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

*Technologies de l'information — Système de codage d'image  
JPEG 2000: Motion JPEG 2000*

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may involve the use of a patent, as indicated in Annex H.

ISO/IEC 15444-3 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology, Subcommittee SC 29, Coding of audio, picture, multimedia and hypermedia information*, in collaboration with ITU-T. The identical text is published as ITU-T Rec. T.802.

This second edition cancels and replaces the first edition (ISO/IEC 15444-3:2002), which has been technically revised. It also incorporates the amendment ISO/IEC 15444-3:2002/Amd.2:2003.

ISO/IEC 15444 consists of the following parts, under the general title *Information technology — JPEG 2000 image coding system*:

- *Part 1: Core coding system*
- *Part 2: Extensions*
- *Part 3: Motion JPEG 2000*
- *Part 4: Conformance testing*
- *Part 5: Reference software*
- *Part 6: Compound image file format*
- *Part 8: Secure JPEG 2000*
- *Part 9: Interactivity tools, APIs and protocols*
- *Part 10: Extensions for three-dimensional data*
- *Part 11: Wireless*
- *Part 12: ISO base media file format*

The following part is under preparation:

- *Part 13: An entry level JPEG 2000 encoder*

## Introduction

This Recommendation | International Standard is the consequent revision of the Motion JPEG 2000 specification, based on the common text of the MP4 and MJ2 formats, which is called the ISO Base Media File Format.

This Recommendation | International Standard specifies the use of the wavelet-based JPEG 2000 codec for the coding and display of timed sequences of images. It has been defined by ISO/IEC JTC 1/SC 29/WG 1 as Part 3 of the JPEG 2000 International Standard. In this Recommendation | International Standard, a file format is defined, and guidelines for the use of the JPEG 2000 codec for timed sequences are supplied. The Motion JPEG 2000 file format MJ2 is designed to contain one or more motion sequences of JPEG 2000 images, with their timing, and also optional audio annotations, all composed into an overall presentation.

To promote interoperability between MJ2 encoders and decoders and to test these systems for compliance to this Recommendation | International Standard, a framework of compliance testing is provided. Compliance testing is the testing of a candidate product for the existence of specific characteristics required by a standard. It involves testing the capabilities of an implementation against both the compliance requirements in the relevant standard and the statement of the implementation's capability.

Motion JPEG 2000 is expected to be used in a variety of applications, particularly where the codec is already available for other reasons, or where the high-quality frame-based approach, with no inter-frame coding, is appropriate. These application areas include:

- digital still cameras;
- error-prone environments such as wireless and the Internet;
- PC-based video capturing;
- high-quality digital video recording for professional broadcasting and motion picture production from film-based to digital systems; and
- high-resolution medical and satellite imaging.

Motion JPEG 2000 is a flexible format, permitting a wide variety of usages, such as editing, display, interchange, and streaming.

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**INTERNATIONAL STANDARD  
ITU-T RECOMMENDATION**

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

## 1 Scope

This Recommendation | International Standard specifies the use of the wavelet-based JPEG 2000 codec for the coding and display of timed sequences of images (motion sequences), possibly combined with audio, and composed into an overall presentation. In this Recommendation | International Standard, a file format is defined, and guidelines for the use of the JPEG 2000 codec for motion sequences are supplied. This Recommendation | International Standard also specifies profiles and the framework, concepts, methodology for testing and the criteria to be achieved to claim compliance to this Recommendation | International Standard.

## 2 Normative 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.

- ITU-T Recommendation T.800 (2002) | ISO/IEC 15444-1:2004, *Information technology – JPEG 2000 image coding system: Core coding system*.
- ITU-T Recommendation T.803 (2002) | ISO/IEC 15444-4:2004, *Information technology – JPEG 2000 image coding system: Conformance testing*.
- ISO 639-2:1998, *Codes for the representation of names of languages – Part 2: Alpha-3 code*.
- ISO/IEC 14496-1:2004, *Information technology – Coding of audio-visual objects – Part 1: Systems* [particularly the syntax description language (SDL), clause 14].
- ISO/IEC 15444-12:2005, *Information technology – JPEG 2000 image coding system – Part 12: ISO base media file format* (technically identical to ISO/IEC 14496-12).

## 3 Definitions

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

**3.1 Motion sequence:** A timed sequence of JPEG 2000 images.

## 4 Compatibility and technology derivation

### 4.1 Family members

This is a stand-alone Recommendation | International Standard; it defines the file format for MJ2. However, it stands as a member of a family of Recommendations | International Standards with common formatting.

The other family members include:

- the JPEG 2000 single image format, JP2;
- the ISO Base Media File Format, on which the MP4 format is based;
- the QuickTime file format, on which the ISO Base Media format is based.

## ISO/IEC 15444-3:2007 (E)

These specifications share a common definition for the structure of a file (a sequence of objects, called boxes here and atoms in QuickTime), and a common definition of the general structure of an object (the size and type).

All these specifications require that readers ignore objects that are unrecognizable to them.

This Recommendation | International Standard takes precedence over those from which it inherits, in any case where there are differences or conflicts; however, no such conflicts are known to exist.

### 4.2 ISO Media file inheritance and compatibility

The Motion JPEG 2000 file format is defined as derived from the ISO Base Media file format. Notwithstanding anything in that base specification, hint tracks are not a normative part of this Recommendation | International Standard. Clauses 7 (Streaming Support) and 10 (RTP Hint Track Format), though compatible with this Recommendation | International Standard, do not form normative parts of this Recommendation | International Standard. They may be used as a compatible, optional, extension, but are not required for compatibility with this Recommendation | International Standard. There may be license implications in the use of this or other compatible extensions to this format.

### 4.3 JP2 inheritance and compatibility

The still image format, JP2, defines a number of boxes. The signature box from that specification shall be present. If the JP2 specification requires a particular position (e.g., first in the file), that positioning shall be followed here.

It is permissible under this Recommendation | International Standard to make a file that adheres to both this Recommendation | International Standard and the JP2 specification. In that case:

- 1) The compatibility list shall include all the compatible brands.
- 2) The objects (boxes or atoms) required by the JP2 specification shall also be present.
- 3) The objects (boxes or atoms) optional in the JP2 specification may also be present.

A still image reader, reading a file which contains both a presentation (conformant to this Recommendation | International Standard) and a still image, would 'see' only the still image. Likewise, a motion reader would 'see' only the presentation. A more powerful reader may display both, or offer the user a choice.

The JP2 specification includes an optional IPR (Intellectual Property Rights) box which is therefore also optional in this Recommendation | International Standard. Among other issues, this addresses unique identification and protection of content.

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### 4.4 Conformance

Implementations of Motion JPEG 2000 decoders shall support JPEG 2000 image sequences, as well as raw and two-complement audio if audio output is available. They may also support compressed audio, using MP4 formats, or other track types from MPEG-4. The support of such MPEG-4 tracks is not required; however, readers shall not fail if they are present. If MPEG-4 composition (BIFS) is used, then the simple composition used in this Recommendation | International Standard should also be set up in such a way that a reader not implementing BIFS will display a suitable result.

Files conformant with this Recommendation | International Standard shall contain at least one Motion JPEG 2000 video track. They may contain more video tracks, uncompressed audio, or compressed MP4 audio.

### 4.5 Profiles and levels

There are two tools for profiling Motion JPEG 2000 files.

The first consists of the optional specification of tools and levels of the JPEG 2000 coding system (codestream features). These are indicated in the optional sample description extension JP2 Profile Box (see clause 5).

The second tool allows a file overall to be identified as belonging to a definition which forms a proper subset of the general specification. Such definitions might restrict such features as:

- the use of data references, and multiple files;
- the layout order of the boxes, and the data within the boxes (e.g., that data is in time order and interleaved);



- the use of profiles of the JPEG 2000 codestream;
- the existence of other tracks, and their format (e.g., audio, MPEG-7, etc.).

The conformance to these restricted profiles is indicated in the file type box by the addition of the compatible profiles as brands within the compatibility list. Annex A defines the available profiles in this Recommendation | International Standard.

#### 4.6 Visual composition

Composition of multiple image sequences in a 2D environment can be achieved by using multiple video tracks which overlap in time. Their composition is defined by the following structures:

- The matrix in the track header specifies their positioning and scaling.
- The layer field in the track header specifies the front-to-back ordering of the tracks.
- The graphics mode and opcolor fields in the video media header are used to specify the ways in which each track is composited onto the existing image (this compositing is performed from back to front).

Applications requiring more complex compositing may use the BIFS system from MPEG-4, optionally. The matrix, graphics mode, and layers should be set up so that a reader not implementing BIFS displays the desired result. Matrix values which occur in the headers specify a transformation of video images for presentation. The point (p,q) is transformed into (p',q') using the matrix as follows:

$$\begin{pmatrix} p & q & 1 \end{pmatrix} * \begin{vmatrix} a & b & u \\ c & d & v \\ x & y & w \end{vmatrix} = \begin{pmatrix} m & n & z \end{pmatrix}$$

$$m = ap + cq + x; n = bp + dq + y; z = up + vq + w;$$

$$p' = m/z; q' = n/z$$

The coordinates {p,q} are on the decompressed frame, and {p',q'} are at the rendering output. Therefore, for example, the matrix {2,0,0, 0,2,0, 0,0,1} exactly doubles the pixel dimension of an image. The coordinates transformed by the matrix are not normalized in any way, and represent actual sample locations. Therefore {x,y} can, for example, be considered a translation vector for the image.

The coordinate origin is located at the upper left corner, and X values increase to the right, and Y values increase downwards. {p,q} and {p',q'} are to be taken as absolute pixel locations relative to the upper left hand corner of the original image (after scaling to the size determined by the track header's width and height) and the transformed (rendering) surface, respectively.

Each track is composed using its matrix as specified into an overall image; this is then transformed and composed according to the matrix at the movie level in the MovieHeaderBox. It is application-dependent whether the resulting image is 'clipped' to eliminate pixels, which have no display, to a vertical rectangular region within a window, for example. So for example, if only one video track is displayed and it has a translation to {20,30}, and a unity matrix is in the MovieHeaderBox, an application may choose not to display the empty "L" shaped region between the image and the origin.

All the values in a matrix are stored as 16.16 fixed-point values, except for u, v and w, which are stored as 2.30 fixed-point values. For upwards compatibility into the MPEG-4 BIFS (scene composition) system, matrices used here restrict (u,v,w) to be (0,0,1), for which the hex values are (0,0,0x40000000). This permits the simple composition used here to be mapped into BIFS if a scene later requires full scene management.

The values in the matrix are stored in the order {a,b,u, c,d,v, x,y,w}.

Tracks are composed to the presentation surface from back (highest layer number) to front (lowest layer number), against an indeterminate initial colour. There are various composition modes available; the backmost (first-rendered) track would normally use 'copy' as the initial image is indeterminate. Subsequent layers can then be composed on top in a variety of ways. Table 1 details the composition modes available. Note that (currently) only the 'transparent' mode uses the opcolor field.

Table 1 – Graphics composition modes

Mode	Code	Description
Copy	0x0	Copy the source image over the destination.
Transparent	0x24	Replace the destination pixel with the source pixel if the source pixel is not equal to the opcolor. (Also known as 'blue-screen').
Alpha	0x100	Replace the destination pixel with a blend of the source and destination pixels, with the proportion controlled by the alpha channel. The alpha channel is applied to all channels.
Pre-multiplied black alpha	0x102	Pre-multiplied with black means that the colour components of each pixel have already been blended with a black pixel, based on their alpha channel value. Effectively, this means that the image has already been combined with a black background, which must be removed before composition.
Component alpha	0x110	One or more alpha channels are present, which are applied to individual colour channels, and the image must be composed channel-by-channel.

Images are only alpha-composed if both the graphics composition mode requests alpha composition, and the images contain alpha channels, as declared by the Channel Definition Box inside the JP2 Header Box. Therefore the graphics mode can be used to prevent alpha composition of an image with alpha channels, if that is desired.

If there is a single alpha channel applied to the entire image, then the value of the graphics must be 'Alpha' if that channel is a straight 'Opacity' channel, and must be 'Pre-multiplied black alpha' if that channel is a 'Pre-multiplied' opacity channel. If there are one or more alpha channels in the image which are applied to individual channels and not to the whole image, and alpha composition is desired, then the 'Component alpha' value must be used for the graphics mode. Support of 'Component alpha' composition is optional in this Recommendation | International Standard.

The alpha blending formulas are defined in ITU-T Rec. T.800 | ISO/IEC 15444-1.

NOTE – Use of the "transparent" opcode may yield unexpected results when the image codestreams are compressed in a non-reversible fashion, or are subject to scaling in quality or resolution, either during or after content production. Such operations are not guaranteed to preserve individual sample values precisely.

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#### 4.7 Box order

All JPEG 2000 files start with a signature box, therefore this rule is added to the Box Order rules:

- 1) The JP2 Signature Box and File Type Box shall occur first and second in the file.

## 5 File identification

In the file type compatibility box, the brand shall be 'mjp2' for files conforming to this Recommendation | International Standard, and 'mjp2' shall be a member of the compatibility list.

See Annex A for a complete list of all profile brand names.

The preferred file extension is '.mj2'. The MIME type video/mjp2 is used, as defined in the appropriate RFC.

## 6 Required additions

### 6.1 Sample description box

#### 6.1.1 Definition

Box Types: 'mjp2', 'raw ?', 'twos'  
 Container: Sample Table Box ('stbl')  
 Mandatory: Yes  
 Quantity: Exactly one

A Motion JPEG 2000 visual sample entry shall contain a JP2 Header Box from ITU-T Rec. T.800 | ISO/IEC 15444-1; however, the sRGB YCC enumerated colour space (codepoint 18) from ITU-T Rec. T.801 | ISO/IEC 15444-2 may also be used to identify the colour space used, in addition to ITU-T Rec. T.800 | ISO/IEC 15444-1 numerated colour spaces (such as sRGB and greyscale). If the JP2 Header Box indicates the presence of alpha channels, then the 'depth' field in the VisualSampleEntry must also indicate their presence, with the value 0x20. Similarly, if the JP2 Header Box defines

a monochrome image with no alpha, the 'depth' field must contain the value indicating grayscale (0x28). Otherwise, the 'depth' field must declare colour images (0x18).

If two fields are present in the samples, the JP2 Header Box applies to the complete image, not to each field individually. Therefore the height as declared in the JP2 Header Box and the VisualSampleEntry applies to the entire de-interlaced image.

NOTE – This means that you may not be able to construct a legitimate JP2 file by composing a single field's codestream together with the JP2 header box found in the sample description.

The sample format for Motion JPEG 2000 data is a set of boxes. Currently this Recommendation | International Standard permits only JP2 Codestream Boxes ('jp2c') as defined in the JP2 specification. If there is no Field Coding Box present, or the field count is 1, the sample shall contain precisely one codestream box. If the field count is 2, then there shall be two codestream boxes. Other boxes, if present in the sample, shall be ignored. The last (or only) box in the sample may have a value of 0 for its length field, indicating it extends to the end of the sample, as indicated by the sample size given in the sample size table. The actual codestreams presented to the decoder are formed by concatenating the contents of the JP2 Prefix Box, if any, in the sample description before each codestream presented in the jp2c box(es) in the samples. If field coding is used, the same prefix is concatenated before both fields. Typically, the prefix will contain a JPEG 2000 main header; however, this is not required in the general case, though specific profiles may limit the use of the prefix box.

If the codestreams used in a sequence conform to a specific profile of the JPEG 2000 coder, a JP2 Profile Box may be used to indicate such conformance.

The visual sample entry may optionally contain a field-ordering box (see below). If `fieldcount` is 2, each field will be half the height of the overall image, as declared in the 'height' field of the sample description. To be precise, if the height field contains the value  $H$ , then the field with the topmost scanline has  $((H+1) \div 2)$  lines, and the other field has  $(H \div 2)$  lines. The utility of the prefix box may be diminished when field coding is used, especially when  $H$  is odd.

The original format of the material (interlace or progressive) may be documented by the Original Format Box. The `original_fieldcount` must take the value 1 (progressive) or 2 (interlaced). When the value is 2, the `original_fieldorder` documents whether the topmost line came from the earlier or later field. The documentation of the original format is independent of whether the material has been coded as progressive (frame-based) or interlaced, which is documented by the field coding box. This box is informative only and may assist readers in display or transcoding. For example, material that was originally interlaced but is encoded frame-based and must be displayed on an interlaced display can be positioned so that the display interlace matches the original material's interlace.

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The values present in the VisualSampleEntry, its constituent boxes including the JP2 Header Box, and the codestreams that these boxes describe, must agree, to the extent that the format and precision of fields allow. This agreement includes, but is not limited to, width and height information, and the resolution declaration (within the accuracy permitted by the different representations). Files with conflicts are non-conforming and readers may attempt to decide which values are correct, or reject the file.

The fields `horizresolution` and `vertresolution` document the highest resolution component of the image (which is typically, but not required to be, the luminance, in a sub-sampled image).

For audio tracks, in the formats defined here (with code points 'raw' and 'twos'), the data is stored as uncompressed samples. If stereo is stored, the data consists of interleaved left/right samples. The raw format uses offset-binary; for 8-bit samples, values range from 0 to 255, with 128 indicating silence. For 'twos', 8-bit values range from -128 to 127, with 0 being silence. Values of 16 bits are similarly derived (with the bytes in network byte order, or big-endian format).

### 6.1.2 Syntax

```
// Visual Sequences

class MJ2SampleEntry() extends VisualSampleEntry ('mjp2'){
    JP2HeaderBox();
    FieldCodingBox(); // optional
    MJP2ProfileBox(); // optional
    MJP2PrefixBox(); // optional
    MJP2SubSamplingBox(); // optional
    MJP2OriginalFormatBox(); // optional
}

// Field-Based Coding
```

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```
class FieldCodingBox() extends Box('fiel'){
    int(8)      fieldcount;
    int(8)      fieldorder; // both storage and temporal order
}

class MJ2OriginalFormatBox() extends Box('orfo'){
    int(8)      original_fieldcount;
    int(8)      original_fieldorder;
}

class MJ2ProfileBox() extends FullBox('jp2p', 0, 0){
    unsigned int(32)[] compatible_brands;
}

class MJ2PrefixBox() extends Box('jp2x'){
    int(8)[]    data; // the data is the initial codestream part
}

class MJ2SubSamplingBox () extends Box('jsub'){
    unsigned    int(8) horizontal_sub;
    unsigned    int(8) vertical_sub;
    unsigned    int(8) horizontal_offset;
    unsigned    int(8) vertical_offset;
}

// Audio Sequences

class MJ2AudioSampleEntry() extends AudioSampleEntry (AudioFormat){
}
```

### 6.1.3 Semantics

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AudioFormat is either 'raw' or 'twos'. ([standards.iteh.ai](https://standards.iteh.ai))

Compressorname the value "\017Motion JPEG 2000" is recommended (\017 is 15, the length of the string as a byte)

depth takes one of the following values:  
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- 0x18 – images are in colour with no alpha;
- 0x28 – images are in grayscale with no alpha;
- 0x20 – images have alpha (gray or colour).

compatible\_brands is a list, filled to the end of the containing box, of JPEG 2000 profiles, to which the associated codestreams conform; see the JPEG 2000 specification for the defined values.

Horizontal\_sub and vertical\_sub indicate whether the chroma components of a YCbCr encoding were downsampled in the codestream; the value indicates the number of luminance samples to a single chroma sample in the given direction. This can assist decoders in memory allocation, or in using optimized sub-sampled display interfaces.

Horizontal\_offset and vertical\_offset specify the offset of the first chroma sample from the first luminance sample, as measured on the sample grid. If a CRG marker is present in the codestream, these values take precedence over those in the codestream. See Annex C for example values.

fieldcount specifies the number of fields in the samples, and shall be 1 or 2.

fieldorder describes the order of the two fields, and is only relevant if fieldcount equals 2:

- 0 Field coding unknown;
- 1 Field with the topmost line is stored first in the sample; fields are in temporal order;
- 6 Field with the topmost line is stored second in the sample; fields are in temporal order.

original\_fieldcount specifies the number of fields in original material before encoding, and shall be 1 or 2.

original\_fieldorder describes the order of the two fields, and is only relevant if original\_fieldcount equals 2:

- 0 Field coding unknown;
- 11 Topmost line came from the earlier field;
- 16 Topmost line came from the later field.