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| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  39th Meeting: by teleconference, 18–24 April 2020 | Document: JCTVC-AM0024-v1 |

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| *Title:* | **Illustration of the shutter interval info SEI message in HEVC Draft** | | |
| *Status:* | Input document to JCT-VC | | |
| *Purpose:* | Information | | |
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# Abstract

This contribution describes a software implementation (SII-Processing) that illustrates the use of the shutter interval information SEI message in HEVC draft [1]. Specifically, the software illustrates the example of encoding and decoding content in a manner consistent with ATSC 3.0 Annex D [2] and signalling the corresponding shutter interval values with the shutter interval information SEI message.

# Introduction

Shutter interval is the amount of time that an image sensor is exposed to produce each source picture. The shutter interval SEI message is adopted in HEVC Draft 2 [1]. 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 syntax of the SEI message is shown in Table 1.

Table 1 Shutter interval information SEI message syntax

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

The shutter interval information SEI message may be used in any application in which shutter interval information would be useful. In this contribution, we provide software for a particular use of the SEI message as a way of illustrating how it may be used and to provide a basis for experimentation. Specifically, the software illustrates the example of encoding and decoding content in a manner consistent with ATSC 3.0 Annex D and signalling the corresponding shutter interval values.

# Illustration of SII SEI message based on ATSC 3.0 Annex D

## Encoder and decoder workflows

The software provided is based on the latest version of HEVC reference software HM (SHA: 09edbed227b910ee59e4e2afd9bae6d996a271b7) after the shutter interval information SEI messages is merged.

The encoding workflow is illustrated in Figure 1. A source high-frame rate (HFR) content is processed to create modified HFR content (PreProcessed HFR) in which every other frame is an average of the current and previous pictures. Temporal averaging approximates a longer shutter interval, particularly when source shutter interval is equal to picture duration. Temporal averaging is intended to reduced judder when only the blended pictures are viewed (PreProcessed LFR).

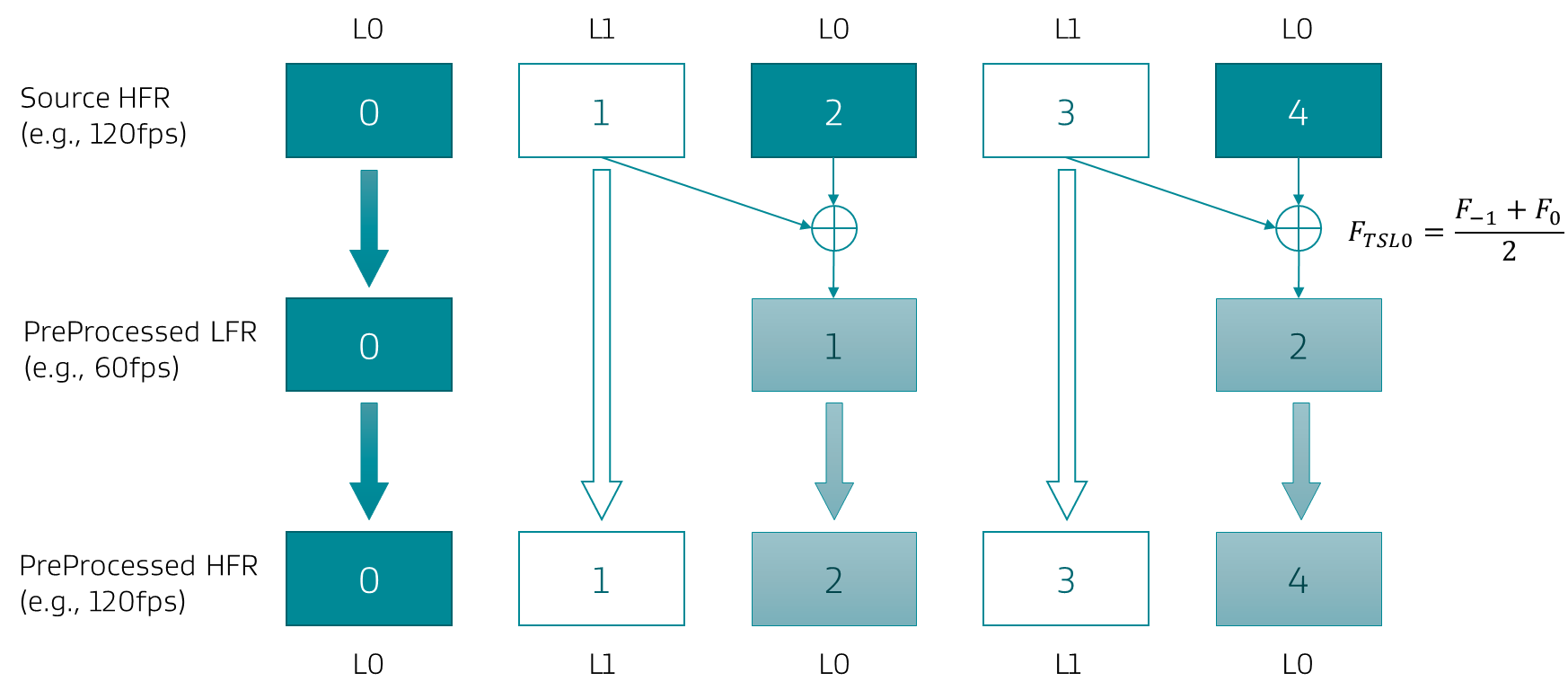


Figure encoding workflow

The decoding workflow is illustrated in Figure 2. Decoded low-frame rate (Decoded LFR) content may be extracted from the decoded bitstream for the PreProcessed HFR content (Decoded HFR). Additionally, an approximation of the source HFR content (PostProcessed HFR) may be obtained from the decoded PreProcessed HFR bitstream by reversing the averaging operations performed in the encoder.

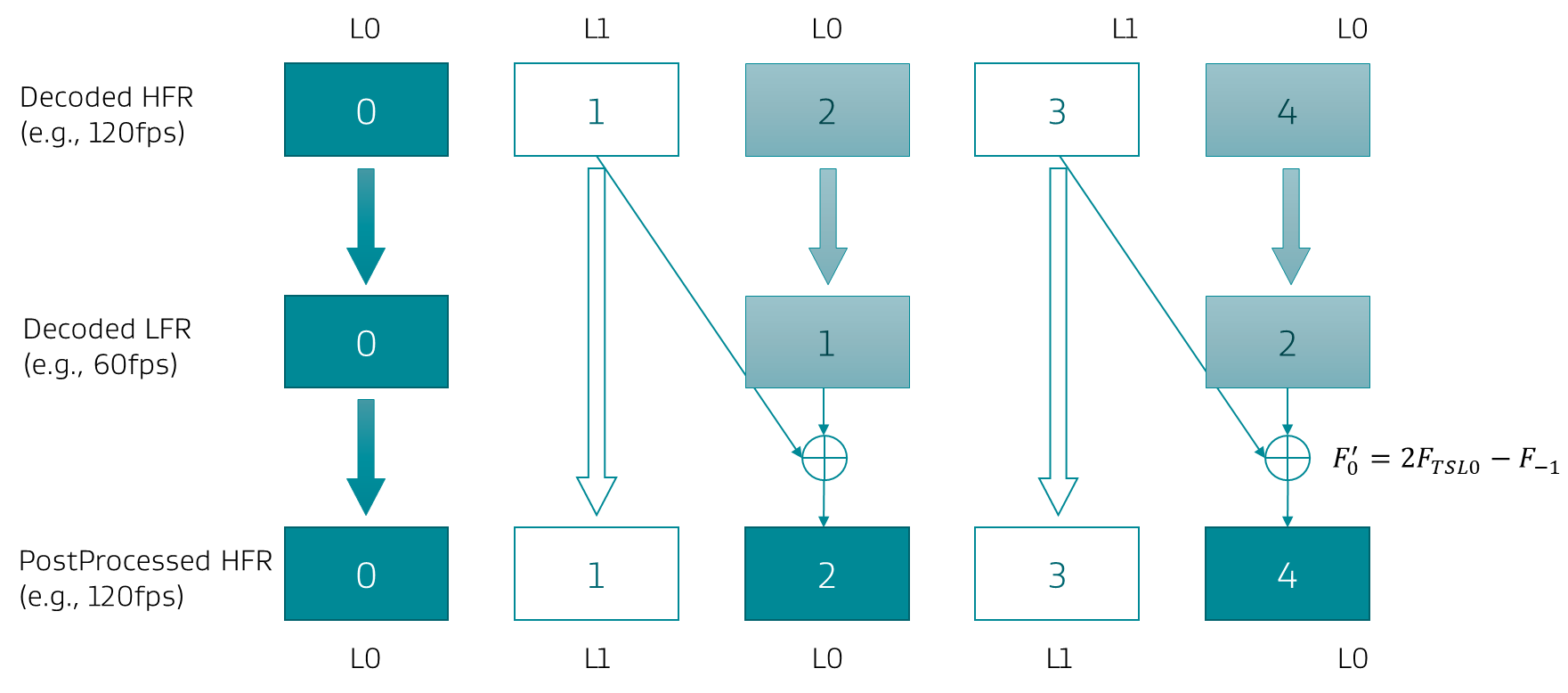


Figure decoding workflow

## Syntax settings

For the ATSC 3.0 Annex D example., in the case in which the source shutter interval is equal to the picture interval, expressed as the reciprocal of picture rate, the value of sii\_num\_units\_in\_shutter\_interval for the source (HFR) content is determined as follows:

sii\_num\_units\_in\_shutter\_interval = sii\_time\_scale / picture rate

The corresponding value of sii\_num\_units\_in\_shutter\_interval for the LFR version of the content is determined as follows:

sii\_num\_units\_in\_shutter\_interval = 2 \* sii\_time\_scale / picture rate

Setting sii\_time\_scale = 24000000, example values of sii\_num\_units\_in\_shutter\_interval are tabulated for HFR and LFR in Table 2.

To support this example application, the syntax values are set as follows:

* sii\_time\_scale = 24000000
* fixed\_shutter\_interval\_within\_clvs\_flag = 0
* sii\_max\_sub\_layers\_minus1 = 4 (In HEVC CTC, for RA, the GOP size is set to 16).
* sub\_layer\_num\_units\_in\_shutter\_interval[ i ] = LFR value in Table 2 for i = 0, 1, 2, 3
* sub\_layer\_num\_units\_in\_shutter\_interval[ 4 ] = HFR value in Table 2

Table sii\_num\_units\_in\_shutter\_interval value for Source (HFR) and LFR

|  |  |  |  |
| --- | --- | --- | --- |
| picture rate  (sec-1) | | sii\_num\_units\_in\_shutter\_interval  (sii\_time\_scale = 24000000)  (source shutter interval = 1 / picture rate) | |
| Source (HFR) | LFR | Source (HFR) | LFR |
| 24 | 12 | **1000000** | **2000000** |
| 30 | 15 | **800000** | **1600000** |
| 48 | 24 | **500000** | **1000000** |
| 50 | 25 | **480000** | **960000** |
| 60 | 30 | **400000** | **800000** |
| 96 | 48 | **250000** | **500000** |
| 100 | 50 | **240000** | **480000** |
| 120 | 60 | **200000** | **400000** |
| 240 | 120 | **100000** | **200000** |

## Software description

The SII-Process software package is enabled by Macro:

* **SHUTTER\_INTERVAL\_SEI\_PROCESSING = 1.**

Two encoder configurations are provided:

* shutter\_interval\_info\_fix.cfg // common setting with single shutter interval
* shutter\_interval\_info\_mul.cfg // shutter interval SEI processing with multiple shutter intervals

(note: each of the two example cfg assumes that HFR is 120fps; but in the software the correct value is computed based on sequence picture rate)

The encoding command line is:

TAppEncoderStatic -c seq.cfg -c encoder\_randomaccess\_main10.cfg -c shutter\_interval\_info\_mul.cfg -sii preprocessed\_seq.yuv

The decoding commandline is:

TAppDecoderStatic -b seq.bit -o dec.yuv -sii postprocessd\_seq.yuv

Optionally, to decode corresponding LFR, use:

TAppDecoderStatic -b seq.bit -o dec.yuv -t 3

(In this example, set -t 3 for HEVC CTC RA test case with GOP size = 16.)

# Simulations

We ran simulations using HM CTC Class B (HD) test sequences. It was observed that the software implementation (SII-Processing) and SII SEI message function as expected. ATSC 3.0 Annex D notes that double images may be expected when the source shutter interval is significantly shorter than the picture interval, which is likely the case for many CTC test sequences.

# Acknowledgment

We would like to thank Chad Fogg from MovieLabs for help to crosscheck the software.

# 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. “ATSC Standard: Video – HEVC”, Advanced Television Systems Committee, A/341:2019, 14 Feb. 2019

# Patent rights declaration(s)

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