International Standard

ISO/IEC 23001-19

Information technology — MPEG systems technologies —

Part 19: Carriage of green metadata

First edition
2026-08

Reference number
ISO/IEC 23001-19:2026(en)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword ... **iv**
Introduction ... **v**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms, definitions and abbreviated terms ... **1**
3.1 Terms and definitions ... 1
3.2 Abbreviated terms ... 2
4 Overview ... **2**
4.1 Overall architecture for carriage of green metadata ... 2
4.2 Referenceable code points ... 3
4.2.1 Uniform resource names ... 3
4.2.2 Restricted scheme types ... 3
4.2.3 Sample entry types ... 3
4.2.4 Track reference types ... 3
4.2.5 Box types ... 3
5 Carriage of green metadata in ISO Base Media File Format ... **4**
5.1 General ... 4
5.2 Decoder-power indication metadata ... 4
5.2.1 Definition ... 4
5.2.2 Syntax ... 4
5.2.3 Semantics ... 5
5.3 Display-power reduction metadata ... 5
5.3.1 General ... 5
5.3.2 Display power indication metadata ... 5
5.3.3 Display fine control metadata ... 6
5.3.4 Display attenuation map metadata ... 7
6 Encapsulation and signalling in MPEG-DASH ... **12**
6.1 General ... 12
6.2 Decoder-power indication ... 12
6.3 Display-power indication ... 13
6.4 Display attenuation map information ... 14
6.4.1 Metadata signalling in the MPD manifest file ... 14
6.4.2 Descriptors ... 15
7 Conformance and reference software ... **19**
Annex A (normative) **Green metadata MPEG-DASH schema** ... **20**
Annex B (informative) **MPEG-DASH MPD examples** ... **22**
Annex C (informative) **Conformance and reference software** ... **32**
Annex D (informative) **Generation and use of green metadata** ... **34**
Bibliography ... **41**

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 https://www.iso.org/directives or https://www.iec.ch/members_experts/refdocs).

ISO and IEC draw attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO and IEC take no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO and IEC had received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://www.iso.org/patents and https://patents.iec.ch. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

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 https://www.iso.org/iso/foreword.html. In the IEC, see https://www.iec.ch/understanding-standards.

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

A list of all parts in the ISO 23001 series can be found on the ISO and IEC websites.

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 https://www.iso.org/members.html and https://www.iec.ch/national-committees.

Introduction

Green metadata is used for representing information that will help to reduce the energy consumption in the video distribution chain, towards a more sustainable industry.

This document addresses technologies defining the carriage of green metadata for storage and delivery purposes. This document includes (but is not limited to):

— Storage and carriage of green metadata using the ISO Base Media File Format (ISOBMFF) as specified in ISO/IEC 14496-12;

— Encapsulation, signalling, and streaming of green metadata data in a media streaming system, e.g., dynamic adaptive streaming over HTTP (DASH) as specified in ISO/IEC 23009-1.

Information technology — MPEG systems technologies —

Part 19:
Carriage of green metadata

1 Scope

This document defines a storage and delivery format for metadata for energy-efficient decoding, encoding, presentation, and selection of media (green metadata) as defined in ISO/IEC 23001-11. The green metadata are timed metadata which can be associated with other tracks in the ISO Base Media File Format. Timed metadata such as power consumption information and their metrics are defined in this document for carriage in files based on ISO/IEC 14496-12.

In the context of DASH delivery, the green metadata representations and their association to the media representations are also defined using the signalling mechanisms specified in ISO/IEC 23009-1:2022 and ISO/IEC 23009-3[1].

These metadata can be used for multiple purposes, including optimizing power consumption during playback and supporting dynamic adaptive streaming.

2 Normative references

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

ISO/IEC 14496-5, *Information technology — Coding of audio-visual objects — Part 5: Reference software*

ISO/IEC 14496-12, *Information technology — Coding of audio-visual objects — Part 12: ISO base media file format*

ISO/IEC 14496-15, *Information technology — Coding of audio-visual objects — Part 15: Carriage of network abstraction layer (NAL) unit structured video in the ISO base media file format*

ISO/IEC 23001-10:2020, *Information technology — MPEG systems technologies — Part 10: Carriage of timed metadata metrics of media in ISO base media file format*

ISO/IEC 23001-11:2023, *Information technology — MPEG systems technologies — Part 11: Energy-efficient media consumption (green metadata)*

ISO/IEC 23009-1:2022, *Information technology — Dynamic adaptive streaming over HTTP (DASH) — Part 1: Media presentation description and segment formats*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 23001-11 apply.

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

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

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

3.2 Abbreviated terms

DASH dynamic adaptive streaming over HTTP (specified in ISO/IEC 23009-1)

ISOBMFF ISO base media file format (specified in ISO/IEC 14496-12)

4 Overview

4.1 Overall architecture for carriage of green metadata

Figure 1 shows the functional architecture utilizing green metadata. The media pre-processor is applied to analyse and to filter the content source and a video encoder is used to encode the content to a bitstream for delivery. The bitstream is delivered to the receiver and decoded by a video decoder with the output rendered on a presentation subsystem that implements a display process.

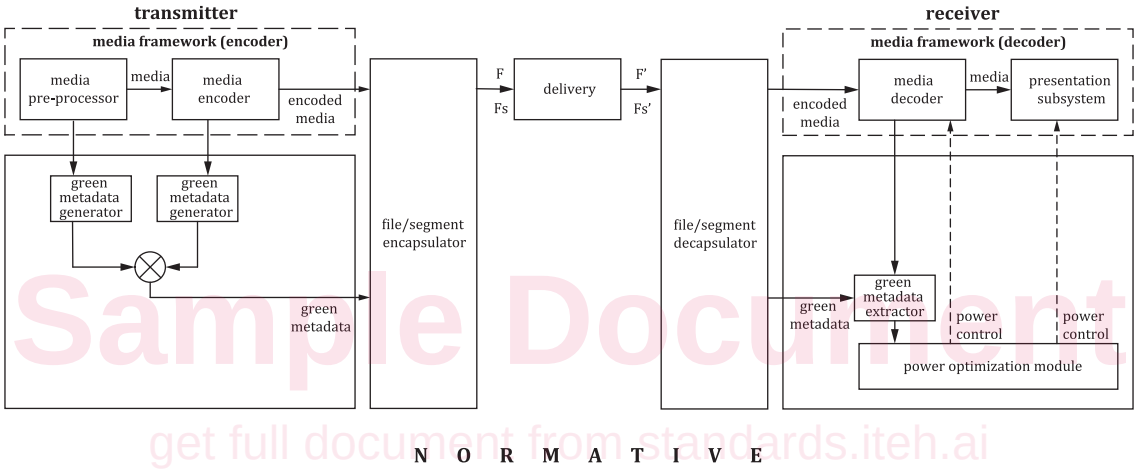

Figure 1 — Functional architecture

The green metadata is extracted from either the media encoder or the media pre-processor. In both cases, the green metadata is multiplexed or encapsulated in the conformant bitstream. Such green metadata is used at the receiver to reduce the power consumption for video decoding and presentation.

The bitstream is packaged into a file (F) or a sequence of an initialization segment and media segments for streaming (Fs), according to a particular media container file format. In this document, the media container file format is the ISO Base Media File Format specified in ISO/IEC 14496-12. The file encapsulator may also include metadata into the file or the segments. Both are delivered using a delivery mechanism to the receiver, for decoding and presentation.

A file decapsulator processes the received file (F') or the received segments (Fs') and extracts the green metadata sample description boxes and coded bitstreams and parses the metadata. The file (F) or segments (Fs) that the file encapsulator outputs are identical to the file (F') or segments (Fs') that the file decapsulator takes as input. At the receiver, the metadata extractor sends the extracted green metadata to a power optimization module for efficient power control. For instance, the power optimization module interprets the green metadata and then applies appropriate operations to reduce the video decoder's power consumption when decoding the video and to reduce the presentation subsystem's power consumption when rendering the video.

The following interfaces are normatively specified in this document:

— F/F': media file including the specification of the track formats, which may contain constraints on the elementary streams contained within the samples of the tracks; see Clause 5 for timed metadata.

— Clause 6 specifies the delivery related interfaces for DASH delivery.

See Annex D for more information on the generation and use of the green metadata.

4.2 Referenceable code points

4.2.1 Uniform resource names

The URNs specified in this document are listed in Table 1.

Table 1 — URNs specified in this document

URN	Clause	Informative description
urn:mpeg:mpegI:green:2025	6.4.2	Namespace for the XML elements and attributes specified in this document
urn:mpeg:mpegI:green:2025:ami	6.4.2	Scheme identifier for the display attenuation map DASH MPD descriptor
urn:mpeg:mpegI:green:2025:role	6.4.1	Scheme identifier for a DASH MPD role descriptor for green metadata.

4.2.2 Restricted scheme types

The restricted scheme types specified in this document are listed in Table 2.

Table 2 — Restricted scheme types specified in this document.

Restricted scheme type	Clause	Informative description
gmat	5.3.3.2	Restricted scheme type for a display attenuation map track

4.2.3 Sample entry types

The sample entry types specified in this document are listed in Table 3.

Table 3 — Sample entry types specified in this document.

Sample entry type	Clause	Informative description
depi	5.2.1	Sample entry for a track carrying Decoder-Power Indication metadata
dipi	5.3.2.1	Sample entry for a track carrying Display-Power Indication metadata
dfce	5.3.2.1	Sample entry for a track carrying Display Fine Control metadata

4.2.4 Track reference types

The track reference types specified in this document are listed in Table 4.

Table 4 — Track reference types specified in this document.

Track reference type	Clause	Informative description
gmam	5.3.4.2.1	Referenced track is a video track to which the display attenuation map applies.

4.2.5 Box types

The box types specified in this document are listed in Table 5. In the table, the box types specified in ISO/IEC 23001-19 are in black text with links to the corresponding clauses in the specification. Related container boxes specified in ISOBMFF are marked in grey. Non-related ISOBMFF boxes are not included in

the table. Mandatory boxes are, as in ISOBMFF, marked with an asterisk. Box types without a four character code are marked with '-' in the structure.

Table 5 — Box types specified in this document.

Box types, structure, and cross-reference (Informative)												
moov										*	ISOBMFF	*container for all the metadata*
	trak									*	ISOBMFF	*container for an individual track or stream*
		mdia								*	ISOBMFF	*container for the media information in a track*
			minf							*	ISOBMFF	*media information container*
				stbl						*	ISOBMFF	*sample table box, container for the time/space map*
					stsd					*	ISOBMFF	*sample descriptions (codec types, initialization etc.)*
						-					ISOBMFF	*sample entry or restricted sample entry*
							rinf				ISOBMFF	*restricted scheme info box*
								frma			ISOBMFF	*original format box*
								schm			ISOBMFF	*scheme type box*
								schi			ISOBMFF	*scheme information box*
									amid		5.3.3.1	*attenuation map information box*
						depi					5.2.1	*decoder power indication metadata sample entry*
						dipi					5.3.1	*display power indication metadata sample entry*
						dfce					5.3.2.1	*display fine control metadata sample entry*
							dfcC				5.3.2.1	*display fine control configuration box*

5 Carriage of green metadata in ISO Base Media File Format

5.1 General

If green metadata is carried in an ISO Base Media File Format, it shall be carried in the metadata tracks within the ISO Base Media File Format. Different green metadata types and corresponding storage formats are identified by their unique sample entry codes.

A metadata track carrying green metadata is linked to the track it describes by means of a 'cdsc' (content describes) track reference.

5.2 Decoder-power indication metadata

5.2.1 Definition

Sample Entry Type: 'depi'

Container: Sample Description Box ('stsd')

Mandatory: No

Quantity: 0 or 1

The Decoder-Power Indication metadata is defined in ISO/IEC 23001-11. It provides decoder complexity reduction ratios for the media track to which the metadata track refers by means of 'cdsc' reference.

5.2.2 Syntax

The Decoder-Power Indication metadata uses the following entry:

```
class DecoderPowerIndicationMetaDataSampleEntry()
   extends MetaDataSampleEntry ('depi') {
```

```
}
```

The Decoder-Power Indication metadata samples use the following syntax:

```
aligned(8) class DecoderPowerIndicationMetaDataSample(){
   unsigned int(8) dec_ops_reduction_ratio_from_max;
   signed int(16)  dec_ops_reduction_ratio_from_prev;
}
```

5.2.3 Semantics

Semantics are defined in ISO/IEC 23001-11.

5.3 Display-power reduction metadata

5.3.1 General

The Display-Power Reduction metadata is defined in ISO/IEC 23001-11. Display-Power Reduction metadata provides frame statistics and quality indicators for the media track that the metadata track refers to by means of ‘cdsc’ reference. These metadata allow the client to attain a specified quality level by scaling frame-buffer pixels and to reduce power correspondingly by decreasing the display backlight or OLED voltage.

Display-Power Reduction metadata is of three types:

1. metadata that indicates power saving at different quality levels over the sample duration. This metadata shall use the 'dipi' (Display Power Indication) sample entry type.
2. metadata that allows fine control of the display to achieve power reduction at a specified quality level. This metadata shall use the ’dfce’ (Display Fine Control) sample entry type.
3. metadata that conveys pixel-wise information that can be applied to frames in the original video sequence to reduce the total energy consumption resulting from rendering the frames of that video. This metadata shall use the ‘amid’ (Display Attenuation Map) sample entry type.

Static metadata for the display fine control is stored in the sample entry. Dynamic metadata is stored in the samples.

5.3.2 Display power indication metadata

5.3.2.1 Definition

Sample Entry Type: ‘dipi’

Container: Sample Description Box (‘stsd’)

Mandatory: No

Quantity: 0 or 1

This metadata indicates potential power savings at different quality levels over the sample duration.

5.3.2.2 Syntax

The Display Power Indication metadata uses the following sample entry:

```
aligned(8) class DisplayPowerIndicationMetaDataSampleEntry() extends
MetaDataSampleEntry (‘dipi‘) {
}
```

The Display Power Indication metadata samples use the following syntax:

```
class QualityLevels (num_quality_levels) {
   unsigned int(8) rgb_component_for_infinite_psnr;
   for (i = 1; i <= num_quality_levels; i++) {
      unsigned int(8) max_rgb_component;
      unsigned int(8) scaled_psnr_rgb;
   }
}

aligned class DisplayPowerIndicationMetaDataSample () {
   unsigned int(4) num_quality_levels;
   unsigned int(4) reserved=0;}
   QualityLevels(num_quality_levels)
}
```

The PSNR variables appearing in the syntax presented above are as defined in ISO/IEC 23001-11 and should not be confused with the PSNR metric defined in ISO/IEC 23001-10:2020, 4.2.

5.3.2.3 Semantics

Semantics are defined in ISO/IEC 23001-11.

5.3.3 Display fine control metadata

5.3.3.1 Definition

Sample Entry Type: 'dfce'

Container: Sample Description Box ('stsd')

Mandatory: No

Quantity: 0 or 1

The dynamic Display Fine Control metadata is stored in the samples and is associated with one or more video frames.

The Decoding Time to Sample box provides the decoding time for the sample so that the metadata contained therein is made available to the display with sufficient lead time relative to the video composition time. The video composition time and metadata composition time are identical. The lead time is required because display settings have to be adjusted in advance of presentation time for correct operation. If `num_constant_backlight_voltage_time_intervals > 1`, then the lead time should be larger than the largest `constant_backlight_voltage_time_interval`.

5.3.3.2 Syntax

The Display Fine Control metadata uses the following sample entry:

```
class DisplayFineControlMetaDataSampleEntry()
   extends MetaDataSampleEntry ('dfce') {
    DisplayFineControlConfigurationBox();
}


aligned(8) class DisplayFineControlConfigurationBox
   extends FullBox('dfcC', version = 0, flags = 0) {
    unsigned int(2) num_constant_backlight_voltage_time_intervals;
    unsigned int(6) reserved = 0;
    unsigned int(16)constant_backlight_voltage_time_interval[
                     num_constant_backlight_voltage_time_intervals ];
    unsigned int(2) num_max_variations;
    unsigned int(6) reserved = 0;
```