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| *Title:* | **SEI messages on SEI messages** | | |
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# Abstract

This contribution proposes two new SEI messages, named the essential supplemental information (ESI) SEI message and the non-essential supplemental information (NSI) SEI message, for inclusion into HEVC.

The ESI SEI message provides the list of essential SEI messages that are present in the bitstream, where an essential SEI message provides information that the encoder (i.e., the content producer) considers as essential for the decoder side to properly process to enable a desirable user experience. The NSI SEI message provides the list of non-essential SEI messages that are present in the bitstream, where a non-essential SEI message is an SEI message that is not considered by the encoder (i.e., the content producer) as an essential SEI message.

The authors advocate that the two proposed SEI messages should also be considered for inclusion into AVC and future video coding standards.

# Background

In video coding specifications, as long as something does not affect decoding of picture samples, that information can be included in an SEI message. This includes frame packing information as well as omnidirectional projection indication information. However, from systems and application point of view, such information is essential for the entire video application system to perform well, and thus such information should be treated similarly as those information that is important for video decoding interoperability such as codec, profile and level in systems operations, including encapsulating a coded video bitstream into a media file according to the ISO base media file format (ISOBMFF) or a media presentation according to the dynamic adaptive streaming over HTTP (DASH).

When encapsulating a coded video bitstream into an ISOBMFF file or a DASH media presentation, essential information such as mentioned above needs to be exposed at high level, e.g., in the file format sample entry, the DASH media presentation description (MPD), and/or MIME type parameters. To avoid scanning the bitstream to figure out what essential information is included in SEI messages in the bitstream, and more difficultly, figure out which information in which SEI messages is essential or not (as whether some of such information should be considered essential may be at the discretion of the encoder, i.e., the content producer), it would be greatly useful to have such information easily accessible in the bitstream, e.g., collectively in one SEI message. If such an SEI message is available, it would also avoid the need of checking and making a different systems design in systems standards each time when a new SEI message containing essential information is introduced (one recent such example is omnidirectional projection indication).

This contribution tries to address this issue by proposing a new SEI message, named essential supplemental information (ESI) SEI message, to convey information on the list of essential SEI messages present in the bitstream. At the same time, for possible convenience, another new SEI message, named the non-essential supplemental information (NSI) SEI message, is also proposed, to convey information on the list of non-essential SEI messages present in the bitstream.

# The essential supplemental information (ESI) SEI message

## ESI SEI message syntax

|  |  |
| --- | --- |
| essential\_supplemental\_information( payloadSize ) { | **Descriptor** |
| **num\_essential\_sei\_msg\_types** | u(16) |
| for( i = 0; i < num\_essential\_sei\_msg\_types; i++ ) { |  |
| **essential\_sei\_payload\_type**[ i ] | u(16) |
| **num\_esei\_init\_payload\_databits**[ i ] | u(16) |
| for( j = 0; j < num\_esei\_init\_pldbits; j++ ) { |  |
| **esei\_payload\_data\_bit**[ i ][ j ] | u(1) |
| while( !byte\_aligned( ) ) |  |
| **esei\_alignment\_bit\_equal\_to\_zero** /\* equal to 0 \*/ | f(1) |
| } |  |
| } |  |

## ESI SEI message semantics

The essential supplemental information (ESI) SEI message conveys information on all essential SEI messages present in the bitstream. An essential SEI message is such an SEI message for which the carried information is considered by the encoder (i.e., the content producer) as essential for the decoder side to properly process to enable a desirable user experience. It is at the discretion of the encoder (i.e., the content producer) to determine which types of SEI messages are essential SEI messages in a particular bitstream.

When an ESI SEI message is present in any access unit of a CVS, an ESI SEI message shall be present in the first access unit of the CVS. The ESI SEI message persists in decoding order from the current access unit until the end of the CVS.

An SEI NAL unit containing an ESI SEI message shall not contain any other SEI message that is not a non-essential supplemental information SEI message. When there are multiple ESI messages present in a CVS, they shall have the same content.

**num\_essential\_sei\_msg\_types** specifies the number of types of SEI messages present in the CVS that are considered as essential SEI messages.

**essential\_sei\_payload\_type**[ i ] indicates the payloadType value of the i-th type of essential SEI messages. For any two different values m and n, the values of essential\_sei\_payload\_type[ m ] and essential\_sei\_payload\_type[ n ] shall not be identical.

**num\_esei\_init\_payload\_databits**[ i ] specifies the number of the following bits that provide additional information about the i-th type of essential SEI messages present in the CVS.

**esei\_payload\_data\_bit**[ i ][ j ] specfies the j-th bit of the bits that provide additional information about the i-th type of essential SEI messages present in the CVS.

The num\_esei\_init\_payload\_databits[ i ] bits follow the SEI payload syntax for the payloadType of the i-th type of essential SEI messages, and contain a number of syntax elements starting from the first syntax element in the SEI payload syntax, but may or may not contain all the syntax elements in the SEI payload syntax. The last bit shall be the last bit of a syntax element in the SEI payload syntax. The syntax elements contained in these bits have the same semantics as if they were in an SEI message with the payloadType, with the exception that the information here applies to the entire CVS.

These bits should provide sufficient information for indicating what types of processing is needed at the decoder side from processing capability point of view, based on which systems layer entities can determine whether the decoder side can properly process the bitstream to enable a desirable user experience. For example, if the payloadType is 45 (i.e., the frame packing arrangement SEI message), these bits should at least include the syntax element frame\_packing\_arrangement\_type. For another example, if the payloadType is 150 (i.e., the omnidirectional projection indication SEI message as specified in JCTVC-Z1005), these bits should at least include the syntax element projection\_type.

**esei\_alignment\_bit\_equal\_to\_zero** shall be equal to 0.

# The non-essential supplemental information (NSI) SEI message

## NSI SEI message syntax

|  |  |
| --- | --- |
| nonessential\_supplemental\_information( payloadSize ) { | **Descriptor** |
| **num\_nonessential\_sei\_msg\_types** | u(16) |
| for( i = 0; i < num\_nonessential\_sei\_msg\_types; i++ ) { |  |
| **nonessential\_sei\_payload\_type**[ i ] | u(16) |
| **num\_nesei\_init\_payload\_databits**[ i ] | u(16) |
| for( j = 0; j < num\_nesei\_init\_pldbits; j++ ) { |  |
| **nesei\_payload\_data\_bit**[ i ][ j ] | u(1) |
| while( !byte\_aligned( ) ) |  |
| **nesei\_alignment\_bit\_equal\_to\_zero** /\* equal to 0 \*/ | f(1) |
| } |  |
| } |  |

## NSI SEI message semantics

The non-essential supplemental information (NSI) SEI message conveys information on all the non-essential SEI messages present in the bitstream. A non-essential SEI message is such an SEI message that is not considered by the encoder (i.e., the content producer) as an essential SEI message. It is at the discretion of the encoder (i.e., the content producer) to determine which types of SEI messages are non-essential SEI messages in a particular bitstream.

When a NSI SEI message is present in any access unit of a CVS, a NSI SEI message shall be present in the first access unit of the CVS. The NSI SEI message persists in decoding order from the current access unit until the end of the CVS.

An SEI NAL unit containing a NSI SEI message shall not contain any other SEI message that is not an ESI SEI message. When there are multiple NSI messages present in a CVS, they shall have the same content.

When a particular type of SEI messages is identified by an ESI SEI message in a CVS as essential SEI messages, the same type of SEI messages shall not be identified by a NSI SEI message in the CVS as non-essential SEI messages.

**num\_nonessential\_sei\_msg\_types** specifies the number of types of SEI messages present in the CVS that are considered as non-essential SEI messages.

**nonessential\_sei\_payload\_type**[ i ] indicates the payloadType value of the i-th type of non-essential SEI messages. For any two different values m and n, the values of nonessential\_sei\_payload\_type[ m ] and nonessential\_sei\_payload\_type[ n ] shall not be identical.

**num\_nesei\_init\_payload\_databits**[ i ] specifies the number of the following bits that provide additional information about the i-th type of non-essential SEI messages present in the CVS.

**nesei\_payload\_data\_bit**[ i ][ j ] specfies the j-th bit of the bits that provide additional information about the i-th type of non-essential SEI messages present in the CVS.

The num\_nesei\_init\_payload\_databits[ i ] bits follow the SEI payload syntax for the payloadType of the i-th type of non-essential SEI messages, and contain a number of syntax elements starting from the first syntax element in the SEI payload syntax, but may or may not contain all the syntax elements in the SEI payload syntax. The last bit shall be the last bit of a syntax element in the SEI payload syntax. The syntax elements contained in these bits have the same semantics as if they were in an SEI message with the payloadType, with the exception that the information here applies to the entire CVS.

**nesei\_alignment\_bit\_equal\_to\_zero** shall be equal to 0.

# Forming the lists of essential and non-essential SEI messages

The authors studied the SEI messages specified in Annex D, including in the published HEVC specification as well as in the draft amendment text in JCTVC-Z1005, but not those SEI messages specified for the multi-layer contexts, i.e., in Annex F and the subsequent annexes. Below is a recommendation for the Annex D SEI messages on forming the lists of essential and non-essential SEI messages.

Critics from JCT-VC experts knowledgeable in the different areas covered by the various different SEI messages are warmly welcome.

It is suggested that the following SEI messages, when present (natively present or contained in a nesting SEI message), which surely affect the rendering of decoded pictures in a serious manner, are strongly recommended to be included into the list of essential SEI messages, but the decision is still at the discretion of the encoder:

* The frame packing arrangement SEI message
* The display orientation SEI message
* The segmented rectangular frame packing arrangement SEI message
* The omnidirectional projection indication SEI message

The following SEI messages, when present (natively present or contained in a nesting SEI message), which affect the rendering of decoded pictures to some extent, may or may not be included into the list essential SEI messages, at the discretion of the encoder:

* The film grain characteristics SEI message
* The post-filter hint SEI message
* The tone mapping information SEI message
* The no display SEI message
* The no display SEI message
* The mastering display colour volume SEI message
* The chroma resampling filter hint SEI message
* The knee function information SEI message
* The colour remapping information SEI message
* The deinterlaced picture information SEI message
* The content light level information SEI message
* The alternative transfer characteristics SEI message
* The ambient viewing environment SEI message
* The content colour volume SEI message

Other SEI messages, when present (natively present or contained in a nesting SEI message), are less likely to affect the rendering of decoded pictures, may or may not be included into the list of essential SEI messages, at the discretion of the encoder. For example, the encoder may determine that a user data registered by Recommendation ITU-T T.35 SEI message or a user data unregistered SEI message carries essential information and consequently include that SEI payload type into the list of essential SEI messages and provide some additional information to sufficiently indicate the required processing capability.

# Systems level exposure of essential supplemental information

On the file format level, the essential supplemental information carried in the ESI SEI message can be included in the sample entry. For example, the SEI NAL unit containing an ESI SEI message (which may also contain a NSI SEI message) can be directly included in the array of SEI NAL units in the decoder configuration record of an HEVC sample entry, as specified in ISO/IEC 14496-15, which specifies the file formats for AVC and its extensions as well as HEVC and its extensions. It is recommended that the SEI NAL unit containing an ESI SEI message should be included as the first SEI NAL unit of the SEI NAL unit array in the decoder configuration record.

ISO/IEC 14496-15 also specifies the sub-parameters for the MIME type ‘codecs’ parameter for AVC and HEVC and their extensions. On the DASH level, the MIME type parameter can be directly exposed as an attribute (i.e., @mimeType) in the MPD. The SEI NAL unit containing an ESI SEI message can be directly included as part of the ‘codecs’ parameter or a different MIME type parameter, thus enabling its exposure to the MPD through the @mimeType attribute.

In MPEG-2 systems, the SEI NAL unit containing an ESI SEI message can be directly included as part of the descriptor that contains the video codec profile and level information, as a similar descriptor.

In applications using RTP for media transport and SDP for signalling, the SEI NAL unit containing an ESI SEI message can be directly included into an SDP file as an SDP attribute.

# Patent rights declaration(s)

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