

**ISO/IEC JTC 1/SC 29/WG 11**

**Coding of moving pictures and audio**

**Convenorship: UNI (Italy)**

**ISO/IEC JTC 1/SC 29/WG 11 N18895**

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**INTERNATIONAL ORGANISATION FOR STANDARDISATION**

**ORGANISATION INTERNATIONALE DE NORMALISATION**

**ISO/IEC JTC 1/SC 29/WG 11**

**CODING OF MOVING PICTURES AND AUDIO**

**ISO/IEC JTC 1/SC 29/WG 11 N18895**

**Geneva, CH – October 2019**

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| **Source:** | **3DG** |
| **Title:** | **Draft DoC for ISO/IEC CD 23090-9 Geometry-based Point Cloud Compression** |

**Draft DoC for ISO/IEC CD 23090-9 Geometry-based Point Cloud Compression**

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NOTE: This is a draft only – actual disposition of comments will be generated as an output of the MPEG 129th Brussel meeting.

# General

List of general issues with classification:

## Definitions

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| --- | --- | --- | --- | --- | --- |
| **MB/** | **Clause/**  **Paragraph/**  **Subclause**  **Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| **NC1** |
| US-019 | 6.1, 6.2 | te | Essential subclauses, but incomplete. | Please consider making them complete. | Accept |
|
| US-022 | 6.3 | te | Empty subclause for “Geometry octree”. Unclear if they should be removed or to be completed. | Please clarify. | Accept |
|
| US-023 | 6.4.2 | te | The formula to update occMapP does not seem to be correct. | Consider changing the formula to occMapP = occMapP | ( (( occMap >> srcIdx ) & 0x01) << dstIdx ). | Accept |
|

## Geometry coding

Note - some include the HLS aspects

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| US-029 | 7.3.3.2 | te | gsh\_num\_points does not seem to be necessary as it can be derived after decoding the geometry. | Consider removing the syntax element. | Discussed in BoG, 3DG welcomes proposals for consideration. Possible options are to: - use SEI metadata - add explicit check to decoding process - add conformance constraints: - bitstream: must have correct num points - decoder: must do right thing - remove and use levels instead |
| US-053 | 7.4.3.4 | te | In the paragraph starting with “When direct\_mode\_flag is equal to 0”, the initialization of nodeIdx seems incorrect. | Consider initializing nodeIdx to 0. | Accept |
| US-054 | 7.4.3.4 | te | The equations after “If NeighbAvailabilityMaskisnot equal to0, the following applies” do not seem to be correct. First, parenthesis should be used for '&' operation. Second, the computed values do not seem to be the desired ones. | Fix the formula. | Accept |
| FR -093 | 7.4.3.5 | te | Uncompleted semantics for geometry trisoup. Missing range on unbounded descriptors. | Define range for geometry trisoup syntax elements | To be reviewed, 3DG welcomes proposals for consideration |
| US-064 | 9.1 | te | trisoup segment\_indicator and vertex\_position are unary coded with large values of maxVal. | The committee should consider alternative binarisation schemes. | To be reviewed, 3DG welcomes proposals for consideration |

## Attribute coding

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| FR -090 | 7.3.4.4 | te | Unclear whether "values" is a variable or a syntax element. Besides "remaining\_values" should be renamed to not comprise the chain "values" already in use | Apply ISO/ITU-T rules for syntax | Accept |
| US-030 | 7.3.4.2 | te | Attribute slice header enumerates QP-related parameters specifically for luma and chroma. How about the point clouds with different attribute types? | Please clarify or consider appropriate improvements. | Discussed in BoG. Recommend to use component indexes rather than luma/chroma |
| US-032 | 7.3.4.3 | te | Consider removing the tight decoding dependency between maxPredDiff and predIndex with suitable constraints or by other technical means. | Evaluate technical measures to simplify implementations. | To be reviewed, 3DG welcomes proposals for consideration |

## AEC (Arithmetic Entropy Coding)

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| CA-066 | 9.5.1 | te | The descriptor for dictionary-based parsing should be de(v) and not ae(v) | Change the descriptor to de(v) | Accept |

## HLS

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| US-001 |  | te | The bitstream format does not adequately support identification of frames at the slice level. | Consider adding the ability to signal multiple frames. | This has been addressed by the adoption of m51025 |
| US-006 | Table 5 | te | Review if further attribute types should be identified. | Add frame index attribute type and any further types identified by the committee. | To be reviewed, 3DG welcomes proposals for consideration |
| US-025 | 7.3.2.1 | te | sps\_source\_scale\_factor should be represented as a rational number. | Include \_numerator, and \_denominator syntax elements. | Discussed in BoG, encoding of numerator and denominator needs to be defined. 3DG welcomes proposals for consideration |
| US-028 | 7.3.2.4 | te | Consider if GPS and APS should be merged into a single parameter set, while retaining the functionality of signalling multiple GPS/APS variants. | Give due consideration to the use of the feature versus needs of high-level encapsulation. | Discussed in BoG, the benefit of merging the two seems to be outweighed by the loss of flexibility |
| US-037 | 7.4 | te | Parameter set contents should be identical within a sequence. | Add constraint on parameter set contents. | Discussed in BoG, recommend to add constraint |
| FR -089 | 7.3.2.1 7.4.2.1 | te | profile\_compatibility\_flags syntax and semantics are inconsistent: - profile\_idc is undefined - profile\_compatibility\_flags semantics describes an array while a bitwise operator might be intended? | Harmonize syntax and semantics of profile\_compatibility\_flags | Accept |
| FR -092 | 7.4.2.1 | te | attribute\_label\_four\_types is 32 bits long but Table 5 defining the semantics only defines 2 values. Remaining values seem "unspecified" | Consider shortening the 4 bytes reserved values. Define a range of "reserved (for future use)" values and possibly one value that is "unspecified" (e.g. value 2). Please see MPEG video coding standards usage of terms "reserved" and "unspecified" | Discussed in BoG. The term 'unspecified' has a meaning consistent with that of 3.1.14. The purpose of attribute\_label\_four\_bytes is to provide fourcc style naming of attributes for user applications. Recommended to reserve part of the range for future use by known ids, eg 0 - 255. Recommended to mark the rest of the range as unspecified Further input is welcomed |
| US-024 | 7.3.2.1 | te | Consider adding an SPS constraint flag indicating that all points are unique for all slices in a frame. | Refine specification text. | This has been addressed by the adoption of m51064 |
| US-039 | 7.4.2.1 | te | Clarify semantics of sps\_extension\_present\_flag. | The flag must be equal to 0 for bitstream conformance with this version of the specification, but decoders must accept a value equal to 1. | Discussed in BoG, recommended to use proposed fix |
| US-041 | 7.4.2.1 | te | sps\_bounding\_box\_size\_\* should not be inferred equal to 1 when not present.In such cases, the bounding box is not known, and point positions are limited by level constraints. | Refine specification text. | Discussed in BoG, recommended to remove inference and specify that when not present the bounding box is unspecified |
| US-042 | 7.4.2.1 | te | Text is ambiguous as to whether the sps\_bounding\_box\_scale\_factor applies to the sps\_bounding\_box\_\* values. | Clarify the interpretation of sps\_bounding\_box\_\* values. | Discussed in BoG, recommended that only the (x,y,z) position should be scaled. Consider renaming the element to indicate that scaling applies to the offset. |
| US-044 | 7.4.2.1 | te | sps\_bounding\_box\_\* should be rephrased to refer to the reconstructed output rather than the source format. | Refine specification text. | Discussed in BoG, recommend to accept |
| US-045 | 7.4.2.1 | te | profile\_compatibility\_flags, review text requiring unknown values to be zero. | A decoder must accept unknown values being 1.For bitstream conformance with this specification, the value must be zero. | Discussed in BoG, further analysis is required. |
| US-026 | 7.3.2.2 | te | Consider representation of tile inventory syntax elements. | Consider alternatives to ue(v) and se(v). | Discussed in BoG, recommend to: - change num\_tiles to u(16) - add syntax element to specify log2\_bounding\_box\_max, and use u(n) Further consideration should be given to the limit on n |
| US-027 | 7.3.2.2 | te | The subclause is neither called by any parent subclause nor listed as an independent tlv\_type. | Please clarify or consider appropriate improvements. | Discussed in BoG, recommend to add missing tlv type |
| US-046 | 7.4.2.2 | te | Review necessity of permitting setting num\_tiles to 0. | Minimum value for num\_tiles (when inventory is present) should be 1. | Discussed in BoG, recommend to use minimum of one tile in the inventory and rename syntax element. It is noted that there is a possible interaction with multi-frame sequences. It is recommended to review this aspect of m51025 which was not presented at the meeting. If a persistence method is used for tiles, then num\_tiles may need to be capable of being 0 to clear persistence. |
| US-047 | 7.4.2.2 | te | Review behaviour when tile inventory is not present. | tile\_bounding\_box\_offset\_\* should not be inferred equal to sps\_bounding\_box\_offset\_\* and tile\_bounding\_box\_size\_\* should not be inferred equal to sps\_bounding\_box\_size\_\*. | Discussed in BoG, recommend to accept proposed change |

## Profile

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| FR -085 | Annex A | te | Profiles, levels, conformance points should be defined and set for the sake of interoperability | Set profiles, levels and conformance point in a further version | To be reviewed, 3DG welcomes proposals for consideration |
| US-071 | A | te | No profiles or levels are defined in the specification. | Consider useful operating points in the definition of profiles to address identified use cases. | To be reviewed, 3DG welcomes proposals for consideration |

# Technical Changes

Technical issues are not considered as bug fix and need to be discussed be the group to confirm that the required change is intended.

## General

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| CA-081 | All | ge | There are still a few technologies under evaluation which improve the compression efficiency of some sequences by more than 50%. It is clear that G-PCC technologies and the specification are not yet in a stable enough phase to reach the DIS stage | Maintain the document at the CD stage | A number of contributions under consideration have been adopted at this meeting, notably m50008 and m50921 on geometry coding. Further proposals made at this meeting are under active consideration in Core Experiments. |
| FR -079 | All | ge | Grammatical approximations that may beget misinterpretation | Proofread the entire specification | Accept |
| FR -094 | clause 8 | ge | Figures for describing processes (e.g. decoding process) would be helpful in understanding the specified technology | It is suggested to add descriptive figures, architecture diagram | Accept |
| JP01-095 | General | ge | Editorial refinement and further technical improvement are necessary to ensure the interoperability of the implementation of this standard. | For the DIS text, accept the refinement and improvement based on the technical discussion till the 128th WG11 meeting, e.g. CE results, AHG discussion, etc. | The text will be reviewed and refined. Technical improvements have been adopted and 3DG welcomes further input |
| US-072 | All | ge | Document layout is inconsistent. | Review layout of document and code fragments for consistency. | Accept |
| US-077 | All | ge | The text should be checked to ensure completeness, correctness, and editorial maturity. | Please make editorial improvements and consider all appropriate technical contributions. | Accept |

## Definitions

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| FR -078 | All | ge | Clause 3.1.5 defines attribute and provides examples (also cited in Table 5 e.g. reflectance) however clauses 3.3 on "Attribute coding related" only mentions luma and chroma kind of attributes. Attribute slice header provides information specific to luma/chroma | Clarify whether the G-PCC standard applies only to luma/chroma attributes and possibly generalize | Accept |
| US-009 | 3.3 | ge | Luma and chroma listed. Would attributes other than luma/chroma, e.g., “reflectance” be addressed? | Please clarify or consider adding at least one other attribute type in Section 3.3. | Accept |

## HLS

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| FR -086 | clause 6 | ge | Bitstream format should be defined. Some bitstream structures are aligned with byte\_alignment() (clause 7.3.2) and may help with Annex B however no bit stream format is defined. Unclear how tiles/slices are organized in the bitstream | It is suggested to synchronize with V-PCC and MPEG systems to define a bitstream format consistent with MPEG usage | Discussed in BoG. The annex B encapsulation format is suitable for use in MPEG systems, and alignment with V-PCC is not deemed to be necessary. Organisation of tiles and slices will be described in section 6 on the coded data format. |
| US-075 | All | ge | Byte stream appears to be structured in a rather different manner in other MPEG codec standards, e.g. V-PCC. | Please consider defining bytestream format consisting of a sequence of units similar to what is defined for V-PCC, or appropriate technical improvements. | Discussed in BoG. The annex B encapsulation format conveys a sequence of units. Further alignment with V-PCC is not deemed to be necessary due the differing codec design |
| US-076 | All | ge | Some text and HLS are explicitly for luma and chroma. The text should be checked to ensure completeness with other attribute types. | Please make editorial improvements and consider all appropriate technical improvements. | Accept |

# Editorial (primarily delegated to editors for detailed consideration)

List of editorial issues with classification:

## General

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| --- | --- | --- | --- | --- | --- |
| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| CA-080 | All | Ed | Different sections of the specification are written in different styles, in part due to the constant technical changes that are currently happening. | A review of the specification is required to harmonize the styles of various sections before the document can be moved to the DIS stage | Accept |
| FR -087 | 6, 7 | ed | The term "source" is used in different context but is undefined e.g. "source boundary box", "source point cloud" | Clarify source meaning relatively to the context | Accept |
| FR -088 | 7 | ed | Syntax elements are sometimes camelCase and sometimes snake\_case | Apply ISO/ITU-T rules for syntax | Accept |
| FR-096 | Introduction | ed | The introduction states that the draft standard correspond to Geometry-based PCC however no specificities related to this standard is mentioned in the introduction. | Add few sentences at the end of the introduction stipulating specific intent characterizing Geometry-based PCC standard (against other PCC standards). Ditto clause 1 "Scope". | Discussed in BoG. Text will be refined and reviewed at the next meeting. |
| US-002 | Table 1 Table 2 | ed | Add index values to table columns/rows to improve readability and maintain consistency with specification text. | Refine specification text. | Accept |
| US-007 | 3 | ed | Review definitions for specification coverage. | For example define "sibling node (geometry octree)". | Accept |
| US-038 | 7.4.1 | ed | Review text for omitted word 'bitstream' or equivalent. | Refine specification text. | Accept |
| US-056 | 7.4.4.3 | ed | Functions min( ) and max( ) are used instead of Min( ) and Max( ). | Fix specification text. | Accept |
| US-073 | All | ed | Review use of language in boilerplate text such as 'Input of the process', 'Output of the process', and other variants. | Ensure consistency throughout the document.Use definitive article to improve readability. | Accept |
| US-074 | All | ed | Review the use of language for agreement in number. | For example, correct '5.8.1 Inputs of the process are the variables a and b'. | Accept |
| US-082 | All, 5.9 | ed | Avoid use of array sizes to convey pseudo type information (eg c[3] = CrossProduct...) that is not described by the document conventions. | Refine specification text. | Accept |
| US-083 | All, 5.8 | ed | Check for consistent capitalisation of function and variable names. | Fix inconsistencies with, for example, [Ss]impleAtan2, [Aa]tanLut, popCnt, iLog2, iSqrt, divExp2RoundHalfInf, etc., | Accept |

## Definitions

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| US-008 | 3.1.19 | ed | The term “slice” to be defined is referenced in its definition. | Please consider appropriate improvements. | Accept |
| US-010 | 3.3.3 | ed | A\_1 seems duplicated in the text (A\_1A\_1 through A\_D). | Fix specification text. | Accept |
| US-011 | 5.8 | ed | In the definitions of Min( ), Max( ) and Sign( ) the right hand side of the equations is repeated. | Fix specification text. | Accept |
| US-012 | 5.8.1 | ed | The variable z is used but not defined. | Add definition. | Accept |
| US-013 | 5.8.1 | ed | The name of the simpleAtan2 function should be reviewed. | Capitalisation is inconsistent in the text; the simple adjective is not necessary; correct typo in paragraph 2 (SimplAtan2). | Accept |
| US-014 | 5.8.2 | ed | A textual description may be more straightforward. | Consider text in the form 'the number of 1-valued bits present in the binary representation of x'. | Accept |
| US-015 | 5.8.2 5.8.3 | ed | There is no need to specify a constraint on x, since it must always be true. | Remove constraint. | Accept |
| US-016 | 5.11 | ed | Consider adding octal and binary representation formats that are used in the text. | Refine specification text. | Accept |
| US-017 | 6 | ed | No definition of what constitutes a slice in terms of data units. | Add definition. | Accept |
| US-018 | 6 | ed | There is no description of the output point representation used by the specification. | Clarify the output of the decoding process, and in particular how the indices of RecPic (constructed in 8.4) function in relation to the attribute descriptors in the SPS (7.3.2.1). | Accept |
| US-020 | 6.1, 6.2, 6.3 | ed | Sections are missing content. | Refine specification text. | Accept |
| US-021 | 6.2 | ed | Should “picture format” be “point cloud format”? | Please clarify. | Accept |
| US-059 | 8.2.2 | ed | The term "packed geometry octree" is used but not defined | Add definition. | Accept |

## Geometry coding

Note - some include the HLS aspects

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| US-055 | 7.4.3.4 | ed | occupancy\_byte: 6.4.2 should be invoked with occupancy\_byte as an input, not occupancy\_map. | Fix semantic description. | Accept |
| US-058 | 8.2.1 | ed | Remove reference to direct coding point. | Refine specification text. | Accept |
| US-060 | 8.2.2 | ed | The calculation of x,y,z using childIdx is incorrect for x and y. | The general form of the bit test should be "(a & b) == b". | Accept |
| US-061 | 8.2.2 | ed | PointCount is set but never initialised. | It should be set to 0 at the start of each slice. | Accept |
| US-049 | 7.4.2.3 | ed | Variable NeighbAvailBoundary is defined but not used. | Remove this definition or make use of the variable. | Accept |
| US-050 | 7.4.2.3 | ed | “Six neighbouring parent nodes” seems ambiguous. | Specify the six neighbouring parent nodes. | Accept |
| US-051 | 7.4.2.3 | ed | unique\_geometry\_points\_flag: does not preclude that points from different slices may have the same position. | Clarify semantics. | This has been addressed by the adoption of m51064 |
| US-052 | 7.4.3.2 | ed | The variable origin\_scale does not follow the general naming conventions. | Refine specification text. | Accept |

## Attribute coding

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| US-031 | 7.3.4.3 | ed | Variable pointCount is undefined. | Define pointCount. | Accept |
| US-033 | 7.3.4.3 7.4.4.3 | ed | maxPredDiff is accessed as an array, however, in 7.4.4.3 it is defined as a scalar variable. | Fix inconsistency. | Accept |
| US-034 | 7.3.4.3 7.4.4.3 | ed | Since there is a data dependency between maxPredDiff and predIndex, the description of neighbours and their reconstructed values should refer to the reconstruction process. | Review semantic description. | Accept |
| US-035 | 7.3.4.3 | ed | Definition of dimension variable is inconsistent with document conventions. | Use a scoped variable for dimensionality of attribute data rather than italicised local variable. | Accept |
| US-036 | 7.3.4.4 | ed | Semantics of isZero name conflicts with earlier use of zerorun. | Rename syntax elements to better convey meaning. | Accept |

## AEC (Arithmetic Entropy Coding)

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| US-003 | Table 11 | ed | dict\_lut0\_idx is missing a decoding process. | Add decoding process. | Accept |
| US-004 | Table 25 | ed | Definition of ctxTblD[n] for occupancy\_byte is incomplete. | Add missing dependency upon NeighbourPattern. | Accept |
| US-065 | 9.5 | ed | The text description of the dictionary syntax and semantics is in a different format to the rest of the specification. | Ensure a specification text is consistent. | Accept |
| US-067 | 9.5.1 | ed | Remove context names. | Use the mechanism in 9.6 for contextualisation. | Accept |
| US-068 | 9.5.1 | ed | limitedContextMode should be derived from the syntax element name being decoded. | Refine specification text. | Accept |
| US-069 | 9.5.1 | ed | Multiple instances of the dictionary coder state are required, with selection based upon syntax element and other contextualisation factors. | Refine specification text. | Accept |
| US-070 | 9.5.9 | ed | Remove empty clause. | Refine specification text. | Accept |

## HLS

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| **MB/ NC1** | **Clause/ Subclause**  **Paragraph/ Figure/Table** | **Type** | **Comments** | **Proposed change** | **DDoC response** |
| US-057 | 8 | ed | The use of multiple slices to represent a frame is unclear. | Provide further clarity on how multiple slices are used to represent a point cloud frame and their use in the reconstruction process. | This has been addressed by the adoption of m51025 |
| US-063 | 8.4 | ed | RecPicPointCount is set but never initialised. | It should be set to 0 at the start of each frame. | Accept |
| US-084 | All, 7.3.4.4 | ed | Variable names do not follow conventions set out in 5.11.For example, isZero, isOne. | Review variable naming for consistency with conventions set out in 5.11. | Discussed in BoG, recommend to rename variables |
| FR -091 | 7.4.2.1 | ed | In semantics of \_cicp\_ syntax elements, values are undefined Do the \_cicp\_ related syntax elements apply to any attribute types intended to be covered by G-PCC standard? (e.g. reflectance as provided in Table 5...) | Define \_cicp\_ syntax elements values or refer to an external specification Clarify \_cicp\_ syntax elements attribute range; possibly under a flag presence condition | Accept |
| US-005 | Table 5 | ed | Add column identifying known\_attribute\_label id. | Refine specification text. | This has been addressed by the adoption of m51064 |
| US-040 | 7.4.2.1 | ed | attribute\_instance\_id needs further explanation to describe the use of attributes with identical labels. | Refine specification text. | Accept |
| US-043 | 7.4.2.1 | ed | sps\_bounding\_box\_scale\_factor should indicate that this value is not used in the reconstruction process and merely indicates how the coded point cloud may have been scaled. | Refine specification text. | Accept |
| US-062 | 8.3.1 | ed | Text implies that attrCnt is derived from the APS. | attrCnt should be derived from the SPS. | Accept |
| US-048 | 7.4.2.2 | ed | Add general description of the tile inventory - consider constraining the size of the syntax elements using ue(v). | Add description that conveys the relationship between tiles and slices.Note that the tile inventory does not form part of the decoding process. | Discussed in BoG, a description of the tile inventory will be added The aspect relating to constraints is addressed by US-026 |