uint1, required"
          PatternReference="uint7, required"/>

      <Substream
          Flag="uint1, required"
          AdditionalSubstreamID="uint7, required"/>

    </HEVC_tile_substream_descriptor>
```

D.7.22 HEVC_timing_and_HRD_descriptor

Defined by MPEG in [1].

```
    <HEVC_timing_and_HRD_descriptor
        hrd_management_valid="bool, required"
        target_schedule_idx="uint5, optional"
        N_90khz="uint32, optional, specify both N and K or none"
        K_90khz="uint32, optional, specify both N and K or none"
        num_units_in_tick="uint32, optional"/>
```

D.7.23 HEVC_video_descriptor

Defined by MPEG in [1].

```
    <HEVC_video_descriptor
        profile_space="uint2, required"
        tier_flag="bool, required"
        profile_idc="uint5, required"
        profile_compatibility_indication="uint32, required"
        progressive_source_flag="bool, required"
        interlaced_source_flag="bool, required"
        non_packed_constraint_flag="bool, required"
        frame_only_constraint_flag="bool, required"
        copied_44bits="uint44, default=0"
        reserved_zero_44bits="uint44, default=0"
        level_idc="uint8, required"
        HEVC_still_present_flag="bool, required"
        HEVC_24hr_picture_present_flag="bool, required"
        sub_pic_hrd_params_not_present="bool, default=true"
        HDR_WCG_idc="uint2, default=3"
        temporal_id_min="uint3, optional, specify both min and max or none"
```

```
        temporal_id_max="uint3, optional, specify both min and max or none"/>
```

Note: The attributes **reserved_zero_44bits** and **copied_44bits** are identical. The former is the original name in amendment 3 of [1] and the latter is the new name when the amendment was integrated in [1]. Both attributes are optional but only one shall be specified.

D.7.24 hierarchy_descriptor

Defined by MPEG in [1].

```
<hierarchy_descriptor
    no_view_scalability_flag="bool, default=true"
    no_temporal_scalability="bool, default=true"
    no_spatial_scalability="bool, default=true"
    no_quality_scalability="bool, default=true"
    hierarchy_type="uint4, required"
    hierarchy_layer_index="uint6, required"
    tref_present="bool, required"
    hierarchy_embedded_layer_index="uint6, required"
    hierarchy_channel="uint6, required"/>
```

D.7.25 IBP_descriptor

Defined by MPEG in [1].

```
<IBP_descriptor
    closed_gop="bool, required"
    identical_gop="bool, required"
    max_gop_length="uint14, required"/>
```

D.7.26 ISO_639_language_descriptor

Defined by MPEG in [1].

```
<ISO_639_language_descriptor>
  <!-- One per language -->
  <language code="char3, required" audio_type="uint8, required"/>
</ISO_639_language_descriptor>
```

D.7.27 J2K_video_descriptor

Defined by MPEG in [1].

```
<J2K_video_descriptor
    profile_and_level="uint15, required"
    horizontal_size="uint32, required"
    vertical_size="uint32, required"
    max_bit_rate="uint32, required"
    max_buffer_size="uint32, required"
    DEN_frame_rate="uint16, required"
    NUM_frame_rate="uint16, required"
    color_specification="uint8, required when extended_capability_flag == false"
    still_mode="bool, required"
    interlaced_video="bool, required"
    colour_primaries="uint8, required when extended_capability_flag == true"
    transfer_characteristics="uint8, required when extended_capability_flag == true"
    matrix_coefficients="uint8, required when extended_capability_flag == true"
    video_full_range_flag="bool, required when extended_capability_flag == true">

  <stripe
    strp_max_idx="uint8, required"
    strp_height="uint16, required"/>

  <block
    full_horizontal_size="uint32, required"
    full_vertical_size="uint32, required"
```

```
      blk_width="uint16, required"
      blk_height="uint16, required"
      max_blk_idx_h="uint8, required"
      max_blk_idx_v="uint8, required"
      blk_idx_h="uint8, required"
      blk_idx_v="uint8, required"/>

  <!-- one element allowed when extended_capability_flag == true -->
  <mdm
    X_c0="uint16, required"
    Y_c0="uint16, required"
    X_c1="uint16, required"
    Y_c1="uint16, required"
    X_c2="uint16, required"
    Y_c2="uint16, required"
    X_wp="uint16, required"
    Y_wp="uint16, required"
    L_max="uint32, required"
    L_min="uint32, required"
    MaxCLL="uint16, required"
    MaxFALL="uint16, required"/>

  <private_data>
    Hexadecimal content
  </private_data>

</J2K_video_descriptor>
```

D.7.28   JPEG_XS_video_descriptor

Defined by MPEG in [1].

```
<JPEG_XS_video_descriptor
    descriptor_version="uint8, required"
    horizontal_size="uint16, required"
    vertical_size="uint16, required"
    brat="uint32, required"
    interlace_mode = "uint2, required"
    framerate_DEN="1|1.001, required"
    framerate_NUM="uint16, required"
    sample_bitdepth="uint4, together with sampling_structure"
    sampling_structure="uint4, together with bit_depth"
    Ppih="unit16, required"
    level="uint8, required"
    sublevel="uint8, required"
    max_buffer_size="uint32, required"
    buffer_model_type="uint8, required"
    colour_primaries="unit8, required"
    transfer_characteristics="unit8, required"
    matrix_coefficients="unit8, required"
    video_full_range_flag="bool, required"
    still_mode="bool, required">

  <mdm
    X_c0="uint16, required"
    Y_c0="uint16, required"
    X_c1="uint16, required"
    Y_c1="uint16, required"
    X_c2="uint16, required"
    Y_c2="uint16, required"
    X_wp="uint16, required"
    Y_wp="uint16, required"
    L_max="uint32, required"
    L_min="uint32, required"
    MaxCLL="uint16, required"
    MaxFALL="uint16, required"/>
```

```
   <private_data>
     Hexadecimal content
   </private_data>

 </JPEG_XS_video_descriptor>
```

D.7.29   LCEVC_linkage_descriptor

Defined by MPEG in [1].

```
<LCEVC_linkage_descriptor>

  <lcevc_stream_tag>
    Hexadecimal content
  </lcevc_stream_tag>

</LCEVC_linkage_descriptor>
```

D.7.30   LCEVC_video_descriptor

Defined by MPEG in [1].

```
<LCEVC_video_descriptor
    lcevc_stream_tag="uint8, required"
    profile_idc="uint4, required"
    level_idc="uint4, required"
    sublevel_idc="uint2, required"
    processed_planes_type_flag="bool, required"
    picture_type_bit_flag="bool, required"
    field_type_bit_flag="bool, required"
    HDR_WCG_idc="uint2, default=3"
    video_properties_tag="uint4, default=0"/>
```

D.7.31   M4MuxBufferSize_descriptor

Defined by MPEG in [1].

```
<M4MuxBufferSize_descriptor>

  <!-- always required -->
  <DefaultM4MuxBufferDescriptor
      m4MuxChannel="uint8, required"
      FB_BufferSize="uint24, required"/>

  <!-- 0..n -->
  <M4MuxBufferDescriptor
      m4MuxChannel="uint8, required"
      FB_BufferSize="uint24, required"/>

</M4MuxBufferSize_descriptor>
```

D.7.32   m4mux_timing_descriptor

Defined by MPEG in [1].

```
<m4mux_timing_descriptor
    FCR_ES_ID="uint16, required"
    FCRResolution="uint32, required"
    FCRLength="uint8, required"
    FmxRateLength="uint8, required"/>
```

D.7.33   maximum_bitrate_descriptor

Defined by MPEG in [1].

```
<maximum_bitrate_descriptor maximum_bitrate="uint32, in bits/second, required"/>
```

D.7.34   Media_service_kind_descriptor

Defined by MPEG in [1].

```
<Media_service_kind_descriptor>

  <media_service_kind
      media_description="self|associate, required"
      media_type="unknown|video|audio|text/data, required"
      ID_length_code="uint3, optional"
      ID_type="uint13, optional"
      ID_len="uint8, optional"
      media_ID="string, optional">

    <language_media_pair
        configuration_type="uint2, required"
        lang_len_idc="uint2, required"
        lang_len="uint8, optional"
        BCP47_language_code="string, required">

      <media_service_type purpose="uint8, required"/>

    </language_media_pair>
  </media_service_kind>
</Media_service_kind_descriptor>
```

D.7.35   metadata_descriptor

Defined by MPEG in [1].

```
<metadata_descriptor
    metadata_application_format="uint16, required"
    metadata_application_format_identifier="uint32, optional"
    metadata_format="uint8, required"
    metadata_format_identifier="uint32, optional"
    metadata_service_id="uint8, required"
    decoder_config_flags="uint3, required"
    decoder_config_metadata_service_id="uint8, optional">

  <service_identification>
    Hexadecimal content
  </service_identification>

  <decoder_config>
    Hexadecimal content
  </decoder_config>

  <dec_config_identification>
    Hexadecimal content
  </dec_config_identification>

  <reserved_data>
    Hexadecimal content
  </reserved_data>

  <private_data>
    Hexadecimal content
  </private_data>

</metadata_descriptor>
```

D.7.36   metadata_pointer_descriptor

Defined by MPEG in [1].

```
<metadata_pointer_descriptor
```

```
        metadata_application_format="uint16, required"
        metadata_application_format_identifier="uint32, optional"
        metadata_format="uint8, required"
        metadata_format_identifier="uint32, optional"
        metadata_service_id="uint8, required"
        MPEG_carriage_flags="uint2, required"
        program_number="uint16, optional"
        transport_stream_location="uint16, optional"
        transport_stream_id="uint16, optional">

    <metadata_locator>
      Hexadecimal content
    </metadata_locator>

    <private_data>
      Hexadecimal content
    </private_data>

  </metadata_pointer_descriptor>
```

D.7.37   metadata_STD_descriptor

Defined by MPEG in [1].

```
  <metadata_STD_descriptor
      metadata_input_leak_rate="uint22, required"
      metadata_buffer_size="uint22, required"
      metadata_output_leak_rate="uint22, required"/>
```

D.7.38   MPEG2_AAC_audio_descriptor

Defined by MPEG in [1].

```
  <MPEG2_AAC_audio_descriptor
      MPEG2_AAC_profile="uint8, required"
      MPEG2_AAC_channel_configuration="uint8, required"
      MPEG2_AAC_additional_information="uint8, required"/>
```

D.7.39   MPEG2_stereoscopic_video_format_descriptor

Defined by MPEG in [1].

```
  <MPEG2_stereoscopic_video_format_descriptor arrangement_type="uint7, optional"/>
```

D.7.40   MPEG4_audio_descriptor

Defined by MPEG in [1].

```
  <MPEG4_audio_descriptor MPEG4_audio_profile_and_level="uint8, required"/>
```

D.7.41   MPEG4_text_descriptor

Defined by MPEG in [1].

```
  <MPEG4_text_descriptor
      textFormat="uint8, required"
      ThreeGPPBaseFormat="uint8, required"
      profileLevel="uint8, required"
      durationClock="uint24, required"
      sampleDescriptionFlags="uint2, required"
      layer="uint8, required"
      text_track_width="uint16, required"
      text_track_height="uint16, required"
      scene_width="uint16, optional"
      scene_height="uint16, optional"
      horizontal_scene_offset="uint16, optional"
      vertical_scene_offset="uint16, optional">
```

```
    <Compatible_3GPPFormat value="uint8, required"/>

    <Sample_index_and_description
        sample_index="uint8, required"
        textFormat="uint8, required">
      Hexadecimal Content
    </Sample_index_and_description>

</MPEG4_text_descriptor>
```

D.7.42   MPEG4_video_descriptor

Defined by MPEG in [1].

```
<MPEG4_video_descriptor MPEG4_visual_profile_and_level="uint8, required"/>
```

D.7.43   MPEGH_3D_audio_descriptor

Defined by MPEG in [1].

```
<MPEGH_3D_audio_descriptor
    mpegh_3da_profile_level_indication="uint8, required"
    interactivity_enabled="bool, required"
    reference_channel_layout="uint6, required">

  <reserved>
    Hexadecimal content
  </reserved>

</MPEGH_3D_audio_descriptor>
```

D.7.44   MPEGH_3D_audio_multi_stream_descriptor

Defined by MPEG in [1].

```
<MPEGH_3D_audio_multi_stream_descriptor
    this_is_main_stream="bool, required"
    this_stream_id="uint7, required"
    num_auxiliary_streams="uint7, optional">

  <!-- One per group -->
  <mae_group
      mae_group_id="uint7, required"
      is_in_main_stream="bool, required"
      is_in_ts="bool, optional"
      auxiliary_stream_id="uint7, optional"/>

  <CompatibleSetIndication>
    Hexadecimal content
  </CompatibleSetIndication>

  <reserved>
    Hexadecimal content
  </reserved>

</MPEGH_3D_audio_multi_stream_descriptor>
```

D.7.45   MPEGH_3D_audio_scene_descriptor

Defined by MPEG in [1].

```
<MPEGH_3D_audio_scene_descriptor sceneID="uint8, required">

  <!-- up to 127 interactivity groups -->
  <InteractivityGroup
    groupID="uint7, required"
```

```
      allowOnOff="bool, required"
      defaultOnOff="bool, required"
      contentKind="uint4, required"
      contentLanguage="char3, optional">

    <PositionInteractivity
      azimuthOffsetMin="uint7, required"
      azimuthOffsetMax="uint7, required"
      elevationOffsetMin="uint5, required"
      elevationOffsetMax="uint5, required"
      distanceOffsetMin="uint4, required"
      distanceOffsetMax="uint4, required"/>

    <GainInteractivity
      interactivityGainMin="uint6, required"
      interactivityGainMax="uint5, required"/>

  </InteractivityGroup>

  <!-- up to 31 switch groups -->
  <SwitchGroup
    switchGroupID="uint5, required"
    switchGroupAllowOnOff="bool, required"
    switchGroupDefaultOnOff="bool, required"
    switchGroupDefaultGroupID="uint7, required">

    <!-- required -->
    <SwitchGroupMembers>
      7bit Hexadecimal content, 1 to 32 values
    </SwitchGroupMembers>

  </SwitchGroup>

  <!-- up to 31 preset groups -->
  <PresetGroup
    groupPresetID="uint5, required"
    groupPresetKind="uint4, required">

    <!-- 1 to 16 preset conditions -->
    <PresetConditions
      groupPresetGroupID="uint7, required"
      groupPresetDisableGainInteractivity="bool,
          required in groupPresetConditionOnOff=true group"
      groupPresetDisablePositionInteractivity="bool,
          required in groupPresetConditionOnOff=true group"
      groupPresetGain="uint8,
          optional in groupPresetConditionOnOff=true group"
      groupPresetAzOffset="uint8,
          optional in groupPresetConditionOnOff=true group –
          must be specified with groupPresetElOffset and groupPresetDistFactor"
      groupPresetElOffset="uint6,
          optional in groupPresetConditionOnOff=true group –
          must be specified with groupPresetAzOffset and groupPresetDistFactor"
      groupPresetDistFactor="uint4,
          optional in groupPresetConditionOnOff=true group –
          must be specified with groupPresetAzOffset and groupPresetElOffset"/>
  </PresetGroup>

  <reserved>
    Hexadecimal content
  </reserved>

</MPEGH_3D_audio_scene_descriptor>
```

D.7.46 MPEGH_3D_audio_text_label_descriptor

Defined by MPEG in [1].

```xml
<MPEGH_3D_audio_text_label_descriptor
    _3dAudioSceneInfoID="uint8, required"
    numReservedBytes="uint16, optional">

  <DescriptionLanguage descriptionLanguage="char3, required">

    <GroupDescription
        mae_descriptionGroupID="uint7, required"
        groupDescription="string, required"/>

    <SwitchGroupDescription
        mae_descriptionSwitchGroupID="uint5, required"
        switchGroupDescription="string, required"/>

    <GroupPresetDescription
        mae_descriptionGroupPresetID="uint5, required"
        groupPresetDescription="string, required"/>

  </DescriptionLanguage>

</MPEGH_3D_audio_text_label_descriptor>
```

D.7.47 multiplex_buffer_descriptor

Defined by MPEG in [1].

```xml
<multiplex_buffer_descriptor
    MB_buffer_size="uint24, required"
    TB_leak_rate="uint24, required"/>
```

D.7.48 multiplex_buffer_utilization_descriptor

Defined by MPEG in [1]. The two attributes must be present both or absent both.

```xml
<multiplex_buffer_utilization_descriptor
    LTW_offset_lower_bound="uint15, optional"
    LTW_offset_upper_bound="uint15, optional"/>
```

D.7.49 MuxCode_descriptor

Defined by MPEG in [1].

```xml
<MuxCode_descriptor>

  <MuxCodeEntry
      MuxCode="uint4, required"
      version="uint4, required">

    <substructure repetitionCount="uint3, required">
      <slot m4MuxChannel="uint8, required"
            numberOfBytes="uint8, required"/>
    </substructure>

  </MuxCodeEntry>

</MuxCode_descriptor>
```

D.7.50 MVC_extension_descriptor

Defined by MPEG in [1].

```xml
<MVC_extension_descriptor
    average_bitrate="uint16, required"
```

```
        maximum_bitrate="uint16, required"
        view_association_not_present="bool, required"
        base_view_is_left_eyeview="bool, required"
        view_order_index_min="uint10, required"
        view_order_index_max="uint10, required"
        temporal_id_start="uint3, required"
        temporal_id_end="uint3, required"
        no_sei_nal_unit_present="bool, required"
        no_prefix_nal_unit_present="bool, required"/>
```

D.7.51 MVC_operation_point_descriptor

Defined by MPEG in [1].

```
<MVC_operation_point_descriptor
    profile_idc="uint8, required"
    constraint_set0="bool, required"
    constraint_set1="bool, required"
    constraint_set2="bool, required"
    constraint_set3="bool, required"
    constraint_set4="bool, required"
    constraint_set5="bool, required"
    AVC_compatible_flags="uint2, required">

  <!-- One per level -->
  <level level_idc="uint8, required">
    <operation_point
        applicable_temporal_id="uint3, required"
        num_target_output_views="uint8, required">

      <!-- One per ES reference-->
      <ES reference="uint6, required"/>

    </operation_point>
  </level>

</MVC_operation_point_descriptor>
```

D.7.52 NPT_endpoint_descriptor

Defined by MPEG in [2].

```
<NPT_endpoint_descriptor
    start_NPT="uint33, required"
    stop_NPT="uint33, required"/>
```

D.7.53 NPT_reference_descriptor

Defined by MPEG in [2].

```
<NPT_reference_descriptor
    post_discontinuity="bool, default=false"
    content_id="uint7, default=0x7F"
    STC_reference="uint33, required"
    NPT_reference="uint33, required"
    scale_numerator="uint16, required"
    scale_denominator="uint16, required"/>
```

D.7.54 private_data_indicator_descriptor

Defined by MPEG in [1].

```
<private_data_indicator_descriptor private_data_indicator="uint32, required"/>
```

D.7.55   quality_extension_descriptor

Defined by MPEG in [1].

```
<quality_extension_descriptor field_size_bytes="uint8, required">

  <!-- between 1 and 255 metric codes to be provied (although only 7 are defined) -->
  <metric code="uint32, required"/>

</quality_extension_descriptor>
```

D.7.56   registration_descriptor

Defined by MPEG in [1].

```
<registration_descriptor format_identifier="uint32, required">
  <additional_identification_info>
    Hexadecimal content (optional element)
  </additional_identification_info>
</registration_descriptor>
```

D.7.57   SL_descriptor

Defined by MPEG in [1].

```
<SL_descriptor ES_ID="uint16, required"/>
```

D.7.58   smoothing_buffer_descriptor

Defined by MPEG in [1].

```
<smoothing_buffer_descriptor
    sb_leak_rate="uint22, required"
    sb_size="uint22, required"/>
```

D.7.59   STD_descriptor

Defined by MPEG in [1].

```
<STD_descriptor leak_valid="bool, required"/>
```

D.7.60   stereoscopic_program_info_descriptor

Defined by MPEG in [1].

```
<stereoscopic_program_info_descriptor stereoscopic_service_type="uint3, required"/>
```

D.7.61   stereoscopic_video_info_descriptor

Defined by MPEG in [1].

```
<stereoscopic_video_info_descriptor
    base_video="bool, required"
    leftview="bool, optional"
    usable_as_2D="bool, optional"
    horizontal_upsampling_factor="uint4, optional"
    vertical_upsampling_factor="uint4, optional"/>
```

D.7.62   stream_event_descriptor

Defined by MPEG in [2]. Note: **<private_data>** and **<private_text>** are mutually exclusive. They both define the same private data part, the former using hexadecimal format and the latter ASCII text.

```
<stream_event_descriptor
    event_id="uint16, required"
    event_NPT="uint33, required">
  <private_data>
```

```
      Hexadecimal content
    </private_data>
    <private_text>
      ASCII string to be used instead of private_data
    </private_text>
  </stream_event_descriptor>
```

D.7.63   stream_mode_descriptor

Defined by MPEG in [2].

```
  <stream_mode_descriptor stream_mode="uint8, required"/>
```

D.7.64   SVC_extension_descriptor

Defined by MPEG in [1].

```
  <SVC_extension_descriptor
      width="uint16, required"
      height="uint16, required"
      frame_rate="uint16, required"
      average_bitrate="uint16, required"
      maximum_bitrate="uint16, required"
      dependency_id="uint3, required"
      quality_id_start="uint4, required"
      quality_id_end="uint4, required"
      temporal_id_start="uint3, required"
      temporal_id_end="uint3, required"
      no_sei_nal_unit_present="bool, required"/>
```

D.7.65   system_clock_descriptor

Defined by MPEG in [1].

```
  <system_clock_descriptor
      external_clock_reference="bool required"
      clock_accuracy_integer="uint6, required"
      clock_accuracy_exponent="uint3, required"/>
```

D.7.66   target_background_grid_descriptor

Defined by MPEG in [1].

```
  <target_background_grid_descriptor
      horizontal_size="uint14, required"
      vertical_size="uint14, required"
      aspect_ratio_information="uint4, required"/>
```

D.7.67   transport_profile_descriptor

Defined by MPEG in [1].

```
  <transport_profile_descriptor transport_profile="uint8, required">
    <private_data>
      Hexadecimal content
    </private_data>
  </transport_profile_descriptor>
```

D.7.68   video_stream_descriptor

Defined by MPEG in [1].

```
  <video_stream_descriptor
      multiple_frame_rate="bool, required"
      frame_rate_code="uint4, required"
      MPEG_1_only="bool, required"
      constrained_parameter="bool, required"
```

```
        still_picture="bool, required"
        profile_and_level_indication="uint8, required when MPEG_1_only='false'"
        chroma_format="uint2, required when MPEG_1_only='false'"
        frame_rate_extension="bool, required when MPEG_1_only='false'"/>
```

D.7.69   video_window_descriptor

Defined by MPEG in [1].

```
    <video_window_descriptor
        horizontal_offset="uint14, required"
        vertical_offset="uint14, required"
        window_priority="uint4, required"/>
```

D.7.70   virtual_segmentation_descriptor

Defined by MPEG in [1].

```
    <virtual_segmentation_descriptor ticks_per_second="uint21, optional">

    <!-- One per partition -->
    <partition
        partition_id="uint3, required"
        SAP_type_max="uint3, required"
        boundary_PID="uint13, optional"
        maximum_duration="uint29, optional"/>

    </virtual_segmentation_descriptor>
```

D.7.71   VVC_timing_and_HRD_descriptor

Defined by MPEG in [1].

```
    <VVC_timing_and_HRD_descriptor
        hrd_management_valid="bool, required"
        N_90khz="uint32, optional"
        K_90khz="uint32, optional"
        num_units_in_tick="uint32, optional"/>
```

D.7.72   VVC_video_descriptor

Defined by MPEG in [1].

```
    <VVC_video_descriptor
        profile_idc="uint7, required"
        tier_flag="bool, required"
        progressive_source_flag="bool, required"
        interlaced_source_flag="bool, required"
        non_packed_constraint_flag="bool, required"
        frame_only_constraint_flag="bool, required"
        level_idc="uint8, required"
        VVC_still_present_flag="bool, required"
        VVC_24hr_picture_present_flag="bool, required"
        HDR_WCG_idc="uint2, required"
        video_properties_tag="uint4, required"
        temporal_id_min="uint3, optional, specify both min and max or none"
        temporal_id_max="uint3, optional, specify both min and max or none">

    <sub_profile_idc value="uint32, required"/>

    </VVC_video_descriptor>
```

D.8   DVB-defined descriptors

Note that a few descriptors are allowed in specific tables only since they reuse tag values which are otherwise MPEG-reserved [1]. They cannot be used elsewhere. These restrictions, when applicable, are

documented in XML comments for the table-specific descriptor. Such descriptors exist for the AIT [12], the UNT [13] and the INT [14].

D.8.1   AAC_descriptor

Defined by DVB in [5].

```
<AAC_descriptor
    profile_and_level="uint8, required"
    SAOC_DE="bool, default=false"
    AAC_type="uint8, optional">
  <additional_info>
    Hexadecimal content, optional
  </additional_info>
</AAC_descriptor>
```

D.8.2   AC3_descriptor

Defined by DVB in [5].

Because of the presence of an ATSC version of the **AC3_descriptor**, the XML name for the DVB version is <DVB_AC3_descriptor>. For compatibility, <AC3_descriptor> is still accepted.

```
<DVB_AC3_descriptor
    component_type="uint8, optional"
    bsid="uint8, optional"
    mainid="uint8, optional"
    asvc="uint8, optional">
  <additional_info>
    Hexadecimal content, optional
  </additional_info>
</DVB_AC3_descriptor>
```

D.8.3   AC4_descriptor

Defined by DVB in [5].

Because of the possible introduction of an ATSC version of the **AC4_descriptor**, the XML name for the DVB version is <DVB_AC4_descriptor>. For compatibility, <AC4_descriptor> is still accepted.

```
<DVB_AC4_descriptor
    ac4_dialog_enhancement_enabled="bool, optional"
    ac4_channel_mode="uint2, optional">
  <ac4_dsi_toc>
    Hexadecimal content, optional
  </ac4_dsi_toc>
  <additional_info>
    Hexadecimal content, optional
  </additional_info>
</DVB_AC4_descriptor>
```

D.8.4   adaptation_field_data_descriptor

Defined by DVB in [5].

```
<adaptation_field_data_descriptor adaptation_field_data_identifier="uint8, required"/>
```

D.8.5   ancillary_data_descriptor

Defined by DVB in [5].

```
<ancillary_data_descriptor ancillary_data_identifier="uint8, required"/>
```

D.8.6   announcement_support_descriptor

Defined by DVB in [5].

Note that the 16-bit field named **announcement_support_indicator** is automatically built as a bit-mask from all **announcement_type** values.

```
<announcement_support_descriptor>
  <!-- One per announcement type -->
  <announcement
      announcement_type="uint4, required"
      reference_type="uint3, required"
      original_network_id="uint16, optional"
      transport_stream_id="uint16, optional"
      service_id="uint16, optional"
      component_tag="uint8, optional"/>
</announcement_support_descriptor>
```

D.8.7   application_descriptor

Defined by DVB in [12]. Must be in an AIT (table id **0x74**).

```
<application_descriptor
    service_bound="bool, required"
    visibility="uint2, required"
    application_priority="uint8, required">
  <!-- One per profile -->
  <profile
      application_profile="uint16, required"
      version="string 'major.minor.micro', required"/>
  <!-- One per transport_protocol_label -->
  <transport_protocol label="uint8, required"/>
</application_descriptor>
```

D.8.8   application_icons_descriptor

Defined by DVB in [12]. Must be in an AIT (table id **0x74**).

```
<application_icons_descriptor
    icon_locator="string, required"
    icon_flags="uint16, required">
  <reserved_future_use>
    Hexadecimal content
  </reserved_future_use>
</application_icons_descriptor>
```

D.8.9   application_name_descriptor

Defined by DVB in [12] and [15]. Must be in an AIT (table id **0x74**).

```
<application_name_descriptor>
  <!-- One per language -->
  <language code="char3, required" application_name="string, required"/>
</application_name_descriptor>
```

D.8.10   application_recording_descriptor

Defined by DVB in [12]. Must be in an AIT (table id **0x74**).

```
<application_recording_descriptor
    scheduled_recording="bool, required"
    trick_mode_aware="bool, required"
    time_shift="bool, required"
    dynamic="bool, required"
    av_synced="bool, required"
    initiating_replay="bool, required">
  <!-- One per label -->
  <label label="string, required" storage_properties="uint2, required"/>
  <!-- One per component tag -->
  <component tag="uint8, required"/>
```

```
    <private>
      Hexadecimal content
    </private>
    <reserved_future_use>
      Hexadecimal content
    </reserved_future_use>
  </application_recording_descriptor>
```

D.8.11   application_signalling_descriptor

Defined by DVB in [12].

```
<application_signalling_descriptor>
  <!-- One per application -->
  <application application_type="uint15, required"
               AIT_version_number="uint5, required"/>
</application_signalling_descriptor>
```

D.8.12   application_storage_descriptor

Defined by DVB in [12]. Must be in an AIT (table id **0x74**).

```
<application_storage_descriptor
    storage_property="uint8, required"
    not_launchable_from_broadcast="bool, required"
    launchable_completely_from_cache="bool, required"
    is_launchable_with_older_version="bool, required"
    version="uint31, required"
    priority="uint8, required"/>
```

D.8.13   application_usage_descriptor

Defined by DVB in [12]. Must be in an AIT (table id **0x74**).

```
<application_usage_descriptor usage_type="uint8, required"/>
```

D.8.14   audio_preselection_descriptor

Defined by DVB in [5].

```
<audio_preselection_descriptor>
  <!-- One entry per preselection, up to 31 preselections -->
  <preselection
      preselection_id="uint5, required"
      audio_rendering_indication="uint3, required"
      audio_description="bool, default=false"
      spoken_subtitles="bool, default=false"
      dialogue_enhancement="bool, default=false"
      interactivity_enabled="bool, default=false"
      ISO_639_language_code="char3, optional"
      message_id="uint8, optional">
    <multi_stream_info>
      <!-- One per auxiliary component, up to 7 components -->
      <component tag="uint8, required"/>
    </multi_stream_info>
    <future_extension>
      Hexadecimal content
    </future_extension>
  </preselection>
</audio_preselection_descriptor>
```

D.8.15   bouquet_name_descriptor

Defined by DVB in [5].

```
<bouquet_name_descriptor bouquet_name="string, required"/>
```

D.8.16   C2_bundle_delivery_system_descriptor

Defined by DVB in [5].

```
<C2_bundle_delivery_system_descriptor>
  <!-- One per PLP -->
  <plp plp_id="uint8, required"
       data_slice_id="uint8, required"
       C2_system_tuning_frequency="FrequencyHz, required"
       C2_system_tuning_frequency_type="uint2, required"
       active_OFDM_symbol_duration="uint3, required"
       guard_interval="1/128|1/64|uint3, required"
       master_channel="bool, required"/>
</C2_bundle_delivery_system_descriptor>
```

D.8.17   C2_delivery_system_descriptor

Defined by DVB in [5].

```
<C2_delivery_system_descriptor
    plp_id="uint8, required"
    data_slice_id="uint8, required"
    C2_system_tuning_frequency="FrequencyHz, required"
    C2_system_tuning_frequency_type="uint2, required"
    active_OFDM_symbol_duration="uint3, required"
    guard_interval="1/128|1/64|uint3, required"/>
```

D.8.18   CA_identifier_descriptor

Defined by DVB in [5].

```
<CA_identifier_descriptor>
  <!-- One per CAS -->
  <CA_system_id value="uint16, required"/>
</CA_identifier_descriptor>
```

D.8.19   cable_delivery_system_descriptor

Defined by DVB in [5].

```
<cable_delivery_system_descriptor
    frequency="FrequencyHz, required"
    FEC_outer="undefined|none|RS, default=RS"
    modulation="auto|16-QAM|32-QAM|64-QAM|128-QAM|256-QAM, default=16-QAM"
    symbol_rate="SymbolsPerSecond, required"
    FEC_inner="undefined|1/2|2/3|3/4|5/6|7/8|8/9|3/5|4/5|9/10|none, required"/>
```

D.8.20   cell_frequency_link_descriptor

Defined by DVB in [5].

```
<cell_frequency_link_descriptor>

  <!-- One per cell -->
  <cell cell_id="uint16, required" frequency="FrequencyHz, required">
    <!-- One per subcell -->
    <subcell cell_id_extension="uint8, required"
             transposer_frequency="FrequencyHz, required"/>
  </cell>

</cell_frequency_link_descriptor>
```

D.8.21   cell_list_descriptor

Defined by DVB in [5].

```
<cell_list_descriptor>
```

```
        <!-- One per cell -->
        <cell cell_id="uint16, required"
              cell_latitude="int16, required"
              cell_longitude="int16, required"
              cell_extent_of_latitude="uint12, required"
              cell_extent_of_longitude="uint12, required">

          <!-- One per subcell -->
          <subcell cell_id_extension="uint8, required"
                   subcell_latitude="int16, required"
                   subcell_longitude="int16, required"
                   subcell_extent_of_latitude="uint12, required"
                   subcell_extent_of_longitude="uint12, required"/>
        </cell>

    </cell_list_descriptor>
```

D.8.22   CI_ancillary_data_descriptor

Defined by DVB in [5].

```
    <CI_ancillary_data_descriptor>
      <ancillary_data>
        Hexadecimal content
      </ancillary_data>
    </CI_ancillary_data_descriptor>
```

D.8.23   component_descriptor

Defined by DVB in [5].

```
    <component_descriptor
        stream_content="uint4, required"
        stream_content_ext="uint4, default=0xF"
        component_type="uint8, required"
        component_tag="uint8, default=0"
        language_code="char3, required"
        text="string, optional"/>
```

D.8.24   content_descriptor

Defined by DVB in [5].

```
    <content_descriptor>

      <!-- One per classification -->
      <content content_nibble_level_1="uint4, required"
               content_nibble_level_2="uint4, required"
               user_byte="uint8, required"/>

    </content_descriptor>
```

D.8.25   content_identifier_descriptor

Defined by DVB in [9].

```
    <content_identifier_descriptor>

      <!-- One per CRID -->
      <crid crid_type="uint6, required"
            crid_location="uint2, required"
            crid_ref="uint16, optional"
            crid="string, optional"/>

    </content_identifier_descriptor>
```

D.8.26 country_availability_descriptor

Defined by DVB in [5].

```
<country_availability_descriptor country_availability="bool, required">

  <!-- One per country -->
  <country country_code="char3, required"/>

</country_availability_descriptor>
```

D.8.27 CP_descriptor

Defined by DVB in [5].

```
<CP_descriptor CP_system_id="uint16, required" CP_PID="uint13, required">
  <private_data>
    Hexadecimal content
  </private_data>
</CP_descriptor>
```

D.8.28 CP_identifier_descriptor

Defined by DVB in [5].

```
<CP_identifier_descriptor>
  <!-- One per CP system -->
  <CP_system_id value="uint16, required"/>
</CP_identifier_descriptor>
```

D.8.29 cpcm_delivery_signalling_descriptor

Defined by DVB in [19] and [20].

```
<cpcm_delivery_signalling_descriptor cpcm_version="uint8, required">

  <cpcm_v1_delivery_signalling
      copy_control="uint3, required"
      do_not_cpcm_scramble="bool, required"
      viewable="bool, required"
      move_local="bool, required"
      move_and_copy_propagation_information="uint2, required"
      view_propagation_information="uint2, required"
      remote_access_record_flag="bool, required"
      export_beyond_trust="bool, required"
      disable_analogue_sd_export="bool, required"
      disable_analogue_sd_consumption="bool, required"
      disable_analogue_hd_export="bool, required"
      disable_analogue_hd_consumption="bool, required"
      image_constraint="bool, required"
      view_window_start="YYYY-MM-DD hh:mm:ss, optional"
      view_window_end="YYYY-MM-DD hh:mm:ss, optional"
      view_period_from_first_playback="uint16, optional"
      simultaneous_view_count="uint8, optional"
      remote_access_delay="uint16, optional"
      remote_access_date="YYYY-MM-DD hh:mm:ss, optional">

    <cps C_and_R_regime_mask="uint8, required">
      Hexadecimal Content
    </cps>

  </cpcm_v1_delivery_signalling>

</cpcm_delivery_signalling_descriptor>
```

D.8.30   data_broadcast_descriptor

Defined by DVB in [5].

```
<data_broadcast_descriptor
    data_broadcast_id="uint16, required"
    component_tag="uint8, required"
    language_code="char3, required">
  <selector_bytes>Hexadecimal content</selector_bytes>
  <text>String</text>
</data_broadcast_descriptor>
```

D.8.31   data_broadcast_id_descriptor

Defined by DVB in [5].

```
<data_broadcast_id_descriptor data_broadcast_id="uint16, required">
  <selector_bytes>Hexadecimal content</selector_bytes>
</data_broadcast_id_descriptor>
```

D.8.32   default_authority_descriptor

Defined by DVB in [9].

```
<default_authority_descriptor fqdn="string, required"/>
```

D.8.33   DII_location_descriptor

Defined by DVB in [15]. Must be in an AIT (table id **0x74**).

```
<DII_location_descriptor transport_protocol_label="uint8, required">
  <!-- One per module -->
  <module DII_identification="uint15, required" association_tag="uint16, required"/>
</DII_location_descriptor>
```

D.8.34   DSNG_descriptor

Defined by DVB in [5] and [17].

```
<DSNG_descriptor station_identification="string, required"/>
```

D.8.35   DTS_descriptor

Defined by DVB in [5].

```
<DTS_descriptor
    sample_rate_code="uint4, required"
    bit_rate_code="uint6, required"
    nblks="uint7, 0x05 to 0x1F, required"
    fsize="uint14, 0x005F to 0x2000, required"
    surround_mode="uint6, required"
    lfe="bool, default=false"
    extended_surround="uint2, default=0">
  <additional_info>
    Hexadecimal content
  </additional_info>
</DTS_descriptor>
```

D.8.36   DTS_HD_descriptor

Defined by DVB in [5].

```
<DTS_HD_descriptor>

  <!-- Each substructure is optional and may appear at most once -->

  <substream_core
```

```
            channel_count="uint5, required"
            LFE="bool, required"
            sampling_frequency="uint4, required"
            sample_resolution="bool, required">
        <!-- From 1 to 8 asset_info -->
        <asset_info
            asset_construction="uint5, required"
            vbr="bool, required"
            post_encode_br_scaling="bool, required"
            bit_rate="uint13, required"
            component_type="uint8, optional"
            ISO_639_language_code="char3, optional"/>
    </substream_core>

    <substream_0
            channel_count="uint5, required"
            LFE="bool, required"
            sampling_frequency="uint4, required"
            sample_resolution="bool, required">
        <!-- From 1 to 8 asset_info -->
        <asset_info
            asset_construction="uint5, required"
            vbr="bool, required"
            post_encode_br_scaling="bool, required"
            bit_rate="uint13, required"
            component_type="uint8, optional"
            ISO_639_language_code="char3, optional"/>
    </substream_0>

    <substream_1
            channel_count="uint5, required"
            LFE="bool, required"
            sampling_frequency="uint4, required"
            sample_resolution="bool, required">
        <!-- From 1 to 8 asset_info -->
        <asset_info
            asset_construction="uint5, required"
            vbr="bool, required"
            post_encode_br_scaling="bool, required"
            bit_rate="uint13, required"
            component_type="uint8, optional"
            ISO_639_language_code="char3, optional"/>
    </substream_1>

    <substream_2
            channel_count="uint5, required"
            LFE="bool, required"
            sampling_frequency="uint4, required"
            sample_resolution="bool, required">
        <!-- From 1 to 8 asset_info -->
        <asset_info
            asset_construction="uint5, required"
            vbr="bool, required"
            post_encode_br_scaling="bool, required"
            bit_rate="uint13, required"
            component_type="uint8, optional"
            ISO_639_language_code="char3, optional"/>
    </substream_2>

    <substream_3
            channel_count="uint5, required"
            LFE="bool, required"
            sampling_frequency="uint4, required"
            sample_resolution="bool, required">
        <!-- From 1 to 8 asset_info -->
        <asset_info
```

```
            asset_construction="uint5, required"
            vbr="bool, required"
            post_encode_br_scaling="bool, required"
            bit_rate="uint13, required"
            component_type="uint8, optional"
            ISO_639_language_code="char3, optional"/>
    </substream_3>

    <additional_info>
      Hexadecimal content
    </additional_info>

  </DTS_HD_descriptor>
```

D.8.37   DTS_neural_descriptor

Defined by DVB in [5].

```
  <DTS_neural_descriptor config_id="uint8, required">
    <additional_info>
      Hexadecimal content
    </additional_info>
  </DTS_neural_descriptor>
```

D.8.38   DTS_UHD_descriptor

Defined by DVB in [5].

```
  <DTS_UHD_descriptor
      DecoderProfileCode="uint6, required"
      FrameDurationCode="uint2, required"
      MaxPayloadCode="uint2, required"
      StreamIndex="uint3, required">

    <codec_selector>
      Hexadecimal Content
    </codec_selector>

  </DTS_UHD_descriptor>
```

D.8.39   dvb_html_application_boundary_descriptor

Defined by DVB in [15]. Must be in an AIT (table id **0x74**).

```
  <dvb_html_application_boundary_descriptor
      label="string, required"
      regular_expression="string, required"/>
```

D.8.40   dvb_html_application_descriptor

Defined by DVB in [15]. Must be in an AIT (table id **0x74**).

```
  <dvb_html_application_descriptor parameter="string, optional">
    <!-- One per application id: -->
    <application id="uint16, required"/>
  </dvb_html_application_descriptor>
```

D.8.41   dvb_html_application_location_descriptor

Defined by DVB in [15]. Must be in an AIT (table id **0x74**).

```
  <dvb_html_application_location_descriptor
      physical_root="string, required"
      initial_path="string, required"/>
```

D.8.42   dvb_j_application_descriptor

Defined by DVB in [15]. Must be in an AIT (table id **0x74**).

```
<dvb_j_application_descriptor>
  <!-- One per parameter: -->
  <parameter value="string, required"/>
</dvb_j_application_descriptor>
```

D.8.43   dvb_j_application_location_descriptor

Defined by DVB in [15]. Must be in an AIT (table id **0x74**).

```
<dvb_j_application_location_descriptor
    base_directory="string, required"
    classpath_extension="string, required"
    initial_class="string, required"/>
```

D.8.44   ECM_repetition_rate_descriptor

Defined by DVB in [14].

```
<ECM_repetition_rate_descriptor
    CA_system_id="uint16, required"
    ECM_repetition_rate="uint16, required">
  <private_data>
    Hexadecimal content
  </private_data>
</ECM_repetition_rate_descriptor>
```

D.8.45   enhanced_AC3_descriptor

Defined by DVB in [5].

Because of the presence of an ATSC version of the **enhanced_AC3_descriptor**, the XML name for the DVB version is <DVB_enhanced_AC3_descriptor>. For compatibility, the previous <enhanced_AC3_descriptor> is still accepted.

```
<DVB_enhanced_AC3_descriptor
    mixinfoexists="bool, required"
    component_type="uint8, optional"
    bsid="uint8, optional"
    mainid="uint8, optional"
    asvc="uint8, optional"
    substream1="uint8, optional"
    substream2="uint8, optional"
    substream3="uint8, optional">
  <additional_info>
    Hexadecimal content
  </additional_info>
</DVB_enhanced_AC3_descriptor>
```

D.8.46   extended_event_descriptor

Defined by DVB in [5].

```
<extended_event_descriptor
    descriptor_number="uint8, required"
    last_descriptor_number="uint8, required"
    language_code="char3, required">
  <text>String</text>
  <!-- One per item -->
  <item>
    <description>String</description>
    <name>String</name>
  </item>
</extended_event_descriptor>
```

D.8.47 external_application_authorization_descriptor

Defined by DVB in [12]. Must be in an AIT (table id **0x74**).

```
<external_application_authorization_descriptor>
  <!-- One per application -->
  <application
      organization_id="uint32, required"
      application_id="uint16, required"
      application_priority="uint8, required"/>
</external_application_authorization_descriptor>
```

D.8.48 frequency_list_descriptor

Defined by DVB in [5].

```
<frequency_list_descriptor
    coding_type="undefined|satellite|cable|terrestrial|uint2, required">

  <!-- List of frequencies, one element per frequency -->
  <centre_frequency value="FrequencyHz, required"/>

</frequency_list_descriptor>
```

D.8.49 FTA_content_management_descriptor

Defined by DVB in [5].

```
<FTA_content_management_descriptor
    user_defined="bool, required"
    do_not_scramble="bool, required"
    control_remote_access_over_internet="uint2, required"
    do_not_apply_revocation="bool, required"/>
```

D.8.50 graphics_constraints_descriptor

Defined by DVB in [12]. Must be in an AIT (table id **0x74**).

```
<graphics_constraints_descriptor
    can_run_without_visible_ui="bool, required"
    handles_configuration_changed="bool, required"
    handles_externally_controlled_video="bool, required">

  <graphics_configuration>
    Hexadecimal content
  </graphics_configuration>

</graphics_constraints_descriptor>
```

D.8.51 image_icon_descriptor

Defined by DVB in [5].

```
<image_icon_descriptor
    descriptor_number="uint4, required"
    last_descriptor_number="uint4, required"
    icon_id="uint3, required"
    icon_transport_mode="uint2, optional"
    coordinate_system="uint3, optional"
    icon_horizontal_origin="uint12, optional"
    icon_vertical_origin="uint12, optional"
    icon_type="string, optional"
    url="string, optional">

  <icon_data>
    Hexadecimal content
  </icon_data>
```

```
        </image_icon_descriptor>
```

D.8.52   IPMAC_generic_stream_location_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<IPMAC_generic_stream_location_descriptor
    interactive_network_id="uint16, required"
    modulation_system_type="DVB-S2|DVB-T2|DVB-C2|DVB-NGH|uint8, required"
    modulation_system_id="uint16, default=0"
    PHY_stream_id="uint16, default=0">
  <selector_bytes>Hexadecimal content</selector_bytes>
</IPMAC_generic_stream_location_descriptor>
```

D.8.53   IPMAC_platform_name_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<IPMAC_platform_name_descriptor
    language_code="char3, required"
    text="string, required"/>
```

D.8.54   IPMAC_platform_provider_name_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<IPMAC_platform_provider_name_descriptor
    language_code="char3, required"
    text="string, required"/>
```

D.8.55   IPMAC_stream_location_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<IPMAC_stream_location_descriptor
    network_id="uint16, required"
    original_network_id="uint16, required"
    transport_stream_id="uint16, required"
    service_id="uint16, required"
    component_tag="uint8, required"/>
```

D.8.56   ip_signalling_descriptor

Defined by DVB in [15]. Must be in an INT (table id **0x4C**).

```
<ip_signalling_descriptor platform_id="uint24, required"/>
```

D.8.57   ISP_access_mode_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<ISP_access_mode_descriptor access_mode="unused|dialup|uint8, required"/>
```

D.8.58   linkage_descriptor

Defined by DVB in [5].

```
<linkage_descriptor
    transport_stream_id="uint16, required"
    original_network_id="uint16, required"
    service_id="uint16, required"
    linkage_type="uint8, required">
  <!-- if linkage_type == 0x08 -->
  <mobile_handover_info
      handover_type="uint4, required"
      origin_type="NIT|SDT, required"
```

```
        network_id="uint16, required if hand-over_type is 0x01, 0x02, 0x03"
        initial_service_id="uint16, required if origin_type is NIT"/>
  <!-- else if linkage_type == 0x0D -->
  <event_linkage_info
      target_event_id="uint16, required"
      target_listed="bool, required"
      event_simulcast="bool, required"/>
  <!-- else if linkage_type >= 0x0E && linkage_type <= 0x1F -->
  <extended_event_linkage_info>
    <!-- For each event -->
    <event
        target_event_id="uint16, required"
        target_listed="bool, required"
        event_simulcast="bool, required"
        link_type="uint2, required"
        target_id_type="uint2, required"
        user_defined_id="uint16, required if target_id_type == 3"
        target_transport_stream_id="uint16, required if target_id_type == 1"
        target_original_network_id="uint16, optional"
        target_service_id="uint16, optional"/>
  </extended_event_linkage_info>
  <private_data>
    Hexadecimal content
  </private_data>
</linkage_descriptor>
```

D.8.59 local_time_offset_descriptor

Defined by DVB in [5].

```
<local_time_offset_descriptor>
  <!-- One per region -->
  <region country_code="char3, required"
          country_region_id="uint6, required"
          local_time_offset="int, required"
          time_of_change="YYYY-MM-DD hh:mm:ss, required"
          next_time_offset="int, required"/>
  <!-- local_time_offset and next_time_offset: -->
  <!-- -780 to +780 minutes (-13 to +13 hours) -->
</local_time_offset_descriptor>
```

D.8.60 message_descriptor

Defined by DVB in [5].

```
<message_descriptor message_id="uint8, required" language_code="char3, required">
  <text>String</text>
</message_descriptor>
```

D.8.61 mosaic_descriptor

Defined by DVB in [5].

```
<mosaic_descriptor
    mosaic_entry_point="bool, required"
    number_of_horizontal_elementary_cells="uint3, required"
    number_of_vertical_elementary_cells="uint3, required">

  <!-- One per cell in the mosaic -->
  <cell logical_cell_id="uint6, required"
        logical_cell_presentation_info="uint3, required"
        cell_linkage_info="uint8, required"
        bouquet_id="uint16, optional"
        original_network_id="uint16, optional"
        transport_stream_id="uint16, optional"
        service_id="uint16, optional"
```

```
        event_id="uint16, optional">

    <!-- One per elementary cell -->
    <elementary_cell id="uint6, required"/>

  </cell>

</mosaic_descriptor>
```

D.8.62 multilingual_bouquet_name_descriptor

Defined by DVB in [5].

```
<multilingual_bouquet_name_descriptor>
  <!-- One per language -->
  <language code="char3, required" bouquet_name="string, required"/>
</multilingual_bouquet_name_descriptor>
```

D.8.63 multilingual_component_descriptor

Defined by DVB in [5].

```
<multilingual_component_descriptor component_tag="uint8, required">
  <!-- One per language -->
  <language code="char3, required" description="string, required"/>
</multilingual_component_descriptor>
```

D.8.64 multilingual_network_name_descriptor

Defined by DVB in [5].

```
<multilingual_network_name_descriptor>
  <!-- One per language -->
  <language code="char3, required" network_name="string, required"/>
</multilingual_network_name_descriptor>
```

D.8.65 multilingual_service_name_descriptor

Defined by DVB in [5].

```
<multilingual_service_name_descriptor>
  <!-- One per language -->
  <language code="char3, required"
           service_provider_name="string, required"
           service_name="string, required"/>
</multilingual_service_name_descriptor>
```

D.8.66 network_change_notify_descriptor

Defined by DVB in [5].

```
<network_change_notify_descriptor>
  <!-- One per cell -->
  <cell cell_id="uint16, required">
    <!-- One per network change -->
    <change network_change_id="uint8, required"
           network_change_version="uint8, required"
           start_time_of_change="YYYY-MM-DD hh:mm:ss, required"
           change_duration="hh:mm:ss, required"
           receiver_category="uint3, required"
           change_type="uint4, required"
           message_id="uint8, required"
           invariant_ts_tsid="uint16, optional"
           invariant_ts_onid="uint16, optional"/>
  </cell>
</network_change_notify_descriptor>
```

D.8.67 network_name_descriptor

Defined by DVB in [5].

```
<network_name_descriptor network_name="string, required"/>
```

D.8.68 NVOD_reference_descriptor

Defined by DVB in [5].

```
<NVOD_reference_descriptor>
  <!-- One per service -->
  <service transport_stream_id="uint16, required"
           original_network_id="uint16, required"
           service_id="uint16, required"/>
</NVOD_reference_descriptor>
```

D.8.69 parental_rating_descriptor

Defined by DVB in [5].

```
<parental_rating_descriptor>
  <!-- One per country -->
  <country country_code="char3, required" rating="uint8, required"/>
</parental_rating_descriptor>
```

D.8.70 partial_transport_stream_descriptor

Defined by DVB in [5].

```
<partial_transport_stream_descriptor
    peak_rate="uint22, required"
    minimum_overall_smoothing_rate="uint22, default=0x3FFFFF"
    maximum_overall_smoothing_buffer="uint14, default=0x3FFF"/>
```

D.8.71 PDC_descriptor

Defined by DVB in [5].

```
<PDC_descriptor programme_identification_label="MM-DD hh:mm, required"/>
```

D.8.72 prefetch_descriptor

Defined by DVB in [15]. Must be in an AIT (table id **0x74**).

```
<prefetch_descriptor transport_protocol_label="uint8, required">
  <!-- One per module -->
  <module label="string, required" prefetch_priority="int, 1 to 100, required"/>
</prefetch_descriptor>
```

D.8.73 private_data_specifier_descriptor

Defined by DVB in [5].

```
<private_data_specifier_descriptor private_data_specifier="uint32|name, required"/>
```

The value of the attribute is either a 32-bit private data specifier value or a predefined name as used in option **--default-pds**. See section 2.4.2 for more details.

D.8.74 protection_message_descriptor

Defined by DVB in [12].

```
<protection_message_descriptor>
  <!-- One per component, up to 15 components -->
  <component tag="uint8, required"/>
</protection_message_descriptor>
```

D.8.75   RAR_over_DVB_stream_descriptor

Defined by DVB in [9]. Must be in a RNT (table id **0x79**).

```
<RAR_over_DVB_stream_descriptor
  first_valid_date="YYYY-MM-DD hh:mm:ss, required"
  last_valid_date="YYYY-MM-DD hh:mm:ss, required"
  weighting="uint6, required"
  complete_flag="bool, required"
  transport_stream_id="uint16, required"
  original_network_id="uint16, required"
  service_id="uint16, required"
  component_tag="uint8, required"
  download_start_time="YYYY-MM-DD hh:mm:ss,
      optional group with download_period_duration and download_cycle_time"
  download_period_duration="uint8,
      optional group with download_start_time and download_cycle_time"
  download_cycle_time="uint8,
      optional group with download_start_time and download_period_duration"/>
```

D.8.76   RAR_over_IP_descriptor

Defined by DVB in [9]. Must be in a RNT (table id **0x79**).

```
<RAR_over_IP_descriptor
  first_valid_date="YYYY-MM-DD hh:mm:ss, required"
  last_valid_date="YYYY-MM-DD hh:mm:ss, required"
  weighting="uint6, required"
  complete_flag="bool, required"
  url="string, required"/>
```

D.8.77   related_content_descriptor

Defined by DVB in [9].

```
<related_content_descriptor/>
```

D.8.78   RNT_scan_descriptor

Defined by DVB in [9]. Must be in a RNT (table id **0x79**).

```
<RNT_scan_descriptor>

  <RNT_reference
    transport_stream_id="uint16, required"
    original_network_id="uint16, required"
    scan_weighting="uint8, required"/>

</RNT_scan_descriptor>
```

D.8.79   S2_satellite_delivery_system_descriptor

Defined by DVB in [5].

```
<S2_satellite_delivery_system_descriptor
    backwards_compatibility="bool, default=false"
    TS_GS_mode="uint2, default=3"
    scrambling_sequence_index="uint18, optional"
    input_stream_identifier="uint8, optional"
    timeslice_number="uint8, optional"/>
```

D.8.80   S2X_satellite_delivery_system_descriptor

Defined by DVB in [5].

```
<S2X_satellite_delivery_system_descriptor
    receiver_profiles="uint5, required"
```

```
       S2X_mode="uint2, required"
       TS_GS_S2X_mode="uint2, required"
       scrambling_sequence_index="uint18, optional"
       timeslice_number="uint8, required for S2X_mode==2">

   <!-- Master channel is required -->
   <master_channel
       frequency="SatelliteFrequencyHz, required"
       orbital_position="SatelliteOrbitalPosition, eg. 19.2, required"
       west_east_flag="east|west, required"
       polarization="horizontal|vertical|left|right, required"
       roll_off="0.35|0.25|0.20|0.15|0.10|0.05|uint3, required"
       symbol_rate="SatelliteSymbolRate, required"
       input_stream_identifier="uint8, optional"/>

   <!-- When S2X_mode==3, there must be exactly 1 or 2 channel_bond -->
   <channel_bond
       frequency="SatelliteFrequencyHz, required"
       orbital_position="SatelliteOrbitalPosition, eg. 19.2, required"
       west_east_flag="east|west, required"
       polarization="horizontal|vertical|left|right, required"
       roll_off="0.35|0.25|0.20|0.15|0.10|0.05|uint3, required"
       symbol_rate="SatelliteSymbolRate, required"
       input_stream_identifier="uint8, optional"/>

   <reserved_future_use>
     Hexadecimal content
   </reserved_future_use>

 </S2X_satellite_delivery_system_descriptor>
```

D.8.81   S2Xv2_satellite_delivery_system_descriptor

Defined by DVB in [5].

```
 <S2Xv2_satellite_delivery_system_descriptor
     delivery_system_id="uint32, required"
     S2Xv2_mode="1|2|4|5|uint4, required"
     roll_off="0.35|0.25|0.20|0.15|0.10|0.05|uint3, required"
     NCR_version="uint1, required"
     channel_bond="uint2, required"
     polarization="horizontal|vertical|left|right, required"
     TS_GS_S2X_mode="uint2, required"
     receiver_profiles="uint5, required"
     satellite_id="uint24, required"
     frequency="SatelliteFrequencyHz, required"
     symbol_rate="SatelliteSymbolRate, required"
     input_stream_identifier="uint8, optional"
     scrambling_sequence_index="uint18, required for S2Xv2_mode==2 or S2Xv2_mode==5"
     timeslice_number="uint8, required for S2Xv2_mode==2 or S2Xv2_mode==5">

   <!-- one or two secondary delivery systems to be included if channel_bond==1 -->
   <secondary_delivery_system
       id="uint32, required"/>

   <!-- required if S2Xv2_mode==4 or S2Xv2_mode==5 -->
   <superframe
       SOSF_WH_sequence_number="uint8, required"
       reference_scrambling_index="uint20, required"
       SFFI="uint4, optional"
       payload_scrambling_index="uint20, required"
       beamhopping_time_plan_id="uint32, optional"
       superframe_pilots_WH_sequence_number="uint5, required"/>

   <reserved_future_use>
     Hexadecimal content
```

```
        </reserved_future_use>

    </S2Xv2_satellite_delivery_system_descriptor>
```

D.8.82 satellite_delivery_system_descriptor

Defined by DVB in [5]. Redefined in a slightly different way by ARIB (ISDB) in [28].

When this descriptor is extracted from a binary stream to be decompiled in XML format, there is no way to check if this is a DVB or ISDB descriptor without knowing the context. If the command line specifies an option such as **--isdb** or **--japan**, or if an ISDB-specific table was previously encountered, then the stream is assumed to be an ISDB one and the ISDB format of this descriptor is used. Otherwise, the original DVB format is assumed.

```
<satellite_delivery_system_descriptor
    frequency="SatelliteFrequencyHz, required"
    orbital_position="SatelliteOrbitalPosition, eg. 19.2, required"
    west_east_flag="east|west, required"
    polarization="horizontal|vertical|left|right, required"
    roll_off="0.35|0.25|0.20|reserved, default=0.35"
    modulation_system="DVB-S|DVB-S2|ISDB-S, required"
    modulation_type="auto|QPSK|8PSK|16-QAM|ISDB-S|2.6GHzMobile|AdvancedCS,
                    default=QPSK|ISDB-S"
    symbol_rate="SymbolsPerSecond, required"
    FEC_inner="undefined|1/2|2/3|3/4|5/6|7/8|8/9|3/5|4/5|9/10|
                ISDB-S|2.6GHzMobile|AdvancedCS|none, required"/>
```

The attribute **roll_off** is used only when **modulation_system** is "**DVB-S2**".

The list of allowed values for **modulation_type** and **FEC_inner** depends on the value of *modulation_system*.

D.8.83 scheduling_descriptor

Defined by DVB in [8]. Must be in a UNT (table id **0x4B**).

```
<scheduling_descriptor
    start_date_time="YYYY-MM-DD hh:mm:ss, required"
    end_date_time="YYYY-MM-DD hh:mm:ss, required"
    final_availability="bool, required"
    periodicity="bool, required"
    period_unit="second|minute|hour|day|uint2, required"
    duration_unit="second|minute|hour|day|uint2, required"
    estimated_cycle_time_unit="second|minute|hour|day|uint2, required"
    period="uint8, required"
    duration="uint8, required"
    estimated_cycle_time="uint8, required">

  <private_data>
    Hexadecimal content
  </private_data>

</scheduling_descriptor>
```

D.8.84 scrambling_descriptor

Defined by DVB in [5].

```
<scrambling_descriptor scrambling_mode="uint8, required"/>
```

D.8.85 service_descriptor

Defined by DVB in [5].

```
<service_descriptor
```

```
        service_type="uint8, required"
        service_provider_name="string, required"
        service_name="string, required"/>
```

D.8.86   service_availability_descriptor

Defined by DVB in [5].

```
<service_availability_descriptor availability="bool, required">
  <!-- One per cell -->
  <cell id="uint16, required"/>
</service_availability_descriptor>
```

D.8.87   service_identifier_descriptor

Defined by DVB in [5].

```
<service_identifier_descriptor service_identifier="string, required"/>
```

D.8.88   service_list_descriptor

Defined by DVB in [5].

```
<service_list_descriptor>
  <!-- One per service -->
  <service service_id="uint16, required" service_type="uint8, required"/>
</service_list_descriptor>
```

D.8.89   service_move_descriptor

Defined by DVB in [5].

```
<service_move_descriptor
    new_original_network_id="uint16, required"
    new_transport_stream_id="uint16, required"
    new_service_id="uint16, required"/>
```

D.8.90   service_prominence_descriptor

Defined by DVB in [5].

```
<service_prominence_descriptor>

  <sogi
      SOGI_flag="bool, required"
      SOGI_priority="uint12, required"
      service_id="uint16, optional">

    <target_region
        country_code="string, optional"
        primary_region_code="uint8, optional"
        secondary_region_code="uint8, optional"
        tertiary_region_code="uint8, optional"/>

  </sogi>

  <private_data>
    Hexadecimal Content
  </private_data>

</service_prominence_descriptor>
```

D.8.91   service_relocated_descriptor

Defined by DVB in [5].

```
<service_relocated_descriptor
```

```
        old_original_network_id="uint16, required"
        old_transport_stream_id="uint16, required"
        old_service_id="uint16, required"/>
```

D.8.92 SH_delivery_system_descriptor

Defined by DVB in [5].

```
<SH_delivery_system_descriptor diversity_mode="uint4, required">

  <!-- Number of modulations depends on the SH config, e.g. 1 in SFN, 2 in non-SFN -->
  <modulation>

    <!-- Modulation type: exactly one of TDM or OFDM must be present -->
    <TDM
        polarization="horizontal|vertical|left|right, required"
        roll_off="0.35|0.25|0.15|reserved, required"
        modulation_mode="QPSK|8PSK|16APSK|reserved, required"
        code_rate="uint4, required"
        symbol_rate="uint5, required"/>
    <OFDM
        bandwidth="8MHz|7MHz|6MHz|5MHz|1.7MHz|uint3, required"
        priority="uint1, required"
        constellation_and_hierarchy="uint3, required"
        code_rate="uint4, required"
        guard_interval="1/32|1/16|1/8|1/4|uint2, required"
        transmission_mode="1k|2k|4k|8k|uint2, required"
        common_frequency="bool, required"/>

    <!-- At most one interleaver, optional fields must be all absent or all present -->
    <interleaver
        common_multiplier="uint6, required"
        nof_late_taps="uint6, optional"
        nof_slices="uint6, optional"
        slice_distance="uint8, optional"
        non_late_increments="uint6, optional"/>
  </modulation>

</SH_delivery_system_descriptor>
```

D.8.93 short_event_descriptor

Defined by DVB in [5].

```
<short_event_descriptor language_code="char3, required">
  <event_name>String</event_name>
  <text>String</text>
</short_event_descriptor>
```

D.8.94 short_smoothing_buffer_descriptor

Defined by DVB in [5].

```
<short_smoothing_buffer_descriptor
    sb_size="uint2, required"
    sb_leak_rate="uint6, required">

  Hexadecimal content (optional DVB-reserved data)

</short_smoothing_buffer_descriptor>
```

D.8.95 simple_application_boundary_descriptor

Defined by DVB in [12]. Must be in an AIT (table id **0x74**).

```
<simple_application_boundary_descriptor>
  <!-- One per prefix: -->
```

```
    <prefix boundary_extension="string, required"/>
  </simple_application_boundary_descriptor>
```

D.8.96 simple_application_location_descriptor

Defined by DVB in [12]. Must be in an AIT (table id **0x74**).

```
  <simple_application_location_descriptor initial_path="string, required"/>
```

D.8.97 SSU_enhanced_message_descriptor

Defined by DVB in [8]. Must be in a UNT (table id **0x4B**).

```
  <SSU_enhanced_message_descriptor
      descriptor_number="uint4, required"
      last_descriptor_number="uint4, required"
      ISO_639_language_code="char3, required"
      message_index="uint5, required">

    <text>String</text>

  </SSU_enhanced_message_descriptor>
```

D.8.98 SSU_event_name_descriptor

Defined by DVB in [8]. Must be in a UNT (table id **0x4B**).

```
  <SSU_event_name_descriptor ISO_639_language_code="char3, required"
    <name>String</name>
    <text>String</text>
  </SSU_event_name_descriptor>
```

D.8.99 SSU_location_descriptor

Defined by DVB in [8]. Must be in a UNT (table id **0x4B**).

```
  <SSU_location_descriptor
      data_broadcast_id="uint16, required"
      association_tag="uint16, optional">

    <private_data>
      Hexadecimal content
    </private_data>

  </SSU_location_descriptor>
```

D.8.100 SSU_message_descriptor

Defined by DVB in [8]. Must be in a UNT (table id **0x4B**).

```
  <SSU_message_descriptor
      descriptor_number="uint4, required"
      last_descriptor_number="uint4, required"
      ISO_639_language_code="char3, required">

    <text>String</text>

  </SSU_message_descriptor>
```

D.8.101 SSU_subgroup_association_descriptor

Defined by DVB in [8]. Must be in a UNT (table id **0x4B**).

```
  <SSU_subgroup_association_descriptor subgroup_tag="uint40, required"/>
```

D.8.102 SSU_uri_descriptor

Defined by DVB in [8]. Must be in a UNT (table id **0x4B**).

```
<SSU_uri_descriptor
    max_holdoff_time="uint8, required"
    min_polling_interval="uint8, required"
    uri="string, required"/>
```

Warning: As defined in [8], **max_holdoff_time** is a number of minutes and **min_polling_interval** is a number of hours.

D.8.103 stream_identifier_descriptor

Defined by DVB in [5].

```
<stream_identifier_descriptor component_tag="uint8, required"/>
```

D.8.104 stuffing_descriptor

Defined by DVB in [5].

Because of the presence of an ATSC version of the **stuffing_descriptor**, the XML name for the DVB version is **<DVB_stuffing_descriptor>**. For compatibility, **<stuffing_descriptor>** is still accepted.

```
<DVB_stuffing_descriptor>
  Hexadecimal content
</DVB_stuffing_descriptor>
```

D.8.105 subtitling_descriptor

Defined by DVB in [5].

```
<subtitling_descriptor>
  <!-- One per subtitle -->
  <subtitling language_code="char3, required"
              subtitling_type="uint8, required"
              composition_page_id="uint16, required"
              ancillary_page_id="uint16, required"/>
</subtitling_descriptor>
```

D.8.106 supplementary_audio_descriptor

Defined by DVB in [5].

```
<supplementary_audio_descriptor
    mix_type="uint1, required"
    editorial_classification="uint5, required"
    language_code="char3, optional">
  <private_data>
    Hexadecimal content
  </private_data>
</supplementary_audio_descriptor>
```

D.8.107 T2_delivery_system_descriptor

Defined by DVB in [5].

```
<T2_delivery_system_descriptor
    plp_id="uint8, required"
    T2_system_id="uint16, required">

  <!-- Optional extension -->
  <extension
      SISO_MISO="SISO|MISO|uint2, required"
      bandwidth="8MHz|7MHz|6MHz|5MHz|10MHz|1.712MHz|uint4, required"
      guard_interval="1/32|1/16|1/8|1/4|1/128|19/128|19/256|uint3, required"
```

```
        transmission_mode="2k|8k|4k|1k|16k|32k|uint3, required"
        other_frequency="bool, required"
        tfs="bool, required">

    <!-- One per cell -->
    <cell cell_id="uint16, required">
      <!-- Only one if tfs is false, any number if tfs is true -->
      <centre_frequency value="FrequencyHz, required"/>
      <!-- One per subcell -->
      <subcell cell_id_extension="uint8, required"
               transposer_frequency="FrequencyHz, required"/>
    </cell>

  </extension>

</T2_delivery_system_descriptor>
```

D.8.108 T2MI_descriptor

Defined by DVB in [5].

```
<T2MI_descriptor
    t2mi_stream_id="uint3, required"
    num_t2mi_streams_minus_one="uint3, default=0"
    pcr_iscr_common_clock_flag="bool, default=false">
  <reserved>
    Hexadecimal content
  </reserved>
</T2MI_descriptor>
```

D.8.109 target_IP_address_descriptor

Defined by DVB in [14] and [8]. Must be in a UNT (table id **0x4B**) or INT (table id **0x4C**).

```
<target_IP_address_descriptor IPv4_addr_mask="IPv4 address, required">
  <!-- One per IPv4 address: -->
  <address IPv4_addr="IPv4 address, required"/>
</target_IP_address_descriptor>
```

D.8.110 target_IP_slash_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<target_IP_slash_descriptor>
  <!-- One per IPv4 address: -->
  <address
      IPv4_addr="IPv4 address, required"
      IPv4_slash_mask="uint8, required"/>
</target_IP_slash_descriptor>
```

D.8.111 target_IP_source_slash_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<target_IP_source_slash_descriptor>
  <!-- One per pair of IPv4 address: -->
  <address
      IPv4_source_addr="IPv4 address, required"
      IPv4_source_slash_mask="uint8, required"
      IPv4_dest_addr="IPv4 address, required"
      IPv4_dest_slash_mask="uint8, required"/>
</target_IP_source_slash_descriptor>
```

D.8.112 target_IPv6_address_descriptor

Defined by DVB in [14] and [8]. Must be in a UNT (table id **0x4B**) or INT (table id **0x4C**).

```
<target_IPv6_address_descriptor IPv6_addr_mask="IPv6 address, required">
  <!-- One per IPv6 address: -->
  <address IPv6_addr="IPv6 address, required"/>
</target_IPv6_address_descriptor>
```

D.8.113 target_IPv6_slash_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<target_IPv6_slash_descriptor>
  <!-- One per IPv6 address: -->
  <address
      IPv6_addr="IPv6 address, required"
      IPv6_slash_mask="uint8, required"/>
</target_IPv6_slash_descriptor>
```

D.8.114 target_IPv6_source_slash_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<target_IPv6_source_slash_descriptor>
  <!-- One per pair of IPv6 address: -->
  <address
      IPv6_source_addr="IPv6 address, required"
      IPv6_source_slash_mask="uint8, required"
      IPv6_dest_addr="IPv6 address, required"
      IPv6_dest_slash_mask="uint8, required"/>
</target_IPv6_source_slash_descriptor>
```

D.8.115 target_MAC_address_descriptor

Defined by DVB in [14] and [8]. Must be in a UNT (table id **0x4B**) or INT (table id **0x4C**).

```
<target_MAC_address_descriptor MAC_addr_mask="MAC address, required">
  <!-- One per MAC address: -->
  <address MAC_addr="MAC address, required"/>
</target_MAC_address_descriptor>
```

D.8.116 target_MAC_address_range_descriptor

Defined by DVB in [14]. Must be in an INT (table id **0x4C**).

```
<target_MAC_address_range_descriptor>
  <!-- One per MAC address range: -->
  <range MAC_addr_low="MAC address, required"
         MAC_addr_high="MAC address, required"/>
</target_MAC_address_range_descriptor>
```

D.8.117 target_region_descriptor

Defined by DVB in [5].

```
<target_region_descriptor country_code="char3, required">
  <!-- One per region -->
  <region country_code="char3, optional"
          primary_region_code="uint8, optional"
          secondary_region_code="uint8, optional"
          tertiary_region_code="uint16, optional"/>
</target_region_descriptor>
```

D.8.118 target_region_name_descriptor

Defined by DVB in [5].

```
<target_region_name_descriptor
    country_code="char3, required"
    ISO_639_language_code="char3, required">
```

```
    <!-- One per region -->
    <region region_name="string, required"
            primary_region_code="uint8, required"
            secondary_region_code="uint8, optional"
            tertiary_region_code="uint16, optional"/>

</target_region_name_descriptor>
```

D.8.119 target_serial_number_descriptor

Defined by DVB in [14] and [8]. Must be in a UNT (table id **0x4B**) or INT (table id **0x4C**).

```
<target_serial_number_descriptor>
  <!-- Serial data bytes -->
  Hexadecimal content
</target_serial_number_descriptor>
```

D.8.120 target_smartcard_descriptor

Defined by DVB in [14] and [8]. Must be in a UNT (table id **0x4B**) or INT (table id **0x4C**).

```
<target_smartcard_descriptor super_CA_system_id="uint32, required">
  <!-- Private data bytes -->
  Hexadecimal content
</target_smartcard_descriptor>
```

D.8.121 telephone_descriptor

Defined by DVB in [5].

```
<telephone_descriptor
    foreign_availability="bool, required"
    connection_type="uint5, required"
    country_prefix="string, 3 chars max, optional"
    international_area_code="string, 7 chars max, optional"
    operator_code="string, 3 chars max, optional"
    national_area_code="string, 7 chars max, optional"
    core_number="string, 15 chars max, optional"/>
```

D.8.122 teletext_descriptor

Defined by DVB in [5].

```
<teletext_descriptor>
  <!-- One per page -->
  <teletext language_code="char3, required"
            teletext_type="uint5, required"
            page_number="uint16, required"/>
</teletext_descriptor>
```

D.8.123 terrestrial_delivery_system_descriptor

Defined by DVB in [5].

```
<terrestrial_delivery_system_descriptor
    centre_frequency="FrequencyHz, required"
    bandwidth="8MHz|7MHz|6MHz|5MHz, required"
    priority="HP|LP, required"
    no_time_slicing="bool, required"
    no_MPE_FEC="bool, required"
    constellation="QPSK|16-QAM|64-QAM, required"
    hierarchy_information="uint3, required"
    code_rate_HP_stream="1/2|2/3|3/4|5/6|7/8, required"
    code_rate_LP_stream="1/2|2/3|3/4|5/6|7/8, required"
    guard_interval="1/32|1/16|1/8|1/4, required"
    transmission_mode="2k|8k|4k, required"
```

```
    other_frequency="bool, required"/>
```

D.8.124 time_shifted_event_descriptor

Defined by DVB in [5].

```
<time_shifted_event_descriptor
    reference_service_id="uint16, required"
    reference_event_id="uint16, required"/>
```

D.8.125 time_shifted_service_descriptor

Defined by DVB in [5].

Because of the presence of an ATSC version of the **time_shifted_service_descriptor**, the XML name for the DVB version is **<DVB_time_shifted_service_descriptor>**.

For compatibility, **<time_shifted_service_descriptor>** is still accepted.

```
<DVB_time_shifted_service_descriptor reference_service_id="uint16, required"/>
```

D.8.126 time_slice_fec_identifier_descriptor

Defined by DVB in [14].

```
<time_slice_fec_identifier_descriptor
    time_slicing="bool, required"
    mpe_fec="uint2, required"
    frame_size="uint3, required"
    max_burst_duration="uint8, required"
    max_average_rate="uint4, required"
    time_slice_fec_id="uint4, default=0">
  <id_selector_bytes>Hexadecimal content</id_selector_bytes>
</time_slice_fec_identifier_descriptor>
```

D.8.127 transport_protocol_descriptor

Defined by DVB in [15]. Must be in an AIT (table id **0x74**).

```
<transport_protocol_descriptor transport_protocol_label="uint8, required">

  <!-- Only one of the following shall be present -->
  <!-- For protocol id 1: -->
  <object_carousel
      original_network_id="uint16, optional"
      transport_stream_id="uint16, optional"
      service_id="uint16, optional"
      component_tag="uint8, required"/>

  <!-- For protocol id 2: -->
  <ip_mpe
      original_network_id="uint16, optional"
      transport_stream_id="uint16, optional"
      service_id="uint16, optional"
      alignment_indicator="bool, required">
    <!-- One per URL -->
    <url value="string, required"/>
  </ip_mpe>

  <!-- For protocol id 3: -->
  <http>
    <!-- One per URL -->
    <url base="string, required">
      <!-- One per URL extension -->
      <extension value="string, required"/>
    </url>
  </http>
```

```
  <!-- For other (unknown) protocol ids: -->
  <protocol id="uint16, required">
    Hexadecimal content.
  </protocol>

</transport_protocol_descriptor>
```

D.8.128 transport_stream_descriptor

Defined by DVB in [5].

```
<transport_stream_descriptor compliance="string, required"/>
```

D.8.129 TTML_subtitling_descriptor

Defined by DVB in [18].

```
<TTML_subtitling_descriptor
    ISO_639_language_code="char3, required"
    subtitle_purpose="uint6, required"
    TTS_suitability="uint2, required"
    qualifier="uint32, optional"
    service_name="string, optional"
    reserved_zero_future_count="uint8, default=0">

  <!-- one per dvb_ttml_profile value -->
  <dvb_ttml_profile value="uint8, required"/>

  <!-- one per font_id value -->
  <font_id value="uint7, required"/>

</TTML_subtitling_descriptor>
```

D.8.130 TVA_id_descriptor

Defined by DVB in [9].

```
<TVA_id_descriptor>
  <TVA id="uint16, required" running_status="uint3, required"/>
</TVA_id_descriptor>
```

D.8.131 update_descriptor

Defined by DVB in [8]. Must be in a UNT (table id **0x4B**).

```
<update_descriptor
    update_flag="uint2, required"
    update_method="uint4, required"
    update_priority="uint2, required">

  <private_data>
    Hexadecimal content
  </private_data>

</update_descriptor>
```

D.8.132 URI_linkage_descriptor

Defined by DVB in [5].

```
<URI_linkage_descriptor
    uri_linkage_type="uint8, required"
    uri="string, required"
    min_polling_interval="uint16, optional">

  <!-- When uri_linkage_type == 0x03 -->
```

```
    <DVB_I_linkage
        end_point_type="uint8, required"
        service_list_name="string, optional"
        service_list_provider_name="string, optional">
      <private_data>
        Hexadecimal content
      </private_data>
    </DVB_I_linkage>

    <private_data>
      Hexadecimal content
    </private_data>

  </URI_linkage_descriptor>
```

D.8.133 VBI_data_descriptor

Defined by DVB in [5].

```
  <VBI_data_descriptor>
    <!-- One per VBI data service -->
    <service data_service_id="uint8, required">
      <!-- One per field in the service -->
      <field field_parity="bool, default=false" line_offset="uint5, default=0"/>
      <!-- Valid only when data_service_id is not any of 1, 2, 4, 5, 6, 7 -->
      <reserved>
        Hexadecimal content
      </reserved>
    </service>
  </VBI_data_descriptor>
```

D.8.134 VBI_teletext_descriptor

Defined by DVB in [5].

```
  <VBI_teletext_descriptor>
    <!-- One per page -->
    <teletext language_code="char3, required"
              teletext_type="uint5, required"
              page_number="uint16, required"/>
  </VBI_teletext_descriptor>
```

D.8.135 video_depth_range_descriptor

Defined by DVB in [5].

```
  <video_depth_range_descriptor>

    <!-- One per video range -->
    <range range_type="uint8, required"
          video_max_disparity_hint="int12, required when range_type == 0"
          video_min_disparity_hint="int12, required when range_type == 0">
      <range_selector>
        Hexadecimal content
      </range_selector>
    </range>

  </video_depth_range_descriptor>
```

D.8.136 vvc_subpictures_descriptor

Defined by DVB in [5].

```
  <vvc_subpictures_descriptor
    default_service_mode="bool, required"
    processing_mode="uint3, required"
    service_description="string, optional">
```

```
    <subpicture
      component_tag="uint8, required"
      subpicture_id="uint8, required"/>
  </vvc_subpictures_descriptor>
```

D.9 DTG/OFCOM-defined descriptors (DVB private descriptors)

D.9.1   dtg_guidance_descriptor

Defined by DTG in [35].

```
  <dtg_guidance_descriptor
      guidance_type="uint2, required"
      ISO_639_language_code="char3, optional"
      text="string, optional"
      guidance_mode="bool, optional">

    <reserved_future_use>
      Hexadecimal content
    </reserved_future_use>

  </dtg_guidance_descriptor>
```

D.9.2   dtg_HD_simulcast_logical_channel_descriptor

Defined by DTG in [35].

```
  <dtg_HD_simulcast_logical_channel_descriptor>
    <!-- One per service -->
    <service service_id="uint16, required"
            logical_channel_number="uint10, required"
            visible_service="bool, default=true"/>
  </dtg_HD_simulcast_logical_channel_descriptor>
```

D.9.3   dtg_logical_channel _descriptor

Defined by DTG in [35].

```
  <dtg_logical_channel_descriptor>
    <!-- One per service -->
    <service service_id="uint16, required"
            logical_channel_number="uint10, required"
            visible_service="bool, default=true"/>
  </dtg_logical_channel_descriptor>
```

D.9.4   dtg_preferred_name_identifier_descriptor

Defined by DTG in [35].

```
  <dtg_preferred_name_identifier_descriptor name_id="uint8, required"/>
```

D.9.5   dtg_preferred_name_list_descriptor

Defined by DTG in [35].

```
  <dtg_preferred_name_list_descriptor>
    <!-- One per language -->
    <language code="char3, required">
      <!-- One per name -->
      <name name_id="uint8, required" name="string, required"/>
    </language>
  </dtg_preferred_name_list_descriptor>
```

D.9.6   dtg_service_attribute_descriptor

Defined by DTG in [35].

```
<dtg_service_attribute_descriptor>
  <!-- One per service -->
  <service service_id="uint16, required"
          numeric_selection="bool, required"
          visible_service="bool, required"/>
</dtg_service_attribute_descriptor>
```

D.9.7   dtg_short_service_name_descriptor

Defined by DTG in [35].

```
<dtg_short_service_name_descriptor name="string, required"/>
```

D.10 EACEM-defined descriptors (DVB private descriptors)

D.10.1   eacem_HD_simulcast_logical_channel_descriptor

Defined by EACEM in [32].

Because there are several forms of HD_simulcast_logical_channel_descriptor, this EACEM-defined form is named <eacem_HD_simulcast_logical_channel_descriptor>. For compatibility, the previous XML syntax <HD_simulcast_logical_channel_descriptor> is still accepted and is equivalent.

```
<eacem_HD_simulcast_logical_channel_descriptor>
  <!-- One per service -->
  <service service_id="uint16, required"
          logical_channel_number="uint10, required"
          visible_service="bool, default=true"/>
</eacem_HD_simulcast_logical_channel_descriptor>
```

D.10.2   eacem_logical_channel_number_descriptor

Defined by EACEM in [32].

Because there are several forms of logical_channel_number_descriptor, this EACEM-defined form is named <eacem_logical_channel_number_descriptor>. For compatibility, the previous XML syntax <logical_channel_number_descriptor > is still accepted and is equivalent.

```
<eacem_logical_channel_number_descriptor>
  <!-- One per service -->
  <service service_id="uint16, required"
          logical_channel_number="uint10, required"
          visible_service="bool, default=true"/>
</eacem_logical_channel_number_descriptor>
```

D.10.3   eacem_preferred_name_identifier_descriptor

Defined by EACEM in [32].

```
<eacem_preferred_name_identifier_descriptor name_id="uint8, required"/>
```

D.10.4   eacem_preferred_name_list_descriptor

Defined by EACEM in [32].

```
<eacem_preferred_name_list_descriptor>
  <!-- One per language -->
  <language code="char3, required">
    <!-- One per name -->
    <name name_id="uint8, required" name="string, required"/>
  </language>
</eacem_preferred_name_list_descriptor>
```

D.10.5   eacem_stream_identifier_descriptor

Defined by EACEM in [32].

```
<eacem_stream_identifier_descriptor version_byte="uint8, required"/>
```

D.11 Eutelsat-defined descriptors (DVB private descriptors)

D.11.1   eutelsat_channel_number_descriptor

Defined by Eutelsat in [33].

```
<eutelsat_channel_number_descriptor>
  <!-- One per service -->
  <service original_network_id="uint16, required"
           transport_stream_id="uint16, required"
           service_id="uint16, required"
           eutelsat_channel_number="uint10, required"/>
</eutelsat_channel_number_descriptor>
```

D.12 NorDig-defined descriptors (DVB private descriptors)

D.12.1   nordig_logical_channel_descriptor_v1

Defined by NorDig in [34].

```
<nordig_logical_channel_descriptor_v1>
  <!-- One per service -->
  <service service_id="uint16, required"
           logical_channel_number="uint14, required"
           visible_service="bool, default=true"/>
</nordig_logical_channel_descriptor_v1>
```

D.12.2   nordig_logical_channel_descriptor_v2

Defined by NorDig in [34].

```
<nordig_logical_channel_descriptor_v2>
  <!-- One per channel list -->
  <channel_list id="uint8, required"
                name="string, required"
                country_code="char3, required">
    <!-- One per service in the channel list -->
    <service service_id="uint16, required"
             logical_channel_number="uint10, required"
             visible_service="bool, default=true"/>
  </channel_list>
</nordig_logical_channel_descriptor_v2>
```

D.13 BskyB-defined descriptors (DVB private descriptors)

No public reference is available for BskyB private descriptors.

D.13.1   sky_logical_channel_number_descriptor

```
<sky_logical_channel_number_descriptor region_id="uint16, required">
  <!-- One per service -->
  <service service_id="uint16, required"
           service_type="uint8, required"
           channel_id="uint16, required"
           logical_channel_number="uint16, required"
           sky_id="uint16, required"/>
</sky_logical_channel_number_descriptor>
```

D.14 Free TV Australia-defined descriptors (DVB private descriptors)

D.14.1   australia_logical_channel_descriptor

Defined by Free TV Australia in [36].

```
<australia_logical_channel_descriptor>
  <!-- One per service -->
  <service service_id="uint16, required"
           logical_channel_number="uint14, required"
           visible_service="bool, default=true"/>
</australia_logical_channel_descriptor>
```

D.15 AVS-defined descriptors (DVB private descriptors)

D.15.1   AVS3_video_descriptor

Defined by AVS in T/AI 109-6.

```
<AVS3_video_descriptor
    profile_id="uint8, required"
    level_id="uint8, required"
    multiple_frame_rate_flag="bool, required"
    frame_rate_code="uint4, required"
    sample_precision="uint3, required"
    chroma_format="uint2, required"
    temporal_id_flag="bool, required"
    td_mode_flag="bool, required"
    library_stream_flag="bool, required"
    library_picture_enable_flag="bool, required"
    colour_primaries="uint8, required"
    transfer_characteristics="uint8, required"
    matrix_coefficients="uint8, required"/>
```

D.16 AOM-defined descriptors (DVB private descriptors)

D.16.1   AV1_video_descriptor

Defined by AOM in [37].

```
<AV1_video_descriptor
    version="uint7, required"
    seq_profile="uint3, required"
    seq_level_idx_0="uint5, required"
    seq_tier_0="uint1, required"
    high_bitdepth="bool, required"
    twelve_bit="bool, required"
    monochrome="bool, required"
    chroma_subsampling_x="bool, required"
    chroma_subsampling_y="bool, required"
    chroma_sample_position="unknown|vertical|colocated, required"
    HDR_WCG_idc="uint2, required"
    initial_presentation_delay_minus_one="uint4, optional"/>
```

D.17 SCTE-defined descriptors

D.17.1   cue_identifier_descriptor

Defined by ANSI/SCTE in [22].

```
<cue_identifier_descriptor
  cue_stream_type="insert_null_schedule|all|segmentation|tiered_splicing|
                  tiered_segmentation|uint8, required">
  <!-- Defined by SCTE 35 for use in PMT -->
```

```
</cue_identifier_descriptor>
```

D.17.2 EAS_audio_file_descriptor

Defined by ANSI/SCTE in [21]. Must be in a Cable Emergency Alert Table (table id **0xD8**).

```
<EAS_audio_file_descriptor>
  <!-- One entry per audio file -->
  <file audio_format="uint7, required"
        file_name="string, optional"
        audio_source="uint8, required"
        program_number="uint16, optional"
        carousel_id="uint32, optional"
        application_id="uint16, optional"
        download_id="uint32, optional"
        module_id="uint32, optional"/>
</EAS_audio_file_descriptor>
```

D.17.3 EAS_inband_details_channel_descriptor

Defined by ANSI/SCTE in [21]. Must be in a Cable Emergency Alert Table (table id **0xD8**).

```
<EAS_inband_details_channel_descriptor
    details_RF_channel="uint8, required"
    details_program_number="uint16, required"/>
```

D.17.4 EAS_inband_exception_channels_descriptor

Defined by ANSI/SCTE in [21]. Must be in a Cable Emergency Alert Table (table id **0xD8**).

```
<EAS_inband_exception_channels_descriptor>
  <!-- One entry per exception channel -->
  <exception RF_channel="uint8, required" program_number="uint16, required"/>
</EAS_inband_exception_channels_descriptor>
```

D.17.5 EAS_metadata_descriptor

Defined by ANSI/SCTE in [23]. Must be in a Cable Emergency Alert Table (table id **0xD8**).

```
<EAS_metadata_descriptor fragment_number="uint8, default=1">
  <!-- The text inside this element is an XML fragment -->
</EAS_metadata_descriptor>
```

D.17.6 splice_avail_descriptor

Defined by ANSI/SCTE in [22]. Must be in a Splice Information Table (table id **0xFC**).

```
<splice_avail_descriptor
    identifier="uint32, default=0x43554549"
    provider_avail_id="uint32, required"/>
```

D.17.7 splice_DTMF_descriptor

Defined by ANSI/SCTE in [22]. Must be in a Splice Information Table (table id **0xFC**).

```
<splice_DTMF_descriptor
    identifier="uint32, default=0x43554549"
    preroll="uint8, required"
    DTMF="string, required"/>
```

D.17.8 splice_segmentation_descriptor

Defined by ANSI/SCTE in [22]. Must be in a Splice Information Table (table id **0xFC**).

```
<splice_segmentation_descriptor
    identifier="uint32, default=0x43554549"
    segmentation_event_id="uint32, required"
```

```
        segmentation_event_cancel="bool, default=false"
        web_delivery_allowed="bool, default=true"
        no_regional_blackout="bool, default=true"
        archive_allowed="bool, default=true"
        device_restrictions="uint2, default=3"
        segmentation_duration="uint40, optional"
        segmentation_type_id="uint8, required"
        segment_num="uint8, required"
        segments_expected="uint8, required"
        sub_segment_num="uint8, required when segmentation_type_id == 0x34 or 0x36"
        sub_segments_expected="uint8, required when segmentation_type_id == 0x34 or 0x36">
    <segmentation_upid type="uint8, required">
      Hexadecimal content
    </segmentation_upid>
    <!-- One per component when program_segmentation_flag is to be set to 0 -->
    <component component_tag="uint8, required" pts_offset="uint33, required"/>
  </splice_segmentation_descriptor>
```

D.17.9 splice_time_descriptor

Defined by ANSI/SCTE in [22]. Must be in a Splice Information Table (table id **0xFC**).

```
  <splice_time_descriptor
      identifier="uint32, default=0x43554549"
      TAI_seconds="uint48, required"
      TAI_ns="uint32, required"
      UTC_offset="uint16, required"/>
```

D.18 ATSC-defined descriptors

D.18.1 AC3_audio_stream_descriptor

Defined by ATSC in [24].

This is the ATSC version of the AC-3 descriptor. DVB uses a distinct descriptor. In [24], the so-called "System A" designates ATSC while "System B" designates DVB.

```
  <ATSC_AC3_audio_stream_descriptor
      sample_rate_code="uint3, required"
      bsid="uint5, required"
      bit_rate_code="uint6, required"
      surround_mode="uint2, required"
      bsmod="uint3, required"
      num_channels="uint4, required"
      full_svc="bool, required"
      mainid="uint3, optional"
      priority="uint2, optional"
      asvcflags="uint8, optional"
      text="string, optional"
      language="char3, optional"
      language_2="char3, optional">
    <additional_info>
      Hexadecimal content
    </additional_info>
  </ATSC_AC3_audio_stream_descriptor>
```

D.18.2 caption_service_descriptor

Defined by ATSC in [25].

```
  <caption_service_descriptor>
    <!-- One per service -->
    <service language="char3, required"
             digital_cc="bool, required"
             line21_field="bool, optional"
             caption_service_number="uint6, required"
```

```
        easy_reader="bool, required"
        wide_aspect_ratio="bool, required"/>
</caption_service_descriptor>
```

D.18.3 component_name_descriptor

Defined by ATSC in [25].

```
<component_name_descriptor>
  <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
  <component_name_string>
    <string language="char3, required" text="string, required"/>
  </component_name_string>
</component_name_descriptor>
```

D.18.4 content_advisory_descriptor

Defined by ATSC in [25].

```
<content_advisory_descriptor>
  <!-- One per rating region -->
  <region rating_region="uint8, required">
    <!-- One per rated dimension -->
    <dimension rating_dimension_j="uint8, required" rating_value="uint4, required"/>
    <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
    <rating_description>
      <string language="char3, required" text="string, required"/>
    </rating_description>
  </region>
</content_advisory_descriptor>
```

D.18.5 dcc_arriving_request_descriptor

Defined by ATSC in [25].

```
<dcc_arriving_request_descriptor dcc_arriving_request_type="uint8, required">
  <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
  <dcc_arriving_request_text>
    <string language="char3, required" text="string, required"/>
  </dcc_arriving_request_text>
</dcc_arriving_request_descriptor>
```

D.18.6 dcc_departing_request_descriptor

Defined by ATSC in [25].

```
<dcc_departing_request_descriptor dcc_departing_request_type="uint8, required">
  <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
  <dcc_departing_request_text>
    <string language="char3, required" text="string, required"/>
  </dcc_departing_request_text>
</dcc_departing_request_descriptor>
```

D.18.7 EAC3_audio_descriptor

Defined by ATSC in [24].

This is the ATSC version of the Enhanced-AC-3 descriptor. DVB uses a distinct descriptor.

```
<ATSC_EAC3_audio_descriptor
    mixinfoexists="bool, required"
    full_service="bool, required"
    audio_service_type="uint3, required"
    number_of_channels="uint3, required"
    bsid="uint5, optional"
    priority="uint2, optional"
    mainid="uint3, optional"
```

```
       asvc="uint8, optional"
       substream1="uint8, optional"
       substream2="uint8, optional"
       substream3="uint8, optional"
       language="char3, optional"
       language_2="char3, optional"
       substream1_lang="char3, optional"
       substream2_lang="char3, optional"
       substream3_lang="char3, optional">
    <additional_info>
      Hexadecimal content
    </additional_info>
  </ATSC_EAC3_audio_descriptor>
```

D.18.8   extended_channel_name_descriptor

Defined by ATSC in [25].

```
  <extended_channel_name_descriptor>
    <!-- Optional ATSC multiple_string_structure() containing one or more strings -->
    <long_channel_name_text>
      <string language="char3, required" text="string, required"/>
    </long_channel_name_text>
  </extended_channel_name_descriptor>
```

D.18.9   genre_descriptor

Defined by ATSC in [25].

```
  <genre_descriptor>
    <!-- One per attribute -->
    <attribute value="uint8, required"/>
  </genre_descriptor>
```

D.18.10   redistribution_control_descriptor

Defined by ATSC in [25].

```
  <redistribution_control_descriptor>
    <rc_information>
      Hexadecimal content
    </rc_information>
  </redistribution_control_descriptor>
```

D.18.11   service_location_descriptor

Defined by ATSC in [25].

```
  <service_location_descriptor PCR_PID="uint13, optional">
    <!-- One per component -->
    <component stream_type="uint8, required"
               elementary_PID="uint13, required"
               ISO_639_language_code="char3, optional"/>
  </service_location_descriptor>
```

D.18.12   stuffing_descriptor

Defined by ATSC in [25].

This is the ATSC version of the **stuffing_descriptor**. DVB uses a distinct descriptor.

```
  <ATSC_stuffing_descriptor>
    Hexadecimal content
  </ATSC_stuffing_descriptor>
```

D.18.13 time_shifted_service_descriptor

Defined by ATSC in [25].

This is the ATSC version of the **time_shifted_service_descriptor**. DVB uses a distinct descriptor.

```
<ATSC_time_shifted_service_descriptor>
  <!-- One per service -->
  <service time_shift="uint10, required"
           major_channel_number="uint10, required"
           minor_channel_number="uint10, required"/>
</ATSC_time_shifted_service_descriptor>
```

D.19 ISDB-defined descriptors

D.19.1 area_broadcasting_information_descriptor

Defined by ARIB in [28].

```
<area_broadcasting_information_descriptor>

  <!-- One per station -->
  <station
      station_id="uint24, required"
      location_code="uint16, required"
      broadcast_signal_format="uint8, required">

    <additional_station_info>
      Hexadecimal content
    </additional_station_info>

  </station>

</area_broadcasting_information_descriptor>
```

D.19.2 audio_component_descriptor

Defined by ARIB in [28].

```
<audio_component_descriptor
    stream_content="uint4, default=2"
    component_type="uint8, required"
    component_tag="uint8, required"
    stream_type="uint8, required"
    simulcast_group_tag="uint8, default=0xFF"
    main_component="bool, default=true"
    quality_indicator="uint2, required"
    sampling_rate="uint3, required"
    ISO_639_language_code="char3, required"
    ISO_639_language_code_2="char3, optional"
    text="string, optional"/>
```

D.19.3 basic_local_event_descriptor

Defined by ARIB in [28].

```
<basic_local_event_descriptor
    segmentation_mode="uint4, required"
    start_time_NPT="uint33, optional"
    end_time_NPT="uint33, optional"
    start_time="hh:mm:ss, optional"
    duration="hh:mm:ss, optional"
    start_time_extension="mmm, optional"
    duration_extension="mmm, optional">

  <reserved_data>
```

```
    Hexadecimal content
  </reserved_data>

  <!-- One per component tag -->
  <component tag="uint8, required"/>

</basic_local_event_descriptor>
```

D.19.4   board_information_descriptor

Defined by ARIB in [28].

```
<board_information_descriptor
    title="string, required"
    text="string, required"/>
```

D.19.5   broadcaster_name_descriptor

Defined by ARIB in [28].

```
<broadcaster_name_descriptor name="string, required"/>
```

D.19.6   CA_contract_info_descriptor

Defined by ARIB in [31].

```
<CA_contract_info_descriptor
    CA_system_id="uint16, required"
    CA_unit_id="uint4, required"
    fee_name="string, optional">

  <!-- One per component -->
  <component tag="uint8, required"/>

  <contract_verification_info>
    Hexadecimal content
  </contract_verification_info>

</CA_contract_info_descriptor>
```

D.19.7   CA_EMM_TS_descriptor

Defined by ARIB in [31].

```
<CA_EMM_TS_descriptor
    CA_system_id="uint16, required"
    transport_stream_id="uint16, required"
    original_network_id="uint16, required"
    power_supply_period="uint8, required"/>
```

D.19.8   CA_service_descriptor

Defined by ARIB in [31].

```
<CA_service_descriptor
    CA_system_id="uint16, required"
    ca_broadcaster_group_id="uint8, required"
    message_control="uint8, required">

  <!-- One per service -->
  <service id="uint16, required"/>

</CA_service_descriptor>
```

D.19.9   conditional_playback_descriptor

Defined by ARIB in [31].

```
<conditional_playback_descriptor
    CA_system_id="uint16, required"
    CA_PID="uint13, required">

  <private_data>
    Hexadecimal content
  </private_data>

</conditional_playback_descriptor>
```

D.19.10 content_availability_descriptor

Defined by ARIB in [28].

```
<content_availability_descriptor
    copy_restriction_mode="bool, required"
    image_constraint_token="bool, required"
    retention_mode="bool, required"
    retention_state="uint3, required"
    encryption_mode="bool, required">

  <reserved_future_use>
    Hexadecimal content
  </reserved_future_use>

</content_availability_descriptor>
```

D.19.11 data_component_descriptor

Defined by ARIB in [28].

```
<data_component_descriptor data_component_id="uint16, required">
  <additional_data_component_info>
    Hexadecimal content
  </additional_data_component_info>
</data_component_descriptor>
```

D.19.12 data_content_descriptor

Defined by ARIB in [28].

```
<data_content_descriptor
    data_component_id="uint16, required"
    entry_component="uint8, required"
    ISO_639_language_code="char3, required"
    text="string, required">

  <selector_bytes>
    Hexadecimal content
  </selector_bytes>

  <!-- One per component_ref -->
  <component ref="uint8, required"/>

</data_content_descriptor>
```

D.19.13 digital_copy_control_descriptor

Defined by ARIB in [28].

```
<digital_copy_control_descriptor
    digital_recording_control_data="uint2, required"
    user_defined="uint4, default=0"
```

```
    maximum_bitrate="uint8, optional">

  <!-- One per component in the service -->
  <component_control
      component_tag="uint8, required"
      digital_recording_control_data="uint2, required"
      user_defined="uint4, default=0"
      maximum_bitrate="uint8, optional"/>

</digital_copy_control_descriptor>
```

Note: as specified in [28], the *maximum_bitrate* attribute is set in units of ¼ Mb/s (250 kb/s).

D.19.14 emergency_information_descriptor

Defined by ARIB in [28].

```
<emergency_information_descriptor>

  <!-- One entry per event -->
  <event service_id="uint16, required"
        started="bool, required"
        signal_level="uint1, required">

    <!-- One entry per area code -->
    <area code="uint12, required"/>

  </event>

</emergency_information_descriptor>
```

D.19.15 event_group_descriptor

Defined by ARIB in [28].

```
<event_group_descriptor group_type="uint4, required">

  <!-- One per event in actual network -->
  <actual service_id="uint16, required"
        event_id="uint16, required"/>

  <!-- One per event in other networks (group_type == 4 or 5) -->
  <other original_network_id="uint16, required"
        transport_stream_id="uint16, required"
        service_id="uint16, required"
        event_id="uint16, required"/>

  <!-- Optional private data for other group types -->
  <private_data>
    Hexadecimal content
  </private_data>

</event_group_descriptor>
```

D.19.16 extended_broadcaster_descriptor

Defined by ARIB in [28].

```
<extended_broadcaster_descriptor
    broadcaster_type="uint4, required"
    terrestrial_broadcaster_id="uint16, optional">

  <!-- Any number of affiliations, when broadcaster_type == 0x01 or 0x2 -->
  <affiliation id="uint8, required"/>

  <!-- Any number of broadcasters, when broadcaster_type == 0x01 or 0x2 -->
```

```
<broadcaster original_network_id="uint16, required" broadcaster_id="uint8, required"/>

  <private_data>
    Hexadecimal content
  </private_data>

</extended_broadcaster_descriptor>
```

Note: While the fields have different names in [28], the structure of the descriptor is identical for **broadcaster_type** values 0x01 and 0x02. In the XML, the attributes are unified. For instance, the attribute **terrestrial_broadcaster_id** is in fact **terrestrial_sound_broadcaster_id** when **broadcaster_type** is 0x02.

D.19.17 hierarchical_transmission_descriptor

Defined by ARIB in [28].

```
<hierarchical_transmission_descriptor
    high_quality="bool, required"
    reference_PID="uint13, required"/>
```

D.19.18 ISDB_access_control_descriptor

Defined by ARIB in [28].

```
<ISDB_access_control_descriptor
    CA_system_id="uint16, required"
    transmission_type="uint3, default=7"
    PID="uint13, required">

  <private_data>
    Hexadecimal content
  </private_data>

</ISDB_access_control_descriptor>
```

D.19.19 ISDB_component_group_descriptor

Defined by ARIB in [28].

```
<ISDB_component_group_descriptor
  component_group_type="uint3, required">

  <component_group
    component_group_id="uint4, required"
    total_bit_rate="uint8, optional"
    explanation="string, optional">

    <CAUnit
      CA_unit_id="uint4, required">

      <component_tags>
        Up to 16 8-bit component tags
      </component_tags>

    </CAUnit>
  </component_group>

</ISDB_component_group_descriptor>
```

D.19.20 ISDB_connected_transmission_descriptor

Defined by ARIB in [28].

```
<ISDB_connected_transmission_descriptor
  connected_transmission_group_id="uint16, required"
```

```
        segment_type="uint2, required"
        modulation_type_A="uint2, required"
        modulation_type_B="uint2, required"
        modulation_type_C="uint2, required">

        <addtional_connected_transmission_info>
          Hexadecimal data
        </addtional_connected_transmission_info>

  </ISDB_connected_transmission_descriptor>
```

D.19.21 ISDB_hyperlink_descriptor

Defined by ARIB in [28].

```
  <ISDB_hyperlink_descriptor
      hyper_linkage_type="uint8, required"
      link_destination_type="uint8, required">

    <!-- link_destination_type = 0x01 -->
    <Service
      original_network_id="uint16, required"
      transport_stream_id="uint16, required"
      service_id="uint16, required"/>

    <!-- link_destination_type = 0x02 -->s
    <Event
      original_network_id="uint16, required"
      transport_stream_id="uint16, required"
      service_id="uint16, required"
      event_id="uint16, required"/>

    <!-- link_destination_type = 0x03 -->
    <Module
      original_network_id="uint16, required"
      transport_stream_id="uint16, required"
      service_id="uint16, required"
      event_id="uint16, required"
      component_tag="uint8, required"
      module_id="uint16, required"/>

    <!-- link_destination_type = 0x04 -->
    <Content
      original_network_id="uint16, required"
      transport_stream_id="uint16, required"
      service_id="uint16, required"
      content_id="uint16, required"/>

    <!-- link_destination_type = 0x05 -->
    <ContentModule
      original_network_id="uint16, required"
      transport_stream_id="uint16, required"
      service_id="uint16, required"
      content_id="uint16, required"
      component_tag="uint8, required"
      module_id="uint16, required"/>

    <!-- link_destination_type = 0x06 -->
    <ERTNode
      information_provider_id="uint16, required"
      event_relation_id="uint16, required"
      node_id="uint16, required"/>

    <!-- link_destination_type = 0x07 -->
    <StoredContent uri="string, required"/>
```

```
    <private_data>
        Hexadecimal encoded private data
    </private_data>

</ISDB_hyperlink_descriptor>
```

D.19.22 ISDB_LDT_linkage_descriptor

Defined by ARIB in [28].

```
<ISDB_LDT_linkage_descriptor
    original_service_id="uint16, required"
    transport_stream_id="uint16, required"
    original_network_id="uint16, required">

  <Description
    id="uint16, required"
    type="uint4, required"
    user_defined="uint8, required"/>

</ISDB_LDT_linkage_descriptor>
```

D.19.23 ISDB_network_identifier_descriptor

Defined by ARIB in [28].

```
<ISDB_network_identifier_descriptor
    country_code="char3, required"
    media_type="AB|AC|BS|CB|TB, required"
    network_id="uint16, required">

  <private_data>
    Hexadecimal content
  </private_data>

</ISDB_network_identifier_descriptor>
```

D.19.24 ISDB_target_region_descriptor

Defined by ARIB in [28].

```
<ISDB_target_region_descriptor
    region_spec_type="uint8, required"
    regions_mask="string, optional"/>
```

D.19.25 ISDB_terrestrial_delivery_system_descriptor

Defined by ARIB in [28].

```
<ISDB_terrestrial_delivery_system_descriptor
    area_code="uint12, required"
    guard_interval="1/32|1/16|1/8|1/4, required"
    transmission_mode="2k|4k|8k|mode1|mode2|mode3, required">

  <!-- More than one frequency in case of MFN -->
  <frequency value="FrequencyHz, required"/>

</ISDB_terrestrial_delivery_system_descriptor>
```

D.19.26 logo_transmission_descriptor

Defined by ARIB in [28].

```
<logo_transmission_descriptor
    logo_transmission_type="uint8, required"
    logo_id="uint9, optional"
    logo_version="uint12, optional"
```

```
      download_data_id="uint16, optional"
      logo_char="string, optional">

   <reserved_future_use>
     Hexadecimal content
   </reserved_future_use>

</logo_transmission_descriptor>
```

Note: the presence of the various attributes depends on the value of **logo_transmission_type** (see [28]).

D.19.27 node_relation_descriptor

Defined by ARIB in [28].

```
<node_relation_descriptor
    reference_type="uint4, default=0"
    information_provider_id="uint16, optional"
    event_relation_id="uint16, optional"
    reference_node_id="uint16, required"
    reference_number="uint8, required"/>
```

D.19.28 partial_reception_descriptor

Defined by ARIB in [28].

```
<partial_reception_descriptor>
  <service id="uint16, required"/>
</partial_reception_descriptor>
```

D.19.29 reference_descriptor

Defined by ARIB in [28].

```
<reference_descriptor
    information_provider_id="uint16, required"
    event_relation_id="uint16, required">

  <!-- One per reference -->
  <reference
     reference_node_id="uint16, required"
     reference_number="uint8, required"
     last_reference_number="uint8, required"/>

</reference_descriptor>
```

D.19.30 satellite_delivery_system_descriptor

Defined by DVB in [5]. Redefined in a slightly different way by ARIB in [28]. See section D.8.82.

D.19.31 series_descriptor

Defined by ARIB in [28].

```
<series_descriptor
    series_id="uint16, required"
    repeat_label="uint4, required"
    program_pattern="uint3, required"
    expire_date="YYYY-MM-DD, optional"
    episode_number="uint12, required"
    last_episode_number="uint12, required"
    series_name="string, optional"/>
```

D.19.32 service_group_descriptor

Defined by ARIB in [28].

```
<service_group_descriptor service_group_type="uint4, required">

  <!-- One per service when service_group_type == 1 -->
  <service primary_service_id="uint16, required"
          secondary_service_id="uint16, required"/>

  <!-- Optional private data for other group types -->
  <private_data>
    Hexadecimal content
  </private_data>

</service_group_descriptor>
```

D.19.33 short_node_information_descriptor

Defined by ARIB in [28].

```
<short_node_information_descriptor
    ISO_639_language_code="char3, required"
    node_name="string, optional"
    text="string, optional"/>
```

D.19.34 SI_parameter_descriptor

Defined by ARIB in [28].

```
<SI_parameter_descriptor
    parameter_version="uint8, required"
    update_time="YYYY-MM-DD, required">

  <!-- One per SI table -->
  <table id="uint8, required">
    Hexadecimal content (table description bytes)
  </table>

</SI_parameter_descriptor>
```

D.19.35 SI_prime_TS_descriptor

Defined by ARIB in [28].

```
<SI_prime_TS_descriptor
    parameter_version="uint8, required"
    update_time="YYYY-MM-DD, required"
    SI_prime_TS_network_id="uint16, required"
    SI_prime_transport_stream_id="uint16, required">

  <!-- One per SI table -->
  <table id="uint8, required">
    Hexadecimal content (table description bytes)
  </table>

</SI_prime_TS_descriptor>
```

D.19.36 STC_reference_descriptor

Defined by ARIB in [28].

```
<STC_reference_descriptor
    STC_reference_mode="uint4, required"
    external_event_id="uint16, optional"
    external_service_id="uint16, optional"
    external_network_id="uint16, optional"
```

```
        NPT_reference="uint33, optional"
        STC_reference="uint33, optional"
        time_reference="hh:mm:ss, optional"
        time_reference_extension="mmm, optional">

    <reserved_data>
      Hexadecimal content
    </reserved_data>

  </STC_reference_descriptor>
```

D.19.37 system_management_descriptor

Defined by ARIB in [28].

```
  <system_management_descriptor
      broadcasting_flag="uint2, required"
      broadcasting_identifier="uint6, required"
      additional_broadcasting_identification="uint8, required">

    <additional_identification_info>
      Hexadecimal content
    </additional_identification_info>

  </system_management_descriptor>
```

D.19.38 TS_information_descriptor

Defined by ARIB in [28].

```
  <TS_information_descriptor
      remote_control_key_id="uint8, required"
      ts_name="string, required">

    <!-- Up to 3 transmission types -->
    <transmission_type transmission_type_info="uint8, required">
      <service id="uint16, required"/>
    </transmission_type>

    <reserved_future_use>
      Hexadecimal content
    </reserved_future_use>

  </TS_information_descriptor>
```

D.19.39 video_decode_control_descriptor

Defined by ARIB in [28].

```
  <video_decode_control_descriptor
      still_picture="bool, required"
      sequence_end_code="bool, required"
      video_encode_format="uint4, required"
      reserved_future_use="uint2, default=3"/>
```

D.20 Generic format for unsupported tables and descriptors

Unsupported tables and descriptors can be represented using generic XML tags.

D.20.1 Generic short table

```
  <generic_short_table table_id="uint8, required" private="bool, default=true">

  Generic table with binary payload of one short section, to be used when a
  specific table is not yet implemented. The body of this element shall contain
  an even number of hexadecimal digits, the payload of the short section.
```

The private indicator shall be false on MPEG-defined sections and preferably true on DVB-defined and user-defined sections.

```
</generic_short_table>
```

D.20.2   Generic long table

```
<generic_long_table
    table_id="uint8, required"
    table_id_ext="uint16, default=0xFFFF"
    version="uint5, default=0"
    current="bool, default=true"
    private="bool, default=true">
```

Generic table with binary payload of long sections, to be used when a specific table is not yet implemented.

The private indicator shall be false on MPEG-defined sections and preferably true on DVB-defined and user-defined sections.

```
<!-- One per section -->
<section>
  The body of the section elements shall contain an even number of hexadecimal
  digits, the payload of the long section. The CRC32 field is not part of this
  payload, it will be recomputed.
</section>
```

```
</generic_long_table>
```

D.20.3   Generic descriptor

```
<generic_descriptor tag="uint8, required">
```

Generic descriptor with binary payload, to be used when a specific descriptor is not yet implemented. The body of this element shall contain an even number of hexadecimal digits.

```
</generic_descriptor>
```