International Standard

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# Information technology — Coded representation of immersive media —

## Part 30:
## Low latency, low complexity light detection and ranging (LiDAR) coding



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# Contents

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## Introduction

Advancements in 3D capturing and rendering technologies are enabling new applications and services in the fields of assisted and autonomous driving, cartography, and other industrial processes. Point clouds captured with LiDAR (Light Detection And Ranging) sensors, sometimes coupled with traditional camera sensors, have arisen as one of the main representations for such applications. A point cloud frame consists of a set of 3D points. Every point, in addition to having a 3D position, may also be associated with numerous other attributes such as intensity, colour, timestamp, and classification. Such representations require a large amount of data, which can be costly in terms of storage and transmission and are often used in real-time application which requires fast processing of the point cloud data. This document provides the method for efficiently compressing point cloud representations while ensuring low complexity and low latency constraints can be met.

# Information technology — Coded representation of immersive media —

# Part 30: Low latency, low complexity light detection and ranging (LiDAR) coding

## 1 Scope

This document specifies low latency, low complexity light detection and ranging (LiDAR) coding.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 8825-1 | Rec. ITU-T X.690, *Information technology — ASN.1 encoding rules — Part 1: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO/IEC 9834-1 | Rec. ITU-T X.660, *Information technology — Procedures for the operation of object identifier registration authorities — Part 1: General procedures and top arcs of the international object identifier tree*

ISO/IEC 9834-8 | Rec. ITU-T X.667, *Information technology — Procedures for the operation of object identifier registration authorities — Part 8: Generation of universally unique identifiers (UUIDs) and their use in object identifiers*

ISO/IEC 23091-2, *Information technology — Coding-independent code points — Part 2: Video*

Recommendation ITU-T T.35, *Procedure for the allocation of ITU-T defined codes for non-standard facilities*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

### 3.1 General terms

**3.1.1**
**point**
fundamental element of a *point cloud* (3.1.2) comprising a position specified as *Cartesian coordinates* (3.1.8) and zero or more *attributes* (3.1.19)

**3.1.2**
**point cloud**
unordered list of *points* (3.1.1)

**3.1.3**
**point cloud sequence**
sequence of one or more *point clouds* (3.1.2)

**3.1.4**
**point cloud frame**
*point cloud* (3.1.2) in a *point cloud sequence* (3.1.3)

**3.1.5**
**coded point cloud frame**
coded representation of a *point cloud frame* (3.1.4)

**3.1.6**
**canonical point order**
canonical decoding order
order of *points* (3.1.1) decoded from a *slice* (3.1.21) according to the decoding and parsing processes specified in this document

**3.1.7**
**bounding box**
axis-aligned cuboid defining a spatial region that bounds a set of *points* (3.1.1)

**3.1.8**
**coordinates**
<Cartesian> three scalar multiples of respective orthogonal *XYZ* (3.1.11) unit vectors with finite precision and bounds that specify a position relative to a fixed reference



**3.1.9**

**coordinates**
<angular> a position specified as the radial distance $\rho$ from the V axis, an azimuth angle $\varphi$ in the S-T plane and an indexed elevation

**3.1.10**
**coordinates**
<attribute> either *STV* (3.1.12) or scaled *RPI* (3.1.13) point coordinates used to code an attribute

**3.1.11**
**XYZ (axes)**
X, Y and Z axes, in that order, used to represent *Cartesian coordinates* (3.1.8)

**3.1.12**
**STV (axes)**
S, T and V axes, in that order, that are a sequence-dependent permutation of the *XYZ axes* (3.1.11); used to represent the coded *geometry* (3.1.18)

**3.1.13**
**RPI (axes)**
R, P and I axes, in that order, used to represent *angular coordinates* (3.1.9)

**3.1.14**
**sequence coordinate system**
scaled and translated application-specific coordinate system that applies to an entire coded *point cloud sequence* (3.1.3), and in which all *points* (3.1.1) have non-negative, fixed-point coordinates

**3.1.15**
**coding coordinate system**
scaled *sequence coordinate system* (3.1.14) that applies for an entire coded *point cloud sequence* (3.1.3), and in which all *points* (3.1.1) have non-negative integer coordinates

**3.1.16**
**slice coordinate system**
translated *coding coordinate system* (3.1.15) that applies for a single *slice* (3.1.21), and in which all *points* (3.1.1) in the *slice* have non-negative integer coordinates

**3.1.17**
**sensing beam**
sampler of point positions using angular coordinates by rays cast with a fixed elevation and from a point on and rotating around the V axis at the angular origin

**3.1.18**
**geometry**
*point positions* (3.4.1) associated with a set of *points* (3.1.1)

**3.1.19**
**attribute**
scalar or vector property associated with each *point* (3.1.1) in a *point cloud* (3.1.2)

EXAMPLE Colour, reflectance, frame index, etc.

**3.1.20**
**position**
<bit> bit in a binary string or value, representing the factor $2^{position}$



EXAMPLE The LSB has bit position 0.

**3.1.21**
**slice**



geometry and attributes for part of, or an entire, *coded point cloud frame* (3.1.5)

Note 1 to entry: the bounding boxes of any two slices can intersect.

**3.1.22**
**tile**
set of *slices* (3.1.21) identified by a common slice_tag *syntax element* value (3.2.15) whose *geometry* (3.1.18) should be contained within a *bounding box* (3.1.7) specified in a tile inventory data unit

**3.1.23**
**Morton code**
non-negative integer obtained by interleaving the bits of three integers

**3.1.24**
**Morton order**
elements ordered according to their *Morton code* (3.1.23)

**3.1.25**
**sparse array**
array with fewer set elements than total addressable elements; unset elements can have an inferred value when accessed

**3.1.26**
**coarse position**

a coarse representation in 2D plane of position of each *point* (3.1.1) in a *point cloud* (3.1.2), used to represent the coded *geometry* (3.1.18)

**3.1.27**
**lexicographic order**
dictionary order used to order a list of *points* (3.1.1) by firstly in the azimuthal angle and secondly in the elevation angle of these points, and these points are decoded in the order

**3.1.28**
**late points**
points whose order is late according to the lexicographic order due to the noise of data, or transmission delay

**3.1.29**
**neighbour**
point whose coarse position is preceding coarse position of current point according to the lexicographic order

**3.1.30**
**sensing head**
sensor unit within a LiDAR capture system that covers a limited azimuthal range, with multiple sensing heads used to cover a larger field of view

**3.1.31**
**sensing order index**
order index, per head, in which points are captured by the sensing head

## 3.2 High-level syntax and entropy coding terms



**3.2.1**
**ASN.1**
**abstract syntax notation one**
notation specified by Rec. ITU-T X.660 | ISO/IEC 9834-1 that is used for the definition of data types, values and constraints on data types



[SOURCE: Rec. ITU-T X.660 | ISO/IEC 9834-1]

**3.2.2**
**bin**
binary symbol (bit) of the *binarized* (3.2.3) representation of a *syntax element* value (3.2.15)

**3.2.3**
**binarization**
specification of a *syntax element*'s value (3.2.15) as a sequence of *bins* (3.2.2)

**3.2.4**
**bypass**
<symbol> static, equiprobable probability model

**3.2.5**
**bypass**
<stream> *bypass symbols* (3.2.4) that are not encoded in an arithmetic-coded *bitstream* (3.2.6)

**3.2.6**
**bitstream**
<data> sequence of bits

**3.2.7**
**bitstream**
<coded sequence> sequence of bits, in the form of encapsulated *data units* (3.2.12), that represents a coded *point cloud sequence* (3.1.3)

**3.2.8**
**set bit**
bit with the value 1

**3.2.9**
**unset bit**
bit with the value 0

**3.2.10**
**byte**
sequence of 8 bits, typeset with the most significant bit on the left and the least significant bit on the right

Note 1 to entry: When represented in a bitstream, the most significant bit of a byte is first.

**3.2.11**
**byte aligned**
*bitstream* (3.2.6) position that is an integer multiple of eight bits from the position of the first bit in the bitstream

**3.2.12**
**data unit**
**DU**
sequence of *bytes* (3.2.10) conveying a single *syntax structure* (3.2.16) of known length



**3.2.13**
**data unit header**
parameters, located from the start of a *data unit* (3.2.12)



**3.2.14**
**data unit footer**
parameters, located from the end of a *data unit* (3.2.12)

**3.2.15**
**syntax element**
element of data represented in the *bitstream* (3.2.6)

**3.2.16**
**syntax structure**
zero or more *syntax elements* (3.2.15) present together in the *bitstream* (3.2.6) in a specified order

**3.2.17**
**parameter set**
collection of parameters that apply when activated

**3.2.18**
**sequence parameter set**
**SPS**
parameters for an entire coded *point cloud sequence* (3.1.3), conveyed by an SPS *data unit* (3.2.12) and activated when referenced by a geometry data unit