

---

---

**Information technology — JPEG 2000  
image coding system —**

**Part 1:  
Core coding system**

*Technologies de l'information — Système de codage d'images JPEG  
2000 —*

*Partie 1: Système de codage de noyau*

ITeH Standards  
(<https://standards.iteh.ai>)  
Document Preview

[ISO/IEC 15444-1:2019](https://standards.iteh.ai/catalog/standards/iso/59431d08-685d-40a5-8a59-6d23d47e380e/iso-iec-15444-1-2019)

<https://standards.iteh.ai/catalog/standards/iso/59431d08-685d-40a5-8a59-6d23d47e380e/iso-iec-15444-1-2019>



iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

[ISO/IEC 15444-1:2019](https://standards.iteh.ai/catalog/standards/iso/59431d08-685d-40a5-8a59-6d23d47e380e/iso-iec-15444-1-2019)

<https://standards.iteh.ai/catalog/standards/iso/59431d08-685d-40a5-8a59-6d23d47e380e/iso-iec-15444-1-2019>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO/IEC 2019

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

## 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.

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](http://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 and IEC 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](http://www.iso.org/patents)) or the IEC list of patent declarations received (see <http://patents.iec.ch>).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by ITU-T as ITU-T T.800 (06/2019) and drafted in accordance with its editorial rules. It was assigned to Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This fourth edition cancels and replaces the third edition (ISO 15444-1:2016), which has been technically revised.

A list of all parts in the ISO/IEC 15444 series can be found on the ISO website.

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](http://www.iso.org/members.html).



**INTERNATIONAL STANDARD ISO/IEC 15444-1  
RECOMMENDATION ITU-T T.800**

**Information technology – JPEG 2000 image coding system: Core coding system**

**Summary**

This Recommendation | International Standard defines a set of lossless (bit-preserving) and lossy compression methods for coding bi-level, continuous-tone grey-scale, palletized colour, or continuous-tone colour digital still images.

This Recommendation | International Standard:

- specifies decoding processes for converting compressed image data to reconstructed image data;
- specifies a codestream syntax containing information for interpreting the compressed image data;
- specifies a file format;
- provides guidance on encoding processes for converting source image data to compressed image data;
- provides guidance on how to implement these processes in practice.

This edition includes the following changes relative to the previous edition:

- addition of Profile marker segment;
- addition of Extended capabilities marker segment;
- addition of Table A.55 to indicate valid Profile number values;
- clarification of Table A.13 and Table A.19, making it explicit that some MSBs are reserved for future use;
- updating of Table A.10 to indicate that the Profile marker segment is used to indicate the Profile to which the codestream conforms.

NOTE – As this specification was first published as common text only after ISO/IEC JTC1 had approved the first edition in 2000, edition numbers in the ITU and ISO/IEC versions are offset by one. This is the third edition of ITU-T T.800 and the fourth edition of ISO/IEC 15444-1.

ISO/IEC 15444-1:2019

<https://standards.iteh.ai/catalog/standards/iso/59431d08-685d-40a5-8a59-6d23d47e380e/iso-iec-15444-1-2019>

**History**

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T T.800	2002-08-29	16	<a href="http://handle.itu.int/11.1002/1000/5281">11.1002/1000/5281</a>
1.1	ITU-T T.800 (2002) Amd. 1	2005-09-13	16	<a href="http://handle.itu.int/11.1002/1000/8576">11.1002/1000/8576</a>
1.2	ITU-T T.800 (2002) Cor. 1	2007-01-13	16	<a href="http://handle.itu.int/11.1002/1000/9048">11.1002/1000/9048</a>
1.3	ITU-T T.800 (2002) Cor. 2	2007-08-29	16	<a href="http://handle.itu.int/11.1002/1000/9231">11.1002/1000/9231</a>
1.4	ITU-T T.800 (2002) Amd. 2	2009-03-16	16	<a href="http://handle.itu.int/11.1002/1000/9719">11.1002/1000/9719</a>
1.5	ITU-T T.800 (2002) Amd. 3	2010-06-22	16	<a href="http://handle.itu.int/11.1002/1000/11002">11.1002/1000/11002</a>
1.6	ITU-T T.800 (2002) Amd. 4	2011-05-14	16	<a href="http://handle.itu.int/11.1002/1000/11313">11.1002/1000/11313</a>
1.7	ITU-T T.800 (2002) Amd. 5	2012-01-13	16	<a href="http://handle.itu.int/11.1002/1000/11469">11.1002/1000/11469</a>
1.8	ITU-T T.800 (2002) Amd. 6	2013-03-16	16	<a href="http://handle.itu.int/11.1002/1000/11882">11.1002/1000/11882</a>
1.9	ITU-T T.800 (2002) Cor. 3	2014-10-14	16	<a href="http://handle.itu.int/11.1002/1000/12301">11.1002/1000/12301</a>
1.10	ITU-T T.800 (2002) Cor.4	2014-10-14	16	<a href="http://handle.itu.int/11.1002/1000/12302">11.1002/1000/12302</a>
1.11	ITU-T T.800 (2002) Amd. 7	2014-10-14	16	<a href="http://handle.itu.int/11.1002/1000/12300">11.1002/1000/12300</a>
2.0	ITU-T T.800	2015-11-29	16	<a href="http://handle.itu.int/11.1002/1000/12682">11.1002/1000/12682</a>
3.0	ITU-T T.800 (V3)	2019-06-13	16	<a href="http://handle.itu.int/11.1002/1000/13911">11.1002/1000/13911</a>

\* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

## FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

## NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

[ISO/IEC 15444-1:2019](https://standards.iteh.ai/catalog/standards/iso/59431d08-685d-40a5-8a59-6d23d47e380e/iso-iec-15444-1-2019)

<https://standards.iteh.ai/catalog/standards/iso/59431d08-685d-40a5-8a59-6d23d47e380e/iso-iec-15444-1-2019>

## INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

© ITU 2019

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

## CONTENTS

Page

1	Scope .....	1
2	References .....	1
2.1	Identical Recommendations   International Standards .....	1
2.2	Additional references .....	1
3	Definitions .....	2
4	Abbreviations and symbols .....	6
4.1	Abbreviations .....	6
4.2	Symbols .....	7
5	General description .....	8
5.1	Purpose .....	8
5.2	Codestream .....	8
5.3	Coding principles .....	9
6	Encoder requirements .....	10
7	Decoder requirements .....	10
7.1	Codestream syntax requirements .....	11
7.2	Optional file format requirements .....	11
8	Implementation requirements .....	11
Annex A	– Codestream syntax .....	12
A.1	Markers, marker segments and headers .....	12
A.2	Information in the marker segments .....	14
A.3	Construction of the codestream .....	15
A.4	Delimiting markers and marker segments .....	19
A.5	Fixed information marker segment .....	20
A.6	Functional marker segments .....	26
A.7	Pointer marker segments .....	36
A.8	In-bit-stream marker and marker segments .....	40
A.9	Informational marker segments .....	41
A.10	Codestream restrictions conforming to this Recommendation   International Standard .....	43
Annex B	– Image and compressed image data ordering .....	59
B.1	Introduction to image data structure concepts .....	59
B.2	Component mapping to the reference grid .....	59
B.3	Image area division into tiles and tile-components .....	61
B.4	Example of the mapping of components to the reference grid (informative) .....	62
B.5	Transformed tile-component division into resolution levels and sub-bands .....	65
B.6	Division of resolution levels into precincts .....	66
B.7	Division of the sub-bands into code-blocks .....	67
B.8	Layers .....	68
B.9	Packets .....	69
B.10	Packet header information coding .....	70
B.11	Tile and tile-parts .....	75
B.12	Progression order .....	76
Annex C	– Arithmetic entropy coding .....	80
C.1	Binary encoding (informative) .....	80
C.2	Description of the arithmetic encoder (informative) .....	81
C.3	Arithmetic decoding procedure .....	92
Annex D	– Coefficient bit modelling .....	99
D.1	Code-block scan pattern within code-blocks .....	99
D.2	Coefficient bits and significance .....	99
D.3	Decoding passes over the bit-planes .....	100
D.4	Initializing and terminating .....	104
D.5	Error resilience segmentation symbol .....	105

D.6	Selective arithmetic coding bypass .....	105
D.7	Vertically causal context formation .....	106
D.8	Flow diagram of the code-block coding .....	107
Annex E	– Quantization .....	109
E.1	Inverse quantization procedure .....	109
E.2	Scalar coefficient quantization (informative) .....	110
Annex F	– Discrete wavelet transformation of tile-components .....	112
F.1	Tile-component parameters .....	112
F.2	Discrete wavelet transformations .....	112
F.3	Inverse discrete wavelet transformation .....	112
F.4	Forward transformation (informative) .....	123
Annex G	– DC level shifting and multiple component transformations .....	133
G.1	DC level shifting of tile-components .....	133
G.2	Reversible multiple component transformation (RCT) .....	134
G.3	Irreversible multiple component transformation (ICT) .....	134
G.4	Chrominance component sub-sampling and the reference grid .....	135
Annex H	– Coding of images with regions of interest .....	136
H.1	Decoding of ROI .....	136
H.2	Description of the Maxshift method .....	136
H.3	Remarks on region of interest coding (informative) .....	137
Annex I	– JP2 file format syntax .....	140
I.1	File format scope .....	140
I.2	Introduction to the JP2 file format .....	140
I.3	Greyscale/Colour/Palettized/multi-component specification architecture .....	142
I.4	Box definition .....	144
I.5	Defined boxes .....	146
I.6	Adding intellectual property rights information in JP2 .....	161
I.7	Adding vendor-specific information to the JP2 file format .....	161
I.8	Dealing with unknown boxes .....	164
Annex J	– Examples and guidelines .....	165
J.1	Software conventions adaptive entropy decoder .....	165
J.2	Selection of quantization step sizes for irreversible transformations .....	166
J.3	Filter impulse responses corresponding to lifting-based irreversible filtering procedures .....	167
J.4	Example of discrete wavelet transformation .....	168
J.5	Row-based wavelet transform .....	171
J.6	Scan-based coding .....	180
J.7	Error resilience .....	180
J.8	Implementing the Restricted ICC method outside of a full ICC colour management engine .....	181
J.9	An example of the interpretation of multiple components .....	185
J.10	An example of decoding showing intermediate steps .....	185
J.11	Visual frequency weighting .....	189
J.12	Encoder sub-sampling of components .....	191
J.13	Rate control .....	192
J.14	Guidelines on handling YCC codestream .....	196
J.15	Guidelines for digital cinema applications .....	197
Annex K	– Bibliography .....	213
K.1	General .....	213
K.2	Quantization and entropy coding .....	213
K.3	Wavelet transformation .....	213
K.4	Region of interest coding .....	214
K.5	Visual frequency weighting .....	214
K.6	Error resilience .....	214
K.7	Scan-based coding .....	215



	<i>Page</i>
K.8 Colour.....	215
K.9 Guidelines for digital cinema applications .....	215
Annex L – Patent statement .....	217
Annex M – Elementary stream for broadcast applications .....	218
M.1 Introduction .....	218
M.2 Definitions.....	218
M.3 Access unit construction.....	218
M.4 Elementary stream marker box (superbox) .....	219

iTeh Standards  
 (https://standards.itih.ai)  
 Document Preview

[ISO/IEC 15444-1:2019](https://standards.itih.ai/catalog/standards/iso/59431d08-685d-40a5-8a59-6d23d47e380e/iso-iec-15444-1-2019)

<https://standards.itih.ai/catalog/standards/iso/59431d08-685d-40a5-8a59-6d23d47e380e/iso-iec-15444-1-2019>



**INTERNATIONAL STANDARD  
ITU-T RECOMMENDATION**

**Information technology – JPEG 2000 image coding system: Core coding system**

**1 Scope**

This Recommendation | International Standard defines a set of lossless (bit-preserving) and lossy compression methods for coding bi-level, continuous-tone grey-scale, palletized colour, or continuous-tone colour digital still images.

This Recommendation | International Standard:

- specifies decoding processes for converting compressed image data to reconstructed image data;
- specifies a codestream syntax containing information for interpreting the compressed image data;
- specifies a file format;
- provides guidance on encoding processes for converting source image data to compressed image data;
- provides guidance on how to implement these processes in practice.

NOTE – As this specification was first published as common text only after ISO/IEC JTC1 had approved the first edition in 2000, edition numbers in the ITU and ISO/IEC versions are offset by one. This is the third edition of ITU-T T.800 and the fourth edition of ISO/IEC 15444-1.

**2 References**

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

**2.1 Identical Recommendations | International Standards**

- Recommendation ITU-T T.81 (1992) | ISO/IEC 10918-1:1994, *Information technology – Digital compression and coding of continuous-tone still images: Requirements and guidelines.*
- Recommendation ITU-T T.84 (1996) | ISO/IEC 10918-3:1997, *Information technology – Digital compression and coding of continuous-tone still images: Extensions.*
- Recommendation ITU-T T.84 (1996)/Amd.1 (1999) | ISO/IEC 10918-3:1997/Amd.1:1999, *Information technology – Digital compression and coding of continuous-tone still images: Extensions – Amendment 1: Provisions to allow registration of new compression types and versions in the SPIFF header.*
- Recommendation ITU-T T.86 (1998) | ISO/IEC 10918-4:1999, *Information technology – Digital compression and coding of continuous-tone still images: Registration of JPEG Profiles, SPIFF Profiles, SPIFF Tags, SPIFF colour Spaces, APPn Markers, SPIFF Compression types and Registration Authorities (REGAUT).*
- Recommendation ITU-T T.87 (1998) | ISO/IEC 14495-1:2000, *Lossless and near-lossless compression of continuous-tone still images – Baseline.*
- Recommendation ITU-T T.88 (2000) | ISO/IEC 14492:2001, *Information technology – Lossy/lossless coding of bi-level images.*
- Recommendation ITU-T T.810 (2006) | ISO/IEC 15444-11:2007, *Information technology – JPEG 2000 image coding system: Wireless.*
- ISO/IEC 646:1991, *Information technology – ISO 7-bit coded character set for information interchange.*
- ISO 8859-15:1999, *Information technology – 8-bit single-byte coded graphic character sets – Part 15: Latin alphabet No. 9.*

**2.2 Additional references**

- Recommendation ITU-R BT.601-6 (2007), *Studio encoding parameters of digital television for standard 4:3 and wide screen 16:9 aspect ratios.*

- Recommendation ITU-R BT.709-5 (2002), *Parameter values for the HDTV standards for production and international programme exchange*.
- IEC 61966-2-1:1999, *Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB*.
- IEC 61966-2-1:1999/Amd.1:2003, *Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB*.
- IETF RFC 2279 (1998), UTF-8, *a transformation format of ISO 10646*.
- ISO 11664-1:2007 (CIE S 014-1/E:2006), *Colorimetry – Part 1: CIE standard colorimetric observers*.
- ISO 14721, *Space data and information transfer systems – Open archival information system – Reference model*.
- ISO 15076-1, *Image technology colour management – Architecture, profile format and data structure – Part 1: Based on ICC.1:2010*.
- ISO 26428-1:2008, *Digital cinema (D-cinema) distribution master – Part 1: Image characteristics*.
- ISO/IEC 11578:1996, *Information technology – Open Systems Interconnection – Remote Procedure Call*.

### 3 Definitions

For the purposes of this Recommendation | International Standard, the following definitions apply:

- 3.1**  $\lfloor x \rfloor$ , **floor function**: This indicates the largest integer not exceeding  $x$ .
- 3.2**  $\lceil x \rceil$ , **ceiling function**: This indicates the smallest integer not exceeded by  $x$ .
- 3.3** **5-3 reversible filter**: A particular filter pair used in the wavelet transformation. This reversible filter pair has 5 taps in the low-pass and 3 taps in the high-pass.
- 3.4** **9-7 irreversible filter**: A particular filter pair used in the wavelet transformation. This irreversible filter pair has 9 taps in the low-pass and 7 taps in the high-pass.
- 3.5** **access unit**: A coded representation of one video frame.
- 3.6** **AND**: Bit wise AND logical operator.
- 3.7** **arithmetic coder**: An entropy coder that converts variable length strings to variable length codes (encoding) and vice versa (decoding).
- 3.8** **auxiliary channel**: A channel that is used by the application outside the scope of colour space conversion. For example, an opacity channel or a depth channel would be an auxiliary channel.
- 3.9** **bit**: A contraction of the term "binary digit"; a unit of information represented by a zero or a one.
- 3.10** **bit-plane**: A two dimensional array of bits. In this Recommendation | International Standard a bit-plane refers to all the bits of the same magnitude in all coefficients or samples. This could refer to a bit-plane in a component, tile-component, code-block, region of interest, or other.
- 3.11** **bit stream**: The actual sequence of bits resulting from the coding of a sequence of symbols. It does not include the markers or marker segments in the main and tile-part headers or the EOC marker. It does include any packet headers and in-stream markers and marker segments not found within the main or tile-part headers.
- 3.12** **big-endian**: The bits of a value representation occur in order from the most significant to the least significant.
- 3.13** **box**: A portion of the file format defined by a length and unique box type. Boxes of some types may contain other boxes.
- 3.14** **box contents**: Refers to the data wrapped within the box structure. The contents of a particular box are stored within the DBox field within the box data structure.
- 3.15** **box type**: Specifies the kind of information that shall be stored with the box. The type of a particular box is stored within the TBox field within the box data structure.
- 3.16** **byte**: Eight bits.
- 3.17** **channel**: One logical component of the image. A channel may be a direct representation of one component from the codestream, or may be generated by the application of a palette to a component from the codestream.

- 3.18 cleanup pass:** A coding pass performed on a single bit-plane of a code-block of coefficients. The first pass and only coding pass for the first significant bit-plane is a cleanup pass; the third and the last pass of every remaining bit-plane is a cleanup pass.
- 3.19 codestream:** A collection of one or more bit streams and the main header, tile-part headers, and the EOC required for their decoding and expansion into image data. This is the image data in a compressed form with all of the signalling needed to decode.
- 3.20 code-block:** A rectangular grouping of coefficients from the same sub-band of a tile-component.
- 3.21 code-block scan:** The order in which the coefficients within a code-block are visited during a coding pass. The code-block is processed in stripes, each consisting of four rows (or all remaining rows if less than four) and spanning the width of the code-block. Each stripe is processed column by column from top to bottom and from left to right.
- 3.22 coder:** An embodiment of either an encoding or decoding process.
- 3.23 coding pass:** A complete pass through a code-block where the appropriate coefficient values and context are applied. There are three types of coding passes: significance propagation pass, magnitude refinement pass and cleanup pass. The result of each pass (after arithmetic coding, if selective arithmetic coding bypass is not used) is a stream of compressed image data.
- 3.24 coefficient:** The values that are the result of a transformation.
- 3.25 colour channel:** A channel that functions as an input to a colour transformation system. For example, a red channel or a greyscale channel would be a colour channel.
- 3.26 component:** A two-dimensional array of samples. An image typically consists of several components, for instance, representing red, green and blue.
- 3.27 compressed image data:** Part or all of a bit stream. It can also refer to a collection of bit streams in part or all of a codestream.
- 3.28 conforming reader:** An application that reads and interprets a JP2 file correctly.
- 3.29 context:** Function of coefficients previously decoded and used to condition the decoding of the present coefficient.
- 3.30 context label:** The arbitrary index used to distinguish different context values. The labels are used as a convenience of notation rather than being normative.
- 3.31 context vector:** The binary vector consisting of the significance states of the coefficients included in a context.
- 3.32 decoder:** An embodiment of a decoding process, and optionally a colour transformation process.
- 3.33 decoding process:** A process which takes as its input all or part of a codestream and outputs all or part of a reconstructed image.
- 3.34 decomposition level:** A collection of wavelet sub-bands where each coefficient has the same spatial impact or span with respect to the source component samples. These include the HL, LH and HH sub-bands of the same two dimensional sub-band decomposition. For the last decomposition level, the LL sub-band is also included.
- 3.35 delimiting markers and marker segments:** Markers and marker segments that give information about beginning and ending points of structures in the codestream.
- 3.36 discrete wavelet transformation (DWT):** A transformation that iteratively transforms one signal into two or more filtered and decimated signals corresponding to different frequency bands. This transformation operates on spatially discrete samples.
- 3.37 encoder:** An embodiment of an encoding process.
- 3.38 encoding process:** A process that takes as its input all or part of the source image data and outputs a codestream.
- 3.39 file format:** A codestream and additional support data and information not explicitly required for the decoding of codestream. Examples of such support data include text fields providing titling, security and historical information, data to support placement of multiple codestreams within a given data file, and data to support exchange between platforms or conversion to other file formats.
- 3.40 fixed information markers and fixed information marker segments:** Markers and marker segments that offer information about the original image.
- 3.41 functional markers and functional marker segments:** Markers and marker segments that offer information about coding procedures.

- 3.42 grid resolution:** The spatial resolution of the reference grid, specifying the distance between neighbouring points on the reference grid.
- 3.43 guard bits:** Additional most significant bits that have been added to sample data.
- 3.44 header:** Either a part of the codestream that contains only markers and marker segments (main header and tile-part header) or the signalling part of a packet (packet header).
- 3.45 HH sub-band:** The sub-band obtained by forward horizontal high-pass filtering and vertical high-pass filtering. This sub-band contributes to reconstruction with inverse vertical high-pass filtering and horizontal high-pass filtering.
- 3.46 HL sub-band:** The sub-band obtained by forward horizontal high-pass filtering and vertical low-pass filtering. This sub-band contributes to reconstruction with inverse vertical low-pass filtering and horizontal high-pass filtering.
- 3.47 image:** The set of all components.
- 3.48 image area:** A rectangular part of the reference grid, registered by offsets from the origin and the extent of the reference grid.
- 3.49 image area offset:** The number of reference grid points down and to the right of the reference grid origin where the origin of the image area can be found.
- 3.50 image data:** The components and component samples making up an image. Image data can refer to either the source image data or the reconstructed image data.
- 3.51 in-bit-stream markers and in-bit-stream marker segments:** Markers and marker segments that provide error resilience functionality.
- 3.52 informational markers and informational marker segments:** Markers and marker segments that offer ancillary information.
- 3.53 instantaneous bit rate:** For each frame, this corresponds to the size of the contiguous codestream for the frame in bits multiplied by the frame rate.
- 3.54 irreversible:** A transformation, progression, system, quantization, or other process that, due to a systemic or quantization error, disallows lossless recovery. An irreversible process can only lead to lossy compression.
- 3.55 JP2 file:** The name of a file in the file format described in this Recommendation | International Standard. Structurally, a JP2 file is a contiguous sequence of boxes.
- 3.56 JPEG:** Used to refer globally to the encoding and decoding process of the following Recommendations | International Standards:
- Rec. ITU-T T.81 | ISO/IEC 10918-1;
  - Rec. ITU-T T.83 | ISO/IEC 10918-2;
  - Rec. ITU-T T.84 | ISO/IEC 10918-3;
  - Rec. ITU-T T.86 | ISO/IEC 10918-4.
- 3.57 JPEG 2000:** Used to refer globally to the encoding and decoding processes in this Recommendation | International Standard and their embodiment in applications.
- 3.58 LH sub-band:** The sub-band obtained by forward horizontal low-pass filtering and vertical high-pass filtering. This sub-band contributes to reconstruction with inverse vertical high-pass filtering and horizontal low-pass filtering.
- 3.59 LL sub-band:** The sub-band obtained by forward horizontal low-pass filtering and vertical low-pass filtering. This sub-band contributes to reconstruction with inverse vertical low-pass filtering and horizontal low-pass filtering.
- 3.60 layer:** A collection of compressed image data from coding passes of one or more code-blocks of a tile-component. Layers have an order for encoding and decoding that must be preserved.
- 3.61 lossless:** A descriptive term for the effect of the overall encoding and decoding processes in which the output of the decoding process is identical to the input to the encoding process. Distortion-free restoration can be assured. All of the coding processes or steps used for encoding and decoding are reversible.
- 3.62 lossy:** A descriptive term for the effect of the overall encoding and decoding processes in which the output of the decoding process is not identical to the input to the encoding process. There is distortion (measured mathematically). At least one of the coding processes or steps used for encoding and decoding is irreversible.
- 3.63 magnitude refinement pass:** A type of coding pass.