IEEE STANDARDS ASSOCIATION

IEEE Standard for Second-Generation IEEE 1857 Video Coding

IEEE Computer Society

Developed by the
Standards Activities Board

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 1857.4™-2018

IEEE Standard for Second-Generation IEEE 1857 Video Coding

Developed by the

Standards Activities Board
of the
IEEE Computer Society

Approved 23 October 2018

IEEE-SA Standards Board

Abstract: A set of tools for efficient video coding, including directional intra prediction, variable block size inter prediction, context adaptive binary arithmetic coding, and the two corresponding decoding procedures, is defined in this standard. The target applications and services include, but are not limited to, UHDTV (ultra high definition TV), IP-based video surveillance, Internet video, IP-based video conference, IPTV, user-generated multimedia content, and other video/audio-enabled services and applications such as digital television broadcasting, digital storage media, and communication.

Keywords: coding unit, decoding, encoding, entropy coding, field, frame, IEEE 1857.4™, image, inter prediction, Internet video, intra prediction, IPTV, picture, prediction block, prediction unit, quantization, slice, transform, transform block, UHDTV, ultra high definition, video surveillance

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

PDF: ISBN 978-1-5044-5461-2 STD23497
Print: ISBN 978-1-5044-5462-9 STDPD23497

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading "Important Notices and Disclaimers Concerning IEEE Standards Documents." They can also be obtained on request from IEEE or viewed at http://standards.ieee.org/ipr/disclaimers.html.

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents (standards, recommended practices, and guides), both full-use and trial-use, are developed within IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association ("IEEE-SA") Standards Board. IEEE ("the Institute") develops its standards through a consensus development process, approved by the American National Standards Institute ("ANSI"), which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEE Standards are documents developed through scientific, academic, and industry-based technical working groups. Volunteers in IEEE working groups are not necessarily members of the Institute and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers and users of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

IEEE does not warrant or represent the accuracy or content of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to: results; and workmanlike effort. IEEE standards documents are supplied "AS IS" and "WITH ALL FAULTS."

Use of an IEEE standard is wholly voluntary. The existence of an IEEE standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE should be considered the approved IEEE standard.

Official statements

A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, or be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position of IEEE.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE. However, IEEE does not provide consulting information or advice pertaining to IEEE Standards documents. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to comments or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in revisions to an IEEE standard is welcome to join the relevant IEEE working group.

Comments on standards should be submitted to the following address:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854 USA

Laws and regulations

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so

Copyright

IEEE drafts and approved standards are copyrighted by IEEE under U.S. and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

Photocopies

Subject to payment of the appropriate fee, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Updating of IEEE Standards documents

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every ten years. When a document is more than ten years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit the IEEE Xplore at http://ieeexplore.ieee.org/ or contact IEEE at the address listed previously. For more information about the IEEE-SA or IEEE's standards development process, visit the IEEE-SA Website at http://standards.ieee.org.

Errata

Errata, if any, for IEEE standards can be accessed via https://standards.ieee.org/standard/index.html. Search for standard number and year of approval to access the web page of the published standard. Errata links are located under the Additional Resources Detail section. Errata are also available in IEEE Xplore: https://ieeexplore.ieee.org/browse/standards/collection/ieee/. Users are encouraged to periodically check for errata.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken by the IEEE with respect to the existence or validity of any patent rights in connection therewith. If a patent holder or patent applicant has filed a statement of assurance via an Accepted Letter of Assurance, then the statement is listed on the IEEE-SA Website at http://standards.ieee.org/about/sasb/patcom/patents.html. Letters of Assurance may indicate whether the Submitter is willing or unwilling to grant licenses under patent rights without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination to applicants desiring to obtain such licenses.

Essential Patent Claims may exist for which a Letter of Assurance has not been received. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims, or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Participants

At the time this standard was completed, the Audio Video Coding Working Group had the following membership:

Wen Gao, *Chair*
Cliff Reader, *Vice Chair*

Jie Chen	Heyuan Lin	Lu Yu
Siwei Dong	Yong Lin	Qin Yu
Dake He	Zhenan Lin	Quanhe Yu
Yun He	Lingzhi Liu	Weimin Zeng
Zhichu He	Siwei Ma	Xianguo Zhang
Tiejun Huang	Yinji Piao	Haiwu Zhao
Xiaolong Jiang	Zhenjiang Shao	Jianhua Zheng
Sunil Lee	Jun Sun	Xiaozhen Zheng
Weiran Li	Yixin Tong	Minhua Zhou
Fan Liang	Ronggang Wang	Xingguo Zhu

The following members of the individual balloting committee voted on this standard. Ballo ers may have voted for approval, disapproval, or abstention.

Ping An	Li Li	ngg ng Wang
Xin Chang	Fan Liang	Xia chen Wang
Shan Chen	Dong Liu	Yaowei Wang
Keith Chow	Jing Liu	Bo Wu
Wen Gao	Xiaohui Liu	Lifang Wu
Randall Groves	Hanqing Lu	Ruiqin Xiong
Chenchen Gu	Siwei Ma	Long Xu
Zongming Guo	Luntian Mou	Qianqian Xu
Yun He	Michael Newman	Xinchen Ye
Werner Hoelzl	Xingde Pan	Hongfang Yu
Ruimin Hu	Iulian Profir	Lu Yu
Qingming Huang	Honggang Qi	Oren Yuen
Tiejun Huang	Cliff Read r	Chen-Xiong Zhang
Noriyuki Ikeuchi	Li Song	Jian Zhang
Meng Jian	W te Struppler	Nan Zhang
Ming Jiang	i S	Weigang Zhang
Piotr Karocki	Jia de Sun	YiFan Zhang
Haojie Li	Yonghong Tian	Haiwu Zhao
Houqiang Li		Jianhua Zheng

When the IEEE-SA St nd rds Board approved this standard on 23 October 2018, it had the following membership:

Jean-Philippe Faure, *Chair*
Gary Hoffman, *Vice Chair*
John D. Kulick, *Past Chair*
Konstantinos Karachalios, *Secretary*

d B	Xiaohui Liu	Robby Robson
Gu o R. ierz	Kevin Lu	Dorothy Stanley
hristel Hunter	Daleep Mohla	Mehmet Ulema
Joseph L. Koepfinger*	Andrew Myles	Phil Wennblom
Thomas Koshy	Paul Nikolich	Philip Winston
Hung Ling	Ronald C. Petersen	Howard Wolfman
Dong Liu	Annette D. Reilly	Jingyi Zhou

*Member Emeritus

Introduction

This introduction is not part of IEEE Std 1857.4-2018, IEEE Standard for Second-Generation IEEE 1857 Video Coding.

This standard provides regular high-quality and efficient coding tool sets for compression, decompression, and packaging of the video data to save the storage space or bandwidth for transmission over the Internet.

Contents

IEEE Standard for Second-Generation IEEE 1857 Video Coding

1. Overview

1.1 Scope

This standard defines a set of tools for efficient video coding and the corresponding decoding procedure, including intra prediction, inter prediction, transform, quantization, and entropy coding.

1.2 Purpose

This standard is the new generation of IEEE Std 1857™-2013 (IEEE Standard for Advanced Audio and Video Coding), which provides efficient coding tool sets for compression, decompression, and packaging of the video data that should double the coding efficiency of IEEE Std 1857-2013. The target applications and services include, but are not limited to, Internet video, video surveillance, video conference, digital television broadcasting, user-generated video content, and other video/audio-enabled services and applications such as digital video storage and communication.

1.3 Applications

This standard is designed to cover a broad range of applications including, but not limited to, the following:

CATV	cable TV on optical networks, copper, etc.
DBS	direct broadcast satellite video services
DSL	digital subscriber line video services
DTTB	digital terrestrial television broadcasting
IPTV	Internet protocol television
ISM	interactive storage media (optical disks, etc.)
MMM	multimedia mailing
MSPN	multimedia services on packet networks
RTC	real-time conversational services (videoconferencing, videophone, etc.)
RVS	remote video surveillance