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Part 14: Scene description

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Partie 14: Description de scènes

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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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*.

This second edition cancels and replaces the first edition (ISO/IEC 23090-14:2023), which has been technically revised. It also incorporates the Amendment ISO/IEC 23090-14/Amd 1:2023.

The main changes are as follows:

— addition of the support of MPEG-I immersive media codecs, AR anchoring, interactivity, avatar, lighting and MPEG-I haptics;

— various minor improvements and corrections.

A list of all parts in the ISO 23090 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 www.iso.org/members.html and www.iec.ch/national-committees.

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Introduction

This document defines the MPEG-I Scene Description. It provides an architecture for the MPEG-I Scene Description, a set of extensions based on ISO/IEC 12113, a set of APIs, and storage formats for scene description documents and scene description updates documents.

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Information technology — Coded representation of immersive media —

Part 14: Scene description

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This document specifies extensions to existing scene description formats in order to support MPEG media, in particular immersive media. MPEG media includes but is not limited to media encoded with MPEG codecs, media stored in MPEG containers, MPEG media and application formats as well as media provided through MPEG delivery mechanisms. Extensions include scene description format syntax and semantics and the processing model when using these extensions by a Presentation Engine. It also defines a media access function (MAF) API for communication between the Presentation Engine and the media access function for these extensions. While the extensions defined in this document can be applicable to other scene description formats, they are provided for ISO/IEC 12113.

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 12113, *Information technology — Runtime 3D asset delivery format — Khronos glTF™ 2.0*

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

ISO/IEC 21778, *Information technology — The JSON data interchange syntax*

IEEE 754-2019, *IEEE Standard for Floating-Point Arithmetic*

IETF RFC 6902, *JavaScript Object Notation (JSON) Patch*

IETF RFC 8259, *The JavaScript Object Notation (JSON) Data Interchange Format*

ISO/IEC 23090-5, *Information technology – Coded Representation of Immersive Media – Part 5: Visual Volumetric Video-based Coding (V3C) and Video-based Point Cloud Compression (V-PCC)*

ISO/IEC 23090-12, *Information technology — Coded representation of immersive media — Part 12: MPEG immersive video*

3 Terms, definitions, abbreviated terms, and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 12113 and the following apply.

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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/

3.1.1
asset
3D scene described by a *scene description document* (3.1.10) together with corresponding *scene description data* (3.1.9)

3.1.2
node
element in the *scene graph* (3.1.12)

3.1.3
media access function
function that retrieves and prepares media for rendering on request by the *presentation engine* (3.1.7)

3.1.4
media pipeline
chain of media processing components to process media

3.1.5
object
node in a *scene description document* (3.1.10)

3.1.6
patch document
document that contains update instructions

Note 1 to entry: For example, update instruction can be provided as defined in RFC 6902.

3.1.7
presentation engine
engine that processes and renders the *asset* (3.1.1)

3.1.8
scene activation time
time on the media timeline at which the scene described by a *scene description document* (3.1.10) takes effect in the *presentation engine* (3.1.7)

3.1.9
scene description data
binary data that is described by *scene description document* (3.1.10)

3.1.10
scene description document
document describing a 3D scene

Note 1 to entry: For example, scene description document is containing description of node hierarchy, materials, cameras, as well as description information for meshes, animations, and other constructs.

3.1.11
scene description update
patch document (3.1.6) to a *scene description document* (3.1.10) or a *scene description document* (3.1.10)

3.1.12
scene graph
data structure used to represent *objects* (3.1.5) in a 3D scene and their hierarchical relationships

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3.1.13
timed accessor
accessor defined in ISO/IEC 12113 that has an MPEG_accessor_timed extension and is used to describe access to timed data

3.1.14
timed data
timed media
media, which when decoded results in content, possibly containing internal timing values, to be presented at a given presentation time and for a certain duration

3.1.15
augmented reality AR
technique of composing a view from virtual objects and the user's real-world environment

3.1.16
trackable
real-world object that can be tracked by the XR runtime

Note 1 to entry: Each trackable provides a local reference space, also known as a trackable space, in which an anchor can be expressed.

3.1.17
AR anchor
virtual element for which its position, orientation, scale, and other properties are expressed in the trackable space defined by the trackable

Note 1 to entry: A virtual asset's position, orientation, scale and other properties are expressed in relation to an anchor.

3.1.18
avatar
virtual representation of a user

3.1.19
XR Space
Representation of a virtual coordinate system with an origin that corresponds to a physical location

3.2 Abbreviated terms

3D	three-dimensional
3DoF	three degrees of freedom
6DoF	six degrees of freedom
API	application programming interface
AR	augmented reality
DASH	dynamic adaptive streaming over http
dB	decibel
DSR	diffuse to source ratio
EOM	enhanced occupancy mode
ERP	equirectangular projection
glTF	graphics language transmission format

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HOA	higher order ambisonics
ISOBMFF	ISO base media file format
JSON	JavaScript object notation
MAF	media access function
MPEG	moving picture experts group
MIV	mpeg immersive video
IDL	interface definition language
PCM	pulse-code modulation
PLR	point local reconstruction
RT60	60 db reverberation time
SDP	session description protocol
TRS	translation, rotation and scale

3.3 Conventions

3.3.1 General

The mathematical operators used in this document are similar to those used in the C programming language. However, the results of integer division and arithmetic shift operations are defined more precisely, and additional operations are defined, such as exponentiation and real-valued division. Numbering and counting conventions generally begin from 0.

3.3.2 Arithmetic operators

+	addition
−	subtraction (as a two-argument operator) or negation (as a unary prefix operator)
*	multiplication, including matrix multiplication
/	integer division with truncation of the result toward zero. For example, 7 / 4 and −7 / −4 are truncated to 1 and −7 / 4 and 7 / −4 are truncated to −1.
÷	division in mathematical equations where no truncation or rounding is intended.

3.3.3 Logical operators

!	Boolean logical "not".

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3.3.4 Relational operators

> Greater than.

>= Greater than or equal to.

< Less than.

<= Less than or equal to.

== Equal to.

!= Not equal to.

3.3.5 Bit-wise operators

~ bit-wise "not".
When operating on integer arguments, operates on a two's complement representation of the integer value. When operating on a binary argument that contains fewer bits than another argument, the shorter argument is extended by adding more significant bits equal to 0.

& bit-wise "and".
When operating on integer arguments, operates on a two's complement representation of the integer value. When operating on a binary argument that contains fewer bits than another argument, the shorter argument is extended by adding more significant bits equal to 0.

| bit-wise "or".
When operating on integer arguments, operates on a two's complement representation of the integer value. When operating on a binary argument that contains fewer bits than another argument, the shorter argument is extended by adding more significant bits equal to 0.

^ bit-wise "exclusive or".
When operating on integer arguments, operates on a two's complement representation of the integer value. When operating on a binary argument that contains fewer bits than another argument, the shorter argument is extended by adding more significant bits equal to 0.

x >> y arithmetic right shift of a two's complement integer representation of x by y binary digits. This function is defined only for non-negative integer values of y. Bits shifted into the MSBs as a result of the right shift have a value equal to the MSB of x prior to the shift operation.

x << y arithmetic left shift of a two's complement integer representation of x by y binary digits. This function is defined only for non-negative integer values of y. Bits shifted into the LSBs as a result of the left shift have a value equal to 0.

3.3.6 Assignment operators

= assignment operator.

++ increment, i.e. x++ is equivalent to x = x + 1; when used in an array index, evaluates to the value of the variable prior to the increment operation.

-- decrement, i.e. x-- is equivalent to x = x − 1; when used in an array index, evaluates to the value of the variable prior to the decrement operation.

+= increment by amount specified, i.e. x += 3 is equivalent to x = x + 3, and x += (−3) is equivalent to x = x + (−3).

−= decrement by amount specified, i.e. x −= 3 is equivalent to x = x − 3, and x −= (−3) is equivalent to x = x − (−3).

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3.3.7 Other operators

y..z range operator/notation.
This function is defined only for integer values of y and z. When z is larger than or equal to y, it defines an ordered set of values from y to z in increments of 1. Otherwise, when z is smaller than y, the output of this function is an empty set. If this operator is used within the context of a loop, it specifies that any subsequent operations defined are performed using each element of this set, unless this set is empty.

3.3.8 Order of operation precedence

When order of precedence in an expression is not indicated explicitly by use of parentheses, the following rules apply:

— Operations of a higher precedence are evaluated before any operation of a lower precedence.

— Operations of the same precedence are evaluated sequentially from left to right.

Table 1 specifies the precedence of operations from highest to lowest; a higher position in the table indicates a higher precedence.

NOTE For those operators that are also used in the C programming language, the order of precedence used in this document is the same as used in the C programming language.

Table 1 — Operation precedence from highest (at top of table) to lowest (at bottom of table)

operations (with operands x, y, and z)
"x++", "x--"
"!x", "−x" (as a unary prefix operator)
"x * y", "x / y", "x ÷ y", "x % y"
"x + y", "x − y" (as a two-argument operator)
"x << y", "x >> y"
"x < y", "x <= y", "x > y", "x >= y"
"x == y", "x != y"
"x & y"
"x | y"
"x && y"
"x || y"
"x ? y : z"
"x..y"
"x = y", "x += y", "x −= y"

3.3.9 Text description of logical operations

In the text, a statement of logical operations as would be described mathematically in the following form:

```
if( condition 0 )
   statement 0
else if( condition 1 )
   statement 1
...
else /* informative remark on remaining condition */
   statement n
```

— may be described in the following manner:

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— ... as follows / ... the following applies:

— If condition 0, statement 0

— Otherwise, if condition 1, statement 1

— ...

— Otherwise (informative remark on remaining condition), statement n

Each "If ... Otherwise, if ... Otherwise, ..." statement in the text is introduced with "... as follows" or "... the following applies" immediately followed by "If ... ". The last condition of the "If ... Otherwise, if ... Otherwise, ..." is always an "Otherwise, ...". Interleaved "If ... Otherwise, if ... Otherwise, ..." statements can be identified by matching "... as follows" or "... the following applies" with the ending "Otherwise, ...".

In the text, a statement of logical operations as would be described mathematically in the following form:

```
if( condition 0a && condition 0b )
   statement 0
else if( condition 1a || condition 1b )
   statement 1
...
else
   statement n
```

— may be described in the following manner:

— ... as follows / ... the following applies:

— If all of the following conditions are true, statement 0:

  — condition 0a

  — condition 0b

— Otherwise, if one or more of the following conditions are true, statement 1:

  — condition 1a

  — condition 1b

— ...

— Otherwise, statement n

In the text, a statement of logical operations as would be described mathematically in the following form:

if(condition 0)

    statement 0

if(condition 1)

    statement 1

may be described in the following manner:

When condition 0, statement 0

When condition 1, statement 1

In addition, a “continue” statement, which is used within loops, is defined as follows:

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The “continue” statement, when encountered inside a loop, jumps to the beginning of the loop for the next iteration. This results in skipping the execution of subsequent statements inside the body of the loop for the current iteration. For example:

```
for( j =0; j < N; j++ ) {
  statement 0
  if( condition 1 )
      continue
  statement 1
  statement 2
}
```

is equivalent to the following:

```
for( j =0; j < N; j++ ) {
  statement 0
  if( !condition 1 ) {
     statement 1
     statement 2
  }
}
```

4 Overview and architecture

4.1 Overview

This document enables inclusion of timed media in a scene description. This is achieved through first defining features of a scene description that describe how to get the timed media, and second how a rendering process expects the data once it is decoded. In this version of the document, the features are defined as extensions to the glTF format defined in ISO/IEC 12113, see Clause 5.

In addition to the extensions, which provide an integration of timed media with the scene description, the document describes a reference scene description architecture that includes components such as media access function, Presentation Engine, Buffer Control & Management, and Pipelines. To enable cross-platform/cross-vendor interoperability, the document defines media access function (MAF) API and Buffer API, see Clause 6. The MAF API provides an interface between the media access function and the Presentation Engine. The Buffer API is used to allocate and control buffers for the exchange of data between media access function and Presentation Engine.

Not only the timed media described by the scene description may change over the time but also the scene description itself. The document defines how such change of a scene description document is signalled to the Presentation Engine.

Finally, a scene description may be stored, delivered, or extended in a way that is consistent with MPEG formats. The document defines a number of new features that allow a carriage utilizing ISO/IEC 14496-12 and its derived specifications, see Clause 7.

The Annex A provides JSON schemas for the defined extensions to the glTF format.

The support for MPEG-I Media shall be carried out as specified in Annex G.

4.2 Architecture

The scene description is consumed by a Presentation Engine to render a 3D scene to the viewer. The extensions defined in this document, allow for the creation of immersive experiences using timed media. The scene description extensions are designed with the goal of decoupling the Presentation Engine from the media access function. Presentation Engine and media access function communicate through the media access function API, which allows the Presentation Engine to request timed media required for the rendering of the scene. The media access function will retrieve the requested timed media and make it available in a timely manner and in a format that can be immediately processed by the Presentation Engine. For instance,

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