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| *Title:* | **Shutter interval info SEI message in AVC** | | |
| *Status:* | Input document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution proposes that shutter interval information SEI message be adopted in the next version of AVC. Shutter interval information SEI message was previously adopted in HEVC draft [1]. Adopting the SEI message in AVC would facilitate signalling shutter interval information in applications such as frame rate conversion [2], motion analysis, transcoding between AVC and HEVC, and others.

# Introduction

Shutter interval is the amount of time that an image sensor is exposed to produce each source picture. The proposed shutter interval information (SII) SEI message indicates the shutter interval for the associated video source pictures prior to encoding and display, e.g., for camera-captured content.

# Design philosophy

The syntax and semantics proposed below for the SII SEI message for AVC are based on the corresponding SII SEI message for HEVC adapted to AVC. Modifications to the HEVC SII SEI message syntax and semantics are highlighted in yellow. Semantics referring to HEVC SPS and HEVC layers have been deleted. A note referring to ATSC 3.0 has been deleted as it applies only to HEVC.

It is proposed that if an SII SEI message exists for any picture in a CVS it must exist in the first access unit of the CVS.

Unlike HEVC, temporal index (which is used to identify sub-layer index) does not exist in an AVC single layer bitstream. To address this issue when the shutter interval is not fixed within a CVS, it is proposed that a shutter interval information SEI message shall be present for every picture to assign a value for sii\_sub\_layer\_idx to each picture to identify the sub-layer index of the current picture. Other shutter interval related information shall be presented only for the first access unit of the CVS and persist until a new CVS begins or the bitstream ends.

Example syntax element values for the case in which shutter interval is fixed for the CVS is shown in Table A. Example syntax element values for the first and subsequent shutter interval information SEI message for the case in which shutter interval may be different for different sub layers is shown in Table B. In Table A and B, cells that are highlighted in gray indicate that no value is signalled in the shutter interval information SEI message for the corresponding syntax element.

Table A Example of shutter interval information SEI message syntax element values for fixed shutter interval (IDR access unit only)

|  |  |
| --- | --- |
| **syntax element** | **1st shutter interval info SEI message in the CVS** |
| sii\_sub\_layer\_idx | 0 |
| shutter\_interval\_info\_present\_flag | 1 |
| sii\_time\_scale | u(32) |
| fixed\_shutter\_interval\_within\_cvs\_flag | 1 |
| sii\_num\_units\_in\_shutter\_interval | u(32) |
| sii\_max\_sub\_layers\_minus1 |  |
| sub\_layer\_num\_units\_in\_shutter\_interval[ i ] |  |

Table B Example of shutter interval information SEI message syntax element values for non-fixed shutter interval (IDR access unit and non-IDR access units)

|  |  |  |  |
| --- | --- | --- | --- |
| **syntax element** | **1st shutter interval info SEI message in the CVS** | **Subsequent shutter interval info SEI messages in the CVS** | |
| sii\_sub\_layer\_idx | 0 | 0 | ue(v) > 0 |
| shutter\_interval\_info\_present\_flag | 1 | 0 |  |
| sii\_time\_scale | u(32) |  |  |
| fixed\_shutter\_interval\_within\_cvs\_flag | 0 |  |  |
| sii\_num\_units\_in\_shutter\_interval |  |  |  |
| sii\_max\_sub\_layers\_minus1 | u(3) |  |  |
| sub\_layer\_num\_units\_in\_shutter\_interval[ i ] | u(32) |  |  |

# Syntax and semantics

## Proposed shutter interval information SEI message syntax

Table 1 Shutter interval information SEI message syntax

|  |  |  |
| --- | --- | --- |
| shutter\_interval\_info( payloadSize ) { | **C** | **Descriptor** |
| **sii\_sub\_layer\_idx** | 5 | ue(v) |
| if( sii\_sub\_layer\_idx = = 0 ) |  |  |
| **shutter\_interval\_info\_present\_flag** | 5 | u(1) |
| if( shutter\_interval\_info\_present\_flag ) |  |  |
| **sii\_time\_scale** | 5 | u(32) |
| **fixed\_shutter\_interval\_within\_cvs\_flag** | 5 | u(1) |
| if( fixed\_shutter\_interval\_within\_cvs\_flag ) |  |  |
| **sii\_num\_units\_in\_shutter\_interval** | 5 | u(32) |
| else { |  |  |
| **sii\_max\_sub\_layers\_minus1** | 5 | u(3) |
| for( i = 0; i <= sii\_max\_sub\_layers\_minus1; i++ ) |  |  |
| **sub\_layer\_num\_units\_in\_shutter\_interval**[ i ] | 5 | u(32) |
| } |  |  |
| } |  |  |
| } |  |  |
| } |  |  |

## Proposed shutter interval information SEI message syntax

The shutter interval information SEI message indicates the shutter interval for the associated video source pictures prior to encoding and display, e.g., for camera-captured content, the shutter interval is amount of time that an image sensor is exposed to produce each source picture.

**sii\_sub\_layer\_idx** specifies the shutter interval temporal sub-layer index of the current picture. The value of sii\_sub\_layer\_idx shall be equal to 0 when the current access unit is the first access unit of the CVS. When fixed\_shutter\_interval\_within\_cvs\_flag is equal to 1, the value of sii\_sub\_layer\_idx shall be equal to 0. Otherwise, fixed\_shutter\_interval\_within\_cvs\_flag is equal to 0, the value of sii\_sub\_layer\_idx shall be less than or equal to the value of sii\_max\_sub\_layers\_minus1.

**shutter\_interval\_info\_present\_flag** equal to 1 indicates that the syntax elements sii\_time\_scale, fixed\_shutter\_interval\_within\_cvs\_flag, and either sii\_num\_units\_in\_shutter\_interval or sii\_max\_sub\_layers\_minus1 and sub\_layer\_num\_units\_in\_shutter\_interval[ i ] are present. shutter\_interval\_info\_present\_flag equal to 0 indicates that the syntax elements sii\_time\_scale, fixed\_shutter\_interval\_within\_cvs\_flag, sii\_num\_units\_in\_shutter\_interval, sii\_max\_sub\_layers\_minus1, and sub\_layer\_num\_units\_in\_shutter\_interval[ i ] are not present. The value of shutter\_interval\_info\_present\_flag shall be equal to 1 when the current access unit is the first access unit of the CVS. Otherwise, the current access unit is not the first access unit of the CVS, the value of shutter\_interval\_info\_present\_flag shall be equal to 0.

**sii\_time\_scale** specifies the number of time units that pass in one second. The value of sii\_time\_scale shall be greater than 0. For example, a time coordinate system that measures time using a 27 MHz clock has an sii\_time\_scale of 27 000 000.

**fixed\_shutter\_interval\_within\_cvs\_flag** equal to 1 specifies that the indicated shutter interval is the same for all pictures in the CVS. fixed\_shutter\_interval\_within\_cvs\_flagequal to 0 specifies that the indicated shutter interval may not be the same for all pictures in the CVS.

**sii\_num\_units\_in\_shutter\_interval**, when fixed\_shutter\_interval\_within\_cvs\_flag is equal to 1, specifies the number of time units of a clock operating at the frequency sii\_time\_scale Hz that corresponds to the indicated shutter interval of each picture in the CVS. The value 0 may be used to indicate that the associated video content contains screen capture content, computer generated content, or other non-camera-captured content.

The indicated shutter interval, denoted by the variable shutterInterval, in units of seconds, is equal to the quotient of sii\_num\_units\_in\_shutter\_interval divided by sii\_time\_scale. For example, to represent a shutter interval equal to 0.04 seconds, sii\_time\_scale may be equal to 27 000 000 and sii\_num\_units\_in\_shutter\_interval may be equal to 1 080 000.

**sii\_max\_sub\_layers\_minus1** plus 1 specifies the maximum number of shutter interval temporal sub-layers indexes that may be present in the CVS.

**sub\_layer\_num\_units\_in\_shutter\_interval**[ i ], when present, specifies the number of time units of a clock operating at the frequency sii\_time\_scale Hz that corresponds to the shutter interval of each picture in the CVS for which the value of sii\_sub\_layer\_idx is equal to i. The sub-layer shutter interval for each picture for which the value of sii\_sub\_layer\_idx is equal to i, denoted by the variable subLayerShutterInterval[ i ], in units of seconds, is equal to the quotient of sub\_layer\_num\_units\_in\_shutter\_interval[ i ] divided by sii\_time\_scale.

The variable subLayerShutterInterval[ i ], corresponding to the indicated shutter interval of each picture in the sub-layer representation with TemporalId equal to i in the CVS, is thus derived as follows:

if( fixed\_shutter\_interval\_within\_cvs\_flag )  
 subLayerShutterInterval[ i ] = sii\_num\_units\_in\_shutter\_interval ÷ sii\_time\_scale (D.X)  
else  
 subLayerShutterInterval[ i ] = sub\_layer\_num\_units\_in\_shutter\_interval[ i ] ÷ sii\_time\_scale

When a shutter interval information SEI message is present for any access unit in a CVS, a shutter interval information SEI message shall be present for the IDR access unit that is the first access unit of the CVS. All shutter interval information SEI messages that apply to the same access unit shall have the same content.

sii\_time\_scale and fixed\_shutter\_interval\_within\_cvs\_flag persist from the first access unit of the CVS until a new CVS begins or the bitstream ends.

When the value of fixed\_shutter\_interval\_within\_cvs\_flag is equal to 0, a shutter interval information SEI message shall be present for every picture in the CVS. When present, sii\_num\_units\_in\_shutter\_interval, sii\_max\_sub\_layers\_minus1, and sub\_layer\_num\_units\_in\_shutter\_interval[ i ], persist from the first access unit of the CVS until a new CVS begins or the bitstream ends.

# References

1. S. T. McCarthy, G. J. Sullivan, Y.-K. Wang, “Shutter interval information SEI message for HEVC (Draft 2)”, JCTVC-AL1005-v1, Brussels, BE, January, 2020
2. A. Mackin, A. Zhang, and D. Bull, ‘A Frame Rate Conversion Method Based on a Virtual Shutter Angle’ in: IEEE International Conference on Image Processing (ICIP), 2019.

# Patent rights declaration

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