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# Abstract

This document presents an overview of the High Efficiency Image File Format (HEIF, ISO/IEC 23008-12). HEIF specifies the storage of individual images as well as image sequences into a container file. HEIF includes the storage specification of HEVC intra images and HEVC image sequences in which inter prediction is applied in a constrained manner. HEIF files are compatible with the ISO Base Media File Format (ISO/IEC 14496-12) and can also include other media streams, such as timed text and audio.

该文档概述了高效图像文件格式（HEIF，ISO / IEC 23008-12）。 HEIF 指定了将单个图像以及图像序列存储到容器文件中的格式。 HEIF 还包括以限制的方式应用帧间预测的 HEVC 帧内图像和 HEVC 图像序列的存储规范。 HEIF 文件兼容 ISO 基本媒体文件格式（ISO / IEC 14496-12），还可以包括其他媒体流，例如定时文本和音频。

# Introduction

The High Efficiency Image File Format (HEIF, ISO/IEC 23008-12) enables encapsulation of images and image sequences, as well as their associated metadata into a container file. HEIF is compatible with the ISO Base Media File Format (ISOBMFF, ISO/IEC 14496-12). Use cases supported by HEIF include:

* Storage of burst photos.
* 存储连拍图像。
* Support for simultaneous capture of video and still images, i.e. storing still images and timed image sequences into the same file.
* 支持同时捕获视频和静态图像，例如将静态图像和定时图像序列存储在同一个文件里。
* Efficient representation of animations and cinemagraphs.
* 动画和视频的高效率展示。
* Storage of focal and exposure stacks into the same container file.
* 存储焦点和曝光堆叠到同一个容器文件中。
* Storage of images derived from other images of the file, either as derived images represented by non-destructive image editing operations or as pre-computed derived images.
* 存储从文件的其他图像导出的图像，要么作为由非破坏性图像编辑操作表示的派生图像，要么作为预先计算的导出图像。
* Support for storing other media, such as audio and timed text, into the same container file with timed image sequences and synchronizing their playback.
* 支持将其他媒体（如音频和定时文本）存储在具有定时图像序列的同一容器文件中，并同步其播放。

HEIF specifies a structural format, from which codec-specific image formats can be derived. HEIF also includes the specification for encapsulating images and image sequences conforming to the High Efficiency Video Coding (HEVC, ISO/IEC 23008-2 | ITU-T Rec. H.265).

HEIF 指定一种结构格式，从中可以导出编解码器特定的图像格式。 HEIF还包括符合高效率视频编码（HEVC，ISO / IEC 23008-2 | ITU-T H.265建议书）的封装图像和图像序列的规范。

In ISOBMFF, a continuous or timed media or metadata stream forms a track, whereas static media or metadata is stored as items. Consequently, HEIF has the following basic design:

1. Still images are stored as items. All image items are independently coded and do not depend on any other item in their decoding. Any number of image items can be included in the same file.
2. Image sequences are stored as tracks. An image sequence track can be indicated to be displayed either as a timed sequence or in a non-timed manner, such as a gallery of images. An image sequence track needs to be used instead of image items when there is coding dependency between images.

在 ISOBMFF 中，连续或定时的媒体或元数据流组成 track／轨道，而静态媒体或元数据作为 items／项目存储。 因此，HEIF 具有以下基本设计：

1. 静止图像作为 items 存储，所有图像 items 都是独立编码的，并且解码过程不依赖于其他任何 item。 任意数量的图像 items 都可以包含在同一个文件中。

2. 图像序列存储为 track，一个图像序列 track 以时间顺序或非时间的方式显示，例如图像库。 当图像之间存在编码依赖关系时，需要使用图像序列 track 而不是图像 items。

A file may contain both image items and image sequence tracks along with other media. For example, it is possible to create a file that includes image items or image sequence tracks conforming to HEIF, along with video, audio and timed text tracks conforming to any derivative format of the ISOBMFF.

一个文件可以同时包括图像 items 和图像序列 track 以及其他媒体，例如我们可以创建一个既包括符合 HEIF 格式的图像 items 或图像序列 track，又包括符合 ISOBMFF 的任何衍生格式的视频，音频和定时文本 track。

Files conforming to ISOBMFF consist of a sequence of data structures called boxes, each containing a four-character code (4CC) indicating the type of the box, the size of the box in terms of bytes, and the payload of the box. Boxes may be nested, i.e. a box may contain other boxes. ISOBMFF and HEIF specify constraints on the allowed box order and hierarchy.

符合 ISOBMFF 规范的文件由被称为 box 的数据结构序列组成，每个 box 都包含一个四字符代码（4CC），用来指示 box 的类型，box 的大小（以字节为单位）和 box 的有效载荷。 box 可以嵌套，即 box 可以包含其他 boxes。 ISOBMFF 和 HEIF 对 boxes 的顺序和层次结构进行了有效性约束。

References of this document include an overview paper [[1]](#Ref421263846) by the same authors, a publicly available draft standard [[2]](#Ref421263848) (March 2015) and the technically frozen standard [[3]](#Ref431895392) (August 2015). The standard [[3]](#Ref4318953921) will still undergo a final approval ballot, in which no technical changes are made. This document provides a summary of the features of HEIF, whereas the overview paper [[1]](#Ref4212638461) gives a tutorial with examples, a history of the development, and a shallower feature overview. Some parts are shared between the two documents – particularly, Section [2](#Ref420506543) and Annex B of this document originate from [[1]](#Ref4212638462) with minor changes.

对参考文献的说明：文献1是本文稿同一批作者所著，提供了一个教程，包括示例，开发历史和简单的功能概括；文献2是公开的标准草案，文献3是被冻结的草案，仍将进行最终的批准投票，但是没有技术上的变更。

The document is organized as follows:

* Section [2](#Ref4205065431) presents how HEIF files are profiled and signalled.
* 第二节介绍了 HEIF 文件的规范和表示方式。
* Section [3](#Ref421264196) sums up the features related to image items.
* 第三节总结了和图像 items 相关的特性。
* Section [4](#Ref421264199) describes the features of image sequence tracks.
* 第四节描述了图像序列 tracks 的特性。
* Section [5](#Ref421264204) provides a summary how the HEVC image file format is derived from HEIF.
* 第五节简单介绍了 HEVC 图像文件格式从 HEIF 格式派生的方式。
* Annex A includes a feature comparison of HEIF to some other image formats.
* 附录 A 介绍了 HEIF 格式和其他图像格式的特征对比。
* Annex B provides some compression performance results of HEVC image and image sequence coding.
* 附录 B 提供了一些 HEVC 图像和图像序列编码的压缩性能数据。
* Annex C provides a summary of changes between the publicly available draft standard [[2]](#Ref4212638481) and the technically frozen standard [[3]](#Ref4318953922).
* 附录 C 提供了公开的标准草案（引用文献2）和技术冻结标准（引用文献3）之间的变化的总结。

# Brands and MIME type definitions

Brands（品牌） 和 MIME 类型定义

Files conforming to HEIF start with a FileTypeBox, which contains a list of brands the file complies with. Each brand is identified by its unique four-character code. The specification of a brand can include requirements and constraints for files of the brand and for file players supporting the brand. A brand included in the FileTypeBox permits a player that supports the requirements of the brand to play the file.

HEIF 规范的文件都会以 FileTypeBox （文件类型框）开头，其包含了该文件支持的 Brands 列表。Brand 通过独有的 4 元符标示。Brand 的格式可以包括对该 Brand 文件和支持该 Brand 的文件播放器的要求和约束。对于播放器而言，只要支持上述 FileTypeBox 中包含的任一个 Brand，都可以播放该文件。

The brands specified in the HEIF standard are presented in [Table I](#Ref420496296). The HEIF standard specifies the 'mif1' and 'msf1' structural brands, where requirements on file structures present in the file and to be supported by players, are given, but any image coding format can be used. Additionally, HEVC-specific brands are specified as listed in [Table I](#Ref4204962961). Further information on the HEVC-specific brands is provided in Section [5.3](#Ref420496451). As the File Type box is located at the start of the file, it provides easily accessible indications of the file contents to file players. It can be expected that the Main profile of HEVC will be most widely implemented out of all the HEVC profiles. The dedicated brand names, 'heic' and 'hevc', for the Main profile compatible image files allows players that support only the Main profile to determine whether the playback of the file is possible by inspecting the FileTypeBox.

表 1 列出了 HEIF 标准指定的 Brands。HEIF 标准规定 ‘mif1’ 和 ‘msf1’ 两种结构 Brands，它们有一些对于文件结构的要求，这些要求存在于这份文件并且将被播放器支持，虽然有对于文件结构的要求，但是这两种 Brands 可以用于任意图像编码格式。此外，表 1 还列出了 HEVC 专有 Brands，关于专有品牌的进一步信息可以阅读 5.3 章节。由于 FileTypeBox 位于文件的起始位置，它可以轻松的把文件内容的说明信息提供给播放器。可以预见， HEVC 的主要配置将会是所有 HEVC 配置中应用最多的。“heic” 和 “heif” 是兼容 HEVC 主要配置的图像文件的两种品牌名称，它们允许仅支持主配置文件的播放器通过检查 FileTypeBox 来确定是否可以播放文件。

Table I. Brands, MIME subtypes, and file extensions for HEIF.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Brand** | **Coding format** | **Image or** **sequence?** | **MIME type** | **MIME subtype** | **File**  **extension** |
| mif1 | any | image | image | heif | .heif |
| msf1 | any | sequence | image | heif-sequence | .heif |
| heic | HEVC (Main or Main Still Picture profile) | image | image | heic | .heic |
| heix | HEVC  (Main 10 or format range extensions profile) | image | image | heic | .heic |
| hevc | HEVC (Main or Main Still Picture profile) | sequence | image | heic-sequence | .heic |
| hevx | HEVC  (Main 10 or format range extensions profile) | sequence | image | heic-sequence | .heic |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Brand** | **Coding format** | **Image or** **sequence?** | **MIME type** | **MIME subtype** | **File**  **extension** |
| mif1 | 任何 | 图像 | 图像 | heif | .heif |
| msf1 | 任何 | 序列 | 图像 | heif-sequence | .heif |
| heic | HEVC（主要或主要静态图片配置） | 图像 | 图像 | heic | .heic |
| heix | HEVC（主要10或格式范围扩展配置） | 图像 | 图像 | heic | .heic |
| hevc | HEVC（主要或主要静态图片配置） | 序列 | 图像 | heic-sequence | .heic |
| hevx | HEVC（主要10或格式范围扩展配置） | 序列 | 图像 | heic-sequence | .heic |

Internet media types, also known as MIME (Multipurpose Internet Mail Extensions) types, are used by various applications to identify the type of a resource or a file. MIME types consist of a media type ('image' in the case of HEIF files), a subtype, and zero or more optional parameters. For multi-purpose files, the selection of the subtype can be made on the basis of the primary use of the file.

互联网媒体类型，也称为 MIME（多用途互联网邮件扩展）类型，被各种应用程序用于标识资源或文件的类型。MIME 类型由媒体类型（在HEIF文件的情况下为“图像”），子类型以及零个或多个可选参数组成。 对于多用途文件，可以基于文件的首要用途进行子类型的选择。

An optional codecs MIME parameter can be present to indicate the used coding formats of the tracks of the file. Similarly, an optional itemtypes MIME parameter can be present to indicate the used coding format or the type of the derived image item (see section [3.3](#Ref431885297)) as well as the essential properties (see section [3.2](#Ref431893723)) of each image item present in the file. The codecs and itemtypes MIME parameters also include the profile-tier-level value to which an HEVC-coded image sequence track or image item, respectively, conforms.

可选的编解码 MIME 类型参数可以用来表示文件轨道使用的编码格式。类似地，可选的项目类型 MIME 参数可以表示使用的编码格式或派生图像项目的类型（参见第3.3节）以及本文件中展示的图像项目的基本属性（参见第3.2节）。编解码器和项目类型 MIME 参数还包括对应 HEVC 编码图像项目和图像序列轨道的配置级别值。

# Image items

## Roles of images

As multiple images can be stored in the file, it can be useful to differentiate between them by assigning certain roles. The roles specified in HEIF are listed and described in [Table II](#Ref420497295). Note that a single image can be associated with more than one role.

考虑到将多张图像存储在一个文件，有必要分配不同的角色给他们以达到区分图像的目的。表 2 列出了 HEIF 规定的角色，需要注意的是，单张图像可以关联多个角色。

Table II. Roles of images.

|  |  |
| --- | --- |
| **Role** | **Description** |
| coded image | A coded representation of an image. |
| derived image | An image that is represented in a file by an indicated operation to indicated input images and can be obtained by performing the operation to the input images. See also section [3.3](#Ref4318852971). |
| cover image  (a.k.a. primary item) | A representative image of the image items and image sequence tracks of the file. The cover image should be displayed when no other information is available on the preference to display the image items of the file. The file can have only one cover image. |
| thumbnail image | A smaller-resolution representation of a master image. A master image can have multiple thumbnail images (e.g. different resolutions). |
| auxiliary image | An image that complements a master image. For example, an alpha plane or a depth map. Can assist in displaying the master image but is not typically displayed as such. |
| master image | An image that is not a thumbnail image or an auxiliary image. Typically represents a full-resolution displayable image. |
| hidden image | An image that should never be displayed. Can be present in the file for example as an input image for a derived image. |
| pre-derived coded image | A coded image that has been derived from other images. For example, a high dynamic range image derived from an exposure-bracketed set of images. The input images used for derivation are linked to the final pre-derived coded image by referencing. No derivation operation is defined. |

|  |  |
| --- | --- |
| **Role** | **Description** |
| 编码图像 | 图像的编码表示。 |
| 派生图像 | An image that is represented in a file by an indicated operation to indicated input images and can be obtained by performing the operation to the input images. See also section [3.3](#Ref4318852972).  可以通过执行文件中存储的指示信息获取和展示的图像，另见第3.3节。 |
| cover image  (a.k.a. primary item)  封面图像  （a.k.a 首要项） | A representative image of the image items and image sequence tracks of the file. The cover image should be displayed when no other information is available on the preference to display the image items of the file. The file can have only one cover image.  文件中图像项目和图像序列轨道的代表图像。当没有其他可优先展示文件的图像项目时，应显示封面图像。一个文件只能有一个封面图像。 |
| thumbnail image  缩略图像 | A smaller-resolution representation of a master image. A master image can have multiple thumbnail images (e.g. different resolutions).  主图像的较小分辨率表示。 主图像可以具有多个缩略图图像（e.g. 不同的分辨率）。 |
| auxiliary image  辅助图像 | An image that complements a master image. For example, an alpha plane or a depth map. Can assist in displaying the master image but is not typically displayed as such.  用于补充主图像的图像。例如，阿尔法平面或深度图，可以协助主图像的显示，但通常不会显性展示。 |
| master image  主图像 | An image that is not a thumbnail image or an auxiliary image. Typically represents a full-resolution displayable image.  不是缩略图或辅助图像的图像。 通常表示可全分辨率显示图像。 |
| hidden image  隐藏图像 | An image that should never be displayed. Can be present in the file for example as an input image for a derived image.  不应显示的图像。 可以存在于文件中，例如可作为派生图像的输入图像。 |
| pre-derived coded image  预导出的编码图像 | A coded image that has been derived from other images. For example, a high dynamic range image derived from an exposure-bracketed set of images. The input images used for derivation are linked to the final pre-derived coded image by referencing. No derivation operation is defined.  已经从其他图像派生出的编码图像。例如从曝光包围的图像集合得到的高动态范围图像。用于派生的输入图像通过引用链接到最终的预导出的编码图像。预导出的编码图像不再定义派生操作。 |

## Image properties

Images can be indicated to have properties that are either descriptive (i.e. not imposing a modification on the image item) or transformative (i.e. modifying the image). Properties can be marked as essential imposing mandatory parsing by the file player. The currently defined image properties are listed in [Table III](#Ref431826744).

图像可以包含一些属性，属性有两种：描述和变形。描述属性提供有关图像项的信息，而不对图像本身进行修改。变形属性提供有关图像项需要完成的变形修改的信息。属性会强制文件播放器解析。表 3 列出了当前定义的图像属性。

Table III. Image properties.

|  |  |  |  |
| --- | --- | --- | --- |
| **Property** | **Descriptive/ transformative** | **4CC Code** | **Description** |
| Decoder configuration and initialization  解码器配置和初始化 | descriptive  描述 | Specific to the image coding format.  指定图像的编码格式 | The information needed to initialize the decoder. The structure of this information is usually defined in the related image coding format specification.  初始化解码器所需的信息。该信息的结构通常在相关的图像编码格式规范中定义。 |
| Image spatial extents  图像空间范围 | descriptive  描述 | 'ispe' | The width and height of the image item  图像项目的宽度和高度 |
| Pixel aspect ratio  像素长宽比 | descriptive  描述 | 'pasp' | Pixel aspect ratio  像素长宽比 |
| Colour information  色彩信息 | descriptive  描述 | 'colr' | Colour conversion information, such as ICC profile  颜色转换信息，例如 ICC 配置 |
| Pixel Information  像素信息 | descriptive  描述 | 'pixi' | The number and bit depth of colour components in the image item.  图像项目中颜色分量的数量和位深度。 |
| Relative Location  相对位置 | descriptive  描述 | 'rloc' | The horizontal and vertical position of the reconstructed image of the associated image item relative to a referenced image item.  相关图像的重建图像相对于引用图像项目的水平和垂直位置。 |
| Image properties for auxiliary images  辅助图像的属性 | descriptive  描述 | 'auxC' | The type of an associated auxiliary image. Depending on the type, other related information may also be provided within this property.  相关辅助图形的类型，根据类型的不同，该属性可以提供其他相关信息。 |
| Clean aperture | transformative  变形 | 'clap' | Rectangular cropping of the image.  图像的矩形裁剪 |
| Image Rotation  图像旋转 | transformative  变形 | 'irot' | Rotation on the image in units of 90 degrees.  图像以90度为单位旋转。 |

In addition to descriptive image properties, image items can optionally be characterized with metadata items, the format of which follows Exif, XMP, or MPEG-7 metadata.

除了描述属性之外，图像项还可选用元数据项表述特征，例如 Exif、XMP 或 MPEG-7 元数据。

## Derived images

Derived images enable non-destructive image editing, where the original coded images are kept in the file, while new images, called derived images, can be introduced by specifying a transformation operation that is applied to one or more input images. HEIF specifies the generic structures used for storing derived images as items as well as a few specific types of derived images. The item type of a derived image item indicates the transformation operation, while the item payload contains the input parameters to the operation. Item references of type 'dimg' specify the input image(s) of the derived image. The input images can be coded images or derived images. The derived image types specified in the HEIF standard are listed in [Table IV](#Ref431826773). Other types may be specified in other documents or later versions of the HEIF standard.

派生图像允许进行非破坏性图像编辑，其中原始图像保存在文件中，新的派生图像可以通过指定的应用在输入的一张或多张图像上的一个变换操作来引入。HEIF 规定了将派生图像存储为项目的通用结构，同时规定了几种派生图像的特定类型。派生图像项目的类型指定了变换操作，项目的有效内容包含了该操作的输入参数。“dimg” 类型的项目引用指定了派生图像的输入图像。输入图像可以是编码图像或派生图像。表4 HEIF标准中指定的派生图像类型。其他类型可以在 HEIF 标准的其他文件或更高版本中指定。

Table IV. Derived image types.

|  |  |  |
| --- | --- | --- |
| **Name** | **Item 4CC** | **Description** |
| Identity transformation  特性变换 | iden | Cropping and/or rotation by 90, 180, or 270 degrees, imposed through the respective transformative properties.  通过相应的变换属性对图像进行裁剪或 90/180/270 度的旋转。 |
| Image overlay  图像叠加 | iovl | Overlaying any number of input images in indicated order and locations onto the canvas of the output image.  将指定顺序和位置的任意数量的输入图像叠加到输出图像的画布上。 |
| Image grid  图像栅格化 | grid | Reconstructing a grid of input images of the same width and height.  重建和输入图像等宽等高的栅格化图像 |

## Processing of image items by file players

[Figure 1](#Ref431888484) illustrates how a file player processes the coded images and the derived images included in a file. The file player decodes a coded image into a reconstructed image. Similarly, the file player applies the operation of the derived image to the indicated one or more input images to obtain the respective reconstructed image. The descriptive image properties generally describe the reconstructed image, with the exception of the decoder configuration and initialization information, which is associated with the coded image. The transformative image properties, if any, are applied to the reconstructed image to obtain an output image. The output image can be displayed, when the coded image or the derived image is not a hidden image. The output image can also act as an input image to derived images.

图 1 展示了文件播放器处理包含在文件中的编码图像和派生图像的过程。文件播放器将编码图像解码为重建图像。类似地，文件播放器将派生图像的操作应用于对应的的一个或多个输入图像，获得相应的重建图像。 除了与编码图像相关联的解码器配置和初始化信息之外，描述性图像属性通常用来描述重构图像。 变换性图像属性（如果有的话）应用于重建图像从而获得输出图像。当编码图像或派生图像不是隐藏图像时，可以显示输出图像。输出图像也可以作为派生图像的输入。

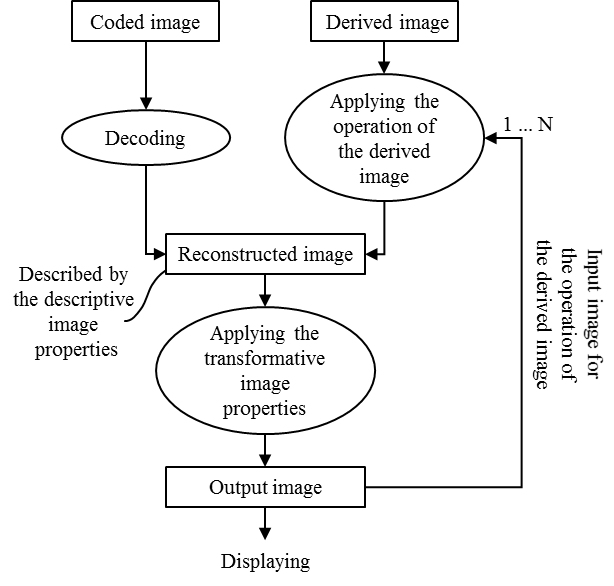


Figure 1. Operations performed by file players

## Indicating alternatives

An HEIF file can contain several image items representing the same image content. A desired file player operation is to select one of the alternative representations of the same image content for displaying. A mechanism, known as entity grouping, is used for indicating alternate groups, which can contain both image items and tracks. Examples where alternate groups can be used include the following:

一个 HEIF 文件可以包含表示相同图像内容的多个图像项目。一个预期的文件播放器的操作时去上述多个图像项目中选择一个用来展示。被称为实体分组的机制可用来产生包含图像项目和轨道的备用组。可以使用替代组的示例包括：

* The same original image is coded into two or more image items with different properties, such as spatial resolution, bit-depth, or color gamut.
* 相同的原始图像被编码成具有不同属性的两个或多个图像项目，例如空间分辨率，位深度或色域。
* The same original image is coded into two or more image items with a different coding format or profile.
* 相同的原始图像被编码成具有不同编码格式或属性的两个或多个图像项目。
* A timed image sequence, such as a cinemagraph, is an alternative to an image item.
* 定时的图像序列可作为是图像项目的替代品，例如电影片段。

# Image sequence tracks

## Introduction

In the ISOBMFF terminology tracks comprise *samples*, such as coded pictures. Each track has a type, identified by a four-character handler code. A sample entry of a track includes decoder initialization information for the linked samples.

ISOBMFF 术语轨道包括 samples／样本，例如编码图像。每一个轨道拥有一个类型，类型使用 4 元字符处理编码定义。一个轨道的样本输入包含引用的样本的解码器初始化信息。

HEIF specifies a new handler type 'pict' for image sequences. An image sequence track inherits the properties and features of a video track except in the following cases:

HEIF 为图像序列指定了一个新的处理程序类型 'pic'。图像序列轨道继承视频轨道的属性和特征，但以下情况除外：

* A key difference between an image sequence track and a video track lies in the interpretation of the timing information given for the track: While the timing information given for a video track adheres the decoding and output timing of the contained video bitstream, the timing information of an image sequence track can represent the capture times (e.g. for separate images of an exposure stack) or the suggested display timing (e.g. for a slide show). It can be indicated whether an image sequence track should be played as a timed sequence or by some non-timed means, such as an image gallery.
* 图像序列轨道和视频轨道之间的关键区别在于对时间信息的解释：视频轨道的时间信息附加所包含的视频比特流的解码和输出时间，图像序列轨道的时间信息可以表示捕获时间（例如曝光叠层的单独图像）或建议的显示时间（例如用于幻灯片放映）。该场景可以用来指示图像序列轨迹以定时序列还是某些非定时的方式播放，例如图像库。
* The sample entries of image sequence tracks are required to include CodingConstraintsBox for indicating the applied prediction constraints and hence assisting players in accessing individual images of the image sequence track. See Section [4.4](#Ref421265473) for further details on CodingConstraintsBox.
* 图像序列轨道的样本输入需要包括用于 CodingConstraintsBox， CodingConstraintsBox 用于指示应用的预测约束，从而协助播放器访问图像序列轨道中的各个图像。有关 CodingConstraintsBox 的更多详细信息，请参见第4.4节。

## Roles of image sequence tracks

Roles can be indicated for image sequence tracks similarly to image items. [Table V](#Ref420499143) lists the roles of the image sequence tracks.

类似图像项目，角色可以用来指示图像序列轨道。表 5 列出了图像序列轨道的角色。

Table V. Roles of image sequence tracks.

|  |  |
| --- | --- |
| **Role** | **Description** |
| thumbnail image sequence  缩略图像序列 | A smaller-resolution representation of a master image sequence.  主图像序列的较小-分辨率表示 |
| auxiliary image sequence  辅助图像序列 | An image sequence that complements a master image sequence. For example, a sequence of alpha plane or depth map images. Can assist in displaying the master image sequence but is not typically displayed as such.  补充主图像序列的图像序列。例如一系列的alpha平面或深度图图像。可以协助显示主图像序列，但通常不会显示。 |
| master image sequence  主图像序列 | An image sequence that is not a thumbnail image sequence or an auxiliary image sequence. Typically contains full-resolution displayable images.  不是缩略图序列或辅助图像序列的图像序列。通常包含可全分辨率显示的图像。 |

## Controlling the playback

The most important features that enable controlling the playback of an HEIF file are listed in [Table VI](#Ref420499749). As indicated in the table, some features were introduced in the ISOBMFF or ISO/IEC 14496-15 and are explicitly inherited by HEIF, while other features were specifically designed for the HEIF standard.

表 6 列出了能够控制 HEIF 文件播放的最重要的特性。如表中所示，一些特性是从 ISOBMFF 和 ISO/IEC 14496-15 引入的，另一些特性是为 HEIF 标准专门设计的。

Table VI. Features controlling image sequence playback.

|  |  |  |
| --- | --- | --- |
| **Feature** | **First appeared in** | **Description** |
| non-displayable sample  不可显示的样本 | ISO/IEC 14496-15 | Is never displayed, but can be used as a reference for predicting other images in the track.  不会显示，但可用作预测轨道中其他图像的参考。 |
| timed vs. non-timed playback  定时与非定时播放 | HEIF | In timed playback, the image sequence is played as video, whereas in non-timed playback the samples of the track are displayed by other means, such as an image gallery. Non-timed playback may be indicated e.g. when a track is used for achieving a better compression efficiency for an exposure stack.  在定时播放中，图像序列被播放为视频，而在非定时播放中，轨道的样本通过诸如图像库的其他方式来显示。某些场景下，非定时播放会被使用，例如轨道是用于实现曝光叠层的更好的压缩效率的时候。 |
| edit list  编辑列表 | ISOBMFF | A list of ranges of the image sequence track in their playback order. Enables modifying the playback order and pace of samples.  在播放顺序中的图像序列轨道的范围列表，用于修改样本的播放顺序和步速。 |
| looping  循环 | HEIF | HEIF allows indicating edit list repetition e.g. for looping animations. The repetition can be indicated to last for a certain duration or be infinite.  HEIF 允许编辑列表重复，例如循环动画。重复可以持续一段时间甚至无限循环。 |
| cropping and rotation  裁剪和旋转 | ISOBMFF | Rectangular cropping and rotation by 90, 180, 270 degrees can be specified.  图像进行裁剪和 90/180/270 度的旋转 |

## Inter-picture prediction and random access

帧间预测和随机访问

HEIF allows the use of inter-picture prediction (a.k.a. inter coding), which can provide significant coding efficiency improvement to image sequences when images are correlated. Such correlation is especially evident in content like image bursts or animation clips.

HEIF 允许使用帧间预测，当图像序列中的图像存在相关性时，图像序列的编码效率会显著改善。这样的相关性在诸如连拍或动画剪辑的内容中尤其明显。

A conventional operation for playing a video track is to decode samples of the track sequentially in their decoding order. If the user seeks to a position within the track, the file player first finds the preceding randomly accessible sample (an intra-coded image) and then sequentially decodes samples of the track until the seek position is reached. While such operation is fine for typical video use cases, image sequence use cases may require faster access to individual images and the ability to edit individual images without affecting any other images. HEIF therefore includes the following two features:

播放一个视频轨道的常规操作是按照轨道中样本的解码顺序依次解码。如果用户想要查找轨道内的某一帧，播放器首先需要找到前面随机访问的样本（帧内编码图像），然后顺序的解码直到到达寻找的位置。虽然在典型的视频播放场景下，这种方式是不错的，但是图像序列应用场景下需要更快的访问单个图像，并且能够编辑单个图像而不影响其他任何图像。因此，HEIF 实现了下述两个功能：

1. CodingConstraintsBox to indicate prediction constraints applying to all the linked samples. For example, it can be indicated that all reference images used for inter-picture prediction are intra-coded images.

1. CodingConstraintsBox 用于指定应用于所以引用样本之上的预测约束，例如可以要求所有用于帧间预测的引用／参考图像都必须是帧内编码图像。

1. Sample-wise listing of referenced samples using the sample grouping mechanism of ISOBMFF. This feature enables decoding of only those samples that are needed for accessing a particular sample and avoids the need of sequential decoding of each sample starting from the previous intra-coded image.

2. 使用ISOBMFF的样本分组机制对引用／参考样本进行分组。该功能允许访问特定样本时，仅解码所需的那些样本，避免了从先前的帧内编码图像开始的对样本顺序解码。

## Information linked to image sequence tracks

[Table VII](#Ref420501586) presents a summary of the information that that must or may complement an image sequence track. By comparing [Table III](#Ref4318267442), and [Table VII](#Ref4205015861), it can be seen that similar information is provided both for image items and image sequence tracks.

表 7 列出了图像序列轨道必要的或可能的补充信息。通过对比表 3 和 表 7，可以发现图像项目和图像序列轨道拥有一些相似的信息。

Table VII. Information associated with image sequence tracks   
(M = mandatory in HEIF files, O = optionally present in HEIF files).

|  |  |  |
| --- | --- | --- |
| **Name** |  | **Description** |
| Sample entry  样本输入 | M | One or more sample entries are included in the SampleDescriptionBox. The coding format is identified with the 4CC of the sample entry (e.g. 'hvc1' for HEVC). A visual sample entry contains:  SampleDescriptionBox 包含一个或多个样本输入。编码格式用样本输入的 4CC 标识（例如，用于HEVC的“hvc1”）。视觉样本输入包含：   * the width and the height of the coded images * 编码图像的宽度和高度 * the initialization data for the decoder * 解码器的初始化数据   A visual sample entry may also contain  视觉样本输入也可以包含：   * cropping information * 裁剪信息 * pixel aspect ratio * 像素长宽比 * color information, such as the ICC profile or color primaries * 颜色信息，如ICC配置文件或颜色原色 |
| Track metadata  轨道元数据 | M | The track-specific metadata is contained in the TrackHeaderBox and some of its child boxes. For example the following information can be specified:  轨道特定的元数据包含在 TrackHeaderBox 及其一些子框中。 例如，可以指定以下信息：   * transformation matrix, e.g. for rotation * 转换矩阵，例如旋转 * duration * 持续时间 |
| Externally specified metadata  外部指定的元数据 | O | Timed metadata track(s) can be used to convey Exif, XMP, and MPEG-7 metadata applying to time-parallel samples of the linked image sequence track.  定时元数据轨道可用于传递应用于引用／参考图像序列轨道的时间并行样本的 Exif，XMP 和 MPEG-7 元数据。 |

# HEVC image file format

## Introduction

The HEIF standard includes the specification of encapsulating HEVC-coded images and image sequences into HEIF-compliant files. The specification includes the following aspects:

HEIF 标准包括将 HEVC 编码的图像和序列封装到 HEIF 兼容文件中的规范。该规范包括以下几个方面：

* The sample entry format and the sample format of HEVC image sequence tracks are identical to those of the HEVC video tracks specified in ISO/IEC 14496-15. For compatibility with HEVC-capable video players, it is therefore advisable to create both an HEVC image sequence track and an HEVC video track that refer to the same coded images.
* HEVC 图像序列轨道的样本输入格式和样本格式与 ISO/IEC 14496-15 中规定的 HEVC 视频轨道相同。 为了与支持 HEVC 的视频播放器兼容，建议创建引用相同编码图像的 HEVC 图像序列轨道和 HEVC 视频轨道。
* The format of the decoder configuration information in the image entry item is identical to that in the sample entry format. Likewise, the item format is identical to the sample format of HEVC video and image sequence tracks. This enables having the same intra-coded image as an image item and as a sample in an HEVC image sequence or video track.
* 图像输入项目中解码器配置信息的格式与样本输入格式相同。类似地，项目格式与 HEVC 视频和图像序列轨迹的样本格式相同。这使得 HEVC 图像序列或视频轨道中的样本具有与图像项目相同的帧内编码图像。
* The configuration information of alpha planes and depth maps follows the respective supplemental enhancement information of HEVC.
* α 平面和深度图的配置信息遵循 HEVC 的相应补充增强信息。

## Additional features

Like many other video coding standards, HEVC supports slices that can be regarded as basic units for transmission and may also be used for parallel processing. In addition, HEVC includes parallelization tools, known as tiles and wavefronts, which can be used in encoding and in a limited fashion also in decoding.

和许多其视频标准一样，HEVC 支持切片，切片可以被视为传输的基本单元，也可以用来并行处理。此外，HEVC 还包括称为 tiles 和 wavefronts 的并行化工具，可以在编码过程应用，也可以在解码过程中以限制的方式使用。

The SubSampleInformationBox of the ISOBMFF enables indicating byte ranges within a sample and indicate properties for those byte ranges. Sub-sample partitioning based on slices, tiles, and wavefronts (i.e., coding tree unit rows) is specified for HEVC video tracks. The same sub-sample partitioning also inherited by HEVC image items and HEVC image sequence tracks. This signalling can be used for decoding a subset tiles of an image, for example. HEIF also enables grouping of a rectangular set of tiles into an HEVC tile item, which can simplify the operation of a file player when decoding a partial image.

ISOBMFF 的 SubSampleInformationBox 可以指示样本中的字节范围，并指出这些字节范围的属性。HEVC 视频轨道指定了基于切片， tiles 和 wavefronts（即编码树单元行）的子样本划分。HECV 图像项目和 HEVC 图像序列轨道原样继承了该特性。该信令可以用于解码图像的子集块，例如，HEIF 允许将举行块／tiles 集合组成一个 HEVC tile 项目，在解码局部图像时，简化播放器的操作。

## Constraints for files and requirements for players

对文件的约束和对播放器要求

[Table VIII](#Ref420502019) describes the additional constraints that all HEVC image files have to follow and the additional requirements for HEVC image file players. A primary alternate group is defined for [Table VIII](#Ref4205020191) to be the alternate group including the cover image. Some of the motivations for including these constraints and requirements in the HEIF standard are provided below the [Table VIII](#Ref4205020192).

表 8 列出了所有 HEVC 图像文件必须遵循的附加约束以及对 HEVC 图像文件播放器的附加要求。表 8 定义了包括了封面图像的首要替代组。 表 8 描述了将这些约束和要求纳入 HEIF 标准的一些动机。

Table VIII. Constraints for HEVC image files and requirements for HEVC image file players

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Brand** | **Constraint or option for files** | **Requirement for players** |
| Primary alternate group  首要替代组 | heic, heix | Files shall include an image item with a coding format inferred by the brand in the primary alternate group.  文件应包括可由首要替代组中的品牌推断出的编码格式的图像项目。 | Player shall display any image item that has a supported coding format and is in the primary alternate group.  播放器应显示具有已支持的编码格式且位于首要替代组中的任何图像项。 |
| Cropping and rotation  裁剪和旋转 | heic, heix, hevc, hevx | - | Player shall support clean aperture and rotation by 90, 180, and 270 degrees.  播放器应支持 clean aperture 和旋转90度，180度和270度。 |
| Constraint on inter-picture prediction  帧间预测约束 | hevc, hevx | Samples in image sequence tracks shall be either intra-coded images or inter-picture predicted images with reference to only intra-coded images.  图像序列轨道中的样本应该为：  帧间预测图像本身或仅引用／参考帧内编码图像的帧间预测图像 | - |

The required support for primary alternate group guarantees proper playback of multi-branded files, where for example the same original image is represented by two alternative images in the file, one coded with HEVC Main profile at 1920x1080 resolution and another coded with HEVC Main 10 profile at 3840x2160 resolution, and both 'heic' and 'heix' brands are included in the FileTypeBox.

首要替代组保证了多品牌文件的正常播放，例如相同的原始图像由文件中的两个替代图像表示，一个以 HEVC 主配置文件编码，1920x1080分辨率，另一个编码为 HEVC Main 10 配置文件，3840x2160 分辨率，“heic” 和 “heix” 品牌都包含在 FileTypeBox 中。

The primary use case for the mandatory support for rotation by 90 degrees is for the photo shooting situations in which the camera orientation is incorrectly detected or concluded. This requirement makes it possible to manually adjust the image or image sequence orientation afterwards without the need for re-encoding the image or image sequence. Similarly, cropping may be useful to enable post-shooting zoom without the need for re-encoding. As rotation by 90, 180, or 270 degrees as well as cropping are mandatory for all HEVC image file players, it is guaranteed that re-encoding is not required to carry out these operations.

强制支持旋转 90 度的主要用例是照相机在拍摄中，方向被错误的检测或结束。该要求使得可以手动调整图像或图像序列的方向，而不需要重新编码图像或图像序列。类似地，裁剪可能有助于在不需要重新编码的情况下变焦拍摄。对于所有 HEVC 图像文件播放器，旋转 90, 180 或 270度 以及裁剪都是强制要求，从而保证了执行这些操作时，不需要重新编码。

The constraints of inter-picture prediction reduce the decoding latency for accessing any particular image within an HEVC image sequence track.

图像间预测约束降低了用于访问 HEVC 图像序列轨道内的任何特定图像的解码延迟。

# Annex A: comparison to other image formats

[Table IX](#Ref420505360) provides a comparison of the features of HEIF to other selected image formats. It can be observed that HEIF is more extensible and comprehensive than the other compared file formats. Particularly the possibility to include other media types, the advanced multi-picture features, and the support for non-destructive editing make HEIF more advanced than the other formats. The rich set of features make HEIF suitable for a broad range of devices and applications, including for example burst photography.

表 9 列出了 HEIF 和其他几种图像格式在几种功能上的对比数据。可以发现，HEIF 相对于其他格式，可扩展性更强，支持更全面，尤其是 HEIF 可以支持其他的媒体格式，超前的多画面功能和非破坏性编辑。丰富的功能使HEIF适用于各种设备和应用，例如连拍。

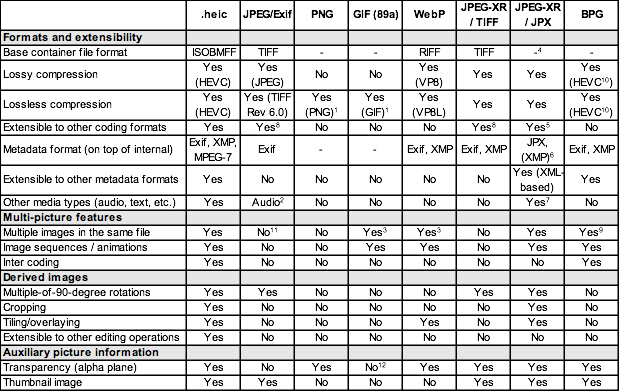
It is acknowledged that a summary such as that in [Table IX](#Ref4205053601) might be somewhat inaccurate when it comes to features of different formats. For example, the table does not cover some of the extensions of JPEG. The authors welcome feedback and corrections to the table.

表 9 里所列出的数据并不全面， 例如不包含 JPEG 的一些扩展，可能和实际情况有些出入，欢迎指正。

The references used to conclude the information in [Table IX](#Ref4205053602) are included in [Table X](#Ref420506350).

表 10 列出了表 9 信息的参考链接。

Table IX. Comparison of the features of some image file formats.



1 In GIF and indexed color PNG encoding, lossy color quantization is applied while the color-quantized image is losslessly compressed.

2 PCM, µ-Law PCM and ADPCM encapsulated in RIFF WAV

3 Only for animations and tiling/overlaying

4 JPX is a box-structured format compatible with ISOBMFF. However, only the File Type box is common in JPX and ISOBMFF.

5 Encapsulation of JPEG-2000 and JPEG-XR have been specified for JPX container. Mappings for other codecs could be similarly specified.

6 JPX (ITU-T T.800 and T.801) specifies an own metadata schema, but is capable of carrying an XML formatted metadata, such as XMP.

7 JPX can contain media complying with ISOBMFF (or derivatives thereof). No accurate synchronization between JPX animations and other media.

8 TIFF as a container format facilitates extensions to other coding formats.

9 Only for animations, thumbnails, and alpha planes. Non-timed image collections not supported.

10 HEVC Main 4:4:4 16 Still Picture profile, Level 8.5, with additional constraints

11 Can be enabled through the MP extension

12 A palette index for fully transparency can be specified

Table X. References for the compared image file formats

|  |  |  |
| --- | --- | --- |
| **Image format** | **Version or date** | **Reference and/or URL** |
| HEIF (.heic) | 03/2015 | ISO/IEC 23008-12  http://mpeg.chiariglione.org/standards/mpeg-h/image-file-format/draft-text-isoiec-fdis-23008-12-carriage-still-image-and-image |
| JPEG |  | ISO/IEC 10918-1 | ITU-T Rec. T.81  http://www.w3.org/Graphics/JPEG/itu-t81.pdf |
| Exif |  | http://www.cipa.jp/std/documents/e/DC-008-2012\_E.pdf |
| PNG |  | http://www.w3.org/TR/PNG/ |
| GIF | 89a | http://www.w3.org/Graphics/GIF/spec-gif89a.txt |
| WebP |  | https://developers.google.com/speed/webp/docs/riff\_container  VP8L: https://developers.google.com/speed/webp/docs/webp\_lossless\_bitstream\_specification |
| JPEG-XR |  | ISO/IEC 29199-2 | ITU-T Rec. T.832  ISO/IEC 15444-2 | ITU-T Rec. T.801 (for JPX) |
| BPG | 0.9.5 | http://bellard.org/bpg/bpg\_spec.txt |

# Annex B: compression performance

In order to assess coding efficiency of the HEVC intra picture coding we carried out a set of experiments using the JCT-VC common test conditions [[4]](#Ref431895984). The resulting picture quality varied typically in the range of 34 dB to 44 dB (in luma peak signal-to-noise ratio) illustrating wide range of quality levels varying from typical web usage to visually lossless levels. More information on the experiment setup is available in [[5]](#Ref421268168).

为了评估 HEVC 图像编码的编码效率，我们使用 JCT-VC 通用测试条件进行了一组实验[4]。图像质量水平在 34dB 至 44dB（亮度峰值信噪比）的范围内变化，涵括了从典型的 web 服务到视觉无损的质量等级。有关实验设置的更多信息，请参见[5]。

[Table XI](#Ref421268032) illustrates coding efficiency of HEVC intra coding with respect to well-known still picture codecs. The results indicate that JPEG would require on average 139 % higher bitrate than HEVC (i.e. 2.39 times the file size) in order to achieve the same objective picture quality. For JPEG-XR and JPEG-2000 the average increase in bitrates are 66 % and 44 %, respectively.

表 11 列出了使用著名的静态图像验证 HEVC 帧内编码的效率。结果表明，为了达到相同的客观图像质量，JPEG 需要比 HEVC 平均高出139％的比特率（即文件大小的2.39倍）。对于 JPEG-XR 和 JPEG-2000，比特率的平均增加分别为 66％ 和 44％。

Table XI. HEVC intra coding performance with respect to legacy formats. Bitrate increase required to achieve the objective quality provided by HEVC intra coding is reported for each test category.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Class** | **Resolution** | **Characteristics** | **JPEG** | **JPEG** **XR** | **JPEG** **2000** |
| Class A | 2560x1600 | Cropped 4Kx2K sequences for Ultra HDTV services | 87 % | 44 % | 48 % |
| Class B | 1920x1080 | High resolution sequences for streaming and broadcast services | 124 % | 62 % | 15 % |
| Class C | 832x480 | Medium resolution sequences for Internet/mobile video services | 122 % | 53 % | 50 % |
| Class D | 416x240 | Low resolution sequences for services to resource constrained devices | 110 % | 47 % | 43 % |
| Class E | 1280x720 | 720p sequences for video conferencing applications | 170 % | 73 % | 23 % |
| Class F | 1024x768, 1280x720 | Computer screen content and computer generated content | 223 % | 118 % | 87 % |
| **Average** |  |  | **139 %** | **66 %** | **44 %** |

Subjective testing performed for different test sets appear to verify the results also when it comes to the perceived quality of material coded with different codecs. For instance, [[6]](#Ref421268229) reports that typically subjective quality of HEVC intra coded pictures are comparable to that of JPEG coded pictures using twice, or sometimes even four times the bitrate of HEVC.

在不同的测试集上的主观测试也验证了上述结果。例如 [6] 中指出，相同的质量下，JPEG 的比特率通常是 HEVC 的 2 倍，甚至是 4 倍。

In order to measure coding efficiency of low latency HEVC encoding structures for different use cases the following experiments were performed. Firstly, the JCT-VC test set [[4]](#Ref4318959841) was used to mimic image bursts. Eight first frames of each sequence was coded using the fourth picture in each clip as a reference picture for inter coding. Secondly, additional use cases with exposure stack, focal stack and cinemagraph content were simulated by coding a representable sequence in each category. For an exposure stack a well-known "Memorial" sequence with 16 different exposures was used. In the focal stack case a "Mersu" sequence with 13 different focus distances was selected and finally a "Car&Tractor" cinemagraph was used to represent an animated clip where majority of the picture is frozen and certain area of the scene is undergoing motion. The results reported in [Table XII](#Ref421268514) indicate that one can expect that for natural content the restricted inter coding can typically provide two to three times better compression than intra picture coding. In special cases like animations where majority of the scene is static the compression efficiency can significantly exceed those levels and be tens of times more efficient than intra coding. More information on the experiment is available in [[5]](#Ref4212681681).

为了衡量不同场景下，低延迟的 HEVC 编码结构的编码效率，进行了下述实验：

第一：使用 JCT -VC 数据集模拟连拍场景，将每个序列的八个第一帧使用每个剪辑中的第四张图片作为帧间编码的参考图像；

第二：通过对每个类别中的可展示序列进行编码来模拟曝光层，焦点堆叠和电影片段内容的附加用例。对于曝光堆，使用了 16 种不同曝光的著名的 “Memorial” 序列。在焦点堆叠用例中，选择了 13 个不同对焦距离的 “Mersu” 序列，最后使用 “Car＆Tractor” 影片来表示动画剪辑场景，其中大部分图片为静止的，某些区域则为运动状态。表 12 中报告的结果表明，对于自然内容，受限帧间编码通常是帧内编码压缩比的 2-3 倍。在特殊场景下，例如大多数背景是静态的动画，压缩效率可以显着增加，是帧内编码的数十倍。有关实验的更多信息，请参见 [5]。

Table XII. Coding efficiency improvements provided by low latency predictive coding of the HEVC Image File Format. Bitrate impact and coding gain are reported with respect to HEVC intra coding.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Content** | **Type** | **Frames** | **Bitrate** **change** | **Coding** **gain** |
| Class A | Image burst | 8 | -46 % | 1.9 |
| Class B | Image burst | 8 | -51 % | 2.0 |
| Class C | Image burst | 8 | -60 % | 2.5 |
| Class D | Image burst | 8 | -63 % | 2.7 |
| Class E | Image burst | 8 | -79 % | 4.8 |
| Class F | Image burst | 8 | -55 % | 2.2 |
| Memorial | Exposure stack | 16 | -29 % | 1.4 |
| Mersu | Focal stack | 13 | -25 % | 1.3 |
| Car&Tractor | Cinemagraph | 48 | -97 % | 33.3 |

# Annex C: summary of specification changes since the publicly available draft

This Annex summarizes the technical changes between the publicly available draft [[2]](#Ref4212638482) and the technically frozen HEIF standard [[3]](#Ref4318953923). The intent of the Annex is to help readers to get an understanding how the publicly available draft [[2]](#Ref4212638483) evolved prior to completing the technical standardization. The changes can clustered in the following categories:

1. The image properties (see [3.2](#Ref4318937232)) were introduced. The decoder configuration and initialization property replaced the image entry items in [[2]](#Ref4212638484) and the other descriptive image properties substituted the items of ISOBMFF-derived metadata in [[2]](#Ref4212638485). The transformative properties for clean aperture and rotation replaced the respective derived image types in [[2]](#Ref4212638486). These changes were carried out mainly to reduce the number of items and item references in the file and consequently to simplify the file structure.
2. The itemtypes optional MIME parameter was introduced to carry information for items, whereas previously the codecs MIME parameter described both tracks and items.
3. The term pre-derived coded image replaced the term pre-computed derived image, since the term is used as a role for a coded image.

# Abbreviations

4CC four-character code

Exif Exchangeable image file format

HEIF High Efficiency Image File Format

HEVC High Efficiency Video Coding

ICC International Color Consortium

ISOBMFF ISO base media file format

MIME Multi-purpose Internet Mail Extensions

URN Uniform Resource Name

XMP Extensible Metadata Platform

# References

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3. ISO/IEC 23008-12, "Image file format," Final Draft International Standard, MPEG N15523, Aug. 2015.
4. F. Bossen, "Common HM test conditions and software reference configurations," JCTVC-K1100, Shanghai, China, Oct. 2012.
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