TSDuck

an extensible toolkit for MPEG/DVB transport streams

TSDuck Version 3.9

Agenda

- TSDuck overview
- TS utilities
- Transport stream processor
- XML table compiler
- Extending TSDuck
- Using TSDuck as an MPEG/DVB library for C++

TSDuck overview

- Process ISO/IEC 13818-1 transport streams
- Set of low-level utilities
  - extensible through plugins
- « Batch & Bash » oriented
  - command-line only, no fancy GUI
  - one utility or plugin = one elementary function
  - can be combined in any order
- Written in C++
  - reusable and extensible code
- Available on Linux, Windows and macOS

TSDuck sample usages (1/2)

- TS acquisition (satellite, terrestrial, IP, etc.)
- TS analysis
- Transmodulation
- Analysis, edition, injection of PSI / SI
  - using and editing PSI/SI in XML format
- TS packets carousel generation
  - packetization of SSU, etc.
- MPE injection and extraction (Multi-Protocol Encapsulation)

TSDuck sample usages (2/2)

- Test bed for CAS or STB
  - injection of test cases
  - DVB Scrambling and DVB SimulCrypt support
- Extraction of specific streams
  - T2-MI (DVB-T2 Modulator Interface)
  - PLP’s (Physical Layer Pipe)
  - Teletext subtitles
  - SCTE 35 splicing
- Any combination of the above and more…

TSDuck availability

- Web site
  https://tsduck.github.io/
- Open-source code
  https://github.com/tsduck/tsduck
- BSD license
  - liberal, no GPL-like contamination
- Installation
  - pre-built binary installers for Windows, Fedora, Ubuntu, Raspbian
  - using Homebrew on macOS

TSDuck documentation

- User's Guide

  https://github.com/tsduck/tsduck/raw/master/doc/tsduck.pdf

  - utilities reference
  - tsp plugins reference
  - sample usages
- Programmer's Reference

  https://tsduck.github.io/doxy/html/

  - generated by Doxygen from source code
  - C++ common code reference
  - writing tsp plugins guidelines

TS Utilities

the command line utilities summary

TS utilities : data & devices

- Transport stream file
  - raw binary file, sequence of 188-byte TS packets
    - use ***tsresync*** to convert 204-byte packets or corrupted files
  - by default, use standard input & output
    - can use pipes from / to any DVB source
- PSI / SI file
  - raw binary file, sequence of sections
- Specialized hardware
  - DVB-S, DVB-T, DVB-C tuners (cheap CE devices)
  - Dektec modulators and ASI input / output (PCI, USB)
  - smartcards
  - on Linux and Windows but not macOS

TS utilities summary (1/4)

- Transport stream processor
  - ***tsp*** : processing framework using plugins
- TS analysis
  - ***tsanalyze*** : synthetic report
    - TS structure, services, PID's
    - can also produce a « normalized » output for automatic processing
  - ***tspsi*** : detailed analysis of main PSI / SI tables in TS
    - PAT, CAT, PMT, SDT, NIT, BAT
  - ***tsbitrate*** : evaluate original bitrate from PCR's
  - ***tsdate*** : extract date & time information

TS utilities summary (2/4)

- Transport packet analysis
  - ***tsdump*** : dump and analyze transport packets
- TS files recovery
  - ***tsresync*** : fix corrupted capture files
  - ***tsftrunc*** : truncate TS files
  - ***tsfixcc*** : fix continuity counters

TS utilities summary (3/4)

- PSI / SI tables
  - ***tstables*** : extract sections & tables from TS
    - either binary or textual analysis
  - ***tstabdump*** : textual analysis of binary table files
  - ***tspacketize*** : generate TS packets from tables
    - sample usage : delivery of packet carousel for tables
  - ***tstabcomp*** : table compiler from XML source files
    - also a decompiler which generates XML from captured binary tables

TS utilities summary (4/4)

- Various DVB hardware support
  - ***tsdektec*** : control Dektec devices
  - ***tslsdvb*** : list DVB receiver devices
  - ***tsscan*** : scan frequencies in a DVB network
  - ***tsterinfo*** : compute various DVB-T information
  - ***tssmartcard*** : list or reset smartcard reader devices

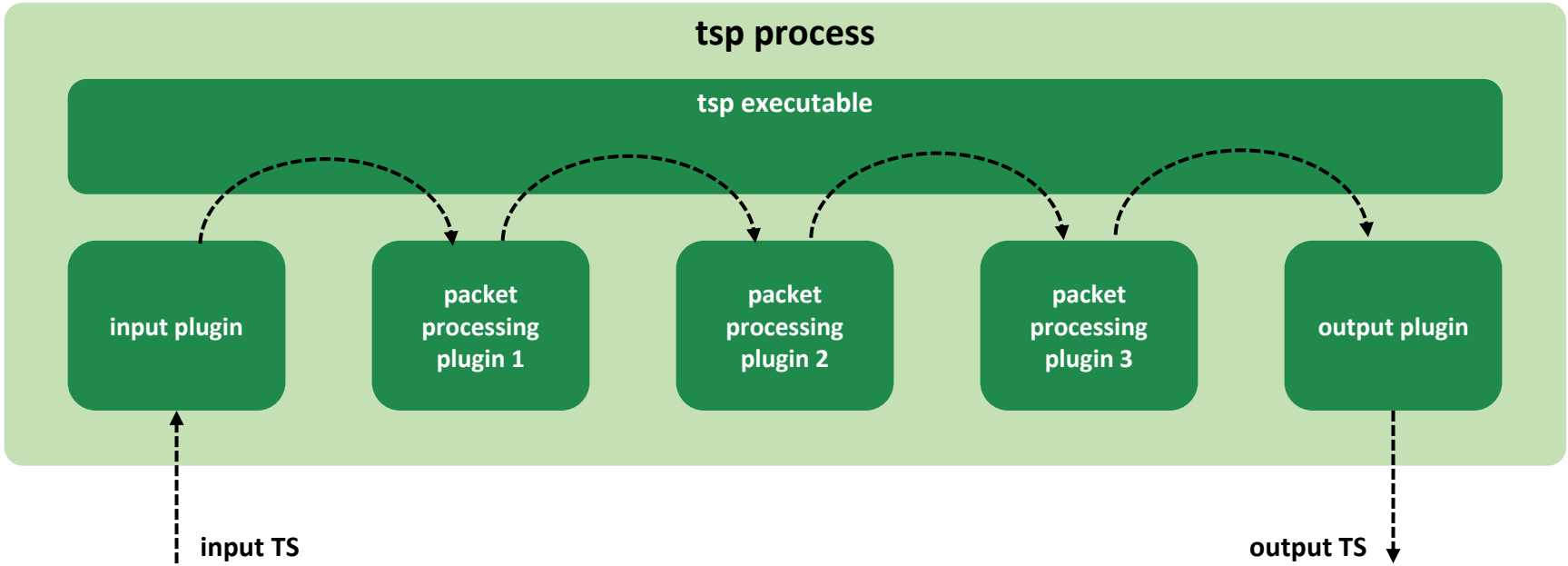
TSP

the transport stream processor

TSP overview

- Transport stream processing framework
  - Combination of elementary processing using plugins
  - One input plugin
    - receive a TS from various sources
  - Any number of packet processing plugins
    - perform transformations on TS packets
    - may remove packets
    - may NOT add packets
  - One output plugin
    - send the resulting TS to various destinations

TSP processing overview



TSP plugins

- Each tsp plugin is a shareable library
  - .so file on Linux and macOS
  - .dll file on Windows
- File naming
  - plugin named *foo* in file tsplugin_*foo*.so (or .dll)
  - same directory as tsp executable
- General command line syntax

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

TSP examples (1/5)

- TS acquisition

```
tsp -I dvb --uhf 21
    -P until --seconds 20
    -O file capture.ts
```

capture DVB-T stream from UHF channel 21

pass packets during 20 seconds, then stop

save TS to file capture.ts

- Display the PMT of a selected service

```
tsp -I dvb --uhf 35
    -P zap france2
    -P sifilter --pmt
    -P tables --max 1
    -O drop
```

extract service « France 2 », rebuild SPTS

extract PID containing PMT

display one table, then stop

drop output packet (don’t care)

TSP examples (2/5)

- Transmodulation of a service over IP multicast

```
tsp –I dvb –-uhf 35
    -P zap france2 –-audio fra
    -O ip 224.10.11.12:1000
```

extract service « France 2 », keeping only one audio track

broadcast resulting SPTS to multicast IP address:port

- On-the-fly replacement of a PSI / SI table

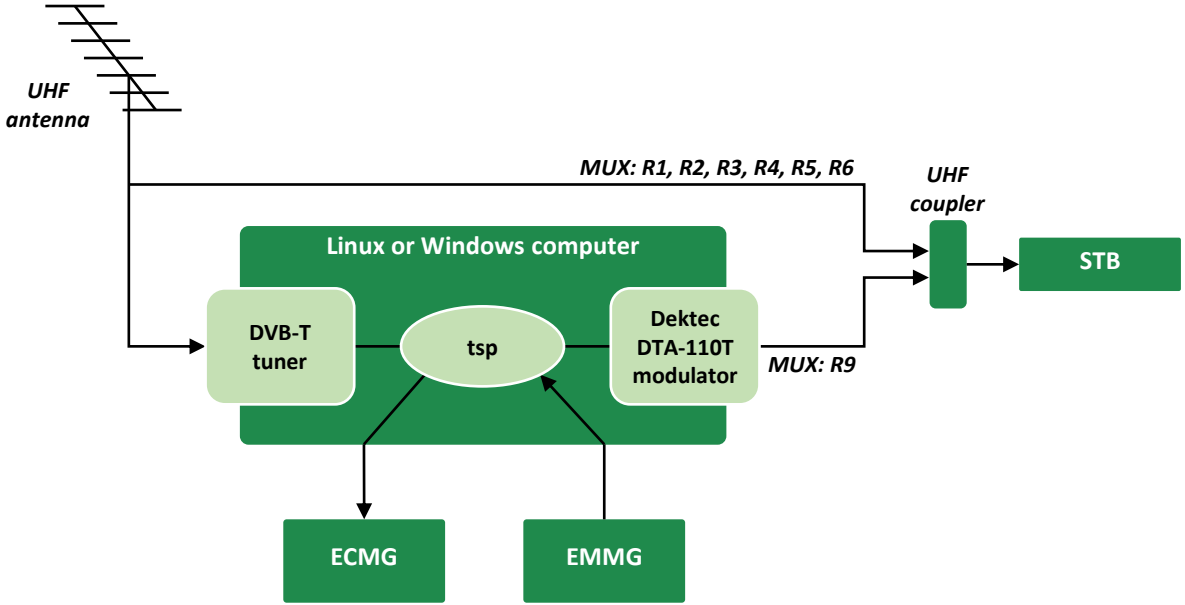
```
tsp -I dvb --uhf 24
    -P inject nit.bin --pid 16 --replace –-stuffing
    -O dektec --uhf 24 --convolution 2/3 --guard 1/32
```

replace content of PID 16 with table from binary file

send modified TS to a Dektec DVB-T modulator on same frequency

TSP examples (3/5)

- Conditional Access System test bed
  - example using French DVB-T network



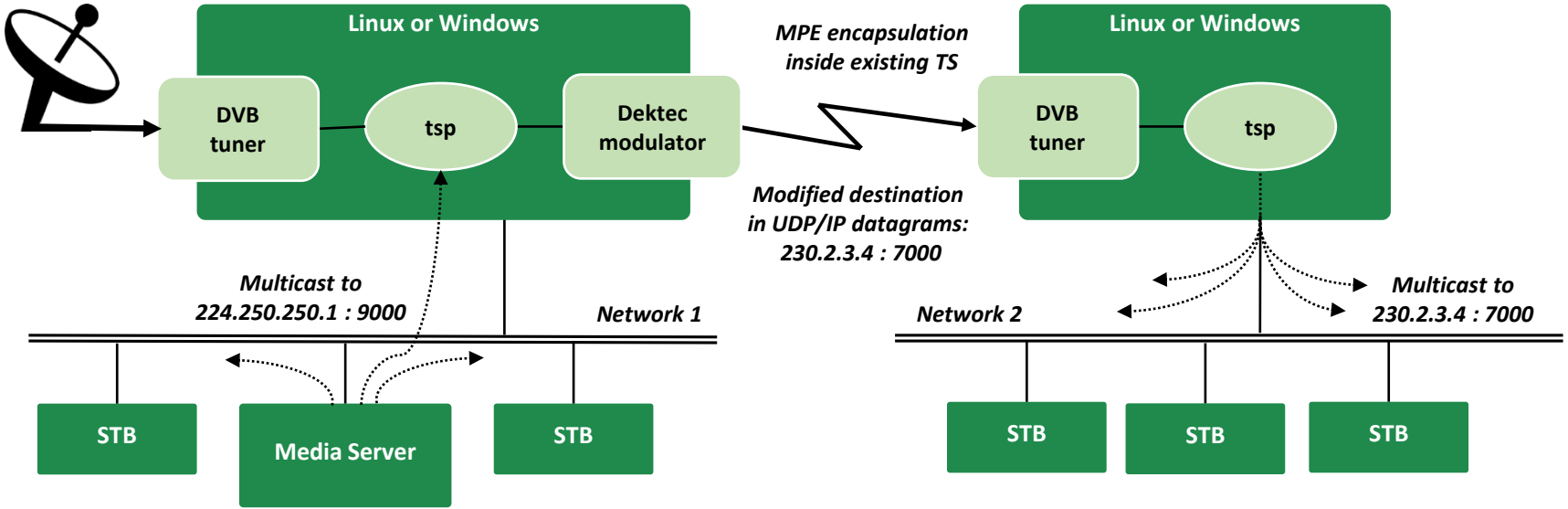
TSP examples (4/5)

- Conditional Access System test bed (continued)

```
tsp -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 -u $UHF_OUTPUT --convolution 2/3 --guard 1/32
```

TSP examples (5/5)

- MPE injection and extraction



TSP input & output plugins

- Input plugins
  - ***null*** : null packet generator
  - ***file*** : binary TS file
  - ***dektec*** : Dektec ASI device
  - ***dvb*** : DVB-S, DVB-T, DVB-C receiver devices
  - ***ip*** : UDP/IP (unicast or multicast)
- Output plugins
  - ***drop*** : drop packets
  - ***file*** : binary TS file
  - ***dektec*** : Dektec ASI or modulator device
  - ***ip*** : UDP/IP (unicast or multicast)
  - ***play*** : render output using VLC, mplayer, xine, whichever is available

TSP processing plugins

- TS transformations
  - PID or packet filtering, PSI/SI transformation or injection, service extraction, time regulation, etc.
- TS analysis and monitoring
  - TS analysis, PSI/SI extraction, PID, bitrate monitoring, ECM or EMM monitoring, etc.
- TS scrambling & descrambling
  - DVB SimulCrypt support for ECM / EMM injection
- Any other processing you wish to develop…
  - 50 packet processing plugins available today

tstabcomp

the PSI / SI table compiler

Compiling PSI/SI tables

- Input source files
  - describe PSI/SI tables in text files
  - XML format
- Output binary files
  - concatenated list of sections
  - same format as used by other tools and plugins
- Reverse operation (decompilation) also available
  - input: binary sections file
  - output: XML file

Sample XML source file

```
<?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">
      <ISO_639_language_descriptor>
        <language code="fre" audio_type="0x45"/>
        <language code="deu" audio_type="0x78"/>
      </ISO_639_language_descriptor>
    </component>
  </PMT>
</tsduck>
```

- Reference format in user’s guide

Typical application: manual table modification

- Tables can be used in XML or binary format anywhere
- Capture a table from a stream directly in XML format

```
tsp -I dvb ... \
    -P tables --pid 16 --tid 0x40 --max 1 --xml nit.xml \
    -O drop
```

- Manually edit the XML file with a text editor
- Inject the updated XML table in the stream

```
tsp -I dvb ... -P inject nit.xml --pid 16 ... -O dektec ...
```

Extending TSDuck

C++ transport stream programming

Extending TSDuck

- TSDuck is extensible
  - Source code provided

    ```
    git clone https://github.com/tsduck/tsduck.git
    ```

  - Common API for Linux, Windows and macOS
    - DVB tuners and Dektec cards are not supported on macOS
  - Programmer's guide
    - Doxygen-generated, see https://tsduck.github.io/
- You can modify it yourself !

Why extending TSDuck ?

- Identify your needs
- Try to find a solution using existing TSDuck
  - review utilities and plugins
- Try to extend an existing utility or plugin
  - add new options
  - add features, don’t modify existing behavior
  - remain upward compatible
- Develop your own plugin
  - it is quite simple, really
- Send your code back to TSDuck maintainer
  - so that everyone can benefit from it

Coding hints

- Don’t write a plugin from scratch
  - use an existing one as code base
  - choose one which is technically similar
    - input? output? PSI/SI transformation? packet filtering?
- Implement simple & elementary features
  - preserve TSDuck philosophy
    - develop several elementary plugins if necessary
    - not a single big plugin implementing several features
- RTFM as usual !

Supported environments

- Linux
  - tested on Intel 32 & 64 bits (Fedora, Ubuntu), ARM 32 bits (Raspberry Pi)
- macOS
  - tested on macOS High Sierra 10.13
- Windows
  - tested on Intel 32 & 64 bits, Windows 7 & 10
  - Microsoft Visual Studio 2017 Community Edition
    - free download from microsoft.com, no license fee
  - NSIS (Nullsoft Scriptable Install System)
    - free software,
    - used to create TSDuck installer with precompiled binaries

Using TSDuck Library

to develop third-party applications

The TSDuck library

- All TSDuck common code is in one large library
  - tsduck.so / tsduck.dll
- Contains generic and reusable C++ code
  - basic operating system independent features
    - system, multi-treading, synchronization, networking, cryptography, etc.
  - MPEG / DVB features
    - TS packets, PSI/SI tables, sections and descriptors, demultiplexing, packetization, DVB tuners, etc.
- Can be used in your application
  - even if not part of TSDuck

Using TSDuck as a library

- Used in an application outside TSDuck
- Install the TSDuck development environment
  - Windows: “Development” option in installer
  - Ubuntu, Debian, Raspbian: package `tsduck-dev`
  - Fedora, Red Hat, CentOS: package `tsduck-devel`
- Typical application source file

```
#include "tsduck.h"
... application code ...
```

Building with TSDuck library on UNIX

- Typical Linux Makefile

```
include /usr/include/tsduck/tsduck.mk
... application-specific rules ...
```

- Typical macOS Makefile

```
include /usr/local/include/tsduck/tsduck.mk
... application-specific rules ...
```

Building with TSDuck library on Windows

- Use Microsoft Visual Studio 2017
  - Community Edition is free
- Modify the application's project file (*app*`.vcxproj`)
  - Add one reference to the TSDuck property file

    ```
    <Import Project="$(TSDUCK)\tsduck.props" />
    ```
  - Just before the final `</Project>` closing tag
  - And build the application as usual

Thank you