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Information technology — Scalable compression and coding of continuous-tone still images —

Part 4: Conformance testing

Technologies de l'information — Compression échelonnable et codage d'images plates en ton continu —

Partie 4: Essai de conformité

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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 ISO documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO/IEC 18477 series can be found on the ISO website.

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Introduction

The ISO/IEC 18477 series, also known under the term JPEG XT, specifies lossy and lossless codestream formats for storage of continous-tone high and low dynamic range photographic content. All parts of the ISO/IEC 18477 series are compatible to the Recommendation ITU-T T.81 | ISO/IEC 10918, also commonly known as JPEG. That is, any decoder conforming to the latter standard will be able to reconstruct codestreams from the ISO/IEC 18477 series to an 8 bits/sample image. Additional features offered by ISO/IEC 18477, such as representation of intermediate or high-dynamic range images, or lossless reconstruction require an extended decoder that implements, in addition to the Rec. ITU-T T.81 | ISO/IEC 10918-1, also one or multiple members of ISO/IEC 18477.

This document provides the framework, concepts and methodology for testing codestreams and implementations, and the criteria to be achieved to claim conformance to the parts and profiles of ISO/IEC 18477. The objective of this document is to promote interoperability between JPEG XT decoders, and to test these systems for conformance to one or multiple specifications that are part of the JPEG XT. Conformance testing is the testing of a candidate implementation for the existence of specific characteristics required by a standard. It involves testing the capabilities of an implementation against the conformance requirements in the relevant standard.

The purpose of this document is to define a common test methodology, to provide a framework for specific abstract test suites (ATS) and to define the procedures to be followed during conformance testing.

Any organization contemplating the use of the test methods defined in this document should carefully consider the constraints on their applicability. Conformance testing does not include robustness testing, acceptance testing, and performance testing, all of which are outside the scope of this text.

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Information technology — Scalable compression and coding of continuous-tone still images —

Part 4: Conformance testing

1 Scope

This document specifies the framework, concepts, methodology for testing, and criteria to be achieved to claim conformance to one or multiple parts of ISO/IEC 18477 as listed below. It provides a framework for specifying abstract test suites and for defining the procedures to be followed during conformance testing.

This document

— specifies conformance testing procedures for decoding of ISO/IEC 18477-1, 18477-2, ISO/IEC 18477-6, ISO/IEC 18477-7, ISO/IEC 18477-8 and ISO/IEC 18477-9,

— specifies conformance testing procedures for codestreams to the above International Standards,

— specifies codestreams, decoded images, and error metrics to be used within the decoder testing procedures, and

— specifies abstract test suites.

This document does not include the following tests:

— testing **decoders** for conformance to ISO/IEC 18477-3 only. ISO/IEC 18477-6, ISO/IEC 18477-7, ISO/IEC 18477-8 and ISO/IEC 18477-9 are extensions of ISO/IEC 18477-3 and the required functionality of ISO/IEC 18477-3 is tested as part of the former standards. Testing **codestreams** for conformance to ISO/IEC 18477-3 is specified in C.2;

— testing codestreams for conformance to ISO/IEC 18477-7 beyond testing them for conformance to individual profiles of this document. Testing such codestreams ("full profile codestreams") for syntactical correctness is, however, covered by testing them for conformance to ISO/IEC 18477-3;

— testing of the composition of background and foreground for images reconstructed from ISO/IEC 18477-9 codestreams as this operation is application dependent;

— acceptance testing: the process of determining whether an implementation satisfies acceptance criteria and enables the user to determine whether or not to accept the implementation. This includes the planning and execution of several kinds of tests (e.g. functionality, quality, and speed performance testing) that demonstrate that the implementation satisfies the user requirements;

— performance testing: measures the performance characteristics of an implementation under test (IUT) such as its throughput, responsiveness, etc. under various conditions.

— robustness testing: the process of determining how well an implementation process data which contains errors.

The ISO/IEC 18477 series consists of multiple parts, each of which defines one or multiple profiles. A given IUT (implementation under test) may claim to implement various parts and profiles of ISO/IEC 18477 at once. To test such implementations, they have to be tested with the Abstract Test Suites of each part and profile they claim to conform to.

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2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 18477-1, *Information technology — Scalable compression and coding of continuous-tone still images — Part 1: Scalable compression and coding of continuous-tone still images*

ISO/IEC 18477-2, *Information technology — Scalable compression and coding of continuous-tone still images — Part 2: Coding of high dynamic range images*

ISO/IEC 18477-3, *Information technology — Scalable compression and coding of continuous-tone still images — Part 3: Box file format*

ISO/IEC 18477-6, *Information technology — Scalable compression and coding of continuous-tone still images — Part 6: IDR Integer Coding*

ISO/IEC 18477-7, *Information technology: Scalable compression and coding of continuous-tone still images, HDR floating point coding*

ISO/IEC 18477-8, *Information technology — Scalable compression and coding of continuous-tone still images — Part 8: Lossless and near-lossless coding*

ISO/IEC 18477-9, *Information technology — Scalable compression and coding of continuous-tone still images — Part 9: Alpha channel coding*

ISO/IEC 10918-1, *Information technology — Digital compression and coding of continuous tone still images — Requirements and guidelines*

3 Terms, definitions, abbreviated terms and symbols

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

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

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

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

3.1 Terms and definitions

3.1.1
abstract test suite
generic conformance testing concepts and procedures for a given requirement

3.1.2
ASCII
binary encoding of 7-bit characters defined by ISO/IEC 646

3.1.3
base decoding path
process of decoding *legacy codestream* (3.1.43) and refinement data to the *base image* (3.1.4), jointly with all further steps until residual data is added to the values obtained from the residual codestream

3.1.4
base image
collection of sample values obtained by entropy decoding the DCT coefficients of the *legacy codestream* (3.1.43) and the refinement codestream, and inversely DCT transforming them jointly

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3.1.5
big endian
order of bytes with the most significant byte first

3.1.6
bit
unit of information representing a single yes/no choice represented by a one or a zero

3.1.7
binary decision
choice between two alternatives

3.1.8
bitstream
partially encoded or decoded sequence of *bits* (3.1.6) comprising an entropy-coded segment

3.1.9
block
8 × 8 array of *samples* (3.1.62) or an 8 × 8 array of DCT coefficient values of one *component* (3.1.19)

3.1.10
box
structured collection of data describing the image or the image decoding process embedded into one or multiple APP_{11} marker segments

Note 1 to entry: See ISO/IEC 18477-3:2015, Annex B for the definition of boxes.

3.1.11
byte
group of 8 bits

3.1.12
coder
embodiment of a *coding process* (3.1.14)

3.1.13
coding model
procedure used to convert input data into symbols to be coded

3.1.14
coding process
general term for referring to an encoding process, a decoding process, or both

3.1.15
coefficient
values that are the result of a discrete cosine transformation

3.1.16
conformance
fulfillment of the specified requirements, as defined in this document, for a given profile and part of ISO/IEC 18477

3.1.17
conformance test procedure
process of assessing *conformance* (3.1.16)

3.1.18
compression
reduction in the number of *bits* (3.1.6) used to represent source image data

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3.1.19
component
two-dimensional array of *samples* (3.1.62) having the same designation in the output or display device

3.1.20
continuous-tone image
image whose *components* (3.1.19) have more than one *bit* (3.1.6) per *sample* (3.1.62)

3.1.21
decoder
embodiment of a *decoding process* (3.1.22)

3.1.22
decoding process
process which takes as its input compressed image data and outputs a *continuous-tone image* (3.1.20)

3.1.23
dequantization
inverse procedure to quantization by which the *decoder* (3.1.21) recovers a representation of the DCT coefficients

3.1.24
downsampling
procedure by which the spatial resolution of a *component* (3.1.19) is reduced

3.1.25
encoder
embodiment of an *encoding process* (3.1.26)

3.1.26
encoding process
process which takes as its input a *continuous-tone image* (3.1.20) and outputs compressed image data

3.1.27
entropy-coded (data) segment
independently decodable sequence of entropy encoded *bytes* (3.1.11) of compressed image data

3.1.28
entropy decoder
embodiment of an *entropy decoding* (3.1.29) procedure

3.1.29
entropy decoding
lossless procedure which recovers the sequence of symbols from the sequence of *bits* (3.1.6) produced by the *entropy encoder* (3.1.30)

3.1.30
entropy encoder
embodiment of an *entropy encoding* (3.1.31) procedure

3.1.31
entropy encoding
lossless procedure which converts a sequence of input symbols into a sequence of *bits* (3.1.6) such that the average number of *bits* (3.1.6) per symbol approaches the entropy of the input symbols

3.1.32
extension image
synonym for *residual image* (3.1.61)

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3.1.33
grayscale image
continuous-tone image (3.1.20) that has only one *component* (3.1.19)

3.1.34
high dynamic range
image or image data comprised of more than 8 bits per *sample* (3.1.62)

3.1.35
Huffman decoder
embodiment of a *Huffman decoding* (3.1.36) procedure

3.1.36
Huffman decoding
entropy decoding (3.1.29) procedure which recovers the symbol from each variable length code produced by the *Huffman encoder* (3.1.37)

3.1.37
Huffman encoder
embodiment of a *Huffman encoding* (3.1.38) procedure

3.1.38
Huffman encoding
entropy encoding (3.1.31) procedure which assigns a variable length code to each input symbol

3.1.39
implementation
realization of a specification

3.1.40
implementation under test
IUT
implementation (3.1.39) that is being evaluated for *conformance* (3.1.16)

3.1.41
intermediate dynamic range
image or image data comprised of more than 8 bits per *sample* (3.1.62)

3.1.42
joint photographic experts group
JPEG
informal name of the committee which created this document

Note 1 to entry: The “joint” comes from the ITU-T and ISO/IEC collaboration.

3.1.43
legacy codestream
collection of *markers* (3.1.51) and syntax elements defined by ISO/IEC 10918-1 bare any additional syntax elements defined by the ISO/IEC 18477 standard, i.e. the legacy codestream consists of the collection of all markers except those APP_{11} markers that describe JPEG XT boxes by the syntax defined in ISO/IEC 18477-3:2015, Annex A

3.1.44
legacy decoding path
collection of operations to be performed on the entropy coded data as described by ISO/IEC 10918-1 jointly with the Legacy Refinement scans before this data is merged with the residual data to form the final output image

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3.1.45
legacy decoder
embodiment of a *decoding process* (3.1.20) conforming to ISO/IEC 10918-1, confined to the lossy DCT process and the baseline, sequential or progressive modes, decoding at most four components to 8 bits per component

3.1.46
legacy image
arrangement of sample values as described by applying the *decoding process* (3.1.20) described by ISO/IEC 10918-1 on the entropy coded data as defined by the said standard

3.1.47
lossless
descriptive term for encoding and decoding processes and procedures in which the output of the decoding procedure(s) is identical to the input to the encoding procedure(s)

3.1.48
lossless coding
mode of operation which refers to any one of the *coding processes* (3.1.14) defined in ISO/IEC 18477-8 in which all of the procedures are *lossless* (3.1.47)

Note 1 to entry: See ISO/IEC 18477-8:2016, Annex H.

3.1.49
lossy
descriptive term for encoding and decoding processes which are not *lossless* (3.1.47)

3.1.50
low dynamic range
image or image data comprised of data with no more than 8 bits per *sample* (3.1.62)

3.1.51
marker
two-byte code in which the first byte is hexadecimal FF and the second byte is a value between 1 and hexadecimal FE

3.1.52
marker segment
marker (3.1.51) together with its associated set of parameters

3.1.53
pixel
collection of sample values in the spatial image domain having all the same sample coordinates

EXAMPLE A pixel may consist of three samples describing its red, green and blue value.

3.1.54
precision
number of *bits* (3.1.6) allocated to a particular *sample* (3.1.62) or DCT coefficient

3.1.55
procedure
set of steps which accomplishes one of the tasks which comprise an encoding or decoding process

3.1.56
quantization value
integer value used in the quantization procedure

3.1.57
quantize
act of performing the quantization procedure for a DCT coefficient

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3.1.58
residual decoding path
collection of operations applied to the entropy coded data contained in the residual data box and residual refinement scan boxes up to the point where this data is merged with the base image to form the final output image

3.1.59
residual image
sample values as reconstructed by inverse quantization and inverse DCT transformation applied to the entropy-decoded coefficients described by the *residual scan* (3.1.60) and residual refinement scans

3.1.60
residual scan
additional pass over the image data invisible to *legacy decoders* (3.1.45) which provides additive and/or multiplicative correction data of the legacy scans to allow reproduction of *high dynamic range* (3.1.34) or wide colour gamut data

3.1.61
refinement scan
additional pass over the image data invisible to *legacy decoders* (3.1.45) which provides additional least significant bits to extend the *precision* (3.1.54) of the DCT transformed *coefficients* (3.1.15)

3.1.62
sample
one element in the two-dimensional image array which comprises a *component* (3.1.19)

3.1.63
sample grid
common coordinate system for all *samples* (3.1.62) of an image

Note 1 to entry: The samples at the top left edge of the image have the coordinates (0,0); the first coordinate increases towards the right, the second towards the bottom.

3.1.64
scan
single pass through the data for one or more of the *components* (3.1.19) in an image

3.1.65
scan header
marker segment (3.1.52) that contains a start-of-scan marker and associated scan parameters that are coded at the beginning of a *scan* (3.1.64)

3.1.66
source image
image used as input to an *encoder* (3.1.25)

3.1.67
superbox
box (3.1.10) that carries other boxes as payload data

3.1.68
table specification data
coded representation from which the tables used in the *encoder* (3.1.24) and *decoder* (3.1.21) are generated and their destinations specified

3.1.69
testing
process of evaluating *conformance* (3.1.16)

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3.1.70
uniform quantization
method of reducing the *precision* (3.1.54) of DCT coefficients to enable more efficient entropy coding of them

3.1.71
upsampling
procedure (3.1.55) by which the spatial resolution of a *component* (3.1.19) is increased

3.2 Symbols

Nf Number of components in an image

R_b Additional bits in the HDR image. 8 + R_b is the sample precision of the reconstructed HDR or IDR image.

3.3 Abbreviated terms

ASCII	American standard code for information interchange
ATS	Abstract test suite
DCT	Discrete cosine transformation
ETS	Executable test suite
HDR	High dynamic range
IDR	Intermediate dynamic range
IUT	Implementation under test
JPEG	Joint photographic experts group
LDR	Low dynamic range
LSB	Least significant bit
MRSE	Mean relative square error
MSE	Mean square error
MSB	Most significant bit
PSNR	Peak signal to noise ratio
TMO	Tone mapping operator
TCS	Test codestream

4 Conventions

4.1 Conformance language

This document consists of normative and informative text.

Normative text is that text which expresses mandatory requirements. The word "shall" is used to express mandatory requirements strictly to be followed in order to conform to this document and from which no deviation is permitted. A conforming implementation is one that fulfils all mandatory requirements.

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