Jpylyzer User Manual

Contents

1 Introduction **1**
- 1.1 About jpylyzer . . . 1
- 1.2 Validation: scope and restrictions . . . 1
- 1.3 Outline of this User Manual . . . 3
- 1.4 Funding . . . 3
- 1.5 License . . . 3

2 Installation and set-up **5**
- 2.1 Obtaining the software . . . 5
- 2.2 Installation with Pip (Linux/Unix, Windows, Mac OS X) . . . 6
- 2.3 Installation of Windows binaries (Windows only) . . . 7
- 2.4 Installation of Debian packages (Ubuntu/Linux) . . . 8

3 Using *jpylyzer* **9**
- 3.1 Overview . . . 9
- 3.2 Command-line usage . . . 9
- 3.3 Using *jpylyzer* as a Python module . . . 14
- 3.4 Java integration . . . 15

4 Structure of a JP2 file **17**
- 4.1 Scope of this section . . . 17
- 4.2 General format structure . . . 17
- 4.3 General structure of a box . . . 19
- 4.4 Defined boxes in JP2 . . . 19

5 Output format **23**
- 5.1 Overview . . . 23
- 5.2 toolInfo element . . . 23
- 5.3 file element . . . 23
- 5.4 fileInfo element . . . 25
- 5.5 statusInfo element . . . 25
- 5.6 isValid element . . . 26
- 5.7 tests element . . . 26

5.8 properties element 26
5.9 propertiesExtension element 26

6 JP2: box by box **29**
6.1 About the properties and tests trees 29
6.2 JPEG 2000 Signature box 30
6.3 File Type box 30
6.4 JP2 Header box (superbox) 31
6.5 Image Header box (child of JP2 Header box) 33
6.6 Bits Per Component box (child of JP2 Header box) 34
6.7 Colour Specification box (child of JP2 Header box) 34
6.8 Palette box (child of JP2 Header box) 37
6.9 Component Mapping box (child of JP2 Header box) 37
6.10 Channel Definition box (child of JP2 Header box) 38
6.11 Resolution box (child of JP2 Header box, superbox) 39
6.12 Capture Resolution box (child of Resolution box) 40
6.13 Default Display Resolution box (child of Resolution box) 41
6.14 Contiguous Codestream box 42
6.15 Intellectual Property box 42
6.16 XML box 42
6.17 UUID box 43
6.18 UUID Info box (superbox) 44
6.19 UUID List box (child of UUID Info box) 45
6.20 Data Entry URL box (child of UUID Info box) 45
6.21 Unknown box 46
6.22 Top-level tests and properties 46

7 Contiguous Codestream box **51**
7.1 General codestream structure 51
7.2 Limitations of codestream validation 53
7.3 Structure of reported output 55
7.4 Contiguous Codestream box 55
7.5 Image and tile size (SIZ) marker segment (child of Contiguous Codestream box) 59
7.6 Coding style default (COD) marker segment 60
7.7 Coding style component (COC) marker segment 62
7.8 Region-of-interest (RGN) marker segment 63
7.9 Quantization default (QCD) marker segment 64
7.10 Quantization component (QCC) marker segment 65
7.11 Progression order change (POC) marker segment 66
7.12 Component registration (CRG) marker segment 67
7.13 Comment (COM) marker segment 68
7.14 Tile part (child of Contiguous Codestream box) 69
7.15 Start of tile part (SOT) marker segment (child of tile part) . . . 70
7.16 Tile-part lengths (TLM) marker segment 71
7.17 Packet length, main header (PLM) marker segment 72

7.18 Packed packet headers, main header (PPM) marker segment . . . 72
7.19 Packet length, tile-part header (PLT) marker segment 73
7.20 Packed packet headers, tile-part header (PPT) marker segment . 73

8 References **75**

Chapter 1

Introduction

1.1 About jpylyzer

This User Manual documents *jpylyzer*, a validator and feature extractor for JP2 images. JP2 is the still image format that is defined by JPEG 2000 Part 1 (ISO/IEC 15444-1). *Jpylyzer* was specifically created to answer the following questions that you might have about any JP2 file:

1. Is this really a JP2 and does it really conform to the format's specifications (validation)?
2. What are the technical characteristics of this image (feature extraction)?

1.2 Validation: scope and restrictions

Since the word 'validation' means different things to different people, a few words about the overall scope of *jpylyzer*. First of all, it is important to stress that *jpylyzer* is not a 'one stop solution' that will tell you that an image is 100% perfect. What *jpylyzer* does is this: based on the JP2 format specification (ISO/IEC 15444-1), it parses a file. It then subjects the file's contents to a large number of tests, each of which is based on the requirements and restrictions that are defined by the standard. If a file fails one or more tests, this implies that it does not conform to the standard, and is no valid JP2. Importantly, this presumes that *jpylyzer*'s tests accurately reflect the format specification, without producing false positives.

1.2.1 'Valid' means 'probably valid'

If a file passes all tests, this is an indication that it is *probably* valid JP2. This (intentionally) implies a certain degree of remaining uncertainty, which is related to the following.

First of all, *jpylyzer* (or any other format validator for that matter) 'validates' a file by trying to prove that it does *not* conform to the standard. It cannot prove that that a file *does* conform to the standard.

Related to this, even though *jpylyzer*'s validation process is very comprehensive, it is not complete. For instance, the validation of JPEG 2000 codestreams at this moment is still somewhat limited. These limitations are discussed in detail here. Some of these limitations (e.g. optional codestream segment markers that are only minimally supported at this stage) may be taken away in upcoming versions of the tool.

1.2.2 No check on compressed bitstreams

One important limitation that most certainly will *not* be addressed in any upcoming versions is that *jpylyzer* does not analyse the data in the compressed bitstream segments. Doing so would involve decoding the whole image, and this is completely out of *jpylyzer*'s scope. As a result, it is possible that a JP2 that passes each of *jpylyzer*'s tests will nevertheless fail to render correctly in a viewer application.

1.2.3 Recommendations for use in quality assurance workflows

Because of the foregoing, a thorough JP2 quality assurance workflow should not rely on *jpylyzer* (or any other format validator) alone, but it should include other tests as well. Some obvious examples are:

- A rendering test that checks if a file renders at all
- Format migration workflows (e.g. TIFF to JP2) should ideally also include some comparison between source and destination images (e.g. a pixel-wise comparison)

Conversely, an image that successfully passes a rendering test or pixel-wise comparison may still contain problematic features (e.g. incorrect colour space information), so validation, rendering tests and pixel-wise comparisons are really complementary to each other.

1.2.4 Note on ICC profile support

The support of ICC profiles in JP2 was recently extended through an amendment to the standard. These changes are taken into account by *jpylyzer*, which is in line with the most recent version of the (updated) standard.

1.3 Outline of this User Manual

We start by describing the installation process of *jpylyzer* for Windows and Unix-based systems. We then explain its basic usage, either as a command-line tool, or as an importable Python module. This is followed by a brief overview of the structure of the JP2 format and its 'box' structure, and an explanation of *Jpylyzer*'s output format. The final sections give a detailed description of the tests that *jpylyzer* performs for validation, and the properties that are reported in the output. The penultimate section does this for all 'boxes', except the 'Contiguous Codestream' box, which is given a section of its own.

1.4 Funding

The development of *jpylyzer* was funded by the EU FP 7 project SCAPE (SCAlable Preservation Environments). More information about this project can be found here:

https://www.scape-project.eu/

1.5 License

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https://www.gnu.org/licenses/

On Debian systems, the complete text of the GNU Lesser General Public License version 3 can be found in:

`/usr/share/common-licenses/LGPL-3`

Chapter 2

Installation and set-up

2.1 Obtaining the software

To obtain the latest version of the software please use the download links at the *jpylyzer* homepage:

https://jpylyzer.openpreservation.org/

You have three options:

1. Install the software with the *Pip* package manager. This works on all platforms (Windows, Linux, Mac, etc.), but you need to have the Python interpreter available on your system. Jpylyzer is compatible with Python 2.7, and Python 3.2 and more recent (Python 3.0 and 3.1 are not supported).

2. Alternatively, for Windows users there is also a set of stand-alone binaries[1]. These allow you to run *jpylyzer* as an executable Windows application, without any need for installing Python. This option is particularly useful for Windows users who cannot (or don't want to) install software on their system.

3. For Linux users Debian packages are available.

These options are described in the following sub-sections.

[1]The *jpylyzer* binaries were created using the *PyInstaller* package: https://www.pyinstaller.org/

2.2 Installation with Pip (Linux/Unix, Windows, Mac OS X)

2.2.1 General installation procedure

First make sure you have a recent version of *pip*. Then install *jpylyzer* with the following command:

```
pip install jpylyzer
```

2.2.2 Single user installation (Linux)

On most Linux systems the above command needs to be run as super user (see below). If you don't want this use the below command for a single-user install:

```
pip install jpylyzer --user
```

This will install the software to the `.local` folder (hidden by default!) in your home directory (`~/.local`). Next try to run *jpylyzer* by entering:

```
jpylyzer
```

Most likely this will result in:

```
jpylyzer: command not found
```

If this happens, add the directory `~/.local/bin` (which is where the jpylyzer command-line tool is installed) to the `PATH` environment variable (you only need to do this once). To do this, locate the (hidden) file `.profile` in you home directory (`~/`), and open it in a text editor. Then add the following lines at the end of the file:

```
# set PATH so it includes the user's .local bin if it exists
if [ -d "$HOME/.local/bin" ] ; then
    PATH="$HOME/.local/bin:$PATH"
fi
```

Save the file, log out of your session and then log in again. Open a command terminal and type:

```
jpylyzer
```

If all went well you now see this:

```
usage: jpylyzer [-h] [--format FMT] [--legacyout] [--mix {1,2}] [--nopretty]
           [--nullxml] [--recurse] [--packetmarkers] [--verbose]
           [--version] [--wrapper]
           jp2In [jp2In ...]
jpylyzer: error: the following arguments are required: jp2In
```

Which means that the installation was successful!

2.2.3 Global installation (Linux)

Simply enter:

```
sudo -H pip install jpylyzer
```

No further configuration is needed in this case.

2.2.4 Note on pre-releases

The above command lines will only install stable versions of jpylyzer. In order to install the latest pre-release, add the `--pre` switch. For example:

```
sudo -H pip install jpylyzer --pre
```

2.3 Installation of Windows binaries (Windows only)

Download the binary using the link on the *jpylyzer* homepage. Unzip the contents of this file to an empty folder on your PC. *Jpylyzer* should now be ready for use.

2.3.1 Testing the installation

To test your installation, open a Command Prompt ('DOS prompt') and type:

```
%jpylyzerPath%\jpylyzer
```

In the above command, replace *%jpylyzerPath%* with the full path to the *jpylyzer* installation directory (i.e. the directory that contains 'jpylyzer.exe' and its associated files). For example, if you extracted the files to directory `c:\tools\jpylyzer`, the command would become:

```
c:\tools\jpylyzer\jpylyzer
```

Executing this command should result in the following screen output:

```
usage: jpylyzer [-h] [--format FMT] [--legacyout] [--mix {1,2}] [--nopretty]
          [--nullxml] [--recurse] [--packetmarkers] [--verbose]
          [--version] [--wrapper]
          jp2In [jp2In ...]
jpylyzer: error: the following arguments are required: jp2In
```

2.3.2 Running jpylyzer without typing the full path

Optionally, you may also want to add the full path of the *jpylyzer* installation directory to the Windows 'Path' environment variable. Doing so allows you to run *jpylyzer* from any directory on your PC without having to type the full path. In Windows 7 you can do this by selecting 'settings' from the 'Start'

menu; then go to 'control panel'/'system' and go to the 'advanced' tab. Click on the 'environment variables' button. Finally, locate the 'Path' variable in the 'system variables' window, click on 'Edit' and add the full *jpylyzer* path (this requires local Administrator privileges). The settings take effect on any newly opened command prompt.

2.4 Installation of Debian packages (Ubuntu/Linux)

For Linux, Debian packages of *jpylyzer* exist. To install, simply download the *.deb* file, double-click on it and select *Install Package*. Alternatively you can also do this in the command terminal by typing:

```
sudo dpkg -i opf-jpylyzer_2.0.0_all.deb
```

In both cases you need to have administrative privileges.

For *Ubuntu* and *Debian* alternative packages are available in the official release channels. To install simply run the following commands:

```
sudo apt-get update
sudo apt-get install python-jpylyzer
```

Chapter 3

Using *jpylyzer*

3.1 Overview

This section describes the general use of *jpylyzer*. The first sub-sections cover the use of *jpylyzer* as a command-line tool and as an importable Python module.

3.2 Command-line usage

This section explains *jpylyzer*'s general command-line interface. For the sake of brevity, full paths to *jpylyzer* are omitted. This means that, depending on your system and settings, you may have to substitute each occurrence of 'jpylyzer' with its full path, the corresponding Windows binary, or a combination of both. The following examples illustrate this:

This User Manual	jpylyzer
Substitution example Linux	`/home/jpylyzer/jpylyzer`
Substitution example Windows binaries	`c:\tools\jpylyzer\jpylyzer`

Furthermore, command line arguments that are given between square brackets (example: `[-h]`) are optional.

3.2.1 Synopsis

Jpylyzer can be invoked using the following command-line arguments:

```
usage: jpylyzer [-h] [--format FMT] [--legacyout] [--mix {1,2}] [--nopretty]
          [--nullxml] [--recurse] [--packetmarkers] [--verbose]
          [--version] [--wrapper]
          jp2In [jp2In ...]
```

3.2.1.1 Positional arguments

Argument	Description
`jp2In`	input JP2 image(s), may be one or more (whitespace-separated) path expressions; prefix wildcard (*) with backslash (\) in Linux

3.2.1.2 Optional arguments

Argument	Description
`[-h, --help]`	show help message and exit
`[--format FMT]`	validation format; allowed values are `jp2` (used by default) and `j2c` (which activates raw codestream validation)
`[--mix {1,2}]`	report additional output in NISO MIX format (version 1.0 or 2.0)
`[--legacyout]`	report output in jpylyzer 1.x format (provided for backward compatibility only)
`[--nopretty]`	suppress pretty-printing of XML output
`[--nullxml]`	extract null-terminated XML content from XML and UUID boxes(doesn't affect validation)
`[--recurse, -r]`	when analysing a directory, recurse into subdirectories (implies `--wrapper` if `--legacyout` is used)
`[--packetmarkers]`	Report packet-level codestream markers (plm, ppm, plt, ppt)
`[--verbose]`	report test results in verbose format
`[-v, --version]`	show program's version number and exit
`[--wrapper, -w]`	wrap output for individual image(s) in 'results' XML element (deprecated from jpylyzer 2.x onward, only takes effect if `--legacyout` is used)

Note that the input can either be a single image, a space-separated sequence of images, a pathname expression that includes multiple images, or any combination of the above. For example, the following command will process one single image:

```
jpylyzer rubbish.jp2
```

The next example shows how to process all files with a 'jp2' extension in the current directory:

```
jpylyzer *.jp2
```

Note that on Unix/Linux based systems pathname expressions may not work properly unless you wrap them in quotation marks:

```
jpylyzer "*.jp2"
```

3.2.2 Output redirection

All output (except warning and system error messages) is directed to the standard output device (stdout). By default this is the console screen. Use your platform's standard output redirection operators to redirect output to a file. The most common situation will be to redirect the output of one invocation of *jpylyzer* to an XML file, which can be done with the '>' operator (both under Windows and Linux):

```
jpylyzer jp2In > outputFile
```

E.g. the following command will run *jpylyzer* on image 'rubbish.jp2' and redirects the output to file 'rubbish.xml':

```
jpylyzer rubbish.jp2 > rubbish.xml
```

The format of the XML output is described here.

3.2.3 'format' option

By default, *jpylyzer* validates against the *JP2* format specification. Starting with version 2.0, *jpylyzer* can also validate raw JPEG 2000 codestreams that are not wrapped inside a *JP2* container. For codestream validation, use the `--format` option with value `j2c`, e.g.:

```
jpylyzer --format j2c rubbish.j2c > rubbish.xml
```

3.2.4 'mix' option

When this option is used, *jpylyzer* reports additional output in *NISO MIX* format. This option takes one argument that defines whether *MIX* 1.0 or *MIX* 2.0 is used. For example, the following command will result in *MIX* 2.0 output:

```
jpylyzer --mix 2 rubbish.jp2 > rubbish.xml
```

The *MIX* output is wrapped inside a *file/propertiesExtension* element. Note that *MIX* output is *only* written for files that are valid JP2 (files that are not valid result in an empty *propertiesExtension* element). Also, the `--mix` option is ignored if `--format` is set to `j2c`, or if `--legacyout` (see below) is used.

3.2.5 'legacyout' option

The output format of *jpylyzer* has changed in version 2.0, which may break existing workflows that expect output in 1.x format. For backward compatibility the `--legacyout` option results in output that follows the old 1.x format. Note that codestream validation is disabled if you use this option.

3.2.6 'recurse' option

If the `--recurse` option is used, *jpylyzer* will recursively traverse all subdirectories of a filepath expression. E.g:

```
jpylyzer /home/myJP2s/*.jp2 > rubbish.xml
```

In this case *jpylyzer* analyses all files that have a *.jp2* extension in directory */home/myJP2s* and all its subdirectories.

3.2.7 'packetmarkers' option

When this option is enabled, jpylyzer will report the properties of the following packet-level codestream markers:

- PLM (packet length, main header) marker
- PPM (packed packet headers, main header) marker
- PLT (packet length, tile-part header) marker
- PPT (packed packet headers, tile-part header) marker

By default these are excluded from the output, in order to prevent excessive output size.

3.2.8 'wrapper' option (deprecated)

This deprecated option is included for backward-compatibility, and only takes effect if `--legacyout` (see above) is used.By default, the *jpylyzer* 1.x releases would create a separate XML tree for each analysed image, without any overarching hierarchy. For multiple-image pathname expressions this resulted in output that was **not** well-formed XML. The `--legacyout` option still results in this is behaviour. For example:

```
jpylyzer --legacyout rubbish.jp2 garbage.jp2 > rubbish.xml
```

In this case, the file 'rubbish.xml' contains a succession of two XML trees, which by itself is not well-formed XML. The `--wrapper` option is provided to create valid XML instead:

```
jpylyzer --legacyout --wrapper rubbish.jp2 garbage.jp2 > rubbish.xml
```

In the above case the XML trees of the individual images are wrapped inside a 'results' element. When the `--recurse` option is used, jpylyzer will automatically wrap the output in a 'results' element, so there's no need to specify `--wrapper` in that case.

Starting with version 2.0, *jpylyzer always* generates well-formed XML (unless the `--legacyout` option is used), which makes the `--wrapper` option largely obsolete, apart from cases where the 'old' behaviour is needed for backward-compatibility reasons.

3.2.9 'nullxml' option

The *nullxml* option was added to enable extraction of XML content that is terminated by a null-byte. By default *jpylyzer* doesn't report the XML in that case, because it throws an exception in the XML parser. Apparently some old versions of the Kakadu demo applications would erroneously add a null-byte to embedded XML, so this option can be used to force extraction for images that are affected by this.

3.2.10 User warnings

Under the following conditions *jpylyzer* will print a user warning to the standard error device (typically the console screen):

3.2.10.1 No images to check

If there are no input images to check (typically because the value of jp2In refers to a non-existent file), the following warning message is shown:

```
User warning: no images to check!
```

3.2.10.2 Unsupported box

In some cases you will see the following warning message:

```
User warning: ignoring 'boxName' (validator function not yet implemented)
```

The reason for this: a JP2 file is made up of units that are called 'boxes'. This is explained in more detail here. Each 'box' has its own dedicated validator function. At this stage validator functions are still missing for a small number of (optional) boxes. *Jpylyzer* will display the above warning message if it encounters a (yet) unsupported box. Any unsupported boxes are simply ignored, and the remainder of the file will be analyzed (and validated) normally.

3.2.10.3 Error while processing a file

In rare cases you may come across one of the following messages:

```
User warning: memory error (file size too large)
```

Memory errors may occur for (very) large images. If you get this warning, try using a machine with more RAM. Also, a machine's chip architecture and the operating system may put constraints on the amount of memory that can be allocated.

The following warning indicates an input error:

```
User warning: I/O error (cannot open file)
```

Finally, the following messages most likely indicate a jpylyzer bug:

```
User warning:runtime error (please report to developers)
```

and:

```
User warning: unknown error (please report to developers)
```

If you ever run into either of these two errors, please get in touch with the jpylyzer developers. The easiest way to do this is to create a new issue at:

https://github.com/openpreserve/jpylyzer/issues

3.2.10.4 Unknown box

Occasionally, you may see this warning message:

```
User warning: ignoring unknown box
```

This happens if *jpylyzer* encounters a box that is not defined by JPEG 2000 Part 1. It should be noted that, to a large extent, JPEG 2000 Part 1 permits the presence of boxes that are defined outside the standard. Again, *jpylyzer* will simply ignore these and process all other boxes normally.

3.3 Using *jpylyzer* as a Python module

Instead of using *jpylyzer* from the command-line, you can also import it as a module in your own Python programs. To do so, install jpylyzer with *pip*. Then import *jpylyzer* into your code by adding:

```
from jpylyzer import jpylyzer
```

Subsequently you can call any function that is defined in *jpylyzer.py*. In practice you will most likely only need the *checkOneFile* function. The following minimal script shows how this works:

```
#! /usr/bin/env python

from jpylyzer import jpylyzer

# Define JP2
myFile = "/home/johan/jpylyzer-test-files/aware.jp2"

# Analyse with jpylyzer, result to Element object
myResult = jpylyzer.checkOneFile(myFile)

# Return image height value
```

```
imageHeight = myResult.findtext('./properties/jp2HeaderBox/imageHeaderBox/height')
print(imageHeight)
```

Here, *myResult* is an *Element* object that can either be used directly, or converted to XML using the *ElementTree* module[1]. The structure of the element object follows the XML output that described here.

For validation a raw JPEG 2000 codestreams, call the *checkOneFile* function with the additional *validationFormat* argument, and set it to `j2c`:

```
# Define Codestream
myFile = "/home/johan/jpylyzer-test-files/rubbish.j2c"

# Analyse with jpylyzer, result to Element object
myResult = jpylyzer.checkOneFile(myFile, 'j2c')
```

3.4 Java integration

It is possible to integrate *jpylyzer* into Java applications. A test class that shows how this works is included in the source repo here. This requires Jython. Note that you may run into performance issues with (very) large images in this case, as Jython does not support memory mapping, so make sure you've got plenty of RAM available.

[1] Note that *jpylyzer* versions 1.8 and earlier returned a formatted XML string instead of an element object!

Chapter 4

Structure of a JP2 file

4.1 Scope of this section

This section gives a brief overview of the JP2 file format. A basic understanding of the general structure of JP2 is helpful for appreciating how *jpylyzer* performs its validation. It will also make it easier to understand *jpylyzer*'s extracted properties, as these are reported as a hierarchical tree that corresponds to the internal structure of JP2.

For an exhaustive description of every detail of the format you are advised to consult Annex I ('JP2 file format syntax') and Annex A ('Codestream syntax') of ISO/IEC 15444-1.

4.2 General format structure

At the highest level, a JP2 file is made up of a collection of *boxes*. A *box* can be thought of as the fundamental building block of the format. Some boxes ('superboxes') are containers for other boxes. The Figure below gives an overview of the top-level boxes in a JP2 file.

A number of things here are noteworthy to point out:

- Some of these boxes are required, whereas others (indicated with dashed lines in the Figure) are optional.
- The order in which the boxes appear in the file is subject to some constraints (e.g. the first box in a JP2 must always be a 'Signature' box, followed by a 'File Type' box).
- Some boxes may have multiple instances (e.g. 'Contiguous Codestream' box), whereas others must be unique (e.g. 'JP2 Header' box).

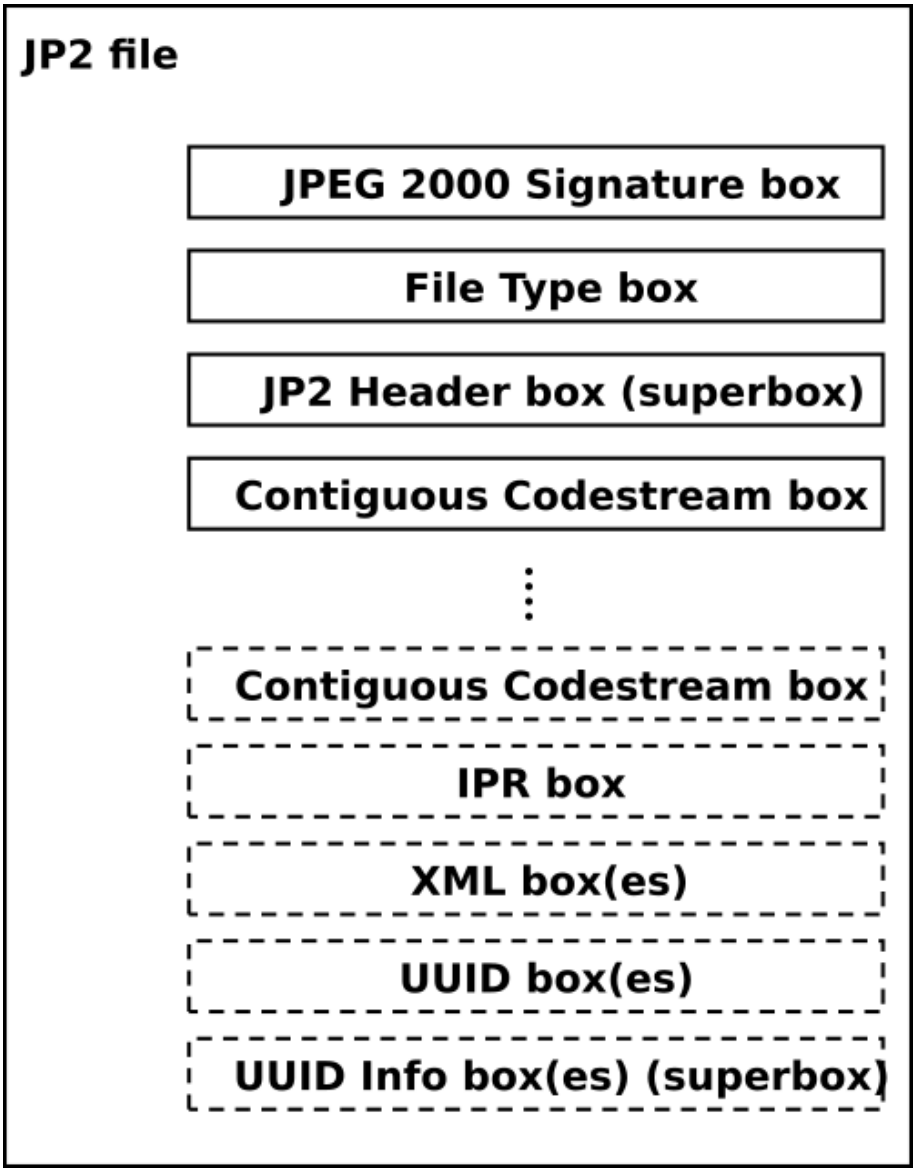


Figure 4.1: Top-level overview of a JP2 file. Boxes with dashed borders are optional.

More specific details can be found in the standard. The important thing here is that requirements like the above are something that should be verified by a validator, and this is exactly what *jpylyzer* does at the highest level of its validation procedure.

4.3 General structure of a box

All boxes are defined by a generic binary structure, which is illustrated by the following Figure:

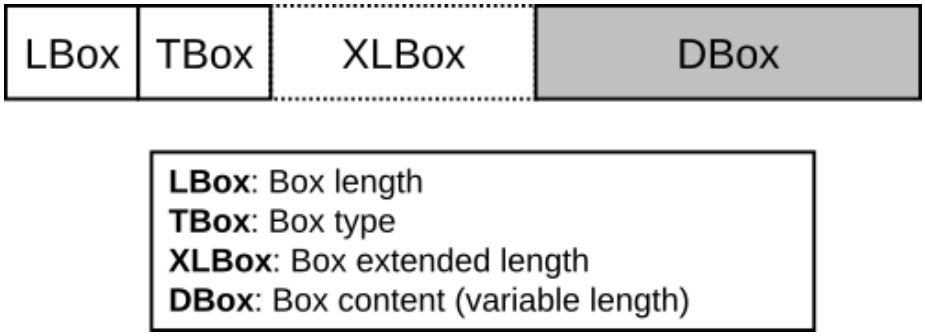


Figure 4.2: General structure of a box.

Most boxes are made up of the following three components:

1. A fixed-length 'box length' field that indicates the total size of the box (in bytes).
2. A fixed-length 'box type' field which specifies the type of information that can be found in this box
3. The box contents, which contains the actual information within the box. Its internal format depends on the box type. The box contents of a 'superbox' will contain its child boxes (which can be parsed recursively).

In some cases a box will also contain an 'extended box length field'. This field is needed if the size of a box exceeds 232-1 bytes, which is the maximum value that can be stored in the 4-byte 'box length' field.

4.4 Defined boxes in JP2

The following Table (taken from Table I.2 in ISO/IEC 15444-1, with minor modifications) lists all boxes that are defined in the standard. Addition signs in the 'box name' column indicate boxes that are children of a 'superbox'.

Box name	Superbox	Required?	Purpose
JPEG 2000 Signature box	No	Required	Identifies the file as being part of the JPEG 2000 family of files.
File Type box	No	Required	Specifies file type, version and compatibility information, including specifying if this file is a conforming JP2 file or if it can be read by a conforming JP2 reader.
JP2 Header box	Yes	Required	Contains a series of boxes that contain header-type information about the file.
+ Image Header box	No	Required	Specifies the size of the image and other related fields.
+ Bits Per Component box	No	Optional	Specifies the bit depth of the components in the file in cases where the bit depth is not constant across all components.
+ Colour Specification box	No	Required	Specifies the colourspace of the image.

Box name	Superbox	Required?	Purpose
+ Palette box	No	Optional	Specifies the palette which maps a single component in index space to a multiple-component image.
+ Component Mapping box	No	Optional	Specifies the mapping between a palette and codestream components.
+ Channel Definition box	No	Optional	Specifies the type and ordering of the components within the codestream, as well as those created by the application of a palette.
+ Resolution box	Yes	Optional	Contains the grid resolution.
++ Capture Resolution box	No	Optional	Specifies the grid resolution at which the image was captured.
++ Default Display Resolution box	No	Optional	Specifies the default grid resolution at which the image should be displayed.
Contiguous Codestream box	No	Required	Contains the codestream.

Box name	Superbox	Required?	Purpose
Intellectual Property box	No	Optional	Contains intellectual property information about the image.
XML box	No	Optional	Provides a tool by which vendors can add XML formatted information to a JP2 file.
UUID box	No	Optional	Provides a tool by which vendors can add additional information to a file without risking conflict with other vendors.
UUID Info box	Yes	Optional	Provides a tool by which a vendor may provide access to additional information associated with a UUID.
+ UUID List box	No	Optional	Specifies a list of UUIDs.
+ URL box	No	Optional	Specifies a URL.

A JP2 file may contain boxes that are not defined by the standard. Such boxes are simply skipped and ignored by conforming reader applications.

Chapter 5

Output format

This section explains *jpylyzer*'s output format.

5.1 Overview

Jpylyzer generates its output in XML format, which is defined by the schema that can be found here. The following Figure shows the output structure:

The root element (*jpylyzer*) contains the following child elements:

1. one *toolInfo* element, which contains information about *jpylyzer*
2. one or more *file* elements, each of which contain information about about the analysed files

The XML output is pretty-printed. You can use the `--nopretty` switch to disable pretty-printing (this produces smaller files and may give a slightly better performance).

5.2 toolInfo element

This element holds information about *jpylyzer*. Currently it contains the following sub-elements:

- *toolName*: name of the analysis tool (i.e. *jpylyzer* or *jpylyzer.exe*, depending on the platform used)
- *toolVersion*: version of *jpylyzer* (*jpylyzer* uses a date versioning scheme)

5.3 file element

The *file* element contains the following sub-elements:

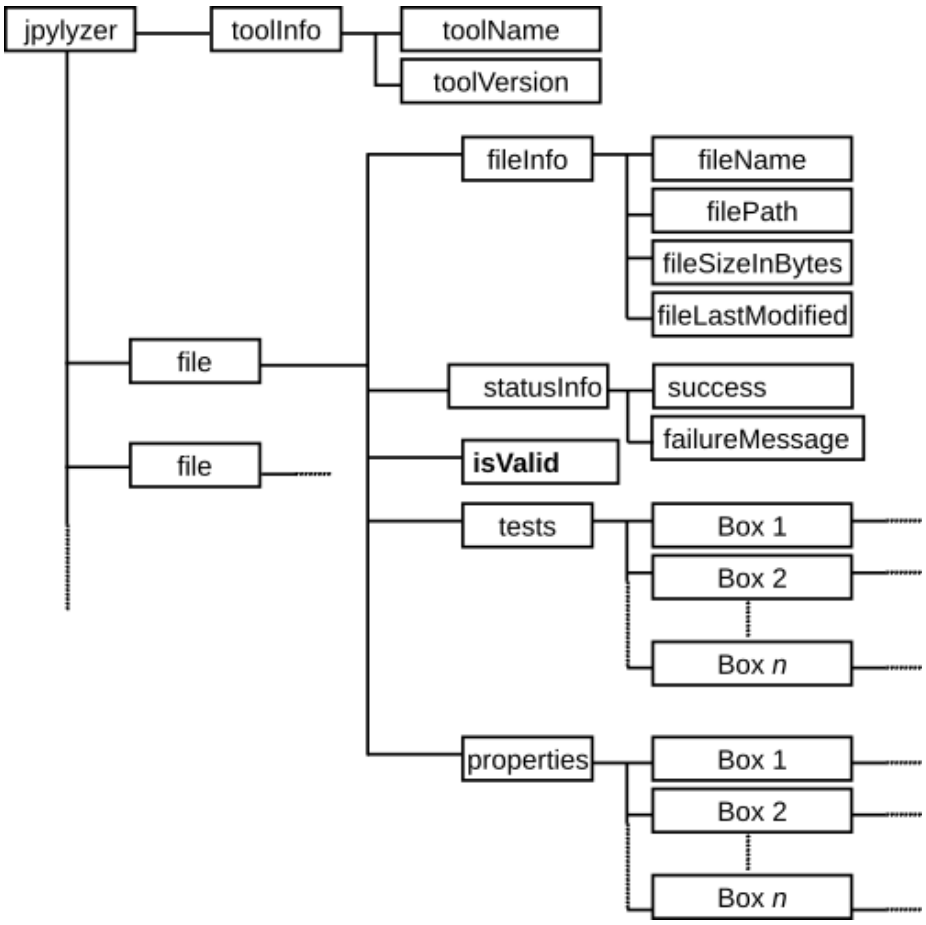


Figure 5.1: Jpylyzer's XML output structure. 'box' elements under 'tests' and 'properties' contain further sub-elements.

1. *fileInfo*: general information about the analysed file
2. *statusInfo*: information about the status of *jpylyzer*'s validation attempt
3. *isValid*: outcome of the validation
4. *tests*: outcome of the individual tests that are part of the validation process (organised by box)
5. *properties*: image properties (organised by box)
6. *propertiesExtension*: wrapper element for NISO *MIX* output (only if the `--mix` option is used)

5.4 fileInfo element

This element holds general information about the analysed file. Currently it contains the following sub-elements:

- *filename*: name of the analysed file without its path (e.g. "rubbish.jp2")
- *filePath*: name of the analysed file, including its full absolute path (e.g. "d:\data\images\rubbish.jp2")
- *fileSizeInBytes*: file size in bytes
- *fileLastModified*: last modified date and time

5.5 statusInfo element

This element holds general information about about the status of *jpylyzer*'s attempt at validating a file. It tells you whether the validation process could be completed without any internal *jpylyzer* errors. It contains the following sub-elements:

- *success*: a Boolean flag that indicates whether the validation attempt completed normally ("True") or not ("False"). A value of "False" indicates an internal error that prevented *jpylyzer* from validating the file.
- *failureMessage*: if the validation attempt failed (value of *success* equals "False"), this field gives further details about the reason of the failure. Examples are:
  - `memory error (file size too large)`
  - `runtime error (please report to developers)`
  - `unknown error (please report to developers)`

5.6 isValid element

This element contains the results of the validation. If a file passed all the tests (i.e. all tests returned "True", see here) it is most likely valid, and the value of *isValid* will be "True". Its value is "False" otherwise. The element has a *format* attribute, which defines the validation format (set by the `--format` command-line option). The *format* attribute can have the following values:

- "jp2" (JP2 validation)
- "j2c" (raw codestream validation)

5.7 tests element

This element is reserved to hold the outcomes of all the individual tests that *jpylyzer* performs to assess whether a file is valid JP2. The results are organised in a hierarchical tree that corresponds to JP2's box structure. Each individual test can have two values:

- "True" if a file passed the test.
- "False" if a file failed the test.

If a file passed *all* tests, this is an indication that it is most likely valid JP2. In that case, the *isValid* element has a value of "True" (and "False" in all other cases). These tests are all explained here and here.

5.7.1 Default and verbose reporting of test results

By default, *jpylyzer* only reports any tests that failed (i.e. returned "False"), including the corresponding part of the box structure. For a valid JP2 the tests element will be empty. If the –verbose flag is used, the results of *all* tests are included (including those that returned "True")[1].

5.8 properties element

This element contains the extracted image properties, which are organised in a hierarchical tree that corresponds to JP2's box structure. See here and here for a description of the reported properties.

5.9 propertiesExtension element

This optional element is reserved for output in alternative formats. Currently it is used to wrap output in NISO *MIX* format if the `--mix` option is used. See

[1] Note that *jpylyzer* versions 1.4 and earlier used the verbose output format by default. This behaviour has changed in version 1.5 onwards, as the lengthy output turned out to be slightly confusing to some users.

the *MIX* documentation for a description of the reported elements.

Chapter 6

JP2: box by box

The following two sections provide a detailed explanation of *jpylyzer*'s functionality and its output. In particular, the following two aspects are addressed:

1. The reported properties
2. The tests that *jpylyzer* performs to establish the validity of a file.

6.1 About the properties and tests trees

The 'properties' element in *jpylyzer*'s output holds a hierarchical tree structure that contains all extracted properties. The 'tests' tree follows the same structure. The hierarchy reflects JP2's box structure (explained here): each box is represented by a corresponding output element that contains the corresponding property entries. If a box is a superbox, the output element will contain child elements for each child box. For some boxes, the output contains further sub-elements. This applies in particular to the Contiguous Codestream box, since its contents are more complex than any of the other boxes. Also, if a Colour Specification box contains an embedded ICC profile, the properties of the ICC profile are stored in a separate sub-element. In addition to this, one 'property' that is reported by *jpylyzer* (the compression ratio) is not actually extracted from any particular box. Instead, it is calculated from the file size and some properties from the Header boxes. As a result, it is reported separately in the root of the properties tree.

6.1.1 Naming of properties

The naming of the reported properties largely follows the standard (ISO/IEC 15444-1). Some minor differences follow from the fact that the standard does have any consistent use of text case, whereas *jpylyzer* uses lower camel case. In addition, some parameters in the standard are compound units that aggregate a

number of Boolean 'switches', where no names are provided for each individual switch. An example of this is the *Scod* (coding style) parameter in the codestream header, which contains three switches that define the use of precincts, start-of-packet markers and end-of-packet markers. For cases like these *jpylyzer* uses its own (largely self-descriptive) names (which are all documented in these sections).

6.2 JPEG 2000 Signature box

This box contains information that allows identification of the file as being part of the JPEG 2000 family of file formats.

6.2.1 Element name

signatureBox

6.2.2 Reported properties

None (box only holds JPEG 2000 signature, which includes non-printable characters)

6.2.3 Tests

Test name	True if
boxLengthIsValid	Size of box contents equals 4 bytes
signatureIsValid	Signature equals 0x0d0a870a

6.3 File Type box

This box specifies file type, version and compatibility information, including specifying if this file is a conforming JP2 file or if it can be read by a conforming JP2 reader.

6.3.1 Element name

fileTypeBox

6.3.2 Reported properties

Property	Description
br	Brand
minV	Minor version

Property	Description
cL*	Compatibility field (repeatable)

6.3.3 Tests

Test name	True if
boxLengthIsValid	(Size of box – 8) /4 is a whole number (integer)
brandIsValid	*br* equals 0x6a703220 (“jp2 ”)
minorVersionIsValid	*minV* equals 0
compatibilityListIsValid	Sequence of compatibility (*cL*) fields includes one entry that equals 0x6a703220 (“jp2 ”)

6.4 JP2 Header box (superbox)

This box is a superbox that holds a series of boxes that contain header-type information about the file.

6.4.1 Element name

jp2HeaderBox

6.4.2 Reported properties

Since this is a superbox, it contains a number of child boxes. These are represented as child elements in the properties tree:

Child element	Description
imageHeaderBox	Properties from Image Header box (required)
bitsPerComponentBox	Properties from Bits Per Component box (optional)
ColourSpecificationBox	Properties from Colour Specification box (required)
paletteBox	Properties from Palette box (optional)
componentMappingBox	Properties from Component Mapping box (optional)
channelDefinitionBox	Properties from Channel Definition box (optional)

Child element	Description
resolutionBox	Properties from Resolution box (optional)

6.4.3 Tests

Test name	True if
containsImageHeaderBox	Box contains required Image Header box
containsColourSpecificationBox	Box contains required Colour Specification box
containsBitsPerComponentBox	Box contains Bits Per Component Box, which is required if *bPCSign* and *bPCDepth* in Image Header Box equal 1 and 128, respectively (test is skipped otherwise)
firstJP2HeaderBoxIsImageHeaderBox	First child box is Image Header Box
noMoreThanOneImageHeaderBox	Box contains no more than one Image Header box
noMoreThanOneBitsPerComponentBox	Box contains no more than one Bits Per Component box
noMoreThanOnePaletteBox	Box contains no more than one Palette box
noMoreThanOneComponentMappingBox	Box contains no more than one Component Mapping box
noMoreThanOneChannelDefinitionBox	Box contains no more than one Channel Definition box
noMoreThanOneResolutionBox	Box contains no more than one Resolution box
colourSpecificationBoxesAreContiguous	In case of multiple Colour Specification boxes, they appear contiguously in the JP2 Header box
paletteAndComponentMappingBoxesOnlyTogether	Box contains a Palette box (only if Component Mapping box is present); box contains a Component Mapping box (only if Palette box is present)

6.5 Image Header box (child of JP2 Header box)

This box specifies the size of the image and other related fields.

6.5.1 Element name

imageHeaderBox

6.5.2 Reported properties

Property	Description
height	Image height in pixels
width	Image width in pixels
nC	Number of image components
bPCSign	Indicates whether image components are signed or unsigned
bPCDepth	Number of bits per component
c	Compression type
unkC	Colourspace Unknown field (“yes” if colourspace of image data is unknown; “no” otherwise)
iPR	Intellectual Property field (“yes” if image contains intellectual property rights information; “no” otherwise)

6.5.3 Tests

Test name	True if
boxLengthIsValid	Size of box contents equals 14 bytes
heightIsValid	*height* is within range [1, 232 - 1]
widthIsValid	*width* is within range [1, 232 - 1]
nCIsValid	*nC* is within range [1, 16384]
bPCIsValid	*bPCDepth* is within range [1,38] OR *bPCSign* equals 255 (in the latter case the bit depth is variable)
cIsValid	*c* equals 7 (“jpeg2000”)
unkCIsValid	*unkC* equals 0 (“no”) or 1 (“yes”)
iPRIsValid	*iPR* equals 0 (“no”) or 1 (“yes”)

6.6 Bits Per Component box (child of JP2 Header box)

This (optional) box specifies the bit depth of the components in the file in cases where the bit depth is not constant across all components.

6.6.1 Element name

bitsPerComponentBox

6.6.2 Reported properties

Property	Description
bPCSign*	Indicates whether image component is signed or unsigned (repeated for all components)
bPCDepth*	Number of bits for this component (repeated for all components)

6.6.3 Tests

Test name	True if
bPCIsValid*	*bPCDepth* is within range [1,38] (repeated for all components)

6.7 Colour Specification box (child of JP2 Header box)

This box specifies the colourspace of the image.

6.7.1 Element name

colourSpecificationBox

6.7.2 Reported properties

Property	Description
meth	Specification method. Indicates whether colourspace of this image is defined as an enumerated colourspace or using a (restricted) ICC profile.
prec	Precedence
approx	Colourspace approximation
enumCS (if meth equals "Enumerated")	Enumerated colourspace (as descriptive text string)
icc (if meth equals "Restricted ICC" or "Any ICC"[1])	Properties of ICC profile as child element (see below)

6.7.3 Reported properties of ICC profiles

If the colour specification box contains an embedded ICC profile, *jpylyzer* will also report the following properties (which are all grouped in an "icc" sub-element in the properties tree). An exhaustive explanation of these properties is given in the ICC specification (ISO 15076-1 / ICC.1:2004-10). Note that *jpylyzer* does *not* validate embedded ICC profiles (even though it does check if a specific ICC profile is allowed in JP2)!

Property	Description
profileSize	Size of ICC profile in bytes
preferredCMMType	Preferred CMM type
profileVersion	Profile version. Format: "majorRevision.minorRevision.bugFixRevision"
profileClass	Profile/device class
colourSpace	Colourspace
profileConnectionSpace	Profile connection space
dateTimeString	Date / time string. Format: "YYYY/MM/DD, h:m:s"
profileSignature	Profile signature
primaryPlatform	Primary platform
embeddedProfile	Flag that indicates whether profile is embedded in file ("yes"/"no")
profileCannotBeUsedIndependently	Flag that indicates whether profile can*not* (!) be used independently from the embedded colour data ("yes"/"no")
deviceManufacturer	Identifies a device manufacturer

[1]The "Any ICC" method is defined in ISO/IEC 15444-2 (the JPX format), and is not allowed in JP2. However, *jpylyzer* offers limited support for JPX here by also reporting the properties of ICC profiles that were embedded using this method. Note that any file that uses this method will fail the "methIsValid" test (and thereby the validation).

Property	Description
deviceModel	Identifies a device model
transparency	Indicates whether device medium is reflective or transparent
glossiness	Indicates whether device medium is glossy or matte
polarity	Indicates whether device medium is positive or negative
colour	Indicates whether device medium is colour or black and white
renderingIntent	Rendering intent
connectionSpaceIlluminantX	Profile connection space illuminant X
connectionSpaceIlluminantY	Profile connection space illuminant Y
connectionSpaceIlluminantZ	Profile connection space illuminant Z
profileCreator	Identifies creator of profile
profileID	Profile checksum (as hexadecimal string)
tag*	Signature of profile tag (repeated for all tags in the profile)
description	Profile description (extracted from 'desc' tag)

6.7.4 Tests

Test name	True if
methIsValid	*meth* equals 1 (enumerated colourspace) or 2 (restricted ICC profile)
precIsValid	*prec* equals 0
approxIsValid	*approx* equals 0
enumCSIsValid (if meth equals "Enumerated")	*enumCS* equals 16 ("sRGB"), 17 ("greyscale") or 18 ("sYCC")
iccSizeIsValid (if meth equals "Restricted ICC")	Actual size of embedded ICC profile equals value of profileSize field in ICC header
iccPermittedProfileClass (if meth equals "Restricted ICC")	ICC profile class is "input device" or "display device"[2]
iccNoLUTBasedProfile (if meth equals "Restricted ICC")	ICC profile type is not N-component LUT based (which is not allowed in JP2)

[2]Originally ISO/IEC 15444-1 only allowed "input device" profiles. Support of "display device" profiles was added through an amendment to the standard in 2013. The behaviour of *jpylyzer* is consistent with this amendment.

6.8 Palette box (child of JP2 Header box)

This (optional) box specifies the palette which maps a single component in index space to a multiple-component image.

6.8.1 Element name

paletteBox

6.8.2 Reported properties

Property	Description
nE	Number of entries in the table
nPC	Number of palette columns
bSign*	Indicates whether values created by this palette column are signed or unsigned (repeated for all columns)
bDepth*	Bit depth of values created by this palette column (repeated for all columns)
cP**	Value for this entry (repeated for all columns, and for the number of entries)

6.8.3 Tests

Test name	True if
nEIsValid	nE is within range [0,1024]
nPCIsValid	nPC is within range [1,255]
bDepthIsValid*	$bDepth$ is within range [1,38] (repeated for all columns)

6.9 Component Mapping box (child of JP2 Header box)

This (optional) box specifies the mapping between a palette and codestream components.

6.9.1 Element name

componentMappingBox

6.9.2 Reported properties

Property	Description
cMP*	Component index (repeated for all channels)
mTyp*	Specifies how channel is generated from codestream component (repeated for all channels)
pCol*	Palette component index (repeated for all channels)

6.9.3 Tests

Test name	True if
cMPIsValid	*cMP* is within range [0,16384]
mTypIsValid*	*mTyp* is within range [0,1] (repeated for all channels)
pColIsValid*	*pCol* is 0 if *mTyp* is 0 (repeated for all channels)

6.10 Channel Definition box (child of JP2 Header box)

This (optional) box specifies the type and ordering of the components within the codestream, as well as those created by the application of a palette.

6.10.1 Element name

channelDefinitionBox

6.10.2 Reported properties

Property	Description
n	Number of channel descriptions
cN*	Channel index (repeated for all channels)
cTyp*	Channel type (repeated for all channels)
cAssoc*	Channel association (repeated for all channels)

6.10.3 Tests

Test name	True if
nIsValid	n is within range [1, 65535]
boxLengthIsValid	(Size of box – 2) / equals 6*n
cNIsValid*	cN is within range [0, 65535] (repeated for all channels)
cTypIsValid*	*cType* is within range [0, 65535] (repeated for all channels)
cAssocIsValid*	*cAssoc* is within range [0, 65535] (repeated for all channels)

6.11 Resolution box (child of JP2 Header box, superbox)

This (optional) box contains the grid resolution.

6.11.1 Element name

resolutionBox

6.11.2 Reported properties

Since this is a superbox, it contains one or two child boxes. These are represented as child elements in the properties tree:

Child element	Description
captureResolutionBox	Properties from Capture Resolution box
displayResolutionBox	Properties from Default Display Resolution box

6.11.3 Tests

Test name	True if
containsCaptureOrDisplayResolutionBox	Box contains either a Capture Resolution box or a Default Display Resolution box, or both
noMoreThanOneCaptureResolutionBox	Box contains no more than one Capture Resolution box

Test name	True if
noMoreThanOneDisplayResolutionBox	Box contains no more than one Default Display Resolution box

6.12 Capture Resolution box (child of Resolution box)

This (optional) box specifies the grid resolution at which the image was captured.

6.12.1 Element name

captureResolutionBox

6.12.2 Reported properties

Resolution information in this box is stored as a set of vertical and horizontal numerators, denominators and exponents. *Jpylyzer* also reports the corresponding grid resolutions in pixels per meter and pixels per inch, which are calculated from these values.

Property	Description
vRcN	Vertical grid resolution numerator
vRcD	Vertical grid resolution denominator
hRcN	Horizontal grid resolution numerator
hRcD	Horizontal grid resolution denominator
vRcE	Vertical grid resolution exponent
hRcE	Horizontal grid resolution exponent
vRescInPixelsPerMeter	Vertical grid resolution, expressed in pixels per meter[3]
hRescInPixelsPerMeter	Horizontal grid resolution, expressed in pixels per meter[4]
vRescInPixelsPerInch	Vertical grid resolution, expressed in pixels per inch[5]
hRescInPixelsPerInch	Horizontal grid resolution, expressed in pixels per inch[6]

[3] Calculated as: vRcN vRcD • 10 vRcE
[4] Calculated as: hRcN hRcD • 10 hRcE
[5] Calculated as: vRescInPixelsPerMeter • 25.4 • 10 -3
[6] Calculated as: hRescInPixelsPerMeter • 25.4 • 10 -3

6.12.3 Tests

Test name	True if
boxLengthIsValid	Size of box contents equals 10 bytes
vRcNIsValid	*vRcN* is within range [1,65535]
vRcDIsValid	*vRcD* is within range [1,65535]
hRcNIsValid	*hRcN* is within range [1,65535]
hRcDIsValid	*hRcD* is within range [1,65535]
vRcEIsValid	*vRcE* is within range [-127,128]
hRcEIsValid	*hRcE* is within range [-127,128]

6.13 Default Display Resolution box (child of Resolution box)

This (optional) box specifies the default grid resolution at which the image should be displayed.

6.13.1 Element name

displayResolutionBox

6.13.2 Reported properties

Resolution information in this box is stored as a set of vertical and horizontal numerators, denominators and exponents. *Jpylyzer* also reports the corresponding grid resolutions in pixels per meter and pixels per inch, which are calculated from these values.

Property	Description
vRdN	Vertical grid resolution numerator
vRdD	Vertical grid resolution denominator
hRdN	Horizontal grid resolution numerator
hRdD	Horizontal grid resolution denominator
vRdE	Vertical grid resolution exponent
hRdE	Horizontal grid resolution exponent
vResdInPixelsPerMeter	Vertical grid resolution, expressed in pixels per meter[7]
hResdInPixelsPerMeter	Horizontal grid resolution, expressed in pixels per meter[8]

[7] Calculated as: vRdN vRdD • 10 vRdE
[8] Calculated as: hRdN hRdD • 10 hRdE

Property	Description
vResdInPixelsPerInch	Vertical grid resolution, expressed in pixels per inch[9]
hResdInPixelsPerInch	Horizontal grid resolution, expressed in pixels per inch[10]

6.13.3 Tests

Test name	True if
boxLengthIsValid	Size of box contents equals 10 bytes
vRdNIsValid	*vRdN* is within range [1,65535]
vRdDIsValid	*vRdD* is within range [1,65535]
hRdNIsValid	*hRdN* is within range [1,65535]
hRdDIsValid	*hRdD* is within range [1,65535]
vRdEIsValid	*vRdE* is within range [-127,128]
hRdEIsValid	*hRdE* is within range [-127,128]

6.14 Contiguous Codestream box

This box contains the codestream. See here.

6.15 Intellectual Property box

This (optional) box contains intellectual property information about the image. The JP2 format specification (ISO/IEC 15444-1) does not provide any specific information about this box, other than stating that "the definition of the format of [its] contents [...] is reserved for ISO". As a result, *jpylyzer* does not currently include a validator function for this box, which is now simply ignored. *Jpylyzer* will display a user warning message in that case.

6.16 XML box

This (optional) box contains XML formatted information.

6.16.1 Element name

xmlBox

[9] Calculated as: vResdInPixelsPerMeter • 25.4 • 10 -3
[10] Calculated as: hResdInPixelsPerMeter • 25.4 • 10 -3

6.16.2 Reported properties

If the contents of this box are well-formed XML (see 'tests' below), the 'xmlBox' element in the properties tree will contain the contents of the XML box. Note that, depending on the character encoding of the original XML, it may contain characters that are not allowed in the encoding that is used for *jpylyzer*'s output. Any such characters will be represented by numerical entity references in the output. If the box contents are not well-formed XML, no properties are reported for this box.

6.16.3 Tests

Test name	True if
containsWellformedXML	Contents of box are parsable, well-formed XML

Note that *jpylyzer* does not check whether the XML is *valid*, as this is not required by the standard. Besides, doing so would make *jpylyzer* significantly slower for XML that contains references to external schemas and DTDs.

6.17 UUID box

This (optional) box contains additional (binary) information, which may be vendor-specific. Some applications (e.g. Kakadu and ExifTool) also use this box for storing XMP metadata (see Section 1.1.4 in Part 3 of the XMP specification[11]).

6.17.1 Element name

uuidBox

6.17.2 Reported properties

If the value of *uuid* indicates the presence of XMP metadata and the contents of this box are well-formed XML, (see 'tests' below), the 'uuidBox' element in the properties tree will contain the XMP data. Note that, depending on the character encoding of the original XML, it may contain characters that are not allowed in the encoding that is used for *jpylyzer*'s output. Any such characters will be represented by numerical entity references in the output. In all other cases, the 'uuidBox' element will contain a standard string representation the of UUID.

[11] Link: https://wwwimages.adobe.com/www.adobe.com/content/dam/Adobe/en/devnet/xmp/pdfs/cs6/XMPSpecificationPart3.pdf

Property	Description
uuid	Standard string representation of UUID (**only** if uuid has value other than *be7acfcb-97a9-42e8-9c71-999491e3afac*). For an explanation of UUIDs see e.g. Leach *et al.*, 2005.
XMP data	XMP metadata (**only** if uuid has value *be7acfcb-97a9-42e8-9c71-999491e3afac*)

Note that except for the XMP case, *jpylyzer* will not be able to report any information on the actual contents of this box, since it is defined outside of the scope of JPEG 2000.

6.17.3 Tests

Test name	True if
boxLengthIsValid	Size of box contents is greater than 16 bytes
containsWellformedXML	Contents of box are parsable, well-formed XML (this test is **only** performed if uuid has value *be7acfcb-97a9-42e8-9c71-999491e3afac*)

6.18 UUID Info box (superbox)

This (optional) box contains additional information associated with a UUID.

6.18.1 Element name

uuidInfoBox

6.18.2 Reported properties

This is a superbox which contains two child boxes. These are represented as child elements in the properties tree:

Child element	Description
uuidListBox	Properties from UUID List box
urlBox	Properties from Data Entry URL box

6.18.3 Tests

Test name	True if
containsOneListBox	Box contains exactly one UUID List box
containsOneURLBox	Box contains exactly one Data Entry URL box

6.19 UUID List box (child of UUID Info box)

This (optional) box specifies a list of UUIDs.

6.19.1 Element name

uuidListBox

6.19.2 Reported properties

Property	Description
nU	Number of UUIDs
uuid*	Standard string representation of UUID (repeated nU times)

6.19.3 Tests

Test name	True if
boxLengthIsValid	Size of box equals nU * 16 + 2

6.20 Data Entry URL box (child of UUID Info box)

This (optional) box specifies a URL.

6.20.1 Element name

urlBox

6.20.2 Reported properties

Property	Description
version	Version number
loc	Location, which specifies a URL of the additional information associated with the UUIDs in the UUID List box that resides in the same UUID Info box

6.20.3 Tests

Test name	True if
flagIsValid	Three bytes that make up "flag" field equal 0x00 00 00 ('flag' is not reported to output because it only contains null bytes)
locIsUTF8	Location (URL) can be decoded to UTF-8
locHasNullTerminator	Location (URL) is a null-terminated string

6.21 Unknown box

An image may contain boxes that are not defined by ISO/IEC 15444-1. Although *jpylyzer* ignores such boxes, it will report some minimal info that will allow interested users to identify them to a limited extent.

6.21.1 Element name

unknownBox

6.21.2 Reported properties

Property	Description
boxType	Four-character text string that specifies the type of information that is found in this box (corresponds to *TBox* in section I.4 of ISO/IEC 15444-1).

6.22 Top-level tests and properties

This sub-section describes the tests and output for the top file level.

6.22.1 Element name

properties

6.22.2 Reported properties

The metrics that are listed here are not 'properties' in a strict sense; instead they are secondary or derived metrics that are calculated by combining information from different parts / boxes of the file.

Property	Description
compressionRatio	Compression ratio

The compression ratio is calculated as the ratio between the size of the uncompressed image data and the actual file size:

compressionRatio = sizeUncompressed sizeCompressed

Here, *sizeCompressed* is simply the file size (*fileSizeInBytes* in output file's 'fileInfo' element). The uncompressed size (in bytes) can be calculated by multiplying the number of bytes per pixel by the total number of pixels:

sizeUncompressed = 1 8 i = 1 nC bPCDepth i • height • width

With:

nC number of image components (from Image Header box)
i component index
bPCDepthi bits per component for component *i* (from Image Header box or Bits Per Component box)
height image height (from Image Header box)
width image width (from Image Header box)

In addition, the root of the properties tree contains the elements for all top-level boxes:

Child element	Description
signatureBox	Properties from JPEG 2000 Signature box
fileTypeBox	Properties from File Type box
jp2HeaderBox	Properties from JP2 Header box
contiguousCodestreamBox	Properties from Contiguous Codestream box
intellectualPropertyBox	Properties from Intellectual Property box (optional)
xmlBox	Properties from XML box (optional)

Child element	Description
uuidBox	Properties from UUID box (optional)
uuidInfoBox	Properties from UUID Info box (optional)

6.22.3 Tests

The tests that *jpylyzer* performs at the root level fall in either of the following two categories:

1. Tests for the presence of required top-level boxes, the order in which they appear and restrictions on the number of instances for specific boxes
2. Tests for consistency of information in different parts of the file. In particular, a lot of the information in the Image Header box is redundant with information in the codestream header, and *jpylyzer* performs a number of tests to verify the consistency between these two.

Test name	True if
containsSignatureBox	File root contains a JPEG 2000 Signature box
containsFileTypeBox	File root contains a File Type box
containsJP2HeaderBox	File root contains a JP2 Header box
containsContiguousCodestreamBox	File root contains a Contiguous Codestream box
containsIntellectualPropertyBox	File root contains an Intellectual Property box, which is required if *iPR* field in Image Header Box equals 1 (test is skipped otherwise)
firstBoxIsSignatureBox	First box is JPEG 2000 Signature box
secondBoxIsFileTypeBox	Second box is File Type box
locationJP2HeaderBoxIsValid	JP2 Header box is located after File Type Box and before (first) Contiguous Codestream box
noMoreThanOneSignatureBox	File root contains no more than one JPEG 2000 Signature box
noMoreThanOneFileTypeBox	File root contains no more than one File Type box
noMoreThanOneJP2HeaderBox	File root contains no more than one JP2 Header box

Test name	True if
heightConsistentWithSIZ	Value of *height* from Image Header Box equals *ysiz –yOsiz* from codestream SIZ header
widthConsistentWithSIZ	Value of *width* from Image Header Box equals *xsiz –xOsiz* from codestream SIZ header
nCConsistentWithSIZ	Value of *nC* from Image Header Box equals *csiz* from codestream SIZ header
bPCSignConsistentWithSIZ	Values of *bPCSign* from Image Header box (or Bits Per Component box) are equal to corresponding *ssizSign* values from codestream SIZ header
bPCDepthConsistentWithSIZ	Values of *bPCDepth* from Image Header box (or Bits Per Component box) are equal to corresponding *ssizDepth* values from codestream SIZ header

Chapter 7

Contiguous Codestream box

7.1 General codestream structure

The Contiguous Codestream box holds the JPEG 2000 codestream, which contains the actual image data in a JP2.

7.1.1 Markers and marker segments

A codestream is made up of a number of functional entities which are called *markers* and *marker segments*. A *marker* is essentially a 2-byte delimiter that delineates the start or end position of a functional entity. A *marker segment* is the combination of a marker and a set of associated parameters (*segment parameters*). However, not every marker has any associated parameters.

7.1.2 General structure of the codestream

The codestream is made up of a number of components. The Figure below gives an overview.

From top to bottom, the Figure shows the following components:

1. A *start of codestream* (SOC) marker, which indicates the start of the codestream
2. A main codestream header (which includes a number of header marker segments)
3. A sequence of one or more *tile parts*. Each tile part consists of the following components:

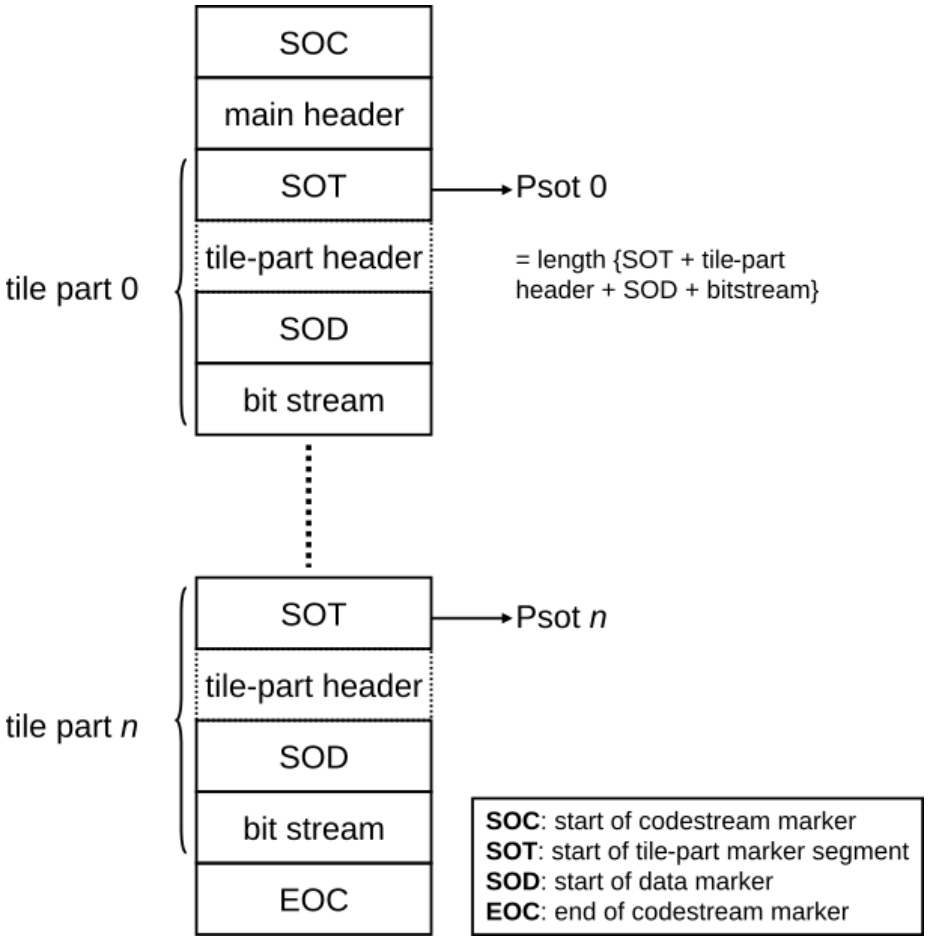


Figure 7.1: General structure of a JPEG 2000 codestream.

   a. A *start of tile-part* (SOT) marker segment, which indicates the start of a tile part, and which also contains index information of the tile part and its associated tile

   b. Optionally this may be followed by one or more additional tile-part header marker segments

   c. A *start of data* (SOD) marker that indicates the start of the bitstream for the current tile part

   d. The bitstream

4. An 'end of codestream' (EOC) marker that indicates the end of the codestream.

7.2 Limitations of codestream validation

It is important to stress here that *jpylyzer* currently doesn't support the full set of marker segments that can occur in a codestream. As a result, the validation of codestreams is somewhat limited. These limitations are discussed in this sub-section.

7.2.1 Main codestream header

Annex A of ISO/IEC 15444-1 lists a total of 13 marker segments that can occur in the main codestream header. Most of these are optional. The current version of *jpylyzer* only offers full support (i.e. reads and validates) for the following main header marker segments (which includes all the required ones):

- Start of codestream (SOC) marker segment (required)
- Image and tile size (SIZ) marker segment (required)
- Coding style default (COD) marker segment (required)
- Coding style component (COC) marker segment (optional)
- Region-of-interest (RGN) marker segment (optional)
- Quantization default (QCD) marker segment (required)
- Quantization component (QCC) marker segment (optional)
- Progression order change (POC) marker segment (optional)
- Component registration (CRG) marker segment (optional)
- Comment (COM) marker segment (optional)

In addition the codestream header may also contain any of the following marker segments, which are all optional:

- Packet length, main header (PLM) marker segment (optional) *

- Packed packet headers, main header (PPM) marker segment (optional) *
- Tile-part lengths (TLM) marker segment (optional) *

The optional markers that are marked with an asterisk above are only minimally supported at this stage.

7.2.2 Tile parts

The tile part validation has similar limitations. The standard lists 11 marker segments that can occur in the tile part header. Currently, *jpylyzer* only fully supports the following ones:

- Start of tile part (SOT) marker segment (required)
- Coding style default (COD) marker segment (optional)
- Coding style component (COC) marker segment (optional)
- Region-of-interest (RGN) marker segment (optional)
- Quantization default (QCD) marker segment (optional)
- Quantization component (QCC) marker segment (optional)
- Progression order change (POC) marker segment (optional)
- Comment (COM) marker segment (optional)
- Start of data (SOD) marker segment (required)

In addition the following optional marker segments may also occur:

- Packet length, tile-part header (PLT) marker segment (optional) *
- Packed packet headers, tile-part header (PPT) marker segment (optional) *

The optional markers that are marked with an asterisk above are only minimally supported at this stage: if *jpylyzer* encounters them, it will include the corresponding element in the *properties* element of the output. However, *jpylyzer* does not analyse the contents of these marker segments, which means that the respective elements in the output will be empty.

7.2.3 Bit streams

In addition to the above limitations, *jpylyzer* can *not* be used to establish whether the data in the bitstream are correct (this would require decoding the compressed image data, which is completely out of *jpylyzer*'s scope)[1]. As

[1]However, support for start of packet (SOP) and end of packet (EPH) markers may be included in future versions.

a result, if *jpylyzer* is used as part of a quality assurance workflow, it is recommended to also include an additional check on the image contents[2]. Also, *jpylyzer* does not perform any checks on marker segments within the bit-stream: start-of packet (SOP) and end-of-packet (EPH) markers.

7.2.4 Detection of incomplete or truncated codestreams

A JP2's tile part header contains information that makes it possible to detect incomplete and truncated codestreams in most cases. Depending on the encoder software used, this method may fail for images that only contain one single tile part (i.e. images that do not contain tiling).

7.2.5 Current limitations of comment extraction

Both the codestream header and the tile part header can contain comment marker segments, which are used for embedding arbitrary binary data or text. *Jpylyzer* will extract the contents of any comments that are text.

7.3 Structure of reported output

The Figure below illustrates the structure of *jpylyzer*'s codestream-level output.

At the top level, the SIZ, COD, QCD and COM marker segments are each represented as individual sub elements. The tile part properties are nested in a *tileParts* element, where each individual tile part is represented as a separate *tilePart* sub element.

7.4 Contiguous Codestream box

7.4.1 Element name

contiguousCodestreamBox

7.4.2 Reported properties

The reported properties for this box are organised into a number groups, which are represented as child elements in the properties tree:

Child element	Description
siz	Properties from the image and tile size (SIZ) marker segment (codestream main header)

[2]For example, in a TIFF to JP2 conversion workflow one could include a pixel-by-pixel comparison of the values in the TIFF and the JP2.

Child element	Description
cod	Properties from the coding style default (COD) marker segment (codestream main header)
coc	Properties from the (optional) coding style component (COC) marker segment (codestream main header)
rgn	Properties from the (optional) region of interest (RGN) marker segment (codestream main header)
qcd	Properties from the quantization default (QCD) marker segment (codestream main header)
qcc	Properties from the (optional) quantization component (QCC) marker segment (codestream main header)
poc	Properties from the (optional) progression order change (POC) marker segment (codestream main header)
crg	Properties from the (optional) component registration (CRG) marker segment (codestream main header)
com	Properties from the (optional) comment (COM) marker segment (codestream main header)
plm	Properties from the (optional) packet length (PLM) marker (codestream main header)
ppm	Properties from the (optional) packed packet headers(PPM) marker segment (codestream main header)
tileParts	Properties from individual tile parts

Note that the *plm* and *ppm* elements are only written if the `--packetmarkers` option is used. The number of PLM and PPM markers is given by the following 2 derived properties (these are always reported, irrespective of `--packetmarkers`):

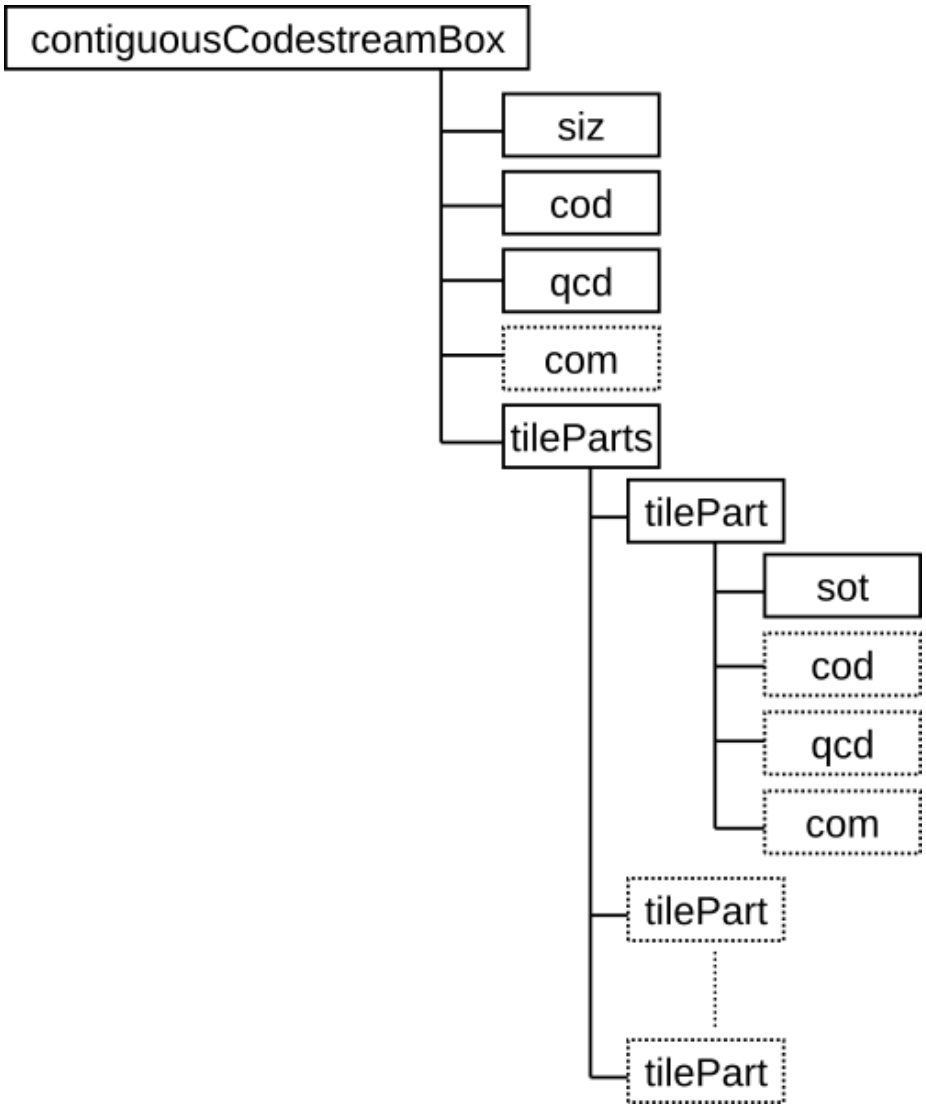


Figure 7.2: Structure of codestream-level XML output.

Property	Description
plmCount	Number of PLM markers in main header
ppmCount	Number of PPM markers in main header

7.4.3 Tests

Test name	True if
codestreamStartsWithSOCMarker	First 2 bytes in codestream constitute a start of codestream (SOC) marker segment
foundSIZMarker	Second marker segment in codestream is image and tile size (SIZ) marker segment
foundCODMarker	Codestream main header contains coding style default (COD) marker segment
foundQCDMarker	Codestream main header contains quantization default (QCD) marker segment
foundExpectedNumberOfTiles	Number of encountered tiles is consistent with expected number of tiles (as calculated from SIZ marker)
foundExpectedNumberOfTileParts	For all tiles, number of encountered tile parts is consistent with expected number of tile parts (values of *tnsot* from SOT marker)
maxOneCcocPerComponent	No more than one *ccoc* value for each component (only reported if codestream contains any COC marker segments)
maxOneCqccPerComponent	No more than one *cqcc* value for each component (only reported if codestream contains any QCC marker segments)
foundEOCMarker	Last 2 bytes in codestream constitute an end of codestream (EOC) marker segment

7.5 Image and tile size (SIZ) marker segment (child of Contiguous Codestream box)

7.5.1 Element name

siz

7.5.2 Reported properties

Property	Description
lsiz	Length of SIZ marker segment in bytes
rsiz	Decoder capabilities
xsiz	Width of reference grid
ysiz	Height of reference grid
xOsiz	Horizontal offset from origin of reference grid to left of image area
yOsiz	Vertical offset from origin of reference grid to top of image area
xTsiz	Width of one reference tile with respect to the reference grid
yTsiz	Height of one reference tile with respect to the reference grid
xTOsiz	Horizontal offset from origin of reference grid to left side of first tile
yTOsiz	Vertical offset from origin of reference grid to top side of first tile
numberOfTiles	Number of tiles[3]
csiz	Number of components
ssizSign*	Indicates whether image component is signed or unsigned (repeated for all components)
ssizDepth*	Number of bits for this component (repeated for all components)
xRsiz*	Horizontal separation of sample of this component with respect to reference grid (repeated for all components)
yRsiz*	Vertical separation of sample of this component with respect to reference grid (repeated for all components)

7.5.3 Tests

[3]Calculated as: numberOfTiles = [xsiz - xOsiz xTsiz] • [ysiz - yOsiz yTsiz]

Test name	True if
lsizIsValid	*lsiz* is within range [41,49190]
rsizIsValid	*rsiz* equals 0 (“ISO/IEC 15444-1”), 1 (“Profile 0”) or 2 (“Profile 1”)
xsizIsValid	*xsiz* is within range [1,232 - 1]
ysizIsValid	*ysiz* is within range [1,232 - 1]
xOsizIsValid	*xOsiz* is within range [0,232 - 2]
yOsizIsValid	*yOsiz* is within range [0,232 - 2]
xTsizIsValid	*xTsiz* is within range [1,232 - 1]
yTsizIsValid	*yTsiz* is within range [1,232 - 1]
xTOsizIsValid	*xTOsiz* is within range [0,232 - 2]
yTOsizIsValid	*yTOsiz* is within range [0,232 - 2]
csizIsValid	*csiz* is within range [1,16384]
lsizConsistentWithCsiz	*lsiz* equals 38 + 3**csiz*
ssizIsValid*	*ssizDepth* is within range [1,38] (repeated for all components)
xRsizIsValid*	*xRsiz* is within range [1,255] (repeated for all components)
yRsizIsValid*	*yRsiz* is within range [1,255] (repeated for all components)

7.6 Coding style default (COD) marker segment

7.6.1 Element name

cod

7.6.2 Reported properties

Property	Description
lcod	Length of COD marker segment in bytes
precincts	Indicates default or user-defined precinct size (“default”/“user defined”)
sop	Indicates use of start of packet marker segments (“yes”/“no”)
eph	Indicates use of end of packet marker segments (“yes”/“no”)
order	Progression order
layers	Number of layers
multipleComponentTransformation	Indicates use of multiple component transformation (“yes”/“no”)
levels	Number of decomposition levels

Property	Description
codeBlockWidth	Code block width
codeBlockHeight	Code block height
codingBypass	Indicates use of coding bypass (“yes”/“no”)
resetOnBoundaries	Indicates reset of context probabilities on coding pass boundaries (“yes”/“no”)
termOnEachPass	Indicates termination on each coding pass (“yes”/“no”)
vertCausalContext	Indicates vertically causal context (“yes”/“no”)
predTermination	Indicates predictable termination (“yes”/“no”)
segmentationSymbols	Indicates use of segmentation symbols (“yes”/“no”)
transformation	Wavelet transformation: “9-7 irreversible” or “5-3 reversible”
precinctSizeX*	Precinct width (repeated for all resolution levels; order: low to high). Equals 32768 if *precincts* is “default”
precinctSizeY*	Precinct height (repeated for all resolution levels; order: low to high). Equals 32768 if *precincts* is “default”

7.6.3 Tests

Test name	True if
lcodIsValid	*lcod* is within range [12,45]
orderIsValid	*order* equals 0 (“LRCP”), 1 (“RLCP”), 2 (“RPCL”), 3 (“PCRL”) or 4 (“CPRL”)
layersIsValid	*layers* is within range [1,65535]
multipleComponentTransformation	IsValid
levelsIsValid	*levels* is within range [0,32]
lcodConsistencyCheck	*lcod* value is consistent with *precincts* and *levels* (Eq A-2 in ISO/IEC 15444-1)
codeBlockWidthExponentIsValid	*codeBlockWidthExponent* is within range [2,10]
codeBlockHeightExponentIsValid	*codeBlockHeightExponent* is within range [2,10]
sumHeightWidthExponentIsValid	*codeBlockWidthExponent* + *codeBlockHeightExponent* 12

Test name	True if
precinctSizeXIsValid*	*precinctSizeX* 2 (except lowest resolution level) (repeated for all resolution levels; order: low to high) (only if *precincts* is "user defined")
precinctSizeYIsValid*	*precinctSizeY* 2 (except lowest resolution level) (repeated for all resolution levels; order: low to high) (only if *precincts* is "user defined")

7.7 Coding style component (COC) marker segment

7.7.1 Element name

coc

7.7.2 Reported properties

Property	Description
lcoc	Length of COC marker segment in bytes
ccoc	Index of the component to which this marker segment relates
precincts	Indicates default or user-defined precinct size ("default"/"user defined")
levels	Number of decomposition levels
codeBlockWidth	Code block width
codeBlockHeight	Code block height
codingBypass	Indicates use of coding bypass ("yes"/"no")
resetOnBoundaries	Indicates reset of context probabilities on coding pass boundaries ("yes"/"no")
termOnEachPass	Indicates termination on each coding pass ("yes"/"no")
vertCausalContext	Indicates vertically causal context ("yes"/"no")
predTermination	Indicates predictable termination ("yes"/"no")
segmentationSymbols	Indicates use of segmentation symbols ("yes"/"no")
transformation	Wavelet transformation: "9-7 irreversible" or "5-3 reversible"

Property	Description
precinctSizeX*	Precinct width (repeated for all resolution levels; order: low to high). Equals 32768 if *precincts* is "default"
precinctSizeY*	Precinct height (repeated for all resolution levels; order: low to high). Equals 32768 if *precincts* is "default"

7.7.3 Tests

Test name	True if
lcocIsValid	*lcoc* is within range [9,43]
ccocIsValid	*ccoc* is within range [0,255] (*csiz* $<$ 257) or [0,16383] (*csiz* $>=$ 257)
levelsIsValid	*levels* is within range [0,32]
lcocConsistencyCheck	*lcoc* value is consistent with *levels*, *csiz* and *precincts* (Eq A-3 in ISO/IEC 15444-1)
codeBlockWidthExponentIsValid	*codeBlockWidthExponent* is within range [2,10]
codeBlockHeightExponentIsValid	*codeBlockHeightExponent* is within range [2,10]
sumHeightWidthExponentIsValid	*codeBlockWidthExponent* + *codeBlockHeightExponent* $\leq$ 12
precinctSizeXIsValid*	*precinctSizeX* $\geq$ 2 (except lowest resolution level) (repeated for all resolution levels; order: low to high) (only if *precincts* is "user defined")
precinctSizeYIsValid*	*precinctSizeY* $\geq$ 2 (except lowest resolution level) (repeated for all resolution levels; order: low to high) (only if *precincts* is "user defined")

7.8 Region-of-interest (RGN) marker segment

7.8.1 Element name

rgn

7.8.2 Reported properties

Property	Description
lrgn	Length of RGN marker segment in bytes
crgn	Index of the component to which this marker segment relates
roiStyle	ROI style for the current ROI
roiShift	Implicit ROI shift

7.8.3 Tests

Test name	True if
lrgnIsValid	*lrgn* is within range [5,6]
crgnIsValid	*crgn* is within range [0,255] (*csiz* < 257) or [0,16383] (*csiz* >= 257)
roiStyleIsValid	*roiStyle* equals 0 ("Implicit ROI (maximum shift)")
roiShiftIsValid	*roiShift* is within range [0,255]

7.9 Quantization default (QCD) marker segment

7.9.1 Element name

qcd

7.9.2 Reported properties

Property	Description
lqcd	Length of QCD marker segment in bytes
qStyle	Quantization style for all components
guardBits	Number of guard bits
epsilon*	- If *qStyle* equals 0 ("no quantization"): *Epsilon* exponent in Eq E-5 of ISO/IEC 15444-1 (repeated for all decomposition levels; order: low to high)- If *qStyle* equals 1 ("scalar derived"): *Epsilon* exponent in Eq E-3 of ISO/IEC 15444-1- If *qStyle* equals 2 ("scalar expounded"): *Epsilon* exponent in Eq E-3 of ISO/IEC 15444-1 (repeated for all decomposition levels; order: low to high)

Property	Description
mu*	- If *qStyle* equals 1 ("scalar derived"): *mu* constant in Eq E-3 of ISO/IEC 15444-1- if *qStyle* equals 2 ("scalar expounded") : *mu* constant in Eq E-3 of ISO/IEC 15444-1 (repeated for all decomposition levels; order: low to high)

7.9.3 Tests

Test name	True if
lqcdIsValid	*lqcd* is within range [4,197]
qStyleIsValid	*qStyle* equals 0 ("no quantization"), 1 ("scalar derived"), or 2 ("scalar expounded")

7.10 Quantization component (QCC) marker segment

7.10.1 Element name

qcc

7.10.2 Reported properties

Property	Description
lqcc	Length of QCC marker segment in bytes
cqcc	Index of the component to which this marker segment relates
qStyle	Quantization style for all components
guardBits	Number of guard bits
epsilon*	- If *qStyle* equals 0 ("no quantization"): *Epsilon* exponent in Eq E-5 of ISO/IEC 15444-1 (repeated for all decomposition levels; order: low to high)- If *qStyle* equals 1 ("scalar derived"): *Epsilon* exponent in Eq E-3 of ISO/IEC 15444-1- If *qStyle* equals 2 ("scalar expounded"): *Epsilon* exponent in Eq E-3 of ISO/IEC 15444-1 (repeated for all decomposition levels; order: low to high)

Property	Description
mu*	- If *qStyle* equals 1 ("scalar derived"): *mu* constant in Eq E-3 of ISO/IEC 15444-1- if *qStyle* equals 2 ("scalar expounded") : *mu* constant in Eq E-3 of ISO/IEC 15444-1 (repeated for all decomposition levels; order: low to high)

7.10.3 Tests

Test name	True if
lqccIsValid	*lqcc* is within range [5,199]
qStyleIsValid	*qStyle* equals 0 ("no quantization"), 1 ("scalar derived"), or 2 ("scalar expounded")

7.11 Progression order change (POC) marker segment

7.11.1 Element name

poc

7.11.2 Reported properties

Property	Description
lpoc	Length of POC marker segment in bytes
rspoc*	Resolution level index for the start of a progression (repeated for all progression order changes)
cspoc*	Component index for the start of a progression (repeated for all progression order changes)
lyepoc*	Layer index for the end of a progression (repeated for all progression order changes)
repoc*	Resolution level index for the end of a progression (repeated for all progression order changes)

Property	Description
cepoc*	Component index for the end of a progression (repeated for all progression order changes)
order*	Progression order (repeated for all progression order changes)

7.11.3 Tests

Test name	True if
lpocIsValid	*lpoc* is within range [9,65535]
rspocIsValid*	*rspoc* is within range [0,32] (repeated for all progression order changes)
cspocIsValid*	*cspoc* is within range [0,255] (*csiz* < 257) or [0,16383] (*csiz >= 257) (repeated for all progression order changes)
lyepocIsValid*	*lyepoc* is within range [1,65535] (repeated for all progression order changes)
repocIsValid*	*repoc* is within range [(*rspoc* + 1),65535] (repeated for all progression order changes)
cepocIsValid*	*cepoc* is within range [(*cspoc* + 1),255] (*csiz* < 257) or [(*cspoc* + 1),16384] (*csiz >= 257), or 0 (repeated for all progression order changes)
orderIsValid*	*order* equals 0 (“LRCP”), 1 (“RLCP”), 2 (“RPCL”), 3 (“PCRL”) or 4 (“CPRL”) (repeated for all progression order changes)

7.12 Component registration (CRG) marker segment

7.12.1 Element name

crg

7.12.2 Reported properties

Property	Description
lcrg	Length of CRG marker segment in bytes
xrg*	Horizontal offset, in units of 1/65536 of *xRsiz* (repeated for all components)
yrg*	Vertical offset, in units of 1/65536 of *yRsiz* (repeated for all components)

7.12.3 Tests

Test name	True if
lcrgIsValid	*lcrg* is within range [6,65534]
xcrgIsValid*	*xcrg* is within range [0,65535] (repeated for all components)
ycrgIsValid*	*ycrg* is within range [0,65535] (repeated for all components)

7.13 Comment (COM) marker segment

7.13.1 Element name

com

7.13.2 Reported properties

Property	Description
lcom	Length of COM marker segment in bytes
rcom	Registration value of marker segment (indicates whether this comment contains binary data or text)
comment	Embedded comment as text (only if *rcom* = 1)

7.13.3 Tests

Test name	True if
lcomIsValid	*lqcd* is within range [5,65535]
rcomIsValid	*rcom* equals 0 (“binary”) or 1 (“ISO/IEC 8859-15 (Latin”))

Test name	True if
commentIsValid	Comment is valid ISO/IEC8859-15 and does not contain control characters, other than tab, newline or carriage return

7.14 Tile part (child of Contiguous Codestream box)

Tile-part level properties and tests. This is not a box or a marker segment!

7.14.1 Element name

tilePart (child of tileParts)

7.14.2 Reported properties

Each tile part element can contain a number of child elements:

Child element	Description
sot	Properties from start of tile (SOT) marker segment
cod	Properties from the (optional) coding style default (COD) marker segment (tile part header)
coc	Properties from the (optional) coding style component (COC) marker segment (tile part header)
rgn	Properties from the (optional) region of interest (RGN) marker segment (tile part header)
qcd	Properties from the (optional) quantization default (QCD) marker segment (tile part header)
qcc	Properties from the (optional) quantization component (QCC) marker segment (tile part header)
poc	Properties from the (optional) progression order change (POC) marker segment (tile part header)

Child element	Description
com	Properties from the (optional) comment (COM) marker segment (tile part header)
plt	Properties from the (optional) packet length (PLT) marker(tile part header)
ppt	Properties from the (optional) packed packet headers(PPT) marker segment (tile part header)

Note that the *plt* and *ppt* elements are only written if the `--packetmarkers` option is used. The number of PLT and PPT markers is given by the following 2 derived properties (these are always reported, irrespective of `--packetmarkers`):

Property	Description
pltCount	Number of PLT markers in tile part header
pptCount	Number of PPT markers in tile part header

7.14.3 Tests

Test name	True if
foundNextTilePartOrEOC	Tile part start offset + *tilePartLength* points to either start of new tile or EOC marker (useful for detecting within-codestream byte corruption)
foundSODMarker	Last marker segment of tile part is a start-of-data (SOD) marker

7.15 Start of tile part (SOT) marker segment (child of tile part)

7.15.1 Element name

sot

7.15.2 Reported properties

Property	Description
lsot	Length of SOT marker segment in bytes
isot	Tile index
psot	Length of tile part
tpsot	Tile part index
tnsot	Number of tile-parts of a tile in the codestream (value of 0 indicates that number of tile-parts of tile in the codestream is not defined in current header)

7.15.3 Tests

Test name	True if
lsotIsValid	*lsot* equals 10
isotIsValid	*isot* is within range [0,65534]
psotIsValid	*psot* is **not** within range [1,13]
tpsotIsValid	*tpsot* is within range [0,254]

The following marker segments are only minimally supported: *jpylyzer* will report their presence in the *properties* element, but it does not perform any further tests or analyses. This may change in upcoming versions of the software.

7.16 Tile-part lengths (TLM) marker segment

7.16.1 Element name

tlm

7.16.2 Reported properties

Property	Description

7.16.3 Tests

Test name	True if

7.17 Packet length, main header (PLM) marker segment

7.17.1 Element name

plm

7.17.2 Reported properties[4]

Property	Description
lplm	Length of PLM marker segment in bytes
zplm	PLM marker segment index
nplm	Number of bytes of Iplm information for the ith tile-part
iplm	Comma separated list of packet length values (as hexadecimal strings)

7.17.3 Tests

Test name	True if

7.18 Packed packet headers, main header (PPM) marker segment

7.18.1 Element name

ppm

7.18.2 Reported properties[5]

Property	Description

[4] Only reported if the `--packetmarkers` option is used.
[5] Only reported if the `--packetmarkers` option is used.

7.18.3 Tests

Test name	True if

7.19 Packet length, tile-part header (PLT) marker segment

7.19.1 Element name

plt

7.19.2 Reported properties[6]

Property	Description
lplt	Length of PLT marker segment in bytes
zplt	PLT marker segment index
nplm	Number of bytes of Iplm information for the ith tile-part
iplt	Comma separated list of packet length values (as hexadecimal strings)

7.19.3 Tests

Test name	True if

7.20 Packed packet headers, tile-part header (PPT) marker segment

7.20.1 Element name

ppt

[6] Only reported if the `--packetmarkers` option is used.

7.20.2 Reported properties[7]

Property	Description

7.20.3 Tests

Test name	True if

[7] Only reported if the `--packetmarkers` option is used.

Chapter 8

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