**ISO/IEC JTC 1/SC 29/WG 03 N0683**

**ISO/IEC JTC 1/SC 29/WG 03  
MPEG Systems   
Convenorship: KATS (Korea, Republic of)**

**Document type:** Output Document

**Title:** Technologies under Consideration for ISO/IEC 14496-15

**Status:** Approved

**Date of document:** 2023-01-12

**Source:** ISO/IEC JTC 1/SC 29/WG 03

**No. of pages:** 8 (with cover page)

**Email of Convenor:** young.L @ samsung . com

**Committee URL:** <https://isotc.iso.org/livelink/livelink/open/jtc1sc29wg3>

**INTERNATIONAL ORGANIZATION FOR STANDARDIZATION**

**ORGANISATION INTERNATIONALE DE NORMALISATION**

**ISO/IEC JTC 1/SC 29/WG 03 MPEG SYSTEMS**

**ISO/IEC JTC 1/SC 29/WG 03 N0683**

**October 2022, Mainz (DE)**

|  |  |
| --- | --- |
| **Title** | **Technologies under Consideration for ISO/IEC 14496-15** |
| **Source** | **WG 03, MPEG Systems** |
| **Status** | **Approved** |
| **Serial Number** | **21962** |

**Abstract**

This document proposes an approach for carriage of a base bitstream (e.g. AVC, HEVC, VVC) and an LCEVC enhancement bitstream in a “single-track”, that is without the need to use two separate PIDs or tracks, but rather carrying the base NALUs and the LCEVC NALUs as if they were a single bitstream.

Two possible solutions to carry a complete set composed by base and LCEVC bitstreams are:

(1) SEI approach: insert LCEVC NALUs as SEI messages in the Base NALUs

(2) Interleaved NALUs approach: insert LCEVC NALUs as interleaved NALUs within the Base NALUs.

The following sections describe the two possible single-track solutions making explicit reference to three existing MPEG Video Coding specification:

• ISO/IEC 14496-10 Advanced Video Coding (AVC/H264)

• ISO/IEC 23008-2 High Efficiency Video Coding (HEVC/H265)

• ISO/IEC 23090-3 Versatile Video Coding (VVC/H266)

**Contents**

[1. NALU aproach 3](#_Toc124444485)

[1.1 AVC/H264 NALU header format 3](#_Toc124444486)

[1.2 HEVC/H265 NALU header format 3](#_Toc124444487)

[1.3 VVC/H266 NALU header format 4](#_Toc124444488)

[1.4 LCEVC NALU header format 5](#_Toc124444489)

[1.5 Compatibility of interleaving LCEVC NAL units with AVC/HEVC/VVC NAL units 6](#_Toc124444490)

[2. SEI aproach 7](#_Toc124444491)

[2.1 Carriage of LCEVC NALUs in SEI messages 7](#_Toc124444492)

[2.2 Suggested solutions for SEI carriage 7](#_Toc124444493)

# NALU aproach

LCEVC encoded data units are Network Abstraction Layer units (NALU) as defined in ISO/IEC 23094-2, Sec. 7.3.2.

Each of the Base video coding standards under considerations here (AVC, HEVC, VVC) defines its own NALU syntax.

The format of the LCEVC NALU, in fact, allows for their unambiguous detection even when parsed according to the NALU syntax of the AVC, HEVC or VVC Base bitstream. This property allows for an “interleaved” single stream base plus enhancement, which means a single stream where LCEVC NALUs are inserted among base NALUs, within the same NALU sequence.

In the resulting interleaved single stream, each Access Unit, defined as the set of NALUS that result in each decoded picture, will contain both the LCEVC NALUs (an LCEVC Access Unit contains only one LCEVC NAL unit) and the Base NALUs relevant for the specific Access Unit.



## AVC/H264 NALU header format

The AVC NALU header is defined in ISO/IEC 14496-10, Sec. 7.3.1, with the following syntax:

| Syntax | Descriptor |
| --- | --- |
| nal\_unit\_header( ) { |  |
| forbidden\_zero\_bit | u(1) |
| nal\_ref\_idc | u(2) |
| nal\_unit\_type | u(5) |
| } |  |

Table 6 – AVC NALU header syntax

The NALU type values and semantics for AVC are specified in Table 7-1 of the specification (IS 14496-10). Table 7 summarizes the usage of the AVC NALU types. Since the AVC NALU type is a field of 5 bits, the possible values are from 0 to 31.

|  |  |  |  |
| --- | --- | --- | --- |
| nal\_unit\_type | Name of nal\_unit\_type | Content of NAL unit and RBSP syntax structure | NAL unit type class |
| 0 - 5 | (…) | (…) | VCL |
| 6 - 20 | (…) | (…) | Non VCL |
| 21 - 23 | RSV | Reserved | Non VCL |
| 24 - 31 | UNSPEC | Unspecified | Non VCL |

Table 7 – AVC NALU types

## HEVC/H265 NALU header format

The HEVC NALU header is defined in ISO/IEC 23008-2, Sec. 7.3.1.2, with the following syntax:

| Syntax | Descriptor |
| --- | --- |
| nal\_unit\_header( ) { |  |
| forbidden\_zero\_bit | f(1) |
| nal\_unit\_type | u(6) |
| nuh\_layer\_id | u(6) |
| nuh\_temporal\_id\_plus1 | u(3) |
| } |  |

Table 8 – HEVC NALU header syntax

The NALU type values and semantics for HEVC are specified in Table 7-1 of the specification (IS 23008-2). Table 9 summarizes the usage of the HEVC NALU types. Since the HEVC NALU type is a field of 6 bits, the possible values are from 0 to 63.

|  |  |  |  |
| --- | --- | --- | --- |
| nal\_unit\_type | Name of nal\_unit\_type | Content of NAL unit and RBSP syntax structure | NAL unit type class |
| 0 - 21 | (…) | (…) | VCL |
| 22 - 31 | RSV | Reserved | VCL |
| 32 - 40 | (…) | (…) | Non VCL |
| 41 - 47 | RSV | Reserved | Non VCL |
| 48 - 63 | UNSPEC | Unspecified | Non VCL |

Table 9 – HEVC NALU types

## VVC/H266 NALU header format

The VVC NALU header is defined in ISO/IEC 23090-3, Sec. 7.3.1.2, with the following syntax:

| Syntax | Descriptor |
| --- | --- |
| nal\_unit\_header( ) { |  |
| forbidden\_zero\_bit | f(1) |
| nuh\_reserved\_zero\_bit | u(1) |
| nuh\_layer\_id | u(6) |
| nal\_unit\_type | u(5) |
| nuh\_temporal\_id\_plus1 | u(3) |
| } |  |

Table 10 – VVC NAL unit header syntax

The NALU type values and semantics for VVC are specified in Table 5 of the specification (IS 23090-3). Table 11 summarizes the usage of the VVC NALU types. Since the VVC NALU type is a field of 5 bits, the possible values are from 0 to 31.

|  |  |  |  |
| --- | --- | --- | --- |
| nal\_unit\_type | Name of nal\_unit\_type | Content of NAL unit and RBSP syntax structure | NAL unit type class |
| 0 - 11 | (…) | (…) | VCL |
| 12 - 25 | (…) | (…) | Non VCL |
| 26 - 27 | RSV | Reserved | Non VCL |
| 28 - 31 | UNSPEC | Unspecified | Non VCL |

Table 11 – VVC NALU types

## LCEVC NALU header format

The LCEVC NALU header is defined in ISO/IEC 23094-2, Sec. 7.3.2, with the following syntax:

| Syntax | Descriptor |
| --- | --- |
| nal\_unit\_header( ) { |  |
| forbidden\_zero\_bit | u(1) |
| forbidden\_one\_bit | u(1) |
| nal\_unit\_type | u(5) |
| reserved\_flag | u(9) |
| } |  |

Table 12 - LCEVC NAL unit header

The NALU type values and semantics for LCEVC are specified in Table 17 of the specification (IS 23094-2). Table 13 summarizes the usage of the LCEVC NALU types. Since the LCEVC NALU type is a field of 5 bits, the possible values are from 0 to 31.

|  |  |  |  |
| --- | --- | --- | --- |
| nal\_unit\_type | Name of nal\_unit\_type | Content of NAL unit and RBSP syntax structure | NAL unit type class |
| 0 - 27 | UNSPEC | Unspecified | Non VCL |
| 28 - 29 | (…) | (…) | VCL |
| 30 | RSV | Reserved | Non VCL |
| 31 | UNSPEC | Unspecified | Non VCL |

Table 13 – LCEVC NALU types

The two NALU type values used to identify VCL NALUs are:

28 = 0x1C = 0b1.1100 (LCEVC NALU type 28Non IDR)

29 = 0x1D = 0b1.1101 (LCEVC NALU type 29IDR)

The two NALU header bytes for the two VCL NALU types of LCEVC are as follows:

0111.1001:1111.1111 (LCEVC NALU type 28 Non-IDR)

0111.1011:1111.1111 (LCEVC NALU type 29 IDR)

## Compatibility of interleaving LCEVC NAL units with AVC/HEVC/VVC NAL units

The following table summarizes the position and semantic of the main fields of the NALU headers of the four MPEG specifications: AVC, HEVC, VVC, LCEVC:

* in yellow the NALU Type field
* in blue the Layer ID field
* in green the Temporal ID field

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | | 14 | 15 |
| AVC | 0 |  |  | NALU Type | | | | |  |  |  |  |  |  | |  |  |
| HEVC | 0 | NALU Type | | | | | | Layer ID (6) | | | | | | | Temp ID (3) | | | |
| VVC | 0 | 0 | Layer ID (6) | | | | | | NALU type | | | | | | Temp ID (3) | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |
|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | | 14 | 15 |
| LCEVC | 0 | 1 | 1 | 1 | 1 | 0/1 | 0/1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 |
| LCEVC 28 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 |
| LCEVC 29 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 |

The following table reports how the base parsers for AVC, HEVC, VVC would interpret the two bytes of NALU headers for the significant LCEVC NALUs.

|  |  |  |  |
| --- | --- | --- | --- |
|  | LCEVC 28|29 | Layer ID | Temp ID |
| AVC parser | AVC 25|27 |  |  |
| HEVC parser | HEVC 60|61 | 63 | 7 |
| VVC parser | VVC 31|31 | 57|59 | 7 |

For the AVC parser, the LCEVC NALU types (interpreted as 25 or 27) fall in the Unspecified range from 24 to 31.

For the HEVC parser, the LCEVC NALU types (interpreted as 60 or 61) fall in the Unspecified range from 48 to 63.

For the VVC parser, the LCEVC NALU types (interpreted as 31) fall in the Unspecified range from 28 to 31.

# SEI aproach

LCEVC encoded data units are Network Abstraction Layer (NAL) units as defined in ISO/IEC 23094-2, Sec. 7.3.2.

All the MPEG base video coding standards considered (e.g., AVC, HEVC, VVC) provide metadata messages that can be used for the carriage of LCEVC. AVC, HEVC and VVC, employ NAL units as basic data units, and additionally the type of NAL unit identified as Supplemental Enhancement Information (SEI) that can be used to embed the LCEVC NAL unit stream.



## Carriage of LCEVC NALUs in SEI messages

When the base encoding for LCEVC is an MPEG standard, the elementary stream is a NALU stream. In this case, the encapsulation of LCEVC Access Units as metadata is implemented using the SEI messages specific for each Base codec. AVC, HEVC and VVC have each a different NALU format (i.e., with different NALU headers) breakdown of NALU types and payloads. However, all of them comprise SEI messages, identified with a nal\_unit\_type field as in the following table, where RBSP stands for raw byte sequence payload (see Table 1 below).

|  |  |  |
| --- | --- | --- |
| MPEG Standard | SEI nal\_unit\_type | Corresponding NAL unit payload |
| AVC | 6 | sei\_rbsp() |
| HEVC | 39\* | sei\_rbsp() |
| VVC | 23\* | sei\_rbsp() |
| \* prefix SEI | | |

Table 1 - SEI NALU type

## Suggested solutions for SEI carriage

There are two possible solutions for using SEI carriage of an LCEVC bitstream:

1. define a new SEI message for LCEVC and referencing it as a new Payload Type in each of the base layer video coding specifications; and/or
2. use an ITU-T T.35 SEI message to carry the LCEVC NALU (see Annex B for more details).