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Information technology — JPEG systems —

Part 10: Reference software

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This second edition cancels and replaces the first edition (ISO/IEC 19566-10:2024), which has been technically revised. It also incorporates the Amendment ISO/IEC 19566-10:2024/Amd 1:2025.

The main changes are as follows:

— Inclusion of more reference implementation supporting all JUMBF Content Types defined throughout the ISO/IEC 19566 series,

— Revision of the JUMBF reference implementation to support the processing of JUMBF data in more image file formats,

— Enhancement of the reference dataset to include more scenarios from different image file formats.

A list of all parts in the ISO 19566 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

The JPEG Universal Metadata Box Format (JUMBF) provides a mechanism to embed and refer generic metadata in JPEG files. Specific content types can be assigned to identify the specific type of the embedded metadata.

This document specifies reference software implementations that handle JUMBF data according to the Content Types specified in the ISO/IEC 19566 series. For each part of the ISO/IEC 19566 series, a reference dataset is also provided, allowing for the conformance checking of candidate applications. The dataset provides cases focusing on the intrinsic characteristics of the JUMBF data model, but also expands to the encoding of JUMBF files in image file formats.

In the second edition of this document (JPEG Systems reference implementations), more reference implementations are included covering all JUMBF Content Types specified in ISO/IEC 19566 specifications. At least one reference implementation exists per ISO/IEC 19566 parts, while more implementations are specified in ISO/IEC 19566-5 [1](JUMBF) and ISO/IEC 19566-8 [2](JPEG Snack).

Information technology — JPEG systems —

Part 10: Reference software

1 Scope

This document specifies a reference software implementation of ISO/IEC 19566-5 [1]. The reference software is accompanied with a reference dataset which provides an extensive list of the various JUMBF data structures specified in ISO/IEC 19566-5 [1].

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org

3.1.1
codestream
compressed image data representation that includes all necessary data to allow a (full or approximate) reconstruction of the sample values of a digital image

3.2 Abbreviated terms

APP11	application marker 11: JPEG XT extension marker
CBOR	concise binary object representation
CLI	command line interface
CSV	comma separated values
GUI	graphical user interface
IoC	inversion of controls
ISOBMFF	ISO base media file format
IV	initial value
JPEG	joint photographic experts group

JPEG-1	image complying to Rec. ITU-T T.81 | ISO/IEC 10918-1
JP2C	JPEG contiguous codestream
JSON	JavaScript[1)] object notation
JUMBF	JPEG universal metadata box format
POJO	plain old Java object
UUID	universally unique identifier
XML	extensible markup language

4 Reference software

4.1 Purpose

The use of the reference software is not required for making an implementation of parser or generator in conformance to any of the parts of the ISO/IEC 19566 series. Requirements established in all parts of the ISO/IEC 19566 series take precedence over the behaviour of the reference software.

4.2 Examples of use

This subclause enumerates possible uses of the reference implementations presented in the annexes:

a) Sample parser. Users can use the reference implementations to inspect, even through visualization, the structure and contents of the JUMBF data model as specified in ISO/IEC 19566-5 [1].

b) Sample generator. Users could use the reference implementations to create JUMBF files that could be used to facilitate the development of applications that take advantage of the benefits of JUMBF specification.

c) Provide anchor implementations for development purposes. JUMBF data model developers could study the reference implementations presented in the annexes in order to gain better insight on the algorithms as well as on how JUMBF Boxes are interconnected.

d) Provide anchor implementations to test possible conformant software. This facilitates developers to have an existing implementation act as a ground truth which will assist them assess the validity of their own implementations.

The lack of detection of any conformance violation by any reference software implementation should not be considered as a definite proof that the codestream under testing conforms to all constraints required for it to be conforming to one of the parts of the ISO/IEC 19566 series. Similarly, the computation resource characteristics in terms of program or data memory usage, execution speed, etc. of sample software encoder or decoder implementations shall not be construed as a representative of the typical, minimal or maximal computational resource characteristics to be exhibited by implementations of some parts of the ISO/IEC 19566 series.

1) JavaScript™ is the trademark of a product supplied by Oracle® Corporation. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

4.3 Warranty disclaimer

Regardless of any and all statements made herein or elsewhere regarding the possible uses of the reference software, the following disclaimers of warranty apply to the provided reference software implementations:

— ITU, ISO and IEC disclaim any and all warranties, whether express, implied, or statutory, including any implied warranties of merchantability or of fitness for a particular purpose.

— In no event shall the contributor(s) or ITU, ISO or IEC be liable for any incidental, punitive or consequential damages of any kind whatsoever arising from the use of these programs.

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— Commercial applications of ITU-T Recommendations and ISO/IEC International Standards, including shareware, may be subject to royalty fees to patent holders.

4.4 General

The rest of the document describes several reference software implementations. Reference software implementations do not intend to be unique. Therefore, some parts of JPEG Systems can have more than one implementation. On the other hand, reference software implementations need to be validated, from functionality and interoperability points of view. Hence, Annex A describes the mechanism followed for validation of the JUMBF reference software. Annex B describes an implementation of reference software for JUMBF (as specified in ISO/IEC 19566-5 [1]). The implementations presented in the subsequent annexes are summarized in Table 1, including information related to the parts of the ISO/IEC 19566 series they cover, the provided functionalities as well as the technology used.

The reference software implementations along with the respective reference datasets are available at https://standards.iso.org/iso-iec/19566/-10/ed-2/en.

Table 1 — Reference software implementations for the ISO/IEC 19566 series

Annex	Software	ISO/IEC 19566 parts	Decoder	Encoder	Technology
Annex B	jumbf-2.2 library	ISO/IEC 19566-5 [1]	Yes	Yes	Java[a]
Annex C	dbench-jumbf-1.0	ISO/IEC 19566-5 [1]	Yes	Yes	C++
Annex E	privsec-1.2 library	ISO/IEC 19566-4 [3]	Yes	Yes	Java
Annex G	jpeg360-1.2 library	ISO/IEC 19566-6 [4]	Yes	Yes	Java
Annex I	jlink-1.2 library	ISO/IEC 19566-7 [5]	Yes	Yes	Java
Annex K	jpegsnack-1.2 library	ISO/IEC 19566-8 [2]	Yes	Yes	Java
Annex L	dbench-jpeg-snack-1.0	ISO/IEC 19566-8 [2]	Yes	Yes	C++

[a] Java™ is the trademark of a product supplied by Oracle® Corporation. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

5 Copyright, licensing and intellectual property

The source code for all reference implementations is provided within the package accompanying this document. ISO/IEC draws the attention of the users of this software to the licence terms and conditions specified in the LICENSE file located in the main directory of each reference software implementation.

Annex A
(informative)

Validation of ISO/IEC 19566-5 (JUMBF) reference software

A.1 General

This subclause describes the validation process that is followed in order to verify the correctness of ISO/IEC 19566-5 [1] reference software implementations. The validation procedure deals with parser and generator implementations separately. Along with the validation procedure, the JPEG Systems reference dataset is included. In principle, any reference implementation presented in this document can parse/generate the reference files of the related ISO/IEC 19566 part.

In general, the aim of the JPEG Systems reference dataset is to address all the available JUMBF Content Types specified in scope of ISO/IEC 19566 series and covering cases of standalone JUMBF files, but also embedding JUMBF Boxes in supporting image file formats. The JPEG Systems reference dataset is split into multiple subdirectories, each of which corresponds to a specific ISO/IEC 19566 part that specifies JUMBF data structures. All the available ISO/IEC 19566 parts and the respective JUMBF Content Types that are specified in each one of them is listed in Table A.1.

Table A.1 — JUMBF Content Types as defined in the ISO/IEC 19566 series

Directory name	JUMBF Content Types
Part 5	XML, JSON, JP2C, CBOR, UUID, Embedded File
Part 4	Protection, Replacement
Part 6	JPEG 360
Part 7	JLINK
Part 8	JPEG Snack

A.2 JUMBF reference dataset

The JPEG Systems reference dataset — which is attached along with this document — consists of multiple directories, one of which is related to the JUMBF reference dataset. This directory consists of an exhaustive list of standalone JUMBF files covering ISO/IEC 19566-5 [1]. In addition, a set of examples of JUMBF data embedded inside images expressed in JPEG encoding formats is presented. All these files cover plenty of combinations for the available JUMBF Description box attributes and Content Types in ISO/IEC 19566-5 [1]. A detailed description about the information of each of the available files is given in the reference dataset description, a csv file which accompanies the dataset and signals the contents of the Description box and the respective Content Boxes. The columns of the reference dataset description file for JUMBF reference dataset are presented in Table A.2. To specify the content of a JUMBF Box (e.g. the XML payload of an XML Content type JUMBF box), a set of input files is included in the dataset. The file name of each of the input documents is referenced through the csv file in the respective columns. In scope of ISO/IEC 19566-5 [1] the contents of a JUMBF Box can be an XML serialized content, a JSON serialized content, a CBOR serialized content, a JPEG codestream or a generic bytestream. In principle, with the reference dataset description file it is possible to define any combination of JUMBF data. Specifically, columns A-K refer to all the various combinations related to the Description box data model. Columns L and M specify the expected number and content (i.e. input file) of the Content Box for each JUMBF Box defined in ISO/IEC 19566-5 [1]. Next, columns N-O correspond to the specific fields defined in UUID Content type JUMBF box, while columns P-R correspond to those of Embedded File Content type JUMBF box. Finally, column S points to the file name of the generated file where the JUMBF data is going to be stored. If a column is not applicable for a specific JUMBF structure, “NULL” value is used. Each line of the csv defines a JUMBF Box that is stored either as a standalone file or embedded in a host image which is encoded using one of the available JPEG encoding formats. Normally, each line corresponds

to a unique file. However, it is also possible for multiple lines to specify a common value in column S. This means that multiple JUMBF Boxes are concatenated to a single file.

Table A.2 — Definition of the JUMBF reference dataset description csv file.

Csv column number	Csv column name	Csv column description	NULL value allowed?
A	Test Id	Name of the specific scenario described in the row	No
B	Content Type (UUID)	The JUMBF Content Type of the JUMBF Box to be generated.	No
C	Host JPEG Image	The name of the JPEG Encoded image that will host the generated JUMBF Box. If NULL, the resulted JUMBF Box will be stored in a separate file (i.e. JUMBF standalone file) with the .jumbf extension.	Yes
D	LBox	Value of the LBox attribute of the JUMBF Box header. Available values: 0 (i.e. Read until the end of file), 1 (i.e. the size in bytes of the box is expressed in the XLBox attribute of the JUMBF Box header), NULL (The actual size in bytes of the JUMBF Box is stored in LBox JUMBF Box header).	Yes
E	Is Requestable?	Boolean value included in the Description box. It corresponds to the "Requestable" field as specified in ISO/IEC 19566-5 [1].	No
F	Label	String value included in the Description box. It corresponds to the "Label" field as specified in ISO/IEC 19566-5 [1].	Yes
G	ID	Numerical value included in the Description box. It corresponds to the "Id" field as specified in ISO/IEC 19566-5 [1].	Yes
H	SHA256HASH (file name)	The name of the file pointing to the bytestream value included in the Description box. It corresponds to the "SHA256Hash" field as specified in ISO/IEC 19566-5 [1].	Yes
I	Contains multiple private fields?	Boolean value that specifies whether there is a private field included in the requested Description box. If set to FALSE, it means that either there is no Private field or there is a single ISOBMFF Box. If set to TRUE, it means that the Private field consists of a 'priv' box.	No
J	Private Field (JUMBF Box file name)	The name of the JUMBF standalone file that contains the bytestream that corresponds to the contents of the private field of the requested Description box.	Yes
K	Padding (Number of bytes)	The number of bytes allocated for the padding box content. If set to 0 then no Padding box is added.	No
L	Number of Content Boxes	The number of Content Boxes included in the requested JUMBF Box.	No
M	Content Box (file name)	The name of the file that corresponds to a Content Box of the requested JUMBF Box. For instance, if the requested JUMBF Box is of XML Content type, then this column could specify a "example.xml" file, pointing to the contents of such JUMBF Box.	No
N	UUID	The 16-byte UUID field as specified in the UUID Content type in ISO/IEC 19566-5 [1].	Yes

Table A.2 *(continued)*

Csv column number	Csv column name	Csv column description	NULL value allowed?
O	Data	The name of the file pointing to the bytestream included in a UUID Content type JUMBF box.	Yes
P	Media Type	String value included in the Embedded File Description box. It corresponds to the “Media Type” field as specified in ISO/IEC 19566-5 [1].	Yes
Q	Filename	String value included in the Embedded File Description box. It corresponds to the “FILE NAME” field as specified in ISO/IEC 19566-5 [1].	Yes
R	Is Externally Referenced?	Boolean value included in the Embedded File Description box. It corresponds to the “External Reference” field as specified in ISO/IEC 19566-5 [1].	Yes
S	Expected file (file name)	The name of the generated file that contains the JUMBF Box described in the Test ID of the respective entry.	No

Finally, apart from the reference dataset and its description file, the JUMBF reference dataset contains another csv file which corresponds to a reference report. The reference report contains information that a parser information can extract from a JUMBF file in the context of ISO/IEC 19566-5 [1]. The columns of this csv file are different from the reference dataset description file and their definition is listed in Table A.3.

Table A.3 — Definition of the JUMBF reference dataset report csv file.

Csv column number	Csv column name	Csv column description	NULL value allowed?
A	File name	Name of the parsed file which contains JUMBF-related information	No
B	Standalone file?	Boolean value that specifies whether the parsed file contains JUMBF information embedded in a (host) JPEG image or contains JUMBF data only.	No
C	LBox	Numerical value of LBox attribute in JUMBF header.	No
D	XLBox	Numerical value of XLBox attribute in JUMBF header.	Yes
E	Content Type UUID	String value specifying the UUID field included in the parsed Description box.	No
F	Description box Toggle	Numerical value included in the parsed Description box. It corresponds to the “Toggle” field as specified in ISO/IEC 19566-5 [1].	No
G	Is requestable	Boolean value that specifies whether the parsed JUMBF Box is requestable. It corresponds to the “Requestable” field as specified in ISO/IEC 19566-5 [1].	No
H	Label	String value specifying the Label field included in the parsed Description box. It corresponds to the “Label” field as specified in ISO/IEC 19566-5 [1].	Yes
I	ID	Numerical value specifying the ID field included in the parsed Description box. It corresponds to the “ID” field as specified in ISO/IEC 19566-5 [1].	Yes
J	SHA256 Hash	String value specifying the HEX encoded SHA-256Has value of the parsed Description box. It corresponds to the “SHA256Hash” field as specified in ISO/IEC 19566-5 [1].	Yes

Table A.3 *(continued)*

Csv column number	Csv column name	Csv column description	NULL value allowed?
K	Private field Exists?	Boolean value specifying whether a private field is included in the parsed Description box.	No
L	UUID box UUID field	String value specifying the UUID field included in the parsed UUID box. The 16-byte UUID field is specified in the "UUID Content type" subclause of ISO/IEC 19566-5 [1].	Yes
M	Embedded File Description box Toggle	Numerical value specifying the toggle of the parsed Embedded File Description box. It corresponds to the "Toggle" field as specified in the "Embedded File Content type" subclause of ISO/IEC 19566-5 [1].	Yes
N	Embedded File Description box Media Type	String value specifying the media type of the parsed Embedded File Description box. It corresponds to the "Media Type" field as specified in the "Embedded File Content type" subclause of ISO/IEC 19566-5 [1].	Yes
O	Embedded File Description box File Name	String value specifying the file name of the parsed Embedded File Description box. It corresponds to the "File name" field as specified in the "Embedded File Content type" subclause of ISO/IEC 19566-5 [1].	Yes
P	Embedded File Description box Content Referenced Externally	Boolean value specifying whether the parsed Embedded File Content type JUMBF box is referenced externally or it is embedded in the current box. It corresponds to the "External file" field as specified in the "Embedded File Content type" subclause of ISO/IEC 19566-5 [1].	Yes
Q	Content Box TBox field	String value of four characters specifying the 4-byte-type value of the Content Box of the parsed JUMBF Box (e.g. 'json', 'bidb').	Yes
R	Content Box Size	Numerical value specifying the number of bytes of the Content Box of the parsed JUMBF Box.	Yes
S	JUMBF Box Padding box Size	Numerical value specifying the number of bytes included in the Padding box of the parsed JUMBF Box.	No

A.3 Validation procedure

A.3.1 General

Given the reference dataset along with its description and report files it is possible to define a validation procedure that parser and generator implementations could use in order to verify their conformance with ISO/IEC 19566-5 [1]. Specifically, this section uses the dataset introduced in Clause A.2 and defines the validation procedures for reference implementations in scope of ISO/IEC 19566-5 [1]. The validation procedure could be easily generalized for all parts of the ISO/IEC 19566 series mentioned in the annexes.

A.3.2 Parser validation

Figure A.1 shows the procedure of validating a candidate parser implementation. For a parser implementation to check its conformance with ISO/IEC 19566-5 [1], it shall be able to provide a report which describes the contents of a JUMBF Box following the structure presented in the reference report.

Initially, the JUMBF reference dataset is provided to the candidate implementation which parses all the files and generates a report. The generated report is first sorted by the first column (i.e. the name of the JUMBF

file) and it is compared with the JUMBF reference dataset report. Provided that the two reports are identical, the candidate parser implementation is considered conformant to ISO/IEC 19566-5 [1].

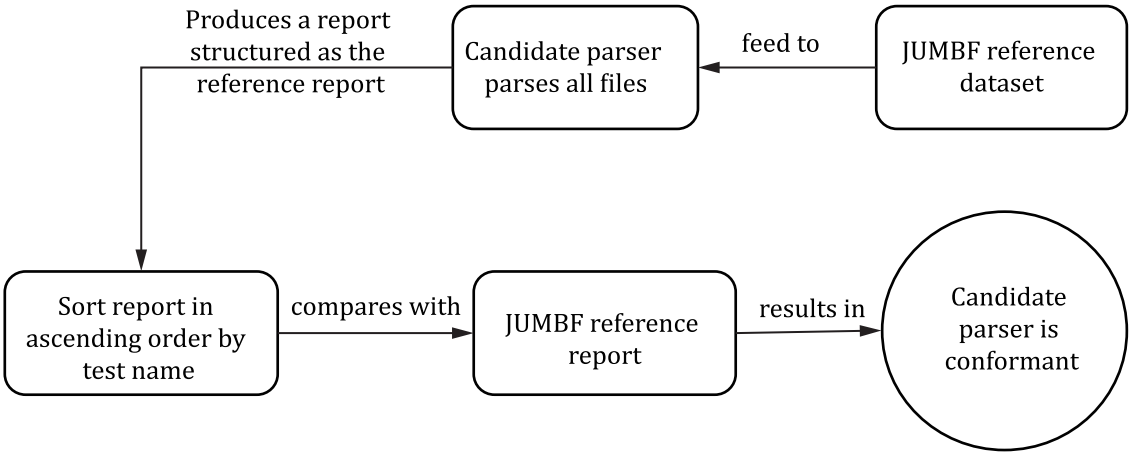

Figure A.1 — Steps to show that a candidate parser implementation conforms to ISO/IEC 19566-5

A.3.3 Generator validation

Figure A.2 shows the procedure of validating a candidate generator implementation. For a generator implementation to check its conformance with ISO/IEC 19566-5 [1] it shall be able to reconstruct the available JUMBF reference dataset, given the respective reference dataset description file.

Initially, the JUMBF reference dataset description is provided to the generator implementation along with all the input files that are referenced in it. The candidate implementation should parse the csv file and generate the corresponding JUMBF data. Finally, the generated dataset is submitted for cross-checking with the reference dataset. Assuming that all files are identical, the candidate generator implementation is considered conformant to ISO/IEC 19566-5 [1].

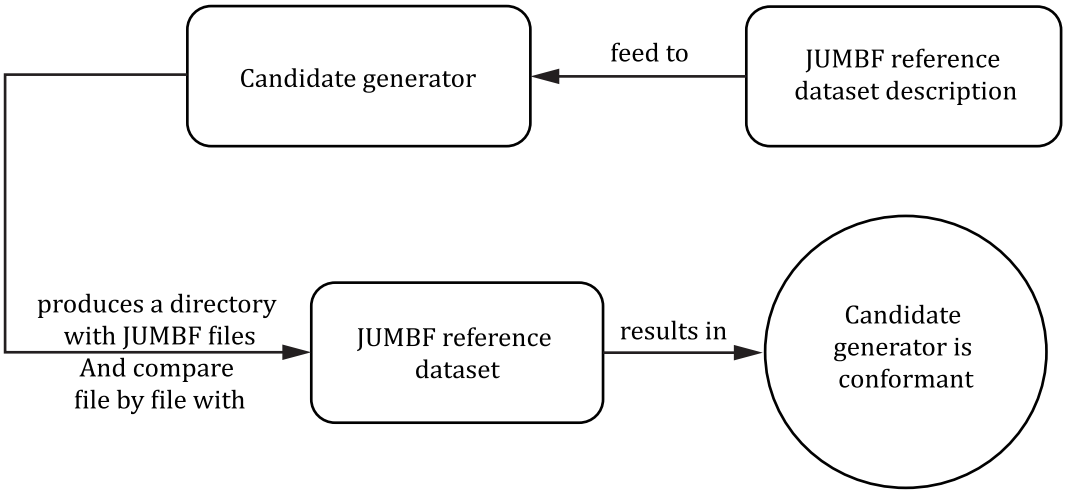

Figure A.2 — Steps to show that a candidate generator implementation conforms to ISO/IEC 19566-5

Annex B
(informative)

JUMBF reference software: Java implementation

B.1 General

This annex describes a Reference Software implementation (identified as Implementation 1) for ISO/IEC 19566-5 [1](JUMBF). The software library is called jumbf-2.2 and it is the main part of a multi-module project, namely jpeg-systems-1.2, whose goal is to support all the JUMBF Boxes presented in the JPEG Systems specifications. It is written in Java[6] and it allows parsing and generating JUMBF data according to ISO/IEC 19566-5 [1]. The design of this software aims to be extended in order to support JUMBF structures from other ISO/IEC 19566 parts. The source code is included under the directory "Reference Implementation/annex-b/java-reference-implementation".

This annex provides background information on the software design approach followed for the development of this reference software for JPEG Universal Metadata Box Format (JUMBF). In addition, it provides details on how to compile the jumbf-2.2 library and how it could be used by other Java applications in order to successfully handle JUMBF data. Clause B.2 defines the hierarchical software design which translates the JUMBF model presented in ISO/IEC 19566-5 [1], into a set of Java classes in a structured and future-proof manner. Next, B.2.4 presents the requirements and the third-party dependencies required in order to compile and use the jumbf-2.2 library. Finally, Clause B.3 demonstrates how two different applications use the library in order to provide an interface which allows the users to interact with JUMBF data.

B.2 Software design

B.2.1 General

The aim of the jumbf-2.2 library is to provide the means to support the manipulation of JUMBF data as specified in ISO/IEC 19566-5 [1]. Since there are additional JUMBF Boxes defined in other ISO/IEC 19566 parts, the jumbf-2.2 library is a module of a broader project where additional libraries extend its functionalities to define other JUMBF structures. The jumbf-2.2 library, as all the other modules defined in this project, cover a specific ISO/IEC 19566 part including the amendments and revised editions that have been issued. The versioning system of the project follows that of the ISO/IEC 19566 parts. Thus, for the JUMBF reference software, the jumbf-2.2 library supports the model and functionalities specified in scope of ISO/IEC 19566-5 [1].

Following the logical structure between the various ISO/IEC 19566 parts, jumbf-2.2 is the main library that all other libraries of the project should rely on. In fact, the jumbf-2.2 library provides the means to generate and parse information that is stored in JUMBF format. The library is written in Java and it uses the Spring Framework[2]. It provides an architecture where the JUMBF model is implemented in a way that other libraries could inherit the JUMBF structure characteristics by simply adding jumbf-2.2 library as a dependency. This allows the architecture to be minimal and extendable.

As specified in ISO/IEC 19566-5 [1], it is possible to store JUMBF data as standalone files or inside a host image (e.g. by embedding the boxes in APP11 markers in the case of JPEG 1). Regarding the first case, the jumbf-2.2 library provides the classes to parse and generate JUMBF data directly from standalone files using the CoreParserService and CoreParserGenerator classes. In this case, the encoded JUMBF data is expressed as standalone files with extension ".jumbf". Regarding the latter case, dedicated classes are implemented for each JPEG file format. As of this version of the jumbf-2.2 library it is possible to process JUMBF data in JPEG

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