



# JCTVC-AK0026-v2

## AHG7: Shutter interval information SEI message

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Dolby Laboratories, Inc.

# Summary of proposal

Add **shutter interval information SEI message** in HEVC and AVC

Purpose:

- to indicate that shutter interval values are the same or different for different temporal sub-layers; and
- to signal one shutter interval value if all sub-layers have the same shutter interval, or signal one shutter interval value for each temporal sub-layer.
- This contribution provides the same functionality as proposed in JCTVC-AJ0029 but with timing information that would be useful to receivers, as suggested in Gothenburg.



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**Shutter interval** is a term of art that indicates the effective exposure duration and is thus also an indicator of motion blur

**Shutter interval** information can be particularly useful when different temporal sub-layers have different effective shutter intervals and thus motion blur.

**Shutter interval** information can be used to adjust the look of video on a display

# Summary of proposal

## Shutter interval, sharpness, and motion smoothness

Minimal motion blur (stuttered motion)



Normal motion blur



Maximum motion blur (smooth motion)



Shutter interval affects the look of displayed video

Small shutter interval → sharper, more stutter

Large shutter interval → more motion blur,  
smoother

Image by en:User:Cburnett - Own work. This W3C-unspecified vector image was created with Inkscape., CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=1499295>



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**Shutter interval** is a term of art that indicates the effective exposure duration and is thus also an indicator of motion blur

**Shutter interval** information can be particularly useful when different temporal sub-layers have different effective shutter intervals and thus motion blur.

**Shutter interval** information can be used to adjust the look of video on a display

# Shutter interval, shutter angle, and frame rate

$$\text{shutter\_angle} = 360 * \text{frame\_rate} * \text{shutter\_interval}$$

Shutter angle is a cinematic term

Shutter angle is relative

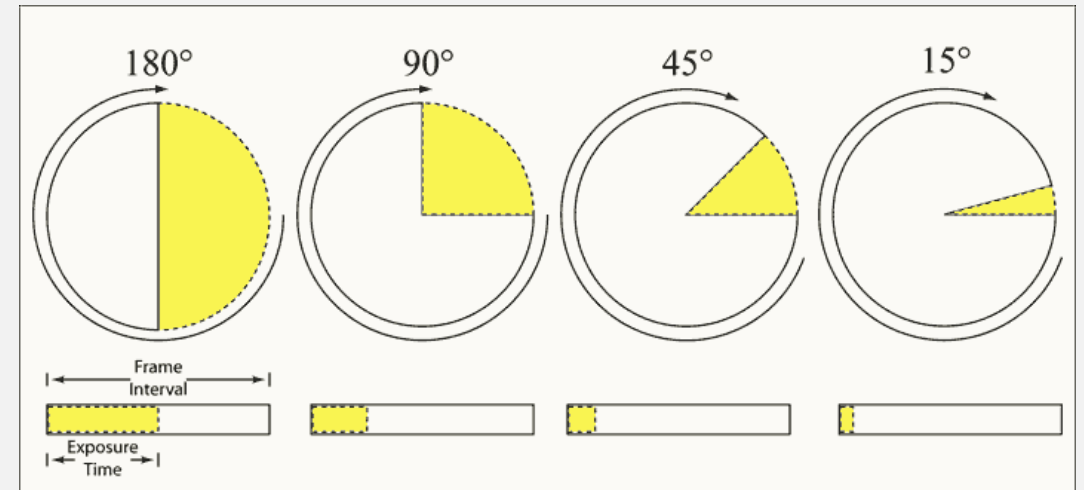
(shutter interval relative to frame duration)

In cinema, at fixed 24 fps, shutter interval and shutter angle are equivalent and the visual impact of shutter angle is well understood

Shutter interval is absolute in units of seconds

Shutter interval is a more direct indicator of motion blur at all frame rates

Rotating disc shutter



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The use of degrees to measure relative exposure time is a hold over from the days when movie cameras used rotating disk shutters

# Shutter interval & shutter angle and temporal sub-layers

120 fps @ 360° shutter angle



Shutter  
interval

Extracted sub-layers

60 fps @ 180° shutter angle



Frame interval

30 fps @ 90° shutter angle

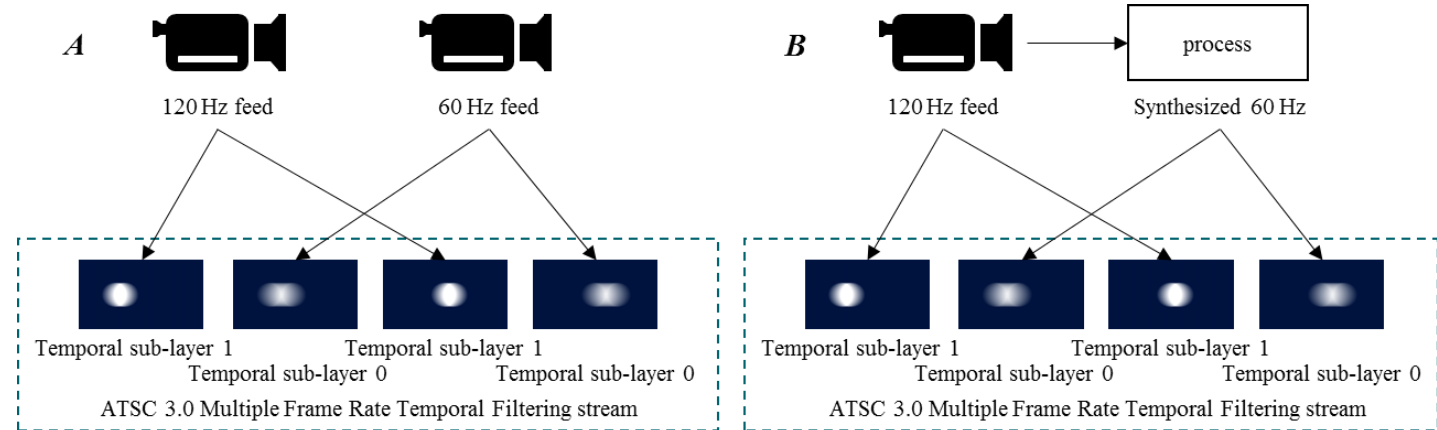


24 fps @ 72° shutter angle



# Shutter interval and ATSC 3.0

ATSC 3.0  
MFRTF  
Encode



Two examples of encoding ATSC 3.0 Multiples Frame Rate Temporal Filtering streams

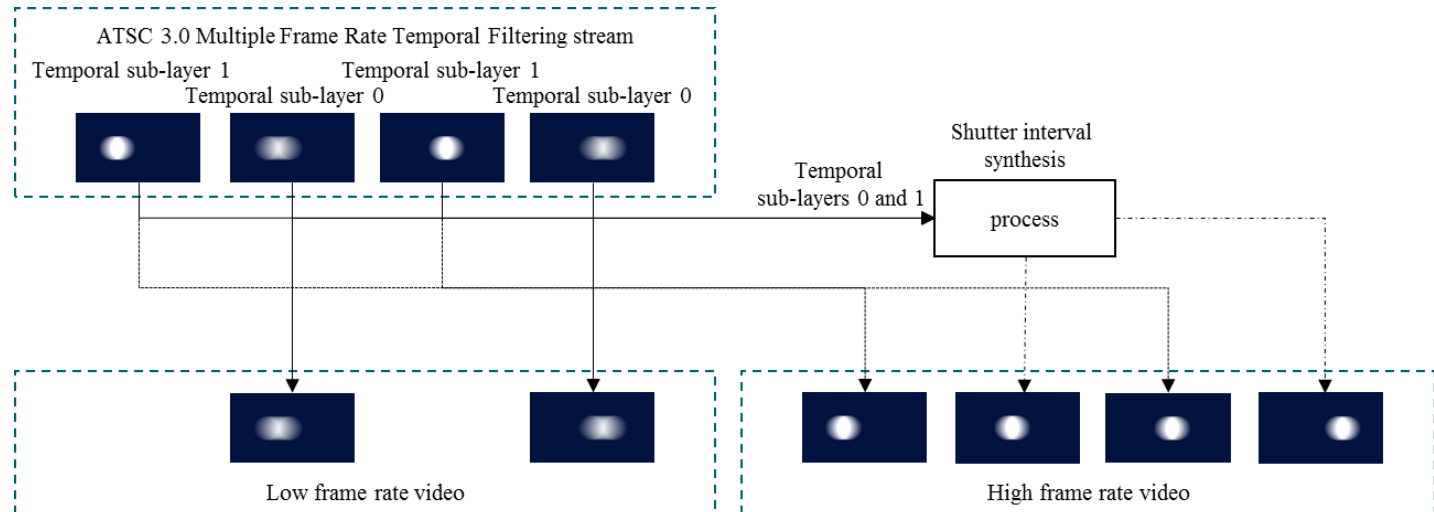
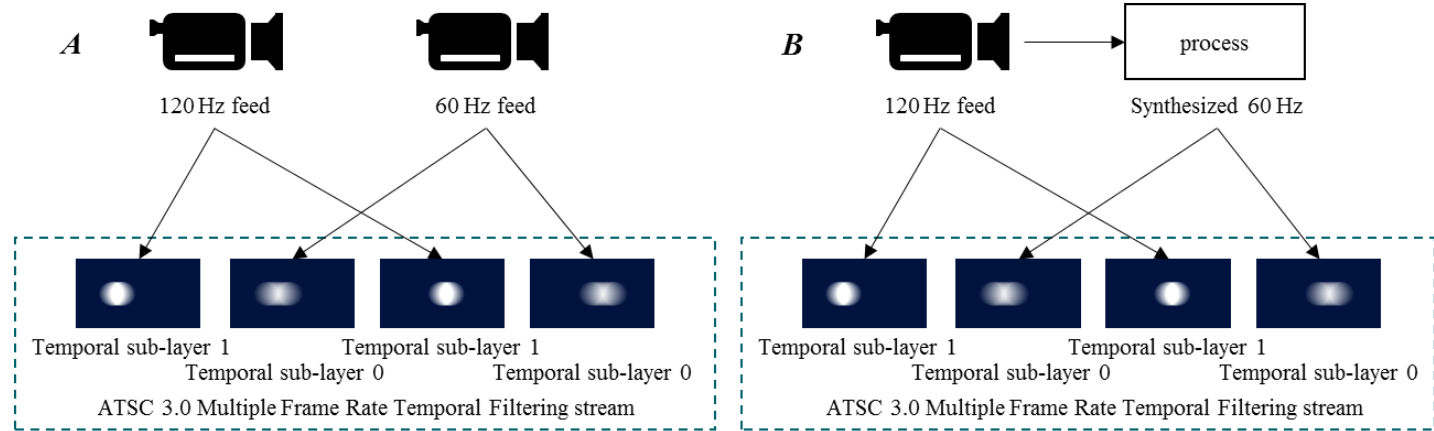
# Shutter interval and ATSC 3.0

ATSC 3.0  
MFRTF  
Encode

Shutter  
interval  
information



ATSC 3.0  
MFRTF  
Decode





# Proposal: 2 variants

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# Proposal – variant 1

**Table 1. Shutter interval information SEI message syntax (variant 1)**

shutter_interval_information ( payloadSize ) {	Descriptor
<b>sii_num_units_in_shutter_interval</b>	u(32)
<b>sii_time_scale</b>	u(32)
<b>sii_max_sub_layers_minus1</b>	u(3)
<b>fixed_shutter_interval_within_cvs_flag</b>	u(1)
if ( !fixed_shutter_interval_within_cvs_flag )	
for( i = 0; i <= sps_max_sub_layers_minus1; i++ ) {	
<b>sub_layer_shutter_interval_numer[ i ]</b>	u(16)
<b>sub_layer_shutter_interval_denom[ i ]</b>	u(16)
}	
}	

## 7.3.x Shutter interval information SEI message semantics (variant 1)

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

**sii\_num\_units\_in\_shutter\_interval** specifies the number of time units of a clock operating at the frequency **sii\_time\_scale** Hz that corresponds to one increment of an shutter clock tick counter. Shutter interval, defined by 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, when **ShutterInterval** is 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\_time\_scale** specifies the number of time units that pass in one second. For example, a time coordinate system that measures time using a 27 MHz clock has a **sii\_time\_scale** of 27 000 000.

When the value of **sii\_time\_scale** is greater than 0, the value of **ShutterInterval** is specified by:

$$\text{ShutterInterval} = \text{sii\_num\_units\_in\_shutter\_interval} \div \text{sii\_time\_scale}$$

Otherwise (the value of **sii\_time\_scale** is equal to 0), **ShutterInterval** should be interpreted as unknown or unspecified.

NOTE – A value of **ShutterInterval** equal to 0 may indicate that the associated video content contain screen capture content, computer generated content, or other non-camera-capture content.

**sii\_max\_sub\_layers\_minus1** plus 1 specifies the maximum number of temporal sub-layers that may be present in each CVS referring to the SPS. The value of **sii\_max\_sub\_layers\_minus1** shall be in the range of 0 to 6, inclusive.

It is a requirement of bitstream conformance that the value of **sii\_max\_sub\_layers\_minus1** in the shutter interval SEI message shall be equal to the value of **sps\_max\_sub\_layers\_minus1** in the SPS.

**fixed\_shutter\_interval\_within\_cvs\_flag** equal to 1 specifies that the value of **ShutterInterval** is the same for all temporal sub-layers in the CVS. **fixed\_shutter\_interval\_within\_cvs\_flag** equal to 0 specifies that value of **ShutterInterval** may not be the same for all temporal sub-layers in the CVS.

**sub\_layer\_shutter\_interval\_numer[ i ]** specifies the numerator used to derive sub layer shutter interval, defined by variable **subLayerShutterInterval[ i ]**, in units of seconds, when **HighestTid** is equal to **i**.

**sub\_layer\_shutter\_interval\_denom[ i ]** specifies the denominator used to derive sub layer shutter interval, defined by variable **subLayerShutterInterval[ i ]**, in units of seconds, when **HighestTid** is equal to **i**.

The value of **subLayerShutterInterval[ i ]** for **HighestTid** equal to **i** is derived as follows. When the value of **fixed\_shutter\_interval\_within\_cvs\_flag** is equal to 0 and the value of **sub\_layer\_shutter\_interval\_denom[ i ]** is greater than 0:

$$\text{subLayerShutterInterval[ i ]} = \text{ShutterInterval} * \text{sub\_layer\_shutter\_interval\_numer[ i ]} \div \text{sub\_layer\_shutter\_interval\_denom[ i ]}$$

Otherwise (the value of **sub\_layer\_shutter\_interval\_denom[ i ]** is equal to 0), **subLayerShutterInterval[ i ]** should be interpreted as unknown or unspecified. When the value of **fixed\_shutter\_interval\_within\_cvs\_flag** is not equal to 0,

$$\text{subLayerShutterInterval[ i ]} = \text{ShutterInterval}$$

# Proposal – variant 2

**Table 2. Shutter interval information SEI message syntax (variant 2)**

shutter_interval_information ( payloadSize ) {	Descriptor
<b>sii_num_units_in_shutter_interval</b>	u(32)
<b>sii_time_scale</b>	u(32)
<b>sii_max_sub_layers_minus1</b>	u(3)
<b>fixed_shutter_interval_within_cvs_flag</b>	u(1)
if ( !fixed_shutter_interval_within_cvs_flag )	
for( i = 0; i <= sps_max_sub_layers_minus1; i++ ) {	
<b>sub_layer_num_units_in_shutter_interval[ i ]</b>	u(32)
}	
}	

## 7.3.x Shutter interval information SEI message semantics (variant 2)

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

**sii\_num\_units\_in\_shutter** specifies the number of time units of a clock operating at the frequency **sii\_time\_scale** Hz that corresponds to one increment of an shutter clock tick counter. Shutter interval, defined by 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, when **ShutterInterval** is 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\_time\_scale** specifies the number of time units that pass in one second. For example, a time coordinate system that measures time using a 27 MHz clock has a **sii\_time\_scale** of 27 000 000.

When the value of **sii\_time\_scale** is greater than 0, the value of **ShutterInterval** is specified by:

$$\text{ShutterInterval} = \text{sii\_num\_units\_in\_shutter\_interval} \div \text{sii\_time\_scale}$$

Otherwise (the value of **sii\_time\_scale** is equal to 0), **ShutterInterval** should be interpreted as unknown or unspecified.

NOTE – A value of **ShutterInterval** equal to 0 may indicate that the associated video content contain screen capture content, computer generated content, or other non-camera-capture content.

**sii\_max\_sub\_layers\_minus1** plus 1 specifies the maximum number of temporal sub-layers that may be present in each CVS referring to the SPS. The value of **sii\_max\_sub\_layers\_minus1** shall be in the range of 0 to 6, inclusive.

It is a requirement of bitstream conformance that the value of **sii\_max\_sub\_layers\_minus1** in the shutter interval SEI message shall be equal to the value of **sps\_max\_sub\_layers\_minus1** in the SPS.

**fixed\_shutter\_interval\_within\_cvs\_flag** equal to 1 specifies that the value of **ShutterInterval** is the same for all temporal sub-layers in the CVS. **fixed\_shutter\_interval\_within\_cvs\_flag** equal to 0 specifies that value of **ShutterInterval** may not be the same for all temporal sub-layers in the CVS.

**sub\_layer\_num\_units\_in\_shutter\_interval[ i ]** specifies the number of time units of a clock operating at the frequency **sii\_time\_scale** Hz that corresponds to one increment of an shutter clock tick counter. Sub layer shutter interval, defined by variable **subLayerShutterInterval[ i ]**, in units of seconds, when **HighestTid** is equal to **i**, is equal to the quotient of **sub\_layer\_num\_units\_in\_shutter\_interval[ i ]** divided by **sii\_time\_scale**.

When the value of **fixed\_shutter\_interval\_within\_cvs\_flag** is equal to 0 and the value of **sii\_time\_scale** is greater than 0, the value of **subLayerShutterInterval[ i ]** is specified by:

$$\text{subLayerShutterInterval[ i ]} = \text{sub\_layer\_num\_units\_in\_shutter\_interval[ i ]} \div \text{sii\_time\_scale}$$

Otherwise (the value of **sii\_time\_scale** is equal to 0), **subLayerShutterInterval[ i ]** should be interpreted as unknown or unspecified. When the value of **fixed\_shutter\_interval\_within\_cvs\_flag** is not equal to 0,

$$\text{subLayerShutterInterval[ i ]} = \text{ShutterInterval}$$

# Conclusion

- Proposal provides support for signalling shutter interval information using an SEI message
- Shutter interval information can be particularly useful when coded video or temporal sub-layers have picture rates different than the frame rate of associated original video content
- Shutter interval information may be used by display or other post-decode processes to achieve a consistent or other desired look for bitstreams extracted at different frame rates
- Recommendation: adopt shutter angle information SEI message in HEVC and AVC



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### SEI message

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