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| *Title:* | **On the MCTS related SEI messages** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This document provides some comments on the motion-constrained tile set (MCTS) related SEI messages in the latest HEVC specification as well as in the draft HEVC amendment text in JCTVC-Z1005 ("HEVC Additional Supplemental Enhancement Information (Draft 1)"), and proposes text changes to address some of the comments.

The text changes are in the attachment, with changes marked relative to JCTVC-Z1005. Some other changes, asserted as obvious and minor, are also included.

# List of comments and suggestions

1. **Comment:** In D.2.43 and D.2.44, some syntax element names are a substring or superset of some other syntax element names in JCTVC-Z1005 or the published HEVC specification. For example: mcts\_identifier is a superset of mcts\_id, and a subset of num\_associated\_mcts\_identifiers\_minus1. Also, some syntax element names for different SEI messages are the same. For example, mcts\_identifier is a syntax element name used by both of the new MCTS related SEI messages.

**Suggestion:** Avoid subset relationships between syntax element names.

Text change for this suggestion is included in the attachment.

1. **Comment:** In D.3.30, there exists the following constraint:

"The number of temporal motion-constrained tile sets SEI messages applicable to the same nuh\_layer\_id value in each access unit shall not exceed 5."

At the same time, this SEI message (payloadType 139) is also included in the list PicUnitRepConSeiList that consists of the payloadType values of the SEI messages that are subject to the restriction on 8 repetitions per picture unit.

**Suggestion:** For consistency, remove the quoted constraint and keep 139 included in PicUnitRepConSeiList.

Text change for this suggestion is included in the attachment.

1. **Comment:** In D.3.30, the value of num\_sets\_in\_message\_minus1 of the temporal MCTSs SEI message is specified to be in the range of 0 to 255, inclusive, i.e., the number of MCTSs allowed to be signalled is at most 256. However, in virtual reality (VR) or 360 degree video applications, considering the possible number of combinations of tiles, each combination corresponding to one MCTS, including cases where a particular tile may be included in multiple MCTSs, the maximum number 256 may not be sufficient.

**Suggestion:** Increase the maximum number of allowed MCTSs to be signalled, e.g., to 1024, 2048, or 4096. Strictly speaking, such a change would cause some backward compatibility issue. However, the issue should be limited, considering that implementations of MCTS have probably been limited before while most likely will be abundant in the future for VR applications.

If such a change is not to be made, then some other means that enables the signalling of the required decoding capability (e.g., level) of combinations of MCTSs should be considered, and sub-bitstream extraction for combinations of MCTSs should also be considered (currently, the MCTS sub-bitstream extraction process only enables extraction of a sub-bitstream for a single MCTS). Comment #11 below is related.

Text change for this suggestion is NOT included in the attachment.

1. **Comment:** In D.3.30, the value ranges of top\_left\_tile\_index[ i ][ j ] and bottom\_right\_tile\_index[ i ][ j ] are missing.

**Suggestion:** Discuss what the value ranges should be for top\_left\_tile\_index[ i ][ j ] and bottom\_right\_tile\_index[ i ][ j ] and add the value ranges.

Text change for this suggestion is NOT included in the attachment.

1. **Comment:** To be meaningful, a motion-constrained tile set extraction information set (MCTS-EIS) SEI message has to depend on a temporal MCTS SEI message. However, the presence of an MCTS-EIS SEI message in an access unit is not conditioned on the presence of a temporal MCTS SEI message. This makes the semantics of the MCTS-EIS SEI message unnecessarily complicated, particularly with the need of specifying its own set of associated/applicable pictures associatedPicSet and the need of specifying a few complicated bitstream constraints on this SEI message itself and on the temporal MCTS SEI message (as part of the semantics of the MCTS-EIS SEI message, which should not be in any case).

**Suggestion:** Add a constraint to require that an MCTS-EIS SEI message shall not be present in an access unit unless there is a temporal MCTS SEI message present in the access unit.

Specify that the set of associated pictures associatedPicSet of the associated temporal MCTS SEI message applies to the MCTS-EIS SEI message.

Remove the following text (that's for specifying the definition of associatedPicSet and the bitstream constraints on the MCTS-EIS SEI message and on the temporal MCTSs SEI message):

"Let a set of pictures associatedPicSet be the pictures from the access unit containing the motion-constrained tile sets extraction information set SEI message, inclusive, up to but not including the first of any of the following in decoding order:

– The next access unit, in decoding order, that contains a motion-constrained tile sets extraction information set SEI message.

– The next IRAP picture with NoRaslOutputFlag equal to 1, in decoding order.

– The next IRAP access unit, in decoding order, with NoClrasOutputFlag equal to 1.

The scope of the motion-constrained tile sets extraction information set SEI message is the set of pictures associatedPicSet.

When a motion-constrained tile sets extraction information set tile sets SEI message is present for any picture in associatedPicSet, a temporal motion-constrained tile set SEI message shall be present for the first picture of associatedPicSet in decoding order and may also be present for other pictures of associatedPicSet. The temporal motion-constrained tile sets SEI message shall have with mcts\_id[ ] equal to mcts\_identifer[ ] for all pictures in associatedPicSet.

When a motion-constrained tile sets extraction information set tile sets SEI message is present for any picture in associatedPicSet, a motion-constrained tile sets extraction information set SEI message shall be present for the first picture of associatedPicSet in decoding order and may also be present for other pictures of associatedPicSet.

The motion-constrained tile sets extraction information set SEI message shall not be present for any picture in associatedPicSet when tiles\_enabled\_flag is equal to 0 for any PPS that is active for any picture in associatedPicSet.

The motion-constrained tile sets extraction information set SEI message shall not be present for any picture in associatedPicSet unless every PPS that is active for any picture in associatedPicSet has the same values of the syntax elements num\_tile\_columns\_minus1, num\_tile\_rows\_minus1, uniform\_spacing\_flag, column\_width\_minus1[ i ], and row\_height\_minus1[ i ].

NOTE 1 – This constraint is similar to the constraint associated with tiles\_fixed\_structure\_flag equal to 1, and it may be desirable for tiles\_fixed\_structure\_flag to be equal to 1 when the motion-constrained tile sets extraction information set SEI message is present (although this is not required)."

Text change for this suggestion is included in the attachment.

1. **Comment:** For both the MCTS-EIS SEI message and the MCTSs extraction information nesting SEI message (referred to as the MCTS nesting SEI message for simplicity), MCTS identifiers represented by instances of the mcts\_id[ i ] syntax element of the associated temporal MCTSs SEI message are used in the semantics. However, the following issues exists here:
2. The current semantics of the temporal MCTSs SEI message specify that mcts\_id[ i ] contains an identifying number that may be used to identify the purpose of the i-th identified tile set. In other words, mcts\_id[ i ] is not the MCTS identifier, but the MCTS purpose, and different MCTSs can have the same value of mcts\_id[ i ] (for the same purpose). Furthermore, values for mcts\_id[ i ] are currently either reserved for future use by ITU-T | ISO/IEC or specified as "may be determined by the application" and decoders encountering temporal MCTSs SEI messages with mcts\_id[ i ] having values of the first category shall ignore the SEI messages (and in this case these two MCTS related SEI messages would also become useless as they depend on temporal MCTSs SEI messages), while values for mcts\_id[ i ] of the second category would be meaningless for any application unless that application specifies the values.
3. When each\_tile\_one\_tile\_set\_flag of the associated temporal MCTSs SEI message is equal to 1, there is no mcts\_id[ i ] present or inferred. Consequently, this scenario, which seems likely to be common, is not supported.

**Suggestion:** Specify the following:

If the value of each\_tile\_one\_tile\_set\_flag of the associated temporal MCTS SEI message is equal to 0, the MCTS identifier of an MCTS of the current picture is the value of the index of the MCTS, where the index is the variable i within the loop of the num\_sets\_in\_message\_minus1 + 1 sets of MCTS information specified by the associated temporal MCTS SEI message. Otherwise, the MCTS identifier of each MCTS, which consists of one single tile, is the tile position of the single tile in the MCTS in tile raster scan order.

Text change for this suggestion is included in the attachment.

1. **Comment:** There exists the following constraint:

"The number of MCTS-EIS SEI messages in each access unit shall not exceed 5."

At the same time, this SEI message (payloadType 152) is also included in the list PicUnitRepConSeiList that consists of the payloadType values of the SEI messages that are subject to the restriction on 8 repetitions per picture unit.

**Suggestion:** For consistency, remove the quoted constraint and keep 152 included in PicUnitRepConSeiList.

Text change for this suggestion is included in the attachment.

1. **Comment:** For both the MCTS-EIS SEI message and the the MCTS nesting SEI message, the value range of a few syntax elements is specified to be 0 to 232 − 2, inclusive, including for the number of extraction information sets and the number of MCTSs associated with one extraction information set or the MCTS-nested SEI messages. The upper limit is unreasonably high.

**Suggestion:** Set the upper limit to a more reasonable and practical value such as 255, 511, 1023, 2047 or 4095.

Text change for this suggestion is included in the attachment.

1. **Comment:** There is a step in the MCTS sub-bitstream extraction process to remove all SEI NAL units that have nuh\_layer\_id equal to 0 and that contain non-MCTS-nested SEI messages. However, having the condition "that have nuh\_layer\_id equal to 0" would keep all SEI NAL units with nuh\_layer\_id greater than 0 in the extracted bitstream, while non-MCTS-nested SEI messages in SEI NAL units with nuh\_layer\_id greater than 0, if present, would not apply to an extracted MCTS, and thus should not be included in the extracted sub-bitstream.

**Suggestion:** Remove the condition "that have nuh\_layer\_id equal to 0" from the step in the MCTS sub-bitstream extraction process that specifies the removal of all SEI NAL units that have nuh\_layer\_id equal to 0 and that contain non-MCTS-nested SEI messages.

Text change for this suggestion is included in the attachment.

1. **Comment:** The final step of the MCTS sub-bitstream extraction process is to adjust the slice segment header of each VCL NAL unit, including setting the values of the slice segment header syntax elements first\_slice\_segment\_in\_pic\_flag and slice\_segment\_address. However, when there is slice segment header dependency of a dependent slice segment of the target MCTS on an independent slice segment of another MCTS, this sub-bitstream extraction process won't generate a conforming bitstream, because a lot of the slice segment syntax elements are not available for that dependent slice segment header.

**Suggestion:** Add the following constraint (to the semantics of the temporal MCTSs SEI message):

A slice segment that contains one or more tiles belonging to any particular MCTS mctsA shall not be a dependent slice segment of an independent slice segment that contains one or more tiles that do not belong to mctsA.

Text change for this suggestion is included in the attachment.

1. **Comment:** An MCTS containing non-neighboring tiles is not supported by the design of the temporal MCTSs SEI message, while the MCTS sub-bitstream extraction specifies the extraction of a sub-bitstream for one MCTS only. However, in virtual reality or 360 degree video applications, non-neighboring tiles may actually correspond to one region on the spherical surface, and it can be desirable to indicate the required decoding capability, e.g., level, of such a set of non-neighboring tiles and to enable extraction of a conforming bitstream for such a set of non-neighboring tiles.

**Suggestion:** Change the MCTS-EIS SEI message as follows:

* In the MCTS sub-bitstream extraction process specified as part of the semantics, instead of extracting a sub-bitstream for one MCTS, a sub-bitstream is extracted for a set of one or more MCTSs.
* The tier and level information for each set of MCTSs for which a conforming bitstream can be extracted is explicitly signalled in the MCTS-EIS SEI message when the set of MCTSs contains more than one MCTS.
* To keep the functionality for sharing of replacement VPSs, SPSs, and PPSs by multiple extractable data sets, within the loop of extraction information sets, add one more loop, such that there is a list of extractable sets of MCTSs signalled for each extraction information set, and for each extractable set of MCTSs, the list of the MCTS identifiers is signalled. The replacement VPSs, SPSs, and PPSs of one extraction information set applies to the extraction of a sub-bitstream for any particular extractable set of MCTSs.

It is asserted that this solution also solves the problem mentioned in comment #3 above.

Text change for this suggestion is included in the attachment.

1. **Comment:** To be meaningful, an MCTS nesting SEI message has to depend on a temporal MCTSs SEI message as well as on an MCTS-EIS SEI message. However, the presence of an MCTS nesting SEI message in an access unit is not conditioned on the presence of a temporal MCTSs SEI message or an MCTS-EIS SEI message.

**Suggestion:** Add the following constraint:

An MCTS nesting SEI message shall not be present in an access unit unless there is an MCTS-EIS SEI message present in the access unit.

Text change for this suggestion is included in the attachment.

1. **Comment:** An SEI NAL unit containing an MCTS nesting SEI message may contain non-MCTS-nested SEI messages. However, this unnecessarily complicates the extraction of a conforming bitstream for an MCTS that contain SEI messages, and actually, one step of the MCTS sub-bitstream extraction process as specified in the semantics of the MCTS-EIS SEI message would remove such SEI NAL units.

**Suggestion:** Add the following constraint:

An SEI NAL unit containing an MCTS nesting SEI message shall not contain any other SEI message that is not MCTS-nested in the MCTS-nesting SEI message.

Text change for this suggestion is included in the attachment.

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