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Multi-Image Application Format (MIAF)

# Introduction

Over the last three decades, several image compression formats have been defined and standardized. Among those are JPEG (ISO/IEC 10918), JPEG2000 (ISO/IEC 15444), JPEG XR (ISO/IEC 29199), WebP, and HEIF+HEVC/AVC (ISO/IEC 23008-12).

The most popular is still JPEG, ubiquitously present on the Web, and on consumer electronics devices (phones, DSLR cameras, point and shoot cameras).

Some of these formats are rather dated and fall short in terms of compression efficiency when compared to recent compression advancements. Some fall short in terms of bit depths, color sampling, animation, and/or auxiliary data support. Many of them do not easily support recent needs in picture formats — for example the ability to represent non-destructive edits, or the handling of sets of images such as brackets and bursts, or panoramas or large tiled spaces.

We believe an extensible picture format based on the HEIF file format in conjunction with, at a minimum, HEVC and AVC solves all these limitations. This file format is a flexible base that enables many of the issues above to be addressed.

The industry needs a common format, embodied in a published standard, to address these needs and focus interoperability. A common format that shows state-of-the-art compression performance, is standardized, and fulfills these requirements and thereby accelerates adoption in software and hardware.

The Multi Image Application Format defines a consistent HEIF container experience across platforms including metadata and container behavior, and supporting developer guidance. The container experience ensures clarity around location and interpretation of the default image, multiple-image, animation, auxiliary images and other features commonly agreed upon as derived from the HEIF — ISO/IEC 23008-12 ‑ standard.

A set of requirements and best practices to ensure a consistent and interoperable developer story for implementing HEIF readers, writers and editors across the entire media ecosystem is part of the MIAF standard, as are constraints on the HEIF format and its default codecs’ profiles and level used to compress the elementary stream.

# Requirements

The Multi Image Application Format was written to support the following requirements:

* Offer state-of-the-art compression performance.
* Support lossy and lossless compression.
* Support bit depths higher than 8 bits.
* Support for color profiles (wide color gamut).
* Support 4:4:4 color sampling.
* Support representing and describing HDR content, including HDR metadata, transfer function and color space definitions.
* Support alpha channel coding (transparency).
* Support depth coding.
* Support animation (animated “GIF”, Live Photo).
* Support efficient compression for sequence of images such as photo burst
* Support handling basic multiple-image and multiple-bitstream scenarios (e.g. multi-exposure, stereo images)
* Support multiple representations of the same image (e.g. multi-resolution including progressively increasing levels of detail, multi-format)
* Support signaling the playback intent for animations and multiple images.
* Support partitioning the main image into rectangular tiles (for random access of big images such as panoramas; to exploit parallelism on multicore architecture; to simplify the operation of a file player when decoding a partial image).
* Offer efficient compression of graphics (logos, gradients) and text.
* Support rich metadata information for each image.
* Support AVC and HEVC, and JPEG XR when feasible, as the underlying default codecs to compress the elementary bitstream data.
* Support an extensibility mechanism to add additional codecs by MPEG and by other consortia.
* Be friendly to HW accelerated encode / decode on modern CPU/DSP (by limiting profiles, levels and codec features).
* Provide a specific extension / mime type that uniquely identifies LIAF profiles.

1. Each Multi Image Application Format profile shall define:
   1. MIAF profile identifier(s) for the conformance points supported by a presentation or device.
   2. A codec and constraints on its profile, level, and/or supported features.
   3. A set of constraints for the HEIF ISOBMFF files.

# Image compression use cases

MIAF was designed to address the following use-cases:

* Hundreds of millions of images are captured, created, uploaded, and shared daily. There is a need to improve on the storage space of these assets, both on device and in the cloud.
* Images comprise a significant portion of web and internet content. Shrinking the size of the image content will help web developers create smaller images that will reduce load time and bandwidth consumption.
* There is a growing tendency towards higher-resolution images. These images should be compressed with state-of-the-art compression algorithm in order to not incur in extra storage space.
* Higher bit depth and wide color gamut is the new frontier for images captured on consumer devices. The common format should support these new use cases.
* Images are often encoded and decoded on low-powered devices. There is a need to adopt HW accelerated blocks for speed, power and memory consumption. AVC (and recently HEVC) have wide support on several hardware platforms, and JPEG XR has sufficiently low complexity to enable fast, low-power implementation even where hardware support is not available.
* In addition to the above, low-powered devices need to leverage techniques that minimize the amount of decode work needed to view an image, including decoding only a region of interest or resolution/scale factor.
* Alpha decoding and compositing are paramount for web applications and UI elements using images.
* New auxiliary images (ex. depth) need to have a commonly defined place in image files. New editing tools will be able to utilize auxiliary data for several new presentation and editing experiences.
* In recent years new ways to present and display animated images have been developed. Live Photo is one example. Live Photo embeds animated content together with static images. The new common format needs to store animated information efficiently (using temporal compression) and be able to instruct players about the presentation intent.
* Professional applications need image content stored with high fidelity. For these scenarios, 4:4:4 color sampling and lossless compression are indispensable to avoid color distortions or compression artifacts.

Other formats have emerged over the last decade but lack wide adoption. MIAF as a common interoperability point based on the HEIF standard is the answer for all these use cases.

# Scope

The Multi-Image Application Format (MIAF) contains coded images, groups and sequences of images along with their metadata and the information about their relations to each other, all embedded in the High Efficiency Image File (HEIF) format.

MIAF builds on the HEIF specification and defines the following:

* a set of additional constraints on ISO/IEC 23008-12 (HEIF) specification, to simplify its file format options;
* specific alpha plane formats;
* a set of specific profiles and levels for the supported coding formats;
* a set of specific metadata formats;
* a set of brands, including application brands indicating conformance with specific profiles;
* a set of rules for extending MIAF format to support additional coding formats, profiles, levels and metadata.

The MIAF specification is intentionally written to be extensible, and to allow for forward compatibility. The format is also permissive of the presence of other data, such as coding formats, metadata, and derived images.

# MIAF Media Objects and profiles

The Multi-Image Application Format (MIAF) enables precise interoperability points for creation, reading, parsing and decoding of images embedded in the High Efficiency Image File (HEIF) format. The MIAF specification fully conforms to the HEIF format and only defines additional constraints to ensure higher interoperability.

The HEIF specification (ISO/IEC 23008-12) defines a file format for the inclusion of one or more images, possibly with one or more sequences of images, with associated metadata and their relationship to each other. While the HEIF specification defines the file format and general requirements for the included coding formats, it does not define specific interoperability points by which capturing devices, editing applications, storage systems, cloud and delivery networks, and playback devices and applications can interoperate with each other.

The MIAF specification, by defining specific constraints on the HEIF format, limiting the supported encoding types to a set of specific profiles and levels, requiring specific metadata formats, and defining a set of brands for signalling such constraints, defines precise interoperability points which enable the industry to deploy particular uses of the HEIF specification to improve interoperability.

It defines the normative requirements for MIAF files as well as for MIAF readers and renderers. The main items defined in MIAF include:

**MIAF application brand** brand indicating that a *MIAF file* conforms to a specific *MIAF profile* and that *MIAF readers* and *MIAF renderers* that only implement the features required by that MIAF profile can process the MIAF file

**MIAF file** containing one or more image and/or image sequence and/or video tracks.

**MIAF master image item** is an image item that may be rendered.

**MIAF auxiliary image item** is an image item that provides auxiliary visual information but is not normally independently rendered.

**MIAF thumbnail image item** is an image item that is referenced using the thumbnail reference type.

**MIAF image item** is an *MIAF master image item*, *MIAF auxiliary image item* or *MIAF thumbnail image item*

**MIAF reader** is an entity that reads and parses *MIAF files*, identifies the type of image coding and metadata, and decodes the coded streams for the coding types/profiles/levels that it supports.

**MIAF player** is an entity including a *MIAF reader* and a *MIAF renderer*.

**MIAF renderer** is an entity that renders the output of *MIAF reader* into a *visual context*, taking into account associated metadata (e.g. colour information) and auxiliary image data (e.g. alpha planes).

**MIAF Profile** is a set of restrictions on a *MIAF file*. These are typically restrictions on the media coding format/profile/level, content protection scheme, or on quantitative measures. MIAF profiles enable interoperability between MIAF files and MIAF readers.

A MIAF file may conform to multiple MIAF profiles. A MIAF reader or MIAF renderer may be capable of processing one or more MIAF profiles.

The main profiles that are currently defined in the MIAF specification include **MIAF HEVC Baseline profile**, **MIAF HEVC Advanced profile**, **MIAF HEVC Extended profile**, and **MIAF AVC Basic profile, MIAF HEVC Advanced HDR profile, MIAF HEVC Extended HDR profile, MIAF HEVC Advanced High profile** and **MIAF HEVC Extended High profile**.

External organizations may define additional MIAF based profiles to achieve interoperability in their target environments, e.g. by specifying coding formats/profiles/levels conforming to the general MIAF format. However, conformance with the mandatory provisions of the MIAF specification is required for any format that claims to be a MIAF format.