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| *Title:* | **Additional Supplemental Enhancement Information for HEVC (Draft 1)** | | |
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| *Source:* | Editors | | |

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# Abstract

This document contains the draft text for changes to the High Efficiency Video Coding (HEVC) standard (Rec. ITU-T H.265 | ISO/IEC 23008-2) to specify additional supplemental enhancement information (SEI) messages for fisheye, SEI manifest, and SEI prefix, along with some corrections to the existing specification text.

**Changes to the specification text:**

*Replace D.2.1 with the following:*

**D.2.1 General SEI message syntax**

|  |  |
| --- | --- |
| sei\_payload( payloadType, payloadSize ) { | **Descriptor** |
| if( nal\_unit\_type  = =  PREFIX\_SEI\_NUT ) |  |
| if( payloadType  = =  0 ) |  |
| buffering\_period( payloadSize ) |  |
| else if( payloadType  = =  1 ) |  |
| pic\_timing( payloadSize ) |  |
| else if( payloadType  = =  2 ) |  |
| pan\_scan\_rect( payloadSize ) |  |
| else if( payloadType  = =  3 ) |  |
| filler\_payload( payloadSize ) |  |
| else if( payloadType  = =  4 ) |  |
| user\_data\_registered\_itu\_t\_t35( payloadSize ) |  |
| else if( payloadType  = =  5 ) |  |
| user\_data\_unregistered( payloadSize ) |  |
| else if( payloadType  = =  6 ) |  |
| recovery\_point( payloadSize ) |  |
| else if( payloadType  = =  9 ) |  |
| scene\_info( payloadSize ) |  |
| else if( payloadType  = =  15 ) |  |
| picture\_snapshot( payloadSize ) |  |
| else if( payloadType  = =  16 ) |  |
| progressive\_refinement\_segment\_start( payloadSize ) |  |
| else if( payloadType  = =  17 ) |  |
| progressive\_refinement\_segment\_end( payloadSize ) |  |
| else if( payloadType  = =  19 ) |  |
| film\_grain\_characteristics( payloadSize ) |  |
| else if( payloadType  = =  22 ) |  |
| post\_filter\_hint( payloadSize ) |  |
| else if( payloadType  = =  23 ) |  |
| tone\_mapping\_info( payloadSize ) |  |
| else if( payloadType  = =  45 ) |  |
| frame\_packing\_arrangement( payloadSize ) |  |
| else if( payloadType  = =  47 ) |  |
| display\_orientation( payloadSize ) |  |
| else if( payloadType  = =  56 ) |  |
| green\_metadata( payloadsize ) /\* specified in ISO/IEC 23001-11 \*/ |  |
| else if( payloadType  = =  128 ) |  |
| structure\_of\_pictures\_info( payloadSize ) |  |
| else if( payloadType  = =  129 ) |  |
| active\_parameter\_sets( payloadSize ) |  |
| else if( payloadType  = =  130 ) |  |
| decoding\_unit\_info( payloadSize ) |  |
| else if( payloadType  = =  131 ) |  |
| temporal\_sub\_layer\_zero\_index( payloadSize ) |  |
| else if( payloadType  = =  133 ) |  |
| scalable\_nesting( payloadSize ) |  |
| else if( payloadType  = =  134 ) |  |
| region\_refresh\_info( payloadSize ) |  |
| else if( payloadType  = =  135 ) |  |
| no\_display( payloadSize ) |  |
| else if( payloadType  = =  136 ) |  |
| time\_code( payloadSize ) |  |
| else if( payloadType  = =  137 ) |  |
| mastering\_display\_colour\_volume( payloadSize ) |  |
| else if( payloadType  = =  138 ) |  |
| segmented\_rect\_frame\_packing\_arrangement( payloadSize ) |  |
| else if( payloadType  = =  139 ) |  |
| temporal\_motion\_constrained\_tile\_sets( payloadSize ) |  |
| else if( payloadType  = =  140 ) |  |
| chroma\_resampling\_filter\_hint( payloadSize ) |  |
| else if( payloadType  = =  141 ) |  |
| knee\_function\_info( payloadSize ) |  |
| else if( payloadType  = =  142 ) |  |
| colour\_remapping\_info( payloadSize ) |  |
| else if( payloadType  = =  143 ) |  |
| deinterlaced\_field\_identification( payloadSize ) |  |
| else if( payloadType  = =  144 ) |  |
| content\_light\_level\_info( payloadSize ) |  |
| else if( payloadType  = =  145 ) |  |
| dependent\_rap\_indication( payloadSize ) |  |
| else if( payloadType  = =  146 ) |  |
| coded\_region\_completion( payloadSize ) |  |
| else if( payloadType  = =  147 ) |  |
| alternative\_transfer\_characteristics( payloadSize ) |  |
| else if( payloadType  = =  148 ) |  |
| ambient\_viewing\_environment( payloadSize ) |  |
| else if( payloadType  = =  149 ) |  |
| content\_colour\_volume( payloadSize ) |  |
| else if( payloadType  = =  150 ) |  |
| equirectangular\_projection( payloadSize ) |  |
| else if( payloadType  = =  151 ) |  |
| cubemap\_projection( payloadSize ) |  |
| else if( payloadType  = =  152 ) |  |
| fisheye\_video\_info( payloadSize ) |  |
| else if( payloadType  = =  154 ) |  |
| sphere\_rotation( payloadSize ) |  |
| else if( payloadType  = =  155 ) |  |
| regionwise\_packing( payloadSize ) |  |
| else if( payloadType  = =  156 ) |  |
| omni\_viewport( payloadSize ) |  |
| else if( payloadType  = =  157 ) |  |
| regional\_nesting( payloadSize ) |  |
| else if( payloadType  = =  158 ) |  |
| mcts\_extraction\_info\_sets( payloadSize ) |  |
| else if( payloadType  = =  159 ) |  |
| mcts\_extraction\_info\_nesting( payloadSize ) |  |
| else if( payloadType  = =  160 ) |  |
| layers\_not\_present( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType  = =  161 ) |  |
| inter\_layer\_constrained\_tile\_sets( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType  = =  162 ) |  |
| bsp\_nesting( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType  = =  163 ) |  |
| bsp\_initial\_arrival\_time( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType  = =  164 ) |  |
| sub\_bitstream\_property( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType  = =  165 ) |  |
| alpha\_channel\_info( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType  = =  166 ) |  |
| overlay\_info( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType  = =  167 ) |  |
| temporal\_mv\_prediction\_constraints( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType  = =  168 ) |  |
| frame\_field\_info( payloadSize ) /\* specified in Annex F \*/ |  |
| else if( payloadType  = =  176 ) |  |
| three\_dimensional\_reference\_displays\_info( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType  = =  177 ) |  |
| depth\_representation\_info( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType  = =  178 ) |  |
| multiview\_scene\_info( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType  = =  179 ) |  |
| multiview\_acquisition\_info( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType  = =  180 ) |  |
| multiview\_view\_position( payloadSize ) /\* specified in Annex G \*/ |  |
| else if( payloadType  = =  181 ) |  |
| alternative\_depth\_info( payloadSize ) /\* specified in Annex I \*/ |  |
| else if( payloadType  = =  200 ) |  |
| sei\_manifest( payloadSize ) |  |
| else if( payloadType  = =  201 ) |  |
| sei\_prefix\_indication( payloadSize ) |  |
| else |  |
| reserved\_sei\_message( payloadSize ) |  |
| else /\* nal\_unit\_type  = =  SUFFIX\_SEI\_NUT \*/ |  |
| if( payloadType  = =  3 ) |  |
| filler\_payload( payloadSize ) |  |
| else if( payloadType  = =  4 ) |  |
| user\_data\_registered\_itu\_t\_t35( payloadSize ) |  |
| else if( payloadType  = =  5 ) |  |
| user\_data\_unregistered( payloadSize ) |  |
| else if( payloadType  = =  17 ) |  |
| progressive\_refinement\_segment\_end( payloadSize ) |  |
| else if( payloadType  = =  22 ) |  |
| post\_filter\_hint( payloadSize ) |  |
| else if( payloadType  = =  132 ) |  |
| decoded\_picture\_hash( payloadSize ) |  |
| else if( payloadType  = =  146 ) |  |
| coded\_region\_completion( payloadSize ) |  |
| else |  |
| reserved\_sei\_message( payloadSize ) |  |
| if( more\_data\_in\_payload( ) ) { |  |
| if( payload\_extension\_present( ) ) |  |
| **reserved\_payload\_extension\_data** | u(v) |
| **payload\_bit\_equal\_to\_one** /\* equal to 1 \*/ | f(1) |
| while( !byte\_aligned( ) ) |  |
| **payload\_bit\_equal\_to\_zero** /\* equal to 0 \*/ | f(1) |
| } |  |
| } |  |

*Renumber clauses D.2.41.3 through D.2.41.5 as D.2.41.4 through D.2.41.6.*

*Add clause D.2.41.3, as follows:*

**D.2.41.3 Fisheye video information SEI message syntax**

|  |  |
| --- | --- |
| fisheye\_video\_info( payloadSize ) { | **Descriptor** |
| **fisheye\_view\_dimension\_idc** | u(3) |
| **fisheye\_reserved\_zero\_5bits** | u(5) |
| **fisheye\_num\_active\_areas\_minus1** | u(8) |
| for( i = 0; i  <=  fisheye\_num\_active\_areas\_minus1; i++ ) { |  |
| **fisheye\_circular\_region\_centre\_x**[ i ] | u(32) |
| **fisheye\_circular\_region\_centre\_y**[ i ] | u(32) |
| **fisheye\_rect\_region\_top**[ i ] | u(32) |
| **fisheye\_rect\_region\_left**[ i ] | u(32) |
| **fisheye\_rect\_region\_width**[ i ] | u(32) |
| **fisheye\_rect\_region\_height**[ i ] | u(32) |
| **fisheye\_circular\_region\_radius**[ i ] | u(32) |
| **fisheye\_scene\_radius**[ i ] | u(32) |
| **fisheye\_camera\_centre\_azimuth**[ i ] | i(32) |
| **fisheye\_camera\_centre\_elevation**[ i ] | i(32) |
| **fisheye\_camera\_centre\_tilt**[ i ] | i(32) |
| **fisheye\_camera\_centre\_offset\_x**[ i ] | u(32) |
| **fisheye\_camera\_centre\_offset\_y**[ i ] | u(32) |
| **fisheye\_camera\_centre\_offset\_z**[ i ] | u(32) |
| **fisheye\_field\_of\_view**[ i ] | u(32) |
| **fisheye\_num\_polynomial\_coeffs**[ i ] | u(16) |
| for( j = 0; j < fisheye\_num\_polynomial\_coeffs[ i ]; j++ ) |  |
| **fisheye\_polynomial\_coeff**[ i ][ j ] | i(32) |
| } |  |
| } |  |

*Renumber clause D.2.45 (Reserved SEI message syntax) as D.2.47.*

*Add clauses D.2.45 and D.2.46, as follows:*

**D.2.45 SEI manifest SEI message syntax**

|  |  |
| --- | --- |
| sei\_manifest( payloadSize ) { | **Descriptor** |
| **manifest\_num\_sei\_msg\_types** | u(16) |
| for( i = 0; i < manifest\_num\_sei\_msg\_types; i++ ) { |  |
| **manifest\_sei\_payload\_type**[ i ] | u(16) |
| **manifest\_sei\_description**[ i ] | u(8) |
| } |  |
| } |  |

**D.2.46 SEI prefix indication SEI message syntax**

|  |  |
| --- | --- |
| sei\_prefix\_indication( payloadSize ) { | **Descriptor** |
| **prefix\_sei\_payload\_type** | u(16) |
| **num\_sei\_prefix\_indications\_minus1** | u(8) |
| for( i = 0; i  <=  num\_sei\_prefix\_indications\_minus1; i++ ) { |  |
| **num\_bits\_in\_prefix\_indication\_minus1**[ i ] | u(16) |
| for( j = 0; j  <=  num\_bits\_in\_prefix\_indication\_minus1[ i ]; j++ ) |  |
| **sei\_prefix\_data\_bit**[ i ][ j ] | u(1) |
| while( !byte\_aligned( ) ) |  |
| **byte\_alignment\_bit\_equal\_to\_one** /\* equal to 1 \*/ | f(1) |
| } |  |
| } |  |

*In D.3.1, replace the following paragraphs:*

The list SingleLayerSeiList is set to consist of the payloadType values 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 134 to 151, inclusive, and 154 to 159, inclusive.

The list VclAssociatedSeiList is set to consist of the payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 151, inclusive, and 154 to 159, inclusive.

The list PicUnitRepConSeiList is set to consist of the payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 151, inclusive, and 154 to 159, inclusive.

*with the following:*

The list SingleLayerSeiList is set to consist of the payloadType values 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, and 200 to 201, inclusive.

The list VclAssociatedSeiList is set to consist of the payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, and 200 to 201, inclusive.

The list PicUnitRepConSeiList is set to consist of the payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 152, inclusive, 154 to 159, inclusive, and 200 to 201, inclusive.

*In D.3.1, in Table D.1, insert the following row immediately after the row for "Cubemap projection" in the table:*

|  |  |
| --- | --- |
| Fisheye video information | The CLVS containing the SEI message |

*In D.3.1, in Table D.1, append the following rows to the end of the table:*

|  |  |
| --- | --- |
| SEI manifest | The CLVS containing the SEI message |
| SEI prefix indication | The CLVS containing the SEI message |

*Renumber clauses D.3.41.1 through D.3.41.6 (and their subordinate subclauses) as D.3.41.2 through D.3.41.7 (and their subordinate subclauses).*

*Move clause D.3.41.7 (and its subordinate subclauses) to be D.3.41.1 (and its subordinate subclauses).*

*Add clause D.3.41.1.7, as follows:*

***D.3.41.1.7 Conversion from a sample location of an active area to sphere coordinates relative to the global coordinate axes***

[Ed. (YK): When a fisheye video information SEI message that applies to a picture is present, the sample resampling process for fisheye video specified in clause D.3.41.1.7 needs to be invoked in clause D.3.41.1.1 that contains the general description of the overall sample location remapping process.]

Input to this clause are:

– the sample location (x, y) in units of luma samples,

– the centre location (xc, yc) and the radius (rc) of the circular region that contains the i-th active area, given by fisheye\_circular\_region\_centre\_x[ i ], fisheye\_circular\_region\_centre\_y[ i ], and fisheye\_circular\_region\_radius[ i ], respectively, all in units of 2−16 luma samples,

– the field of view (θv) of the lens corresponding to the i-th active area, given by fisheye\_field\_of\_view[ i ], in units of 2−16 degrees, and

– the rotation parameters (αc, βc, γc), given by fisheye\_camera\_centre\_azimuth[ i ], fisheye\_camera\_centre\_elevation[ i ], and fisheye\_camera\_centre\_tilt[ i ], respectively, all in units of 2−16 degrees.

Output of this clause are:

– sphere coordinates (ϕ, θ) relative to the global coordinate axes.

The outputs are derived as follows:

ϕ′ = ( Sqrt( ( x − xc ÷ 216 )2 + ( y − yc ÷ 216 )2 ) ÷ ( rc ÷ 216 ) ) \* ( θv ÷ 216 \* π ÷ 180 ) ÷ 2  
θ′ = Atan2( y − yc ÷ 216, x − xc ÷ 216 )  
x1 = Cos( ϕ′ )  
y1 = Sin( ϕ′ ) \* Cos( θ′ )  
z1 = Sin( ϕ′ ) \* Sin( θ′ )  
α = ( αc ÷ 216 ) \* π ÷ 180  
β = ( βc ÷ 216 ) \* π ÷ 180  
γ = ( γc ÷ 216 ) \* π ÷ 180  
x2 = Cos( β ) \* Cos ( γ ) \* x1 − Cos( β ) \* Sin( γ ) \* y1 + Sin( β ) \* z1 (D‑XX)y2 = ( Cos( α ) \* Sin( γ ) + Sin( α ) \* Sin( β ) \* Cos( γ ) ) \* x1 +  
 ( Cos( α ) \* Cos( γ ) − Sin( α ) \* Sin( β ) \* Sin( γ ) ) \* y1 −  
 Sin( α ) \* Cos( β ) \* z1z2 = ( Sin( α ) \* Sin( γ ) − Cos( α ) \* Sin( β ) \* Cos( γ ) ) \* x1 +  
 ( Sin( α ) \* Cos( γ ) + Cos( α ) \* Sin( β ) \* Sin( γ ) ) \* y1 +  
 Cos( α ) \* Cos( β ) \* z1ϕ = Atan2( y2, x2 ) \* 180 ÷ π  
θ = Asin( z2 ) \* 180 ÷ π

*Renumber clauses D.3.41.4 through D.3.41.6 (and their subordinate subclauses) as D.3.41.5 through D.3.41.7 (and subordinate subclauses)*

*Add clause D.3.41.4, as follows:*

**D.3.41.4 Fisheye video information SEI message semantics**

The presence of the fisheye video information SEI message in a CLVS indicates that each coded video picture in the CLVS is a fisheye video information video picture containing a number of active areas captured by fisheye camera lens. The information of the fisheye video information video carried in the fisheye video information SEI message can be used by a receiver to properly render the fisheye video information video.

The fisheye video information SEI message applies to the CLVS that contains the SEI message, also referred to as the current CLVS. When present in a CVLS the fisheye video information SEI message shall be present in the first access unit of the CLVS and may be present in other access units of the CLVS.

**fisheye\_view\_dimension\_idc** indicates the alignment and viewing direction of a fisheye lens, as follows:

– fisheye\_view\_dimension\_idc equal to 0 indicates that fisheye\_num\_active\_areas is equal to 2, and the values of fisheye\_camera\_centre\_azimuth, fisheye\_camera\_centre\_elevation, fisheye\_camera\_centre\_tilt, fisheye\_camera\_centre\_offset\_x, fisheye\_camera\_centre\_offset\_y, and fisheye\_camera\_centre\_offset\_z are such that the active areas have aligned optical axes and face opposite directions, and the sum of fisheye\_field\_of\_view values is greater than or equal to 360 \* 216.

– fisheye\_view\_dimension\_idc equal to 1 indicates that fisheye\_num\_active\_areas is equal to 2, and the values of fisheye\_camera\_centre\_azimuth, fisheye\_camera\_centre\_elevation, fisheye\_camera\_centre\_tilt, fisheye\_camera\_centre\_offset\_x, fisheye\_camera\_centre\_offset\_y, and fisheye\_camera\_centre\_offset\_z are such that the active areas have parallel optical axes that are orthogonal to the line intersecting the camera centre points, and the camera corresponding to i equal to 0 is the left view.

– fisheye\_view\_dimension\_idc equal to 2 indicates that fisheye\_num\_active\_areas is equal to 2, and the values of fisheye\_camera\_centre\_azimuth, fisheye\_camera\_centre\_elevation, fisheye\_camera\_centre\_tilt, fisheye\_camera\_centre\_offset\_x, fisheye\_camera\_centre\_offset\_y, and fisheye\_camera\_centre\_offset\_z are such that the active areas have parallel optical axes that are orthogonal to the line intersecting the camera centre points, and the camera corresponding to i equal to 0 is the right view.

– fisheye\_view\_dimension\_idc equal to 7 indicates that no additional constraints are implied for the syntax element values within the fisheye video information SEI message.

– Values of fisheye\_view\_dimension\_idc in the range of 3 to 6, inclusive, are reserved for future use by ITU-T | ISO/IEC. Decoders encountering a value of fisheye\_view\_dimension\_idc in the range of 3 to 6, inclusive, shall ignore it.

**fisheye**\_**reserved\_zero\_5bits** shall be equal to 0 in bitstreams conforming to this version of this Specification. Other values for fisheye\_reserved\_zero\_5bits are reserved for future use by ITU-T | ISO/IEC. Decoders shall ignore the value of fisheye\_reserved\_zero\_5bits.

**fisheye\_num\_active\_areas\_minus1** plus 1 specifies the number of active areas in the coded picture. The value of fisheye\_num\_active\_areas\_minus1 shall be in the range of 0 to 3, inclusive. Values of fisheye\_num\_active\_areas\_minus1 greater than 3 are reserved for future use by ITU-T | ISO/IEC. Decoders encountering a fisheye video information SEI message with fisheye\_num\_active\_areas\_minus1 greater than 3 shall ignore the fisheye video information SEI message.

**fisheye\_circular\_region\_centre\_x**[ i ] and **fisheye\_circular\_region\_centre\_y**[ i ] specify the horizontal and vertical coordinates of the centre of the circular region that contains the i-th active area in the coded picture, respectively, in units of 2−16 luma samples. The value of fisheye\_circular\_region\_centre\_x[ i ] and fisheye\_circular\_region\_centre\_y[ i ] shall be in the range of 0 to 65 536 \* 216 − 1 (i.e., 4 294 967 295), inclusive.

**fisheye\_rect\_region\_top**[ i ], **fisheye\_rect\_region\_left**[ i ], **fisheye\_rect\_region\_width**[ i ], and **fisheye\_rect\_region\_height**[ i ] specify the coordinates of the top-left corner and the width and height of the i-th rectangular region that contains the i-th active area. These values are specified in units of luma samples.

**fisheye\_circular\_region\_radius**[ i ] specifies the radius of the circular region that contains the i-th active area that is defined as a length from the centre of the circular region specified by fisheye\_circular\_region\_centre\_x[ i ] and fisheye\_circular\_region\_centre\_y[ i ] to the outermost pixel boundary of the circular region, in units of 2−16 luma samples, that corresponds to the maximum field of view of the i-th fisheye lens, specified by fisheye\_field\_of\_view[ i ]. The value of fisheye\_circular\_region\_radius[ i ] shall be in the range of 0 to 65 536 \* 216 − 1 (i.e., 4 294 967 295), inclusive.

The i-th active area is defined as the intersection of the i-th rectangular region, specified by fisheye\_rect\_region\_top[ i ], fisheye\_rect\_region\_left[ i ], fisheye\_rect\_region\_width[ i ], and fisheye\_rect\_region\_height[ i ], and the i-th circular region, specified by fisheye\_circular\_region\_centre\_x[ i ], fisheye\_circular\_region\_centre\_y[ i ], and fisheye\_circular\_region\_radius[ i ].

[Ed. (JB): Is there any restriction between the relative sizes of the diameter of the circle and the length or width of the rect region? (AT): Can the specified parameters exceed the picture size? What happens when the top/left/width/height parameters, for example, exceed the picture size or overlap? Could I have regions with exactly the same region coordinates but have them described with different parameters? If yes, what should I do then? There is also no mention of the range of those values.]

**fisheye\_scene\_radius**[ i ] specifies the radius of a circular region within the i-th active area in units of 2−16 luma samples, where the obstruction, such as the camera body, is not included in the region specified by fisheye\_circular\_region\_centre\_x[ i ], fisheye\_circular\_region\_centre\_y[ i ], and fisheye\_scene\_radius[ i ]. The value of fisheye\_scene\_radius[ i ] shall be less than or equal to fisheye\_circular\_region\_radius[ i ], and shall be in the range of 0 to 65 536 \* 216 − 1 (i.e., 4 294 967 295), inclusive. The enclosed area is the suggested area for stitching as recommended by the encoder.

**fisheye\_camera\_centre\_azimuth**[ i ] and **fisheye\_camera\_centre\_elevation**[ i ] indicate the spherical coordinates that correspond to the centre of the circular region that contains the i-th active area in the cropped output picture, in units of 2−16 degrees. The value of fisheye\_camera\_centre\_azimuth[ i ] shall be in the range of −180 \* 216 (i.e., −11 796 480) to 180 \* 216 − 1 (i.e., 11 796 479), inclusive, and the value of fisheye\_camera\_centre\_elevation[ i ] shall be in the range of −90 \* 216 (i.e., −5 898 240) to 90 \* 216 (i.e., 5 898 240), inclusive.

**fisheye\_camera\_centre\_tilt**[ i ] indicates the tilt angle of the i-th active area of the cropped output picture, in units of 2−16 degrees. The value of fisheye\_camera\_centre\_tilt[ i ] shall be in the range of −180 \* 216 (i.e., −11 796 480) to 180 \* 216 − 1 (i.e., 11 796 479), inclusive.

[Ed. (JB): fisheye\_camera\_centre\_azimuth[ i ] and fisheye\_camera\_centre\_elevation[ i ] refer to the circular region center containing the active area, but fisheye\_camera\_centre\_tilt[ i ] refers to the active area. Is that intentional? (YK): I think some (rather significant) improvement is indeed needed here. From the definition of the term tilt angle, the tilt angle is defined as associated with a sphere region, not a region on a 2D picture, while in the context here the active area, regardless of its shape, is a region on a 2D picture.]

**fisheye\_camera\_centre\_offset\_x**[ i ], **fisheye\_camera\_centre\_offset\_y**[ i ] and **fisheye\_camera\_centre\_offset\_z**[ i ] indicate the XYZ offset values, in units of 2−16 millimeters, of the focal centre of the fisheye camera lens corresponding to the i-th active area from the focal centre origin of the overall fisheye camera configuration. The value of each of fisheye\_camera\_centre\_offset\_x[ i ], fisheye\_camera\_centre\_offset\_y[ i ], and fisheye\_camera\_centre\_offset\_z[ i ] shall be in the range of 0 to 65 536 \* 216 − 1 (i.e., 4 294 967 295), inclusive.

**fisheye\_field\_of\_view**[ i ] specifies the spherical domain coverage of the i-th active area in the coded picture, in units of 2−16 degrees. The value of fisheye\_field\_of\_view[ i ] shall be in the range of 0 to 360 \* 216, inclusive.

[Ed. (JB): fisheye\_field\_of\_view[ i ] isn’t separated by x and y dimensions and refers to active area. Is it really referring to the field of view of the circle rather than the active area? (YK): Good question. If just one component it needs at least say which of the two dimensions this is about. But why just one component anyway.]

**fisheye\_num\_polynomial\_coeffs**[ i ] specifies the number of polynomial coefficients for the circular region corresponding to the i-th active area. The value of fisheye\_num\_polynomial\_coeffs[ i ] shall be in the range of 0 to 8, inclusive. Values of fisheye\_num\_polynomial\_coeffs[ i ] greater than 8 are reserved for future use by ITU-T | ISO/IEC. Decoders encountering a fisheye video information SEI message with fisheye\_num\_polynomial\_coeffs[ i ] greater than 8 shall ignore the fisheye video information SEI message.

**fisheye\_polynomial\_coeff**[ i ][ j ] specifies the j-th polynomial coefficient value, in units of 2−24, of the curve function that maps the normalized distance of a luma sample from the centre of the circular region corresponding to the i-th active area to the angular value of a sphere coordinate from the normal vector of the i-th image plane. [Ed. (YK): What is an "image plane"? Check the need of clarifying this in the text.] The value of fisheye\_polynomial\_coeff[ i ][ j ] shall be in the range of −128 \* 224 (i.e., 2 147 483 648) to 128 \* 224 − 1 (i.e., 2 147 483 647), inclusive.

*Renumber clause D.3.45 (Reserved SEI message semantics) as D.3.47.*

*Add clauses D.3.45 and D.3.46, as follows:*

**D.3.45 SEI manifest SEI message semantics**

The SEI manifest SEI message conveys information on SEI messages that are indicated as expected (i.e., likely) to be present or not present. Such information may include:

1. The indication that certain types of SEI messages are expected (i.e., likely) to be present (although not guaranteed to be present) in the CVS.
2. For each type of SEI message that is indicated as expected (i.e., likely) to be present in the CVS, the degree of expressed necessity of interpretation of the SEI messages of this type.

The degree of necessity of interpretation of an SEI message type may be indicated as "necessary", "unnecessary", or "undetermined".

An SEI message is indicated by the encoder (i.e., the content producer) as being "necessary" when the information conveyed by the SEI message is considered as necessary for interpretation by the decoder or receiving system in order to properly process the content and enable an adequate user experience; it does not mean that the bitstream is required to contain the SEI message in order to be a conforming bitstream. It is at the discretion of the encoder to determine which SEI messages are to be considered as necessary in a particular CVS. However, it is suggested that some SEI messages, such as the frame packing arrangement, segmented rectangular frame packing arrangement, and omnidirectional projection indication SEI messages, should typically be considered as necessary.

1. The indication that certain types of SEI messages are expected (i.e., likely) not to be present (although not guaranteed not to be present) in the CVS.

NOTE – An example of such a usage of an SEI manifest SEI message is to express the expectation that there are no frame packing arrangement SEI messages, segmented rectangular frame packing arrangement SEI messages, display orientation SEI messages, or omnidirectional projection indication SEI messages in the CVS, and therefore that the rendering of the decoded video pictures for display purposes would not need any of the additional post-processing that is commonly associated with the interpretation of these SEI messages.

The content of an SEI manifest SEI message may, for example, be used by transport-layer or systems-layer processing elements to determine whether the CVS is suitable for delivery to a receiving and decoding system, based on whether the receiving system can properly process the CVS to enable an adequate user experience or whether the CVS satisfies the application needs.

When an SEI manifest SEI message is present in any access unit of a CVS, an SEI manifest SEI message shall be present in the first access unit of the CVS. The SEI manifest SEI message persists in decoding order from the current access unit until the end of the CVS. When there are multiple SEI manifest SEI messages present in a CVS, they shall have the same content.

An SEI NAL unit containing an SEI manifest SEI message shall not contain any other SEI messages other than SEI prefix indication SEI messages. When present in an SEI NAL unit, the SEI manifest SEI message shall be the first SEI message in the SEI NAL unit.

**manifest\_num\_sei\_msg\_types** specifies the number of types of SEI messages for which information is provided in the SEI manifest SEI message.

**manifest\_sei\_payload\_type**[ i ] indicates the payloadType value of the i-th type of SEI message for which information is provided in the SEI manifest SEI message. The values of manifest\_sei\_payload\_type[ m ] and manifest\_sei\_payload\_type[ n ] shall not be identical when m is not equal to n.

**manifest\_sei\_description**[ i ] provides information on SEI messages with payloadType equal to manifest\_sei\_payload\_type[ i ] as specified in Table D.23.

Table D.23 – manifest\_sei\_description[ i ] values

|  |  |
| --- | --- |
| **Value** | **Description** |
| 0 | Indicates that there is no SEI message with payloadType equal to manifest\_sei\_payload\_type[ i ] expected to be present in the CVS. |
| 1 | Indicates that there are SEI messages with payloadType equal to manifest\_sei\_payload\_type[ i ] expected to be present in the CVS, and these SEI messages are considered as necessary. |
| 2 | Indicates that there are SEI messages with payloadType equal to manifest\_sei\_payload\_type[ i ] expected to be present in the CVS, and these SEI messages are considered as unnecessary. |
| 3 | Indicates that there are SEI messages with payloadType equal to manifest\_sei\_payload\_type[ i ] expected to be present in the CVS, and the necessity of these SEI messages is undetermined. |
| 4-255 | Reserved |

The value of manifest\_sei\_description[ i ] shall be in the range of 0 to 3, inclusive, in bitstreams conforming to this version of this Specification. Other values for manifest\_sei\_description[ i ] are reserved for future use by ITU-T | ISO/IEC. Decoders shall allow the value of manifest\_sei\_description[ i ] greater than or equal to 4 to appear in the syntax and shall ignore all information for payloadType equal to manifest\_sei\_payload\_type[ i ] signalled in the SEI manifest SEI message and shall ignore all SEI prefix indication SEI messages with prefix\_sei\_payload\_type equal to manifest\_sei\_payload\_type[ i ] when manifest\_sei\_description[ i ] is greater than or equal to 4.

**D.3.46 SEI prefix indication SEI message semantics**

The SEI prefix indication SEI message carries one or more SEI prefix indications for SEI messages of a particular value of payloadType. Each SEI prefix indication is a bit string that follows the SEI payload syntax of that value of payloadType and contains a number of complete syntax elements starting from the first syntax element in the SEI payload.

Each SEI prefix indication for an SEI message of a particular value of payloadType indicates that one or more SEI messages of this value of payloadType are expected (i.e., likely) to be present in the CVS and to start with the provided bit string. A starting bit string would typically contain only a true subset of an SEI payload of the type of SEI message indicated by the payloadType, may contain a complete SEI payload, and shall not contain more than a complete SEI payload. It is not prohibited for SEI messages of the indicated value of payloadType to be present that do not start with any of the indicated bit strings.

These SEI prefix indications should provide sufficient information for indicating what type of processing is needed or what type of content is included. The former (type of processing) indicates decoder-side processing capability, e.g., whether some type of frame unpacking is needed. The latter (type of content) indicates, for example, whether the bitstream contains subtitle captions in a particular language.

The content of an SEI prefix indication SEI message may, for example, be used by transport-layer or systems-layer processing elements to determine whether the CVS is suitable for delivery to a receiving and decoding system, based on whether the receiving system can properly process the CVS to enable an adequate user experience or whether the CVS satisfies the application needs (as determined in some manner by external means outside the scope of this Specification).

In one example, when the payloadType indicates the frame packing arrangement SEI message, an SEI prefix indication should include up to at least the syntax element frame\_packing\_arrangement\_type; and when the payloadType indicates the omnidirectional projection indication SEI message, an SEI prefix indication should include up to at least the syntax element projection\_type.

In another example, for user data registered SEI messages that are used to carry captioning information, an SEI prefix indication should include up to at least the language code; and for user data unregistered SEI messages extended for private use, an SEI prefix indication should include up to at least the UUID.

When an SEI prefix indication SEI message is present in any access unit of a CVS, an SEI prefix indication SEI message shall be present in the first access unit of the CVS. The SEI prefix indication SEI message persists in decoding order from the current access unit until the end of the CVS. When there are multiple SEI prefix indication SEI messages present in a CVS for a particular value of payloadType, they shall have the same content.

An SEI NAL unit containing an SEI prefix indication SEI message for a particular value of payloadType shall not contain any other SEI messages other than an SEI manifest SEI message and SEI prefix indication SEI messages for other values of payloadType.

**prefix\_sei\_payload\_type** indicates the payloadType value of the SEI messages for which one or more SEI prefix indications are provided in the SEI prefix indication SEI message. When an SEI manifest SEI message is also present for the CVS, the value of prefix\_sei\_payload\_type shall be equal to one of the manifest\_sei\_payload\_type[ m ] values for which manifest\_sei\_description[ m ] is equal to 1 to 3, inclusive, as indicated by an SEI manifest SEI message that applies to the CVS.

**num\_sei\_prefix\_indications\_minus1** plus 1 specifies the number of SEI prefix indications.

**num\_bits\_in\_prefix\_indication\_minus1**[ i ] plus 1 specifies the number of bits in the i-th SEI prefix indication.

**sei\_prefix\_data\_bit**[ i ][ j ] specifies the j-th bit of the i-th SEI prefix indication.

The bits sei\_prefix\_data\_bit[ i ][ j ] for j ranging from 0 to num\_bits\_in\_prefix\_indication\_minus1[ i ], inclusive, follow the syntax of the SEI payload with payloadType equal to prefix\_sei\_payload\_type, and contain a number of complete syntax elements starting from the first syntax element in the SEI payload syntax, and may or may not contain all the syntax elements in the SEI payload syntax. The last bit of these bits (i.e., the bit sei\_prefix\_data\_bit[ i ][ num\_bits\_in\_prefix\_indication\_minus1[ i ] ]) shall be the last bit of a syntax element in the SEI payload syntax, unless it is a bit within an itu\_t\_t35\_payload\_byte or user\_data\_payload\_byte.

NOTE – The exception for itu\_t\_t35\_payload\_byte and user\_data\_payload\_byte is provided because these syntax elements may contain externally-specified syntax elements, and the determination of the boundaries of such externally-specified syntax elements is a matter outside the scope of this Specification.

**byte\_alignment\_bit\_equal\_to\_one** shall be equal to 1.

*In F.14.3.1 (General SEI payload semantics), replace the following paragraphs:*

The list VclAssociatedSeiList is set to consist of the payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 151, inclusive, 154 to 159, inclusive, 161, 165, 167, and 168.

The list PicUnitRepConSeiList is set to consist of the payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 151, inclusive, and 154 to 168, inclusive.

*with the following:*

The list VclAssociatedSeiList is set to consist of the payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, 161, 165, 167, 168, and 200 to 201, inclusive.

The list PicUnitRepConSeiList is set to consist of the payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 152, inclusive, 154 to 168, inclusive, and 200 to 201, inclusive.

*In G.14.3.1 (General SEI payload semantics), replace the following paragraphs:*

The list VclAssociatedSeiList is set to consist of payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 151, inclusive, 154 to 159, inclusive, 161, 165, 167, 168, 177, 178, and 179.

The list PicUnitRepConSeiList is set to consist of payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 151, inclusive, 154 to 168, inclusive, and 176 to 180, inclusive.

*with the following:*

The list VclAssociatedSeiList is set to consist of payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, 161, 165, 167, 168, 177, 178, 179, and 200 to 201, inclusive.

The list PicUnitRepConSeiList is set to consist of payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 152, inclusive, 154 to 168, inclusive, 176 to 180, inclusive, and 200 to 201, inclusive.

*In I.14.3.1 (General SEI payload semantics), replace the following paragraphs:*

The list VclAssociatedSeiList is set to consist of payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 151, inclusive, 154 to 159, inclusive, 161, 165, 167, 168, 177, 178, and 179.

The list PicUnitRepConSeiList is set to consist of payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 151, inclusive, 154 to 168, inclusive, and 176 to 181, inclusive.

*with the following:*

The list VclAssociatedSeiList is set to consist of payloadType values 2, 3, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 131, 132, 134 to 152, inclusive, 154 to 159, inclusive, 161, 165, 167, 168, 177, 178, 179, and 200 to 201, inclusive.

The list PicUnitRepConSeiList is set to consist of payloadType values 0, 1, 2, 6, 9, 15, 16, 17, 19, 22, 23, 45, 47, 56, 128, 129, 131, 132, 133, 135 to 152, inclusive, 154 to 168, inclusive, 176 to 181, inclusive, and 200 to 201, inclusive.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_