

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 <i>jpylyzer</i> | 9 |
| 3.1 | Overview | 9 |
| 3.2 | Command-line usage | 9 |
| 3.3 | Using <i>jpylyzer</i> 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 |

| | |
|---|-----------|
| <i>CONTENTS</i> | v |
| 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 *jpglyzer* 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 *jpglyzer* 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 *jpglyzer* 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 binaries¹. 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.

¹The *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 your 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 *jpglyzer* 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, *jpglyzer* will recursively traverse all subdirectories of a filepath expression. E.g:

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

In this case *jpglyzer* 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, *jpglyzer* 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 *jpglyzer* 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 behaviour. For example:

```
jpglyzer --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:

```
jpglyzer --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, *jpglyzer* 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, *jpglyzer* *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 *jpglyzer* 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 *jpglyzer* 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. *Jpglyzer* 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 *jpglyzer* 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 *jpglyzer* 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 *jpglyzer* 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, *jpglyzer* will simply ignore these and process all other boxes normally.

3.3 Using *jpglyzer* as a Python module

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

```
from jpglyzer import jpglyzer
```

Subsequently you can call any function that is defined in *jpglyzer.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 jpglyzer import jpglyzer
```

```
# Define JP2
```

```
myFile = "/home/johan/jpylyzer-test-files/aware.jp2"
```

```
# Analyse with jpglyzer, result to Element object
```

```
myResult = jpglyzer.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* module¹. 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.

¹Note 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).

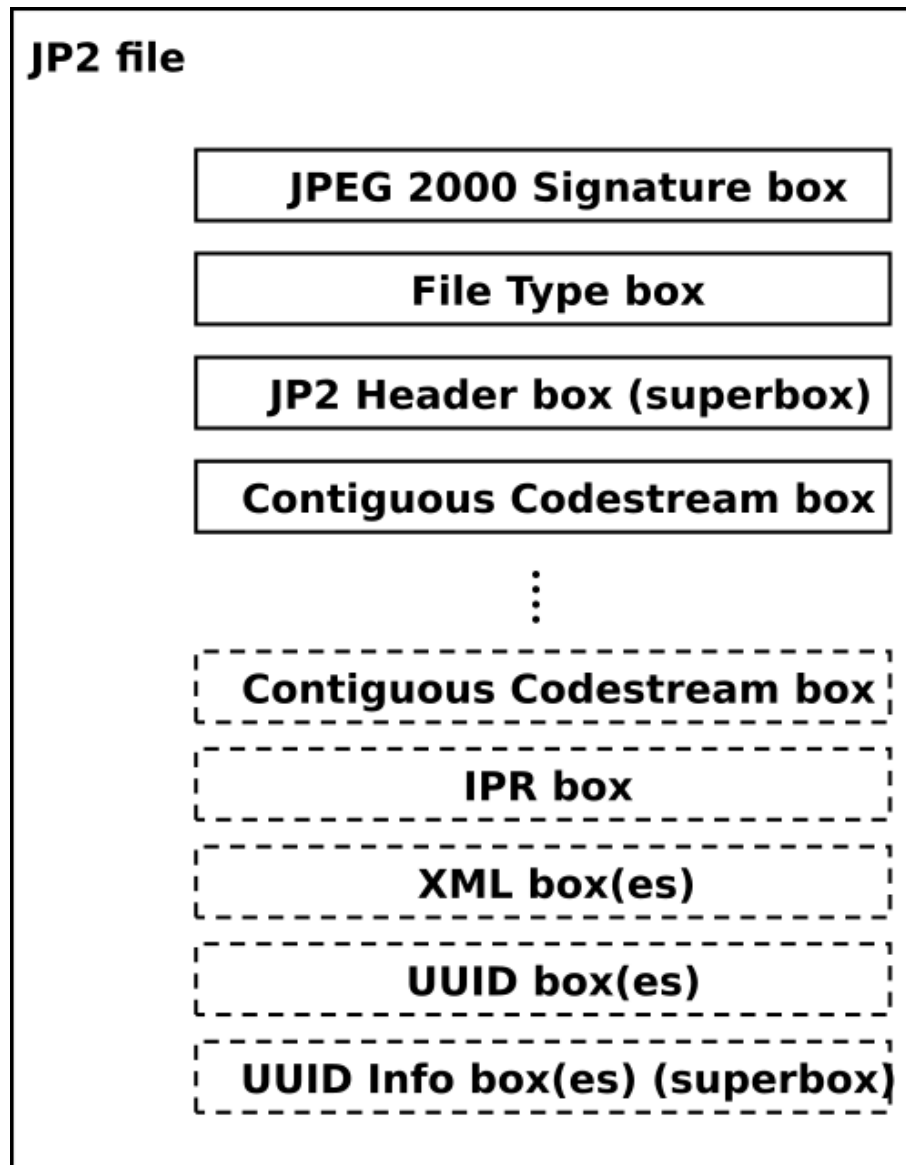


Figure 4.1: Top-level overview of a JP2 file. Boxes with dashed borders are optional.

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 *jpglyzer* 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:

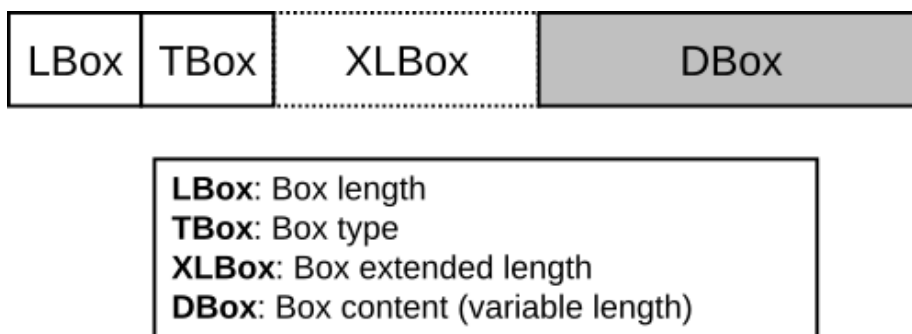


Figure 4.2: General structure of a box.

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 the analysed files

The XML output is pretty-printed. You can use the `--noproretty` 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:

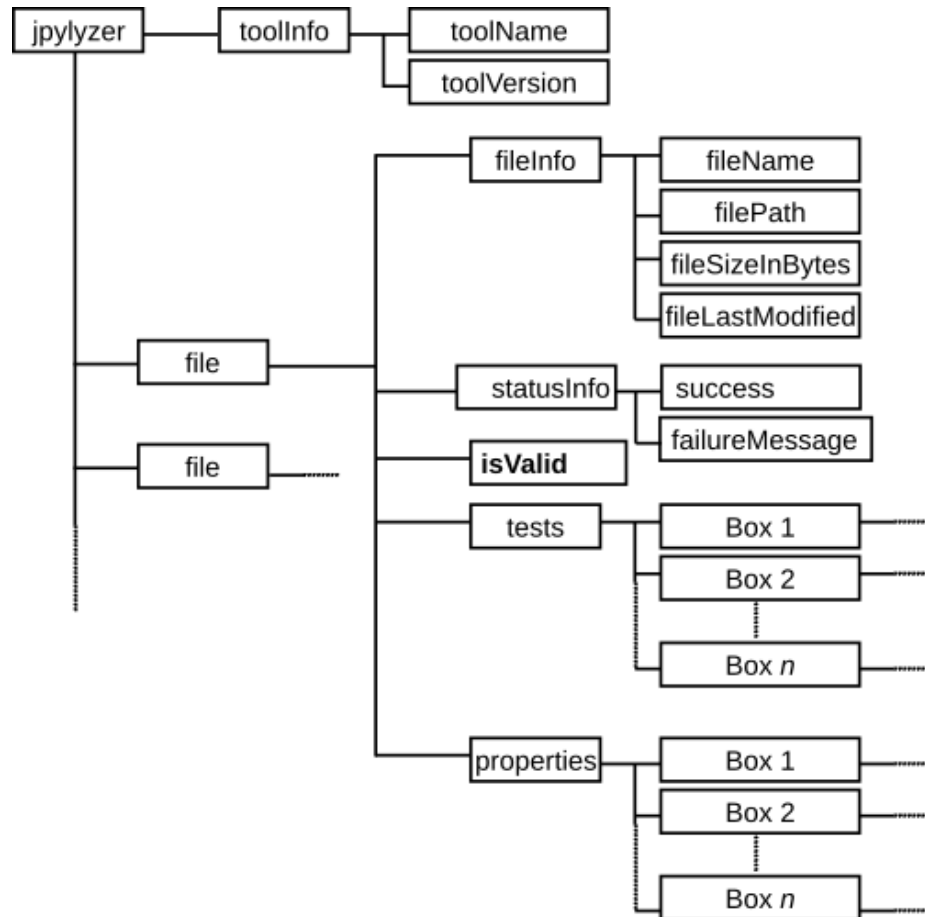


Figure 5.1: Jpylyzer’s XML output structure. ‘box’ elements under ‘tests’ and ‘properties’ contain further sub-elements.

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 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 *jpglyzer* 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, *jpglyzer* 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

¹Note that *jpglyzer* 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 code-stream header, which contains three switches that define the use of precincts, start-of-packet markers and end-of-packet markers. For cases like these *jpglyzer* 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 |
|-------------|----------------------------------|
| <i>cL</i> * | Compatibility field (repeatable) |

6.3.3 Tests

| Test name | True if |
|--------------------------|--|
| boxLengthIsValid | (Size of box – 8) / 4 is a whole number (integer) |
| brandIsValid | <i>br</i> equals 0x6a703220 (“jp2”) |
| minorVersionIsValid | <i>minV</i> equals 0 |
| compatibilityListIsValid | Sequence of compatibility (<i>cL</i>) 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 <i>bPCSign</i> and <i>bPCDepth</i> 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 | <i>height</i> is within range [1, 232 - 1] |
| widthIsValid | <i>width</i> is within range [1, 232 - 1] |
| nCIsValid | <i>nC</i> is within range [1, 16384] |
| bPCIsValid | <i>bPCDepth</i> is within range [1,38] OR <i>bPCSign</i> equals 255 (in the latter case the bit depth is variable) |
| cIsValid | <i>c</i> equals 7 (“jpeg2000”) |
| unkCIsValid | <i>unkC</i> equals 0 (“no”) or 1 (“yes”) |
| iPRIsValid | <i>iPR</i> 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* | <i>bPCDepth</i> 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 colour space of this image is defined as an enumerated colour space or using a (restricted) ICC profile. |
| prec | Precedence |
| approx | Colour space approximation |
| enumCS (if meth equals “Enumerated”) | Enumerated colour space (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, *jpglyzer* 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 *jpglyzer* 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 | Colour space |
| 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 <i>cannot</i> (!) be used independently from the embedded colour data (“yes”/“no”) |
| deviceManufacturer | Identifies a device manufacturer |

¹The “Any ICC” method is defined in ISO/IEC 15444-2 (the JPX format), and is not allowed in JP2. However, *jpglyzer* 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 | <i>meth</i> equals 1 (enumerated colourspace) or 2 (restricted ICC profile) |
| precIsValid | <i>prec</i> equals 0 |
| approxIsValid | <i>approx</i> equals 0 |
| enumCSIsValid (if meth equals “Enumerated”) | <i>enumCS</i> equals 16 (“sRGB”), 17 (“greyscale”) or 18 (“sYCC”) |
| iccSizeIsValid (if meth equals “Restricted ICC”) | Actual size of embedded ICC profile equals value of <i>profileSize</i> 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) |

²Originally 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 *jpglyzer* 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 | <i>nE</i> is within range [0,1024] |
| nPCIsValid | <i>nPC</i> is within range [1,255] |
| bDepthIsValid* | <i>bDepth</i> 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 |
|---------------|--|
| <i>cMP</i> * | Component index (repeated for all channels) |
| <i>mTyp</i> * | Specifies how channel is generated from codestream component (repeated for all channels) |
| <i>pCol</i> * | Palette component index (repeated for all channels) |

6.9.3 Tests

| Test name | True if |
|----------------------|--|
| <i>cMPIsValid</i> | <i>cMP</i> is within range [0,16384] |
| <i>mTypIsValid</i> * | <i>mTyp</i> is within range [0,1] (repeated for all channels) |
| <i>pColIsValid</i> * | <i>pCol</i> is 0 if <i>mTyp</i> 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 |
|-----------------|---|
| <i>n</i> | Number of channel descriptions |
| <i>cN</i> * | Channel index (repeated for all channels) |
| <i>cTyp</i> * | Channel type (repeated for all channels) |
| <i>cAssoc</i> * | Channel association (repeated for all channels) |

6.10.3 Tests

| Test name | True if |
|------------------|--|
| nIsValid | n is within range $[1, 65535]$ |
| boxLengthIsValid | $(\text{Size of box} - 2) / \text{equals } 6 * n$ |
| 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 |

³Calculated as: $vRcN \cdot vRcD \cdot 10^{vRcE}$

⁴Calculated as: $hRcN \cdot hRcD \cdot 10^{hRcE}$

⁵Calculated as: $vRescInPixelsPerMeter \cdot 25.4 \cdot 10^{-3}$

⁶Calculated as: $hRescInPixelsPerMeter \cdot 25.4 \cdot 10^{-3}$

6.12.3 Tests

| Test name | True if |
|------------------|--|
| boxLengthIsValid | Size of box contents equals 10 bytes |
| vRcNIsValid | <i>vRcN</i> is within range [1,65535] |
| vRcDIsValid | <i>vRcD</i> is within range [1,65535] |
| hRcNIsValid | <i>hRcN</i> is within range [1,65535] |
| hRcDIsValid | <i>hRcD</i> is within range [1,65535] |
| vRcEIsValid | <i>vRcE</i> is within range [-127,128] |
| hRcEIsValid | <i>hRcE</i> 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 |
| 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 | <i>vRdN</i> is within range [1,65535] |
| vRdDIsValid | <i>vRdD</i> is within range [1,65535] |
| hRdNIsValid | <i>hRdN</i> is within range [1,65535] |
| hRdDIsValid | <i>hRdD</i> is within range [1,65535] |
| vRdEIsValid | <i>vRdE</i> is within range [-127,128] |
| hRdEIsValid | <i>hRdE</i> 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, *jpglyzer* 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

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 *jpglyzer*’s output.

⁷Calculated as: *vRdN* *vRdD* • 10 *vRdE*

⁸Calculated as: *hRdN* *hRdD* • 10 *hRdE*

⁹Calculated as: *vResdInPixelsPerMeter* • 25.4 • 10 -3

¹⁰Calculated as: *hResdInPixelsPerMeter* • 25.4 • 10 -3

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 specification¹¹).

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.

¹¹Link: <https://www.images.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 <i>be7acfb-97a9-42e8-9c71-999491e3afac</i>). For an explanation of UUIDs see e.g. Leach <i>et al.</i> , 2005. |
| XMP data | XMP metadata (only if uuid has value <i>be7acfb-97a9-42e8-9c71-999491e3afac</i>) |

Note that except for the XMP case, *jpglyzer* 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 <i>be7acfb-97a9-42e8-9c71-999491e3afac</i>) |

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 *jpglyzer* 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 <i>TBox</i> 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:

$$\text{compressionRatio} = \frac{\text{sizeUncompressed}}{\text{sizeCompressed}}$$

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

$$\text{sizeUncompressed} = 1.8 \cdot i = 1.8 \cdot nC \cdot bPCDepth \cdot i \cdot \text{height} \cdot \text{width}$$

With:

nC number of image components (from Image Header box)

i component index

bPCDepth_i 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 *jpglyzer* 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 *jpglyzer* 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 <i>iPR</i> 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 <i>height</i> from Image Header Box equals $ysiz - yOsiz$ from codestream SIZ header |
| widthConsistentWithSIZ | Value of <i>width</i> from Image Header Box equals $xsiz - xOsiz$ from codestream SIZ header |
| nCConsistentWithSIZ | Value of <i>nC</i> from Image Header Box equals <i>csiz</i> from codestream SIZ header |
| bPCSignConsistentWithSIZ | Values of <i>bPCSign</i> from Image Header box (or Bits Per Component box) are equal to corresponding <i>ssizSign</i> values from codestream SIZ header |
| bPCDepthConsistentWithSIZ | Values of <i>bPCDepth</i> from Image Header box (or Bits Per Component box) are equal to corresponding <i>ssizDepth</i> 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:

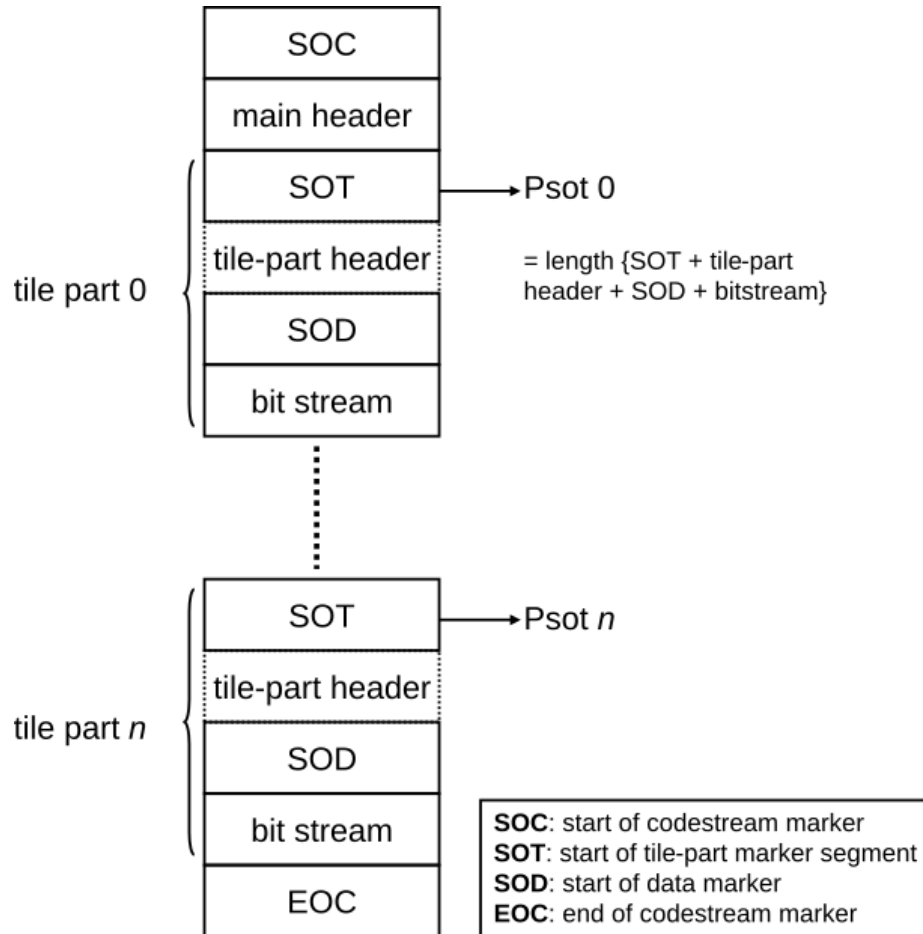


Figure 7.1: General structure of a JPEG 2000 codestream.

- 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, *jpglyzer* 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 *jpglyzer* encounters them, it will include the corresponding element in the *properties* element of the output. However, *jpglyzer* 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, *jpglyzer* 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 *jpglyzer*'s scope)¹. As

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

a result, if *jpglyzer* is used as part of a quality assurance workflow, it is recommended to also include an additional check on the image contents². Also, *jpglyzer* 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 *jpglyzer*'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) |

²For 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`):

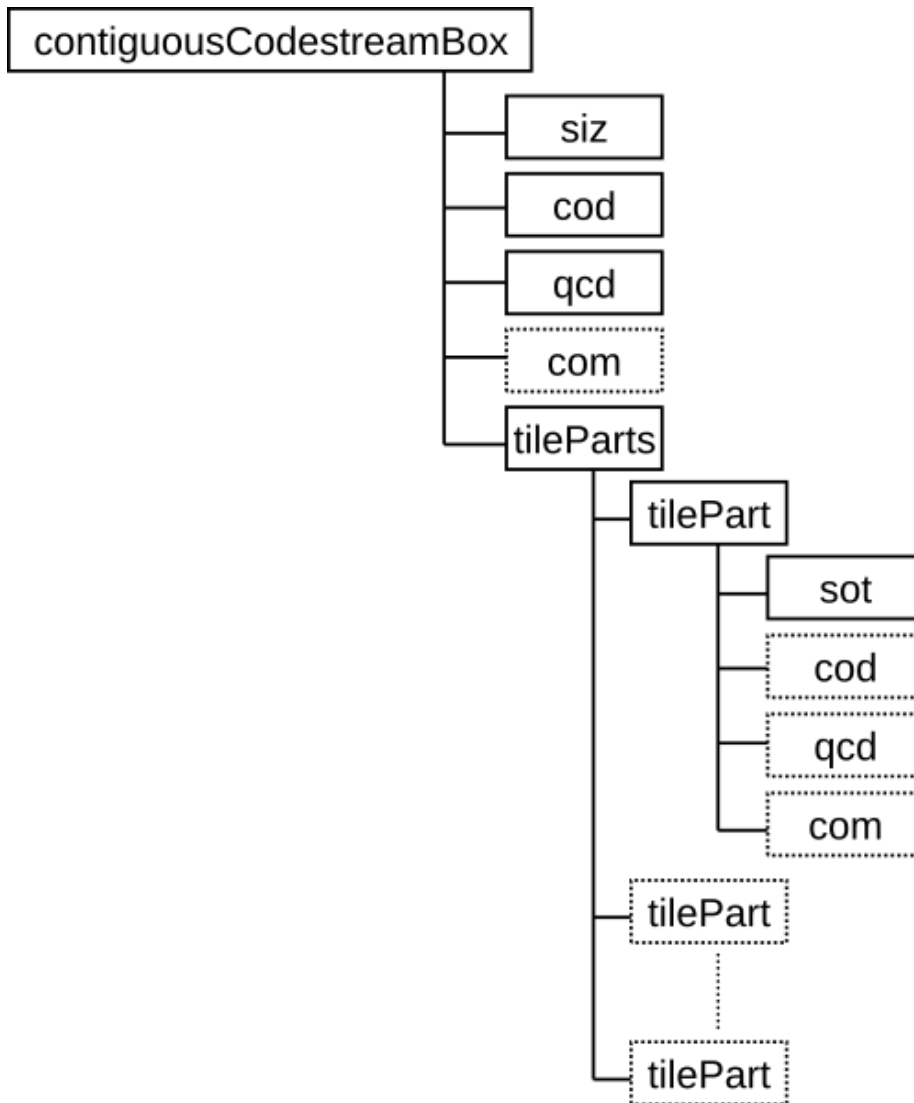


Figure 7.2: Structure of codestream-level XML output.

| 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 <i>tnsot</i> from SOT marker) |
| maxOneCcocPerComponent | No more than one <i>ccoc</i> value for each component (only reported if codestream contains any COC marker segments) |
| maxOneCqccPerComponent | No more than one <i>cqcc</i> 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

³Calculated as: $\text{numberOfTiles} = \lceil \text{xsiz} - \text{xOsiz} \rceil \cdot \lceil \text{ysiz} - \text{yOsiz} \rceil$

| Test name | True if |
|------------------------|--|
| lsizIsValid | <i>lsiz</i> is within range [41,49190] |
| rsizIsValid | <i>rsiz</i> equals 0 (“ISO/IEC 15444-1”), 1 (“Profile 0”) or 2 (“Profile 1”) |
| xsizIsValid | <i>xsiz</i> is within range [1,232 - 1] |
| ysizIsValid | <i>ysiz</i> is within range [1,232 - 1] |
| xOsizIsValid | <i>xOsiz</i> is within range [0,232 - 2] |
| yOsizIsValid | <i>yOsiz</i> is within range [0,232 - 2] |
| xTsizIsValid | <i>xTsiz</i> is within range [1,232 - 1] |
| yTsizIsValid | <i>yTsiz</i> is within range [1,232 - 1] |
| xTOsizIsValid | <i>xTOsiz</i> is within range [0,232 - 2] |
| yTOsizIsValid | <i>yTOsiz</i> is within range [0,232 - 2] |
| csizIsValid | <i>csiz</i> is within range [1,16384] |
| lsizConsistentWithCsiz | <i>lsiz</i> equals $38 + 3 * csiz$ |
| ssizIsValid* | <i>ssizDepth</i> is within range [1,38] (repeated for all components) |
| xRsizIsValid* | <i>xRsiz</i> is within range [1,255] (repeated for all components) |
| yRsizIsValid* | <i>yRsiz</i> 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 |
|----------------------------------|---|
| <code>codeBlockWidth</code> | Code block width |
| <code>codeBlockHeight</code> | Code block height |
| <code>codingBypass</code> | Indicates use of coding bypass (“yes”/“no”) |
| <code>resetOnBoundaries</code> | Indicates reset of context probabilities on coding pass boundaries (“yes”/“no”) |
| <code>termOnEachPass</code> | Indicates termination on each coding pass (“yes”/“no”) |
| <code>vertCausalContext</code> | Indicates vertically causal context (“yes”/“no”) |
| <code>predTermination</code> | Indicates predictable termination (“yes”/“no”) |
| <code>segmentationSymbols</code> | Indicates use of segmentation symbols (“yes”/“no”) |
| <code>transformation</code> | Wavelet transformation: “9-7 irreversible” or “5-3 reversible” |
| <code>precinctSizeX*</code> | Precinct width (repeated for all resolution levels; order: low to high). Equals 32768 if <i>precincts</i> is “default” |
| <code>precinctSizeY*</code> | Precinct height (repeated for all resolution levels; order: low to high). Equals 32768 if <i>precincts</i> is “default” |

7.6.3 Tests

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

| Test name | True if |
|-----------------------|---|
| precinctSizeXIsValid* | <i>precinctSizeX</i> = 2 (except lowest resolution level) (repeated for all resolution levels; order: low to high) (only if <i>precincts</i> is “user defined”) |
| precinctSizeYIsValid* | <i>precinctSizeY</i> = 2 (except lowest resolution level) (repeated for all resolution levels; order: low to high) (only if <i>precincts</i> 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 <i>precincts</i> is “default” |
| precinctSizeY* | Precinct height (repeated for all resolution levels; order: low to high). Equals 32768 if <i>precincts</i> is “default” |

7.7.3 Tests

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

7.8 Region-of-interest (RGN) marker segment

7.8.1 Element name

rgn

7.8.2 Reported properties

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

7.8.3 Tests

| Test name | True if |
|------------------------|--|
| <i>lrgnIsValid</i> | <i>lrgn</i> is within range [5,6] |
| <i>crgnIsValid</i> | <i>crgn</i> is within range [0,255] (<i>csiz</i> < 257) or [0,16383] (<i>csiz</i> ≥ 257) |
| <i>roiStyleIsValid</i> | <i>roiStyle</i> equals 0 (“Implicit ROI (maximum shift)”) |
| <i>roiShiftIsValid</i> | <i>roiShift</i> 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 |
|------------------|--|
| <i>lqcd</i> | Length of QCD marker segment in bytes |
| <i>qStyle</i> | Quantization style for all components |
| <i>guardBits</i> | Number of guard bits |
| <i>epsilon</i> * | - If <i>qStyle</i> equals 0 (“no quantization”): <i>Epsilon</i> exponent in Eq E-5 of ISO/IEC 15444-1 (repeated for all decomposition levels; order: low to high)- If <i>qStyle</i> equals 1 (“scalar derived”): <i>Epsilon</i> exponent in Eq E-3 of ISO/IEC 15444-1- If <i>qStyle</i> equals 2 (“scalar expounded”): <i>Epsilon</i> exponent in Eq E-3 of ISO/IEC 15444-1 (repeated for all decomposition levels; order: low to high) |

| Property | Description |
|----------|---|
| μ^* | - If $qStyle$ equals 1 (“scalar derived”): μ constant in Eq E-3 of ISO/IEC 15444-1- if $qStyle$ equals 2 (“scalar expounded”) : μ 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 |
| ϵ^* | - 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 |
|----------|---|
| μ^* | - If $qStyle$ equals 1 (“scalar derived”): μ constant in Eq E-3 of ISO/IEC 15444-1- if $qStyle$ equals 2 (“scalar expounded”) : μ 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 |
|----------------------------|--|
| <code>lqccIsValid</code> | $lqcc$ is within range [5,199] |
| <code>qStyleIsValid</code> | $qStyle$ 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 |
|----------------------|--|
| <code>lpoc</code> | Length of POC marker segment in bytes |
| <code>rspoc*</code> | Resolution level index for the start of a progression (repeated for all progression order changes) |
| <code>cspoc*</code> | Component index for the start of a progression (repeated for all progression order changes) |
| <code>lyepoc*</code> | Layer index for the end of a progression (repeated for all progression order changes) |
| <code>repoc*</code> | 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 | <i>lpoc</i> is within range [9,65535] |
| rspocIsValid* | <i>rspoc</i> is within range [0,32] (repeated for all progression order changes) |
| cspocIsValid* | <i>cspoc</i> is within range [0,255] (<i>csiz</i> < 257) or [0,16383] (* <i>csiz</i> ≥ 257) (repeated for all progression order changes) |
| lyepocIsValid* | <i>lyepoc</i> is within range [1,65535] (repeated for all progression order changes) |
| repocIsValid* | <i>repoc</i> is within range [(<i>rspoc</i> + 1),65535] (repeated for all progression order changes) |
| cepocIsValid* | <i>cepoc</i> is within range [(<i>cspoc</i> + 1),255] (<i>csiz</i> < 257) or [(<i>cspoc</i> + 1),16384] (* <i>csiz</i> ≥ 257), or 0 (repeated for all progression order changes) |
| orderIsValid* | <i>order</i> 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 |
|--------------|---|
| <i>lcrg</i> | Length of CRG marker segment in bytes |
| <i>xrg</i> * | Horizontal offset, in units of 1/65536 of <i>xRsz</i> (repeated for all components) |
| <i>yrg</i> * | Vertical offset, in units of 1/65536 of <i>yRsz</i> (repeated for all components) |

7.12.3 Tests

| Test name | True if |
|----------------------|--|
| <i>lcrgIsValid</i> | <i>lcrg</i> is within range [6,65534] |
| <i>xcrgIsValid</i> * | <i>xcrg</i> is within range [0,65535] (repeated for all components) |
| <i>ycrgIsValid</i> * | <i>ycrg</i> 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 |
|----------------|--|
| <i>lcom</i> | Length of COM marker segment in bytes |
| <i>rcom</i> | Registration value of marker segment (indicates whether this comment contains binary data or text) |
| <i>comment</i> | Embedded comment as text (only if <i>rcom</i> = 1) |

7.13.3 Tests

| Test name | True if |
|--------------------|---|
| <i>lcomIsValid</i> | <i>lqcd</i> is within range [5,65535] |
| <i>rcomIsValid</i> | <i>rcom</i> 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 + <i>tilePartLength</i> 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 | <i>lsot</i> equals 10 |
| isotIsValid | <i>isot</i> is within range [0,65534] |
| psotIsValid | <i>psot</i> is not within range [1,13] |
| tpsotIsValid | <i>tpsot</i> 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 properties⁴

| Property | Description |
|----------|---|
| lplm | Length of PLM marker segment in bytes |
| zplm | PLM marker segment index |
| nplm | Number of bytes of lplm 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 properties⁵

| Property | Description |
|----------|-------------|
| | |

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

⁵Only 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 properties⁶

| 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

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

7.20.2 Reported properties⁷

| Property | Description |
|----------|-------------|
| | |

7.20.3 Tests

| Test name | True if |
|-----------|---------|
| | |

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

Chapter 8

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