INTERNATIONAL STANDARD

ISO/IEC 23090-3

First edition
2021-02

Information technology — Coded representation of immersive media —

Part 3: Versatile video coding

Technologies de l'information — Représentation codée de média immersifs —
Partie 3: Codage vidéo polyvalent

iTeh Standards
(https://standards.iteh.ai)
Document Preview

ISO/IEC 23090-3:2021
https://standards.iteh.ai/catalog/standards/iso/14aba573-e3a9-4ea2-875a-db551d6240c1/iso-iec-23090-3-2021

Reference number
ISO/IEC 23090-3:2021(E)

© ISO/IEC 2021

iTeh Standards
(https://standards.iteh.ai)
Document Preview

ISO/IEC 23090-3:2021
https://standards.iteh.ai/catalog/standards/iso/14aba573-e3a9-4ea2-875a-db551d6240c1/iso-iec-23090-3-2021

COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO/IEC 2021 – All rights reserved

Contents

Foreword ... vi
Introduction ... vii
1 Scope ... 1
2 Normative references ... 1
3 Terms and definitions ... 1
4 Abbreviated terms ... 13
5 Conventions ... 16
5.1 General ... 16
5.2 Arithmetic operators ... 16
5.3 Logical operators ... 16
5.4 Relational operators ... 17
5.5 Bit-wise operators ... 17
5.6 Assignment operators ... 17
5.7 Range notation ... 17
5.8 Mathematical functions ... 17
5.9 Order of operation precedence ... 18
5.10 Variables, syntax elements and tables ... 19
5.11 Text description of logical operations ... 20
5.12 Processes ... 21
6 Bitstream and picture formats, partitionings, scanning processes and neighbouring relationships ... 21
6.1 Bitstream formats ... 21
6.2 Source, decoded and output picture formats ... 21
6.3 Partitioning of pictures, subpictures, slices, tiles, and CTUs ... 23
6.3.1 Partitioning of pictures into subpictures, slices, and tiles ... 23
6.3.2 Block, quadtree and multi-type tree structures ... 25
6.3.3 Spatial or component-wise partitionings ... 26
6.4 Availability processes ... 27
6.4.1 Allowed quad split process ... 27
6.4.2 Allowed binary split process ... 27
6.4.3 Allowed ternary split process ... 29
6.4.4 Derivation process for neighbouring block availability ... 30
6.5 Scanning processes ... 30
6.5.1 CTB raster scanning, tile scanning, and subpicture scanning processes ... 30
6.5.2 Up-right diagonal scan order array initialization process ... 34
6.5.3 Horizontal and vertical traverse scan order array initialization process ... 35
7 Syntax and semantics ... 35
7.1 Method of specifying syntax in tabular form ... 35
7.2 Specification of syntax functions and descriptors ... 36
7.3 Syntax in tabular form ... 38
7.3.1 NAL unit syntax ... 38
7.3.2 Raw byte sequence payloads, trailing bits and byte alignment syntax ... 38
7.3.3 Profile, tier, and level syntax ... 57
7.3.4 DPB parameters syntax ... 60
7.3.5 Timing and HRD parameters syntax ... 60
7.3.6 Supplemental enhancement information message syntax ... 61
7.3.7 Slice header syntax ... 62
7.3.8 Weighted prediction parameters syntax ... 64
7.3.9 Reference picture lists syntax ... 65
7.3.10 Reference picture list structure syntax ... 66
7.3.11 Slice data syntax ... 66
7.4 Semantics ... 88
7.4.1 General ... 88
7.4.2 NAL unit semantics ... 88

iTeh Standards (https://standards.iteh.ai) Document Preview
ISO/IEC 23090-3:2021
https://standards.iteh.ai/catalog/standards/sist/14aba573-e3a9-4ea2-875a-db551d6240c1/iso-iec-23090-3-2021

7.4.3 Raw byte sequence payloads, trailing bits and byte alignment semantics 95
7.4.4 Profile, tier, and level semantics 141
7.4.5 DPB parameters semantics 146
7.4.6 Timing and HRD parameters semantics 146
7.4.7 Supplemental enhancement information message semantics 150
7.4.8 Slice header semantics 150
7.4.9 Weighted prediction parameters semantics 158
7.4.10 Reference picture lists semantics 159
7.4.11 Reference picture list structure semantics 160
7.4.12 Slice data semantics 161
8 Decoding process 183
8.1 General decoding process 183
8.1.1 General 183
8.1.2 Decoding process for a coded picture 184
8.2 NAL unit decoding process 185
8.3 Slice decoding process 185
8.3.1 Decoding process for picture order count 185
8.3.2 Decoding process for reference picture lists construction 187
8.3.3 Decoding process for reference picture marking 191
8.3.4 Decoding process for generating unavailable reference pictures 192
8.3.5 Decoding process for symmetric motion vector difference reference indices 192
8.3.6 Decoding process for collocated picture and no backward prediction 193
8.4 Decoding process for coding units coded in intra prediction mode 194
8.4.1 General decoding process for coding units coded in intra prediction mode 194
8.4.2 Derivation process for luma intra prediction mode 195
8.4.3 Derivation process for chroma intra prediction mode 198
8.4.4 Cross-component chroma intra prediction mode checking process 199
8.4.5 Decoding process for intra blocks 200
8.5 Decoding process for coding units coded in inter prediction mode 231
8.5.1 General decoding process for coding units coded in inter prediction mode 231
8.5.2 Derivation process for motion vector components and reference indices 235
8.5.3 Decoder-side motion vector refinement process 254
8.5.4 Derivation process for geometric partitioning mode motion vector components and reference indices 259
8.5.5 Derivation process for subblock motion vector components and reference indices 260
8.5.6 Decoding process for inter blocks 285
8.5.7 Decoding process for geometric partitioning mode inter blocks 307
8.5.8 Decoding process for the residual signal of coding blocks coded in inter prediction mode 313
8.5.9 Decoding process for the reconstructed signal of chroma coding blocks coded in inter prediction mode 314
8.6 Decoding process for coding units coded in IBC prediction mode 316
8.6.1 General decoding process for coding units coded in IBC prediction mode 316
8.6.2 Derivation process for block vector components for IBC blocks 317
8.6.3 Decoding process for IBC blocks 321
8.7 Scaling, transformation and array construction process 322
8.7.1 Derivation process for quantization parameters 322
8.7.2 Scaling and transformation process 324
8.7.3 Scaling process for transform coefficients 325
8.7.4 Transformation process for scaled transform coefficients 327
8.7.5 Picture reconstruction process 347
8.8 In-loop filter process 350
8.8.1 General 350
8.8.2 Picture inverse mapping process for luma samples 350
8.8.3 Deblocking filter process 351
8.8.4 Sample adaptive offset process 377
8.8.5 Adaptive loop filter process 379
9 Parsing process 391
9.1 General 391
9.2 Parsing process for k-th order Exp-Golomb codes 391
9.2.1 General 391
9.2.2 Mapping process for signed Exp-Golomb codes 392

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO/IEC 23090-3:2021
https://standards.iteh.ai/catalog/standards/sist/...-3-2021

 © ISO/IEC 2021 – All rights reserved

9.3 CABAC parsing process for slice data 393
9.3.1 General 393
9.3.2 Initialization process 394
9.3.3 Binarization process 418
9.3.4 Decoding process flow 427
Annex A (normative) Profiles, tiers and levels 444
Annex B (normative) Byte stream format 456
Annex C (normative) Hypothetical reference decoder 458
Annex D (normative) Supplemental enhancement information and use of SEI and VUI 480
Bibliography 504

iTeh Standards
(https://standards.iteh.ai)
Document Preview

ISO/IEC 23090-3:2021
https://standards.iteh.ai/catalog/standards/iso/14aba573-e3a9-4ea2-875a-db551d6240c1/iso-iec-23090-3-2021

© ISO/IEC 2021 – All rights reserved

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see http://patents.iec.ch).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*, in collaboration with ITU-T. The technically identical text is published as ITU-T H.266 (08/2020).

iTeh Standards
(https://standards.iteh.ai)
Document Preview

A list of all parts in the ISO/IEC 23090 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

ISO/IEC 23090-3:2021
https://standards.iteh.ai/catalog/standards/iso/14aba573-e3a9-4ea2-875a-db551d6240c1/iso-iec-23090-3-2021

 © ISO/IEC 2021 – All rights reserved

Introduction

Purpose

This document specifies a video coding technology known as versatile video coding. It has been designed with two primary goals. The first of these is to specify a video coding technology with a compression capability that is substantially beyond that of the prior generations of such standards, and the second is for this technology to be highly versatile for effective use in a broader range of applications than that addressed by prior standards. Some key application areas for the use of this document particularly include ultra-high-definition video (e.g., with 3840×2160 or 7620×4320 picture resolution and bit depth of 10 bits as specified in Rec. ITU-R BT.2100), video with a high dynamic range and wide colour gamut (e.g., with the perceptual quantization or hybrid log-gamma transfer characteristics specified in Rec. ITU-R BT.2100), and video for immersive media applications such as 360° omnidirectional video projected using a common projection format such as the equirectangular or cubemap projection formats, in addition to the applications that have commonly been addressed by prior video coding standards.

Profiles, tiers, and levels

This document is designed to be versatile in the sense that it serves a wide range of applications, bit rates, resolutions, qualities, and services. Applications include, but are not limited to, video coding for digital storage media, television broadcasting, video streaming services, real-time communication. In the course of creating this document, various requirements from typical applications have been considered, necessary algorithmic elements have been developed, and these have been integrated into a single syntax. Hence, this document is designed to facilitate video data interchange among different applications.

Considering the practicality of implementing the full syntax of this document, however, a limited number of subsets of the syntax are also stipulated by means of "profiles", "tiers", and "levels". These and other related terms are formally defined in Clause 3.

A "profile" is a subset of the entire bitstream syntax that is specified in this document. Within the bounds imposed by the syntax of a given profile it is still possible to require a very large variation in the performance of encoders and decoders depending upon the values taken by syntax elements in the bitstream, such as the specified size of the decoded pictures. In many applications, it is currently neither practical nor economical to implement a decoder capable of dealing with all hypothetical uses of the syntax within a particular profile.

In order to deal with this problem, "tiers" and "levels" are specified within each profile. A level of a tier is a specified set of constraints imposed on values of the syntax elements in the bitstream. Some of these constraints are expressed as simple limits on values, while others take the form of constraints on arithmetic combinations of values (e.g. picture width multiplied by picture height multiplied by number of pictures decoded per second). A level specified for a lower tier is more constrained than a level specified for a higher tier.

Coded video content conforming to this document uses a common syntax. In order to achieve a subset of the complete syntax, flags, parameters, and other syntax elements are included in the bitstream that signal the presence or absence of syntactic elements that occur later in the bitstream.

Encoding process, decoding process, and use of VUI parameters and SEI messages

Any encoding process that produces bitstream data that conforms to the specified bitstream syntax format requirements of this document is considered to be in conformance with the requirements of this document. The decoding process is specified such that all decoders that conform to a specified combination of capabilities known as the profile, tier, and level will produce numerically identical cropped decoded output pictures when invoking the decoding process associated with that profile for a bitstream conforming to that profile, tier and level. Any decoding process that produces identical cropped decoded output pictures to those produced by the process described herein (with the correct output order or output timing, as specified) is considered to be in conformance with the requirements of this document.

Rec. ITU-T H.274 | ISO/IEC 23002-7 specifies the syntax and semantics of the video usability information (VUI) parameters and supplemental enhancement information (SEI) messages that do not affect the conformance specifications in Annex C. These VUI parameters and SEI messages may be used together with this document.

Versions of this document

This is the first edition of this document.

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO/IEC 23090-3:2021
https://standards.iteh.ai/catalog/standards/sist/2a1e2e2e-2e2e-2e2e-2e2e-2e2e2e2e2e2e/iso-iec-23090-3-2021