TSDuck

An extensible toolbox for MPEG transport streams

Version 3.26

Topics

- TSDuck overview
- Transport stream processor
- PSI/SI table manipulation using XML or JSON
- Extending TSDuck
- TSDuck as an MPEG/DVB C++ library
- Using TSDuck from Java and Python

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
  - Java and Python bindings
- Available on Linux, Windows and macOS

What TSDuck is / is not

TSDuck is a general-purpose toolbox for digital TV engineers

➔ lab, demo, test, integration, debug, end-to-end testing ➔

TSDuck is not an off-the-shelf ready-to-use specialized application for production and operations

Sample usages (1/2)

- TS acquisition (IP, HTTP, HLS, SRT, DVB, ATSC, ISDB, ASI)
- TS analysis
- Transmodulation
- Analysis, edition, injection of PSI/SI
  - using and editing PSI/SI in XML or JSON format
- Service manipulation
  - extract, remove, rename, etc.
- SCTE 35 splicing injection and extraction
- MPE injection and extraction (Multi-Protocol Encapsulation)

Sample usages (2/2)

- Route, merge, fork TS between applications
- 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
- Any combination of the above and more…

Availability

- Web site

  https://tsduck.io/

- Open-source code

  https://github.com/tsduck/tsduck

- BSD license
  - liberal, no GPL-like contamination
  - can be used in all applications

Delivery

- Installation
  - pre-built binary installers for Windows and Linux
    Fedora, CentOS, Ubuntu, Debian, Raspbian
    user's contribution: Arch Linux (AUR)
  - through Homebrew on macOS
    user's contribution: MacPorts
- Documentation
  - user's guide
    PDF, ~500 pages of references and examples
  - programmer's guide
    doxygen-generated, online on tsduck.io
    for C++, Java and Python developers

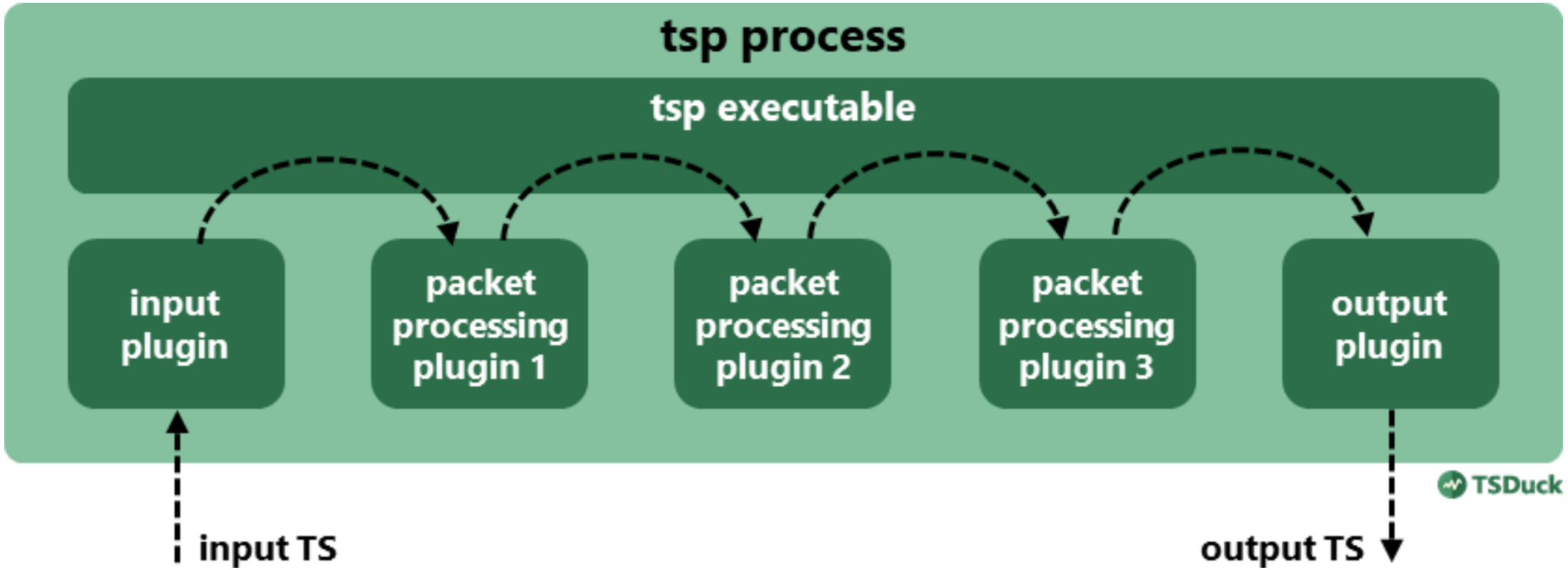
tsp

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 plugin chain



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)
- General command line syntax

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

tsp basic syntax

- TS acquisition

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

capture DVB stream from UHF channel 21

pass packets during 20 seconds, then stop

save packets 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 the PMT

display one table, then stop

drop output packets

Simple examples

- 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.xml --pid 16 --replace –-stuffing
    -O dektec --uhf 24 --convolution 2/3 --guard 1/3
```

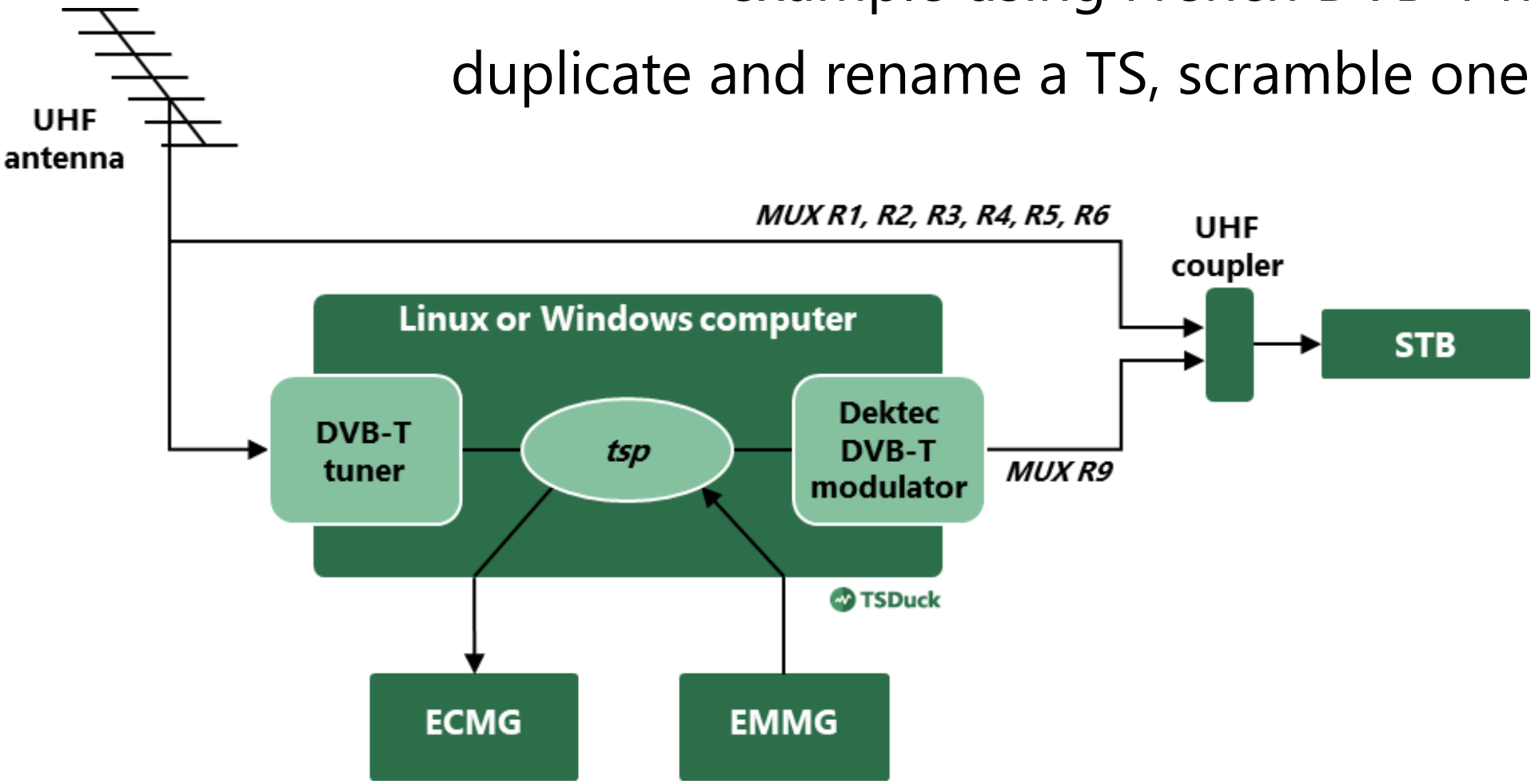
replace content of PID 16 with table from an XML file (a NIT)

send modified TS to a Dektec modulator on same frequency

Sample CAS test bed (1/2)

example using French DVB-T network:

duplicate and rename a TS, scramble one service



Sample CAS test bed (2/2)

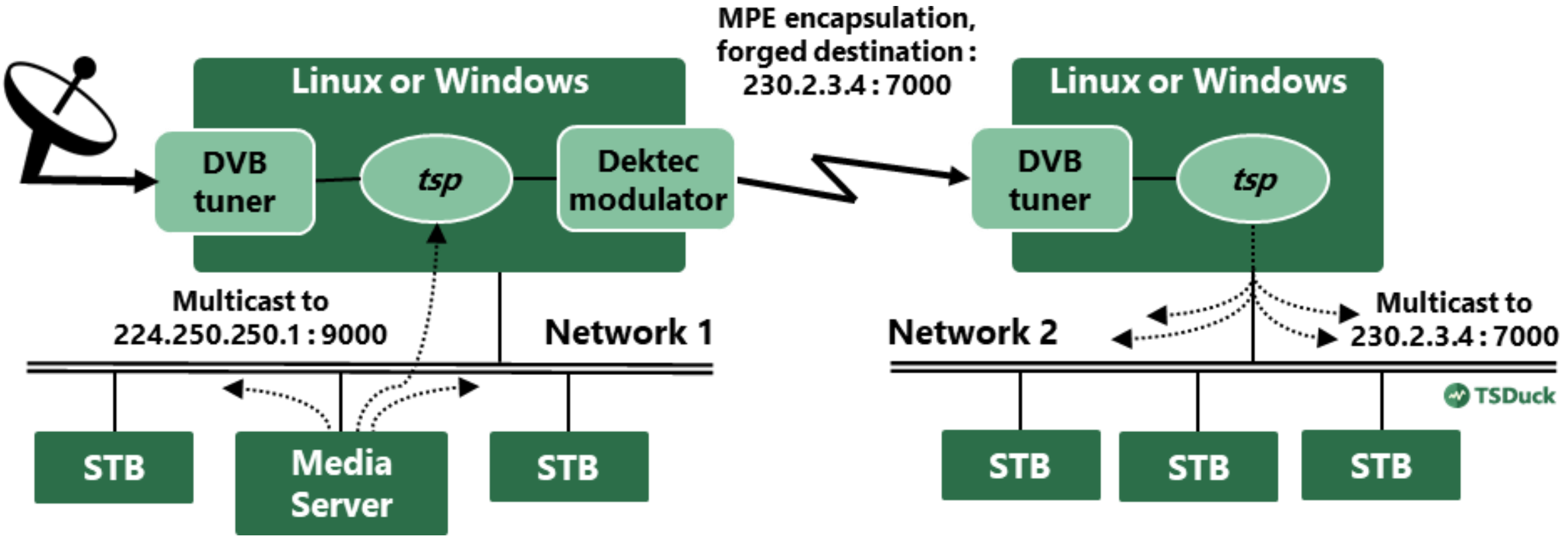

```
tsp -I dvb -u $UHF_INPUT
    -P tsrename -t 9 -a
    -P svrename direct8  -i 0x0901 -l 41 -n "Direct 8 Test"
    -P svrename bfmtv    -i 0x0903 -l 42 -n "BFM TV Test"
    -P svrename 'i>tele' -i 0x0904 -l 43 -n "i>TELE Test"
    -P svrename virgin17 -i 0x0905 -l 44 -n "Virgin 17 Test"
    -P svrename 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
```

rename the TS,
rename all services in the TS
(service name, service id, LCN)

scramble one service,
connect to a real ECM Generator,
update PMT, insert ECM's

accept connection from
a real EMM Generator,
update the CAT, insert EMM's

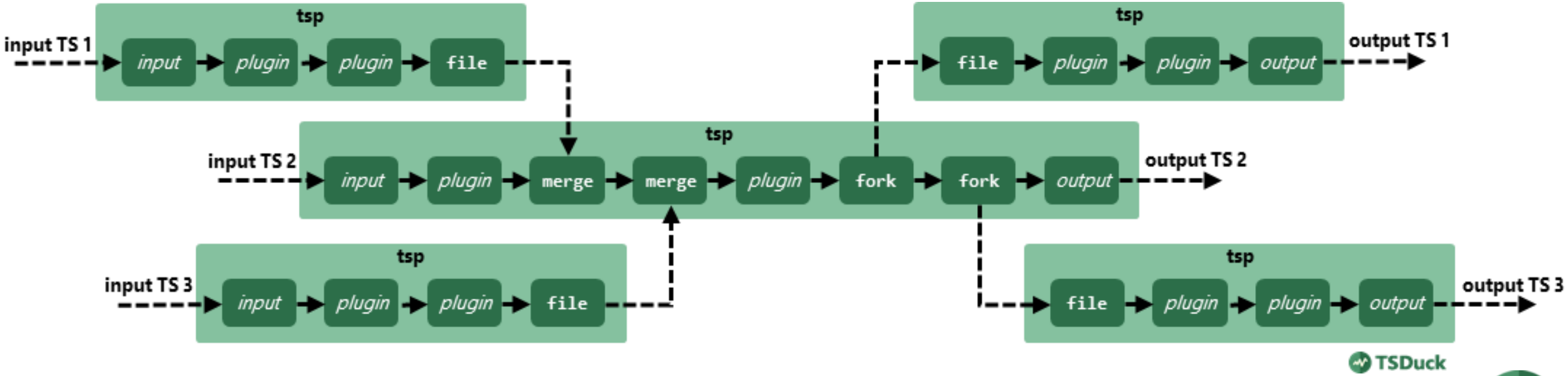
Sample MPE injection and extraction



Multiple tsp instances

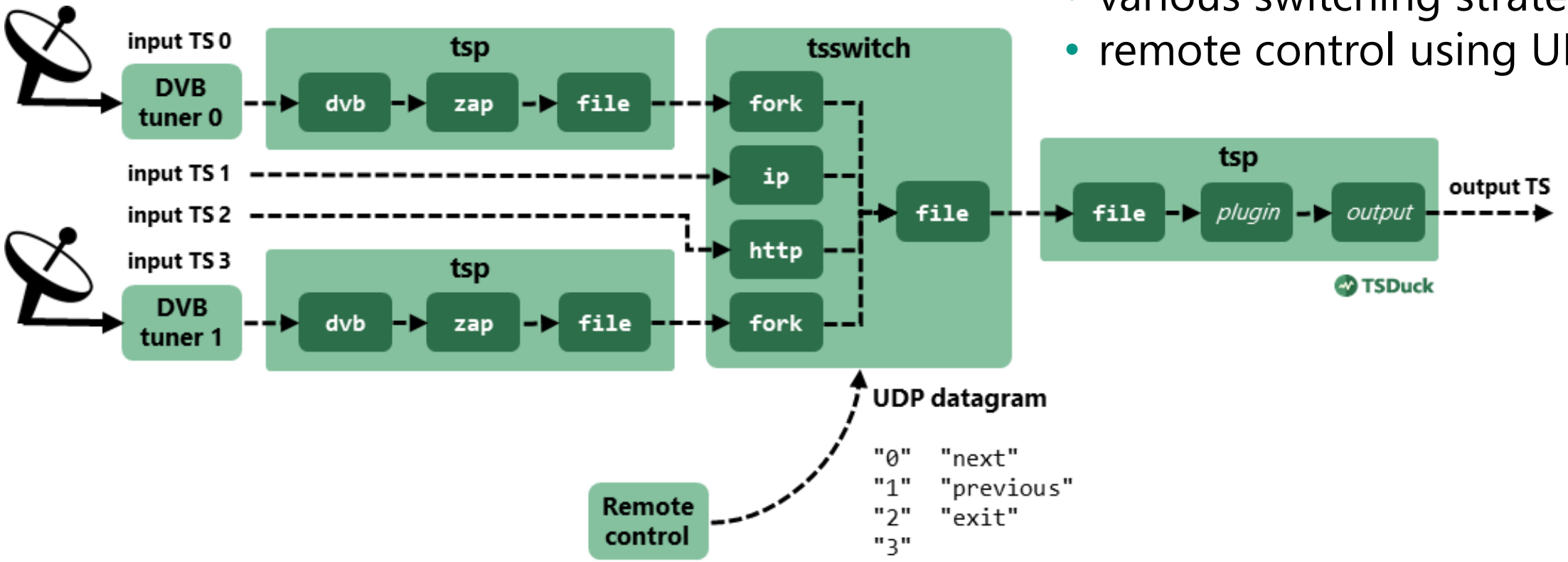
- `fork` : duplicate the TS to another application
- `merge` : merge with a TS coming from another application

  merge service references (PAT, CAT, etc.)



Switching between multiple inputs

- tsswitch command
- same plugins as tsp
- various switching strategies
- remote control using UDP



Input and output plugins

- Input plugins
  - Files: TS, M2TS, PCAP
  - Network: multicast IP, HLS, HTTP, SRT
  - Hardware: tuners (DVB, ATSC, ISDB), Dektec (ASI, demodulators)
  - Application: fork, memory, craft, null
- Output plugins
  - Files: TS, M2TS
  - Network: multicast IP, HLS, SRT
  - Hardware: Dektec (ASI, modulators), HiDes (modulators)
  - Application: fork, memory, drop, media player

Packet processing plugins

- TS transformations
  - PID or packet filtering, PSI/SI transformation or injection, service extraction or modification, etc.
- TS regulation
  - time regulation, time shifting, scheduled recording, 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
- Data injection of extraction
  - SCTE 35, T2-MI, MPE, Teletext
- Any other processing you wish to develop…
  - 67 packet processing plugins available (version 3.26)

PSI/SI tables manipulation

binary, XML or JSON

MPEG tables and sections

- Extraction from TS, injection into TS
- Data formats
  - binary
    raw sections
  - XML
    fully documented in user's guide
    easy to manually edit or process in applications
  - JSON
    through automated XML-to-JSON conversion
    easy to process in applications, especially in Python
- All formats are uniformly used
  - TS extraction, modification, injection
  - file manipulation

Sample XML 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>
```

Multiple ways to update tables in a TS

- Specialized plugins with predefined options
  - BAT, CAT, NIT, PAT, PMT, SDT
- Manual XML handling
  - Extract the table as an XML file
  - Edit the file
  - Reinject the file
- Automated XML modification
  - Using « XML patch files »
  - Flexible XML templates to update tables on the fly
  - Similar to XSLT in principle, but much simpler

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.io/
- You can modify it yourself !

Why extending TSDuck?

- Identify your needs
- Try to find a solution using existing TSDuck plugins
  - 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 using a pull request
  - 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
- Read the « TSDuck coding guidelines » document
  - a recommended reading, although not required

RTFM

(as usual)

Using the TSDuck library

to develop third-party applications
in C++, Java or Python

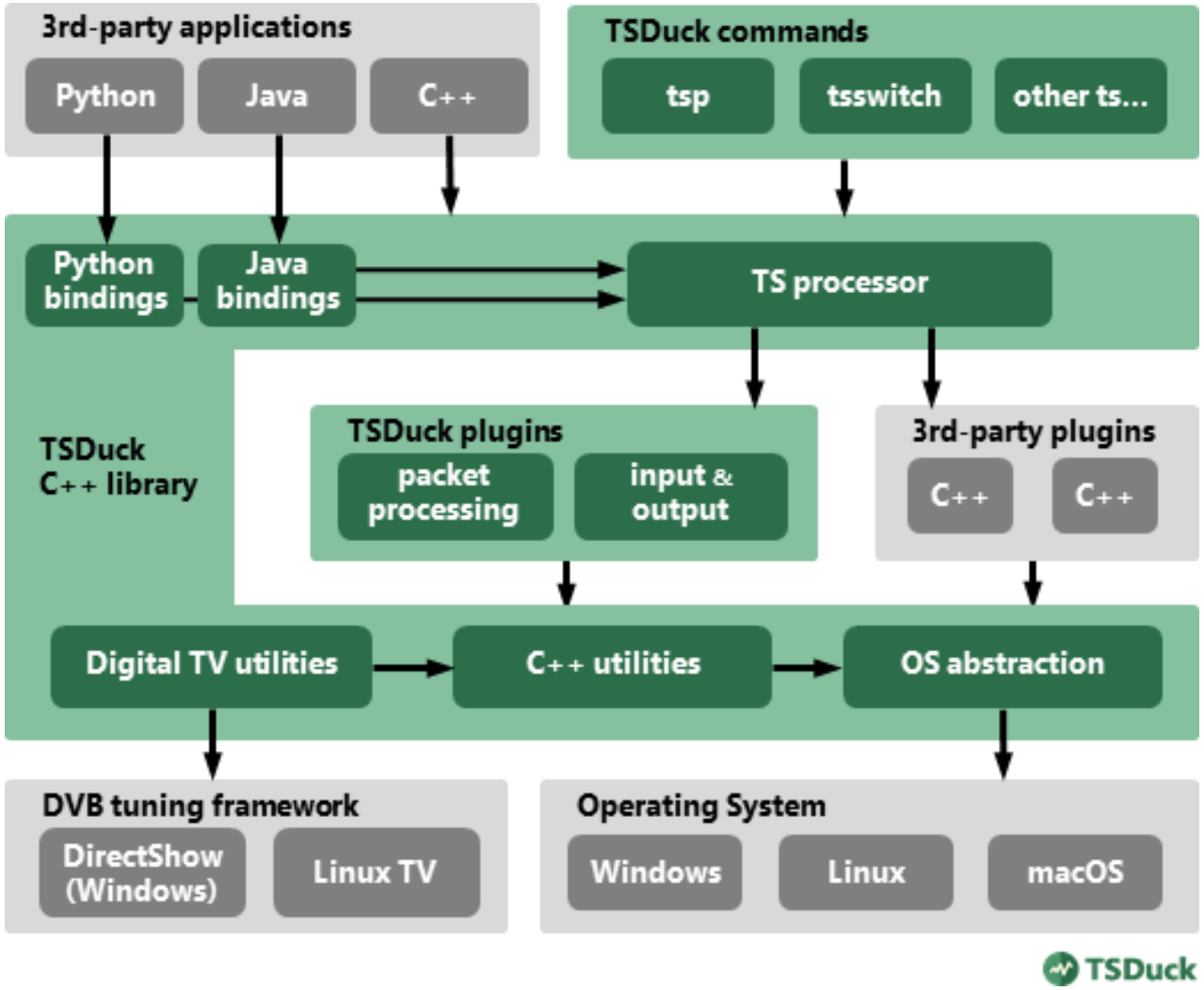
TSDuck library

- All TSDuck common code is in one large library
  - libtsduck.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, encapsulation, DVB tuners, etc.
- Can be used in your application
  - even if not part of TSDuck

Software architecture



- C++ applications
  - all TSDuck features
- Java or Python applications
  - high-level features only
  - interactions using JSON or XML
  - memory buffers for input/output
- Custom plugins
  - C++ only

Programmer's guide

- Online, see https://tsduck.io/doxy/
  - automatically updated every night
- Tutorials
  - building TSDuck and applications using its library
  - developing TSDuck plugins and extensions
  - C++ library tutorial
  - Java and Python bindings
- Reference
  - all C++, Java and Python classes

Thank you

Any question?