

JVET-00237

AHG17: Compact NAL unit header



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Proposal summary



Two proposed changes

1. Compact NAL unit header
 - Signal an extension flag in the NAL unit header that specifies if the NAL unit header is signaled with one byte or if the NAL unit header is extended with one additional byte.
 - The extension byte is needed to express a NuhLayerId larger than 0 or for certain less commonly used NAL unit types (e.g. reserved or unspecified NAL unit types)
2. Fix for reserved IRAP and unspecified NAL unit types
 - Reserve two IRAP NAL unit type values and allow two of the four unspecified NAL unit types to have a non-zero temporal ID

Compact NAL Unit header

Motivation

- In the mainstream usage of VVC, some features of the NAL unit header may not be frequently used
 - NuhLayerID can be expected to be 0 most of the time
 - In VVC, there are 18 specified NAL unit types, 10 NAL unit types are reserved for future use and 4 are unspecified
- In the proposal the NAL unit header is signaled with two bytes if NuhLayerID is larger than 0 or if certain less common NAL unit types are used, else it is signaled with one byte

Compact NAL unit header

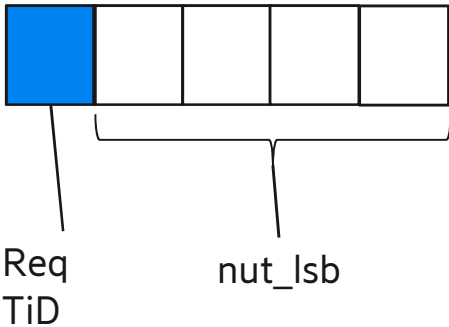
Detailed proposal



- The following changes to the NAL unit header are proposed:
 - Signal a `vcl_flag` indicating whether the NAL unit is a VCL or non-VCL NAL unit
 - Signal `nal_unit_type_lsb` with 2 bits instead of 4
 - Signal a `nuh_extension_flag` specifying whether a 1-byte NAL unit header extension is present
 - If the extension is present,
 - signal `nuh_layer_id_plus1`, `nal_unit_type_ext_bit` and `nuh_reserved_zero_bit` in a second NAL unit header byte
 - signal `nuh_layer_id_plus1` with 6 bits as in HEVC instead of 7 bits
 - else
 - infer `nuh_layer_id_plus1` to be equal to 1 and `nal_unit_type_ext_bit` and `nuh_reserved_zero_bit` to be equal to 0
- Set `NALUnitType` equal to
$$(\text{zero_tid_required_flag} \ll 4) + (\text{vcl_flag} \ll 3) + (\text{nal_unit_type_ext_bit} \ll 2) + \text{nal_unit_type_lsb}$$

In current VVC

NAL unit type bits

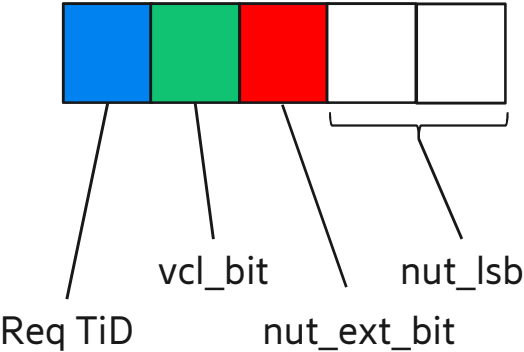


Information whether the NALUnitType value is “specified” in VVC or just reserved or unspecified
18 of 32 values are specified.

Req TiD 0 (1st bit)	Specified	NalUnitType	Name of NalUnitType	Content of NAL unit and RBSP syntax structure	NAL unit type class
0		0	PPS_NUT	Picture parameter set pic_parameter_set_rbsp()	non-VCL
		1	AUD_NUT	Access unit delimiter access_unit_delimiter_rbsp()	non-VCL
		2	PREFIX_SEI_NUT	Supplemental enhancement information sei_rbsp()	non-VCL
		3	SUFFIX_SEI_NUT		
		4	APS_NUT	Adaptation parameter set adaptation_parameter_set_rbsp()	non-VCL
		6..7	RSV_NVCL6.. RSV_NVCL7	Reserved	non-VCL
		8	TRAIL_NUT	Coded slice of a non-STSA trailing picture slice_layer_rbsp()	VCL
		9	STSA_NUT	Coded slice of an STSA picture slice_layer_rbsp()	VCL
		10	RADL_NUT	Coded slice of a RADL picture slice_layer_rbsp()	VCL
		11	RASL_NUT	Coded slice of a RASL picture slice_layer_rbsp()	VCL
1		12..15	RSV_VCL_12.. RSV_VCL_15	Reserved non-IRAP VCL NAL unit types	VCL
		16	DPS_NUT	Decoding parameter set decoding_parameter_set_rbsp()	non-VCL
		17	SPS_NUT	Sequence parameter set seq_parameter_set_rbsp()	non-VCL
		18	EOS_NUT	End of sequence end_of_seq_rbsp()	non-VCL
		19	EOB_NUT	End of bitstream end_of_bitstream_rbsp()	non-VCL
		20	VPS_NUT	Video parameter set video_parameter_set_rbsp()	non-VCL
		21..23	RSV_NVCL21.. RSV_NVCL23	Reserved	non-VCL
		24	IDR_W_RADL	Coded slice of an IDR picture slice_layer_rbsp()	VCL
		25	IDR_N_LP		
		26	CRA_NUT	Coded slice of a CRA picture slice_layer_rbsp()	VCL
		27	GRA_NUT	Coded slice of a gradual random access picture slice_layer_rbsp()	VCL
		28..31	UNSPEC28.. UNSPEC31	Unspecified	non-VCL

Proposed

NAL unit type bits



Information whether the NALUnitType value is “specified” in VVC or just reserved or unspecified. 18 of 32 values are specified.

Req TiD 0 (1st bit)	VCL bit (2nd bit)	Nut_ext bit (3rd bit)	Specified	NalUnitType	Name of NalUnitType	Content of NAL unit and RBSP syntax structure	NAL unit type class
0	0	0	Yes	0	PPS_NUT	Picture parameter set pic_parameter_set_rbsp()	non-VCL
				1	AUD_NUT	Access unit delimiter access_unit_delimiter_rbsp()	non-VCL
				2	PREFIX_SEI_NUT	Supplemental enhancement information sei_rbsp()	non-VCL
				3	SUFFIX_SEI_NUT		
	1	1	Yes	4	APS_NUT	Adaptation parameter set adaptation_parameter_set_rbsp()	non-VCL
				6..7	RSV_NVCL6.. RSV_NVCL7	Reserved	non-VCL
		0		8	TRAIL_NUT	Coded slice of a non-STSA trailing picture slice_layer_rbsp()	VCL
				9	STSA_NUT	Coded slice of an STSA picture slice_layer_rbsp()	VCL
				10	RADL_NUT	Coded slice of a RADL picture slice_layer_rbsp()	VCL
				11	RASL_NUT	Coded slice of a RASL picture slice_layer_rbsp()	VCL
		1		12..15	RSV_VCL_12.. RSV_VCL_15	Reserved non-IRAP VCL NAL unit types	VCL
1	0	0	Yes	16	DPS_NUT	Decoding parameter set decoding_parameter_set_rbsp()	non-VCL
				17	SPS_NUT	Sequence parameter set seq_parameter_set_rbsp()	non-VCL
				18	EOS_NUT	End of sequence end_of_seq_rbsp()	non-VCL
				19	EOB_NUT	End of bitstream end_of_bitstream_rbsp()	non-VCL
	1	1	Yes	20	VPS_NUT	Video parameter set video_parameter_set_rbsp()	non-VCL
				21..23	RSV_NVCL21.. RSV_NVCL23	Reserved	non-VCL
		0		24	IDR_W_RADL	Coded slice of an IDR picture slice_layer_rbsp()	VCL
				25	IDR_N_LP		
				26	CRA_NUT	Coded slice of a CRA picture slice_layer_rbsp()	VCL
				27	GRA_NUT	Coded slice of a gradual random access picture slice_layer_rbsp()	VCL
		1		28..31	UNSPEC28.. UNSPEC31	Unspecified	non-VCL

Compact NAL unit

Proposed changes to syntax and semantics



nal_unit_header() {	Descriptor
zero_tid_required_flag	u(1)
nuh_temporal_id_plus1	u(3)
vcl_flag	u(1)
nal_unit_type_lsb	u(4)u(2)
nuh_extension_flag	u(1)
if_nuh_extension_flag {	
nuh_layer_id_plus1	u(7)u(6)
nal_unit_type_ext_bit	u(1)
nuh_reserved_zero_bit	u(1)
}	
}	

vcl_flag equal to 1 indicates that the NAL unit is a VCL NAL unit or that the NAL unit type is unspecified. vcl_flag equal to 0 indicates that the NAL unit is a non-VCL NAL unit.

nal_unit_type_lsb specifies the least significant bits for the NAL unit type.

nuh_extension_flag equal to 1 specifies that the NAL unit header has an extension. nuh_extension_flag equal to 0 specifies that there is no NAL unit header extension.

nal_unit_type_ext_bit specifies the extension bit for the NAL unit type. If not present, nal_unit_type_ext_bit is inferred to be equal to 0.

The variable NalUnitType, which specifies the NAL unit type, i.e., the type of RBSP data structure contained in the NAL unit as specified in Table 7-1, is derived as follows:

NalUnitType = (zero_tid_required_flag << 4) + (vcl_flag << 3) + (nal_unit_type_ext_bit << 2) + nal_unit_type_lsb

(7-2)

< Table 7-1 that lists NAL unit types is unchanged. >

nuh_layer_id_plus1 specifies the identifier of the layer to which a VCL NAL unit belongs or the identifier of a layer to which a non-VCL NAL unit applies. The value of nuh_layer_id_plus1 shall be in the range of 1 to 62426, inclusive. The value of 63427 may be specified in the future by ITU-T | ISO/IEC. For purposes other than determining the amount of data in the decoding units of the bitstream, decoders shall ignore all data that follow the value 63427 for nuh_layer_id_plus1 in a NAL unit.

NOTE 7 – The value of 63427 for nuh_layer_id_plus1 may be used to indicate an extended layer identifier in a future extension of this Specification.

The variable NuhLayerId is derived as follows:

NuhLayerId = nuh_layer_id_plus1 – 1

(7-3)

The value of NuhLayerId shall be the same for all VCL NAL units of a coded picture. The value of NuhLayerId of a coded picture is the value of the NuhLayerId of the VCL NAL units of the coded picture. If not present, the value of nuh_layer_id_plus1 is inferred to be equal to 1.

nuh_reserved_zero_bit shall be equal to '0' when present. The value 1 of nuh_reserved_zero_bit may be specified in the future by ITU-T | ISO/IEC. Decoders shall ignore (i.e. remove from the bitstream and discard) NAL units with nuh_reserved_zero_bit equal to '1'.

Compact NAL unit header

Estimated results



— CTC

	All Intra Main10		
	Over VTM-5.0		
	Y	U	V
Class A1	0.00%	0.00%	0.00%
Class A2	0.00%	0.00%	0.00%
Class B	-0.01%	-0.01%	-0.01%
Class C	-0.02%	-0.02%	-0.02%
Class E	-0.02%	-0.02%	-0.02%
Overall	-0.01%	-0.01%	-0.01%
Class D	-0.05%	-0.05%	-0.05%
Class F	-0.02%	-0.02%	-0.02%

	Random access Main10		
	Over VTM-5.0		
	Y	U	V
Class A1	-0.01%	-0.01%	-0.01%
Class A2	-0.01%	-0.01%	-0.01%
Class B	-0.02%	-0.02%	-0.02%
Class C	-0.05%	-0.05%	-0.05%
Class E			
Overall	-0.03%	-0.02%	-0.02%
Class D	-0.14%	-0.13%	-0.13%
Class F	-0.06%	-0.05%	-0.05%

	Low delay B Main10		
	Over VTM-5.0		
	Y	U	V
Class A1			
Class A2			
Class B	-0.02%	-0.02%	-0.02%
Class C	-0.04%	-0.04%	-0.04%
Class E	-0.19%	-0.16%	-0.16%
Overall	-0.07%	-0.06%	-0.06%
Class D	-0.11%	-0.09%	-0.09%
Class F	-0.11%	-0.10%	-0.10%

	Low delay P Main10		
	Over VTM-5.0		
	Y	U	V
Class A1			
Class A2			
Class B	-0.02%	-0.02%	-0.02%
Class C	-0.04%	-0.04%	-0.04%
Class E	-0.19%	-0.15%	-0.16%
Overall	-0.07%	-0.06%	-0.06%
Class D	-0.10%	-0.08%	-0.09%
Class F	-0.11%	-0.10%	-0.09%

— Examples with multiple slices per picture

	4k video streaming 10 Mbps @ 60 fps	1080p video 2 Mbps @ 60 fps	4k 360 video 8 Mbps @ 60 fps
Slices per picture	20	5	96
SEI messages per picture	2	1	2
APSS per picture	0.33	0.33	0.33
bit savings (bits per second):	10 718	3038	47 198
bit savings (%):	0.11	0.15	0.59

Fix for reserved IRAP and unspecified NAL unit types



— In the current VVC design there are no reserved IRAP NAL unit types and unspecified types may not have tID > 0

Current VVC design

NalUnitType	Name of NalUnitType	Description	tID constraints
12, 13	RSV_VCL_12 RSV_VCL_13	Reserved non-IRAP VCL	No constraint
14, 15	RSV_VCL_14 RSV_VCL_15	Reserved non-IRAP VCL	No constraint
28, 29	UNSPEC28 UNSPEC29	Unspecified non-VCL	tID = 0
30, 31	UNSPEC30 UNSPEC31	Unspecified non-VCL	tID = 0

Proposed change

NalUnitType	Name of NalUnitType	Description	tID constraints	Nature of change
12, 13	RSV_VCL_12 RSV_VCL_13	Reserved non-IRAP VCL	No constraint	No change
14, 15	UNSPEC14 UNSPEC15	Unspecified non-VCL	No constraint	Moved to enable tID > 0
28, 29	RSV_VCL_28 RSV_VCL_29	Reserved IRAP VCL	tID = 0	Converted from reserved non-IRAP
30, 31	UNSPEC30 UNSPEC31	Unspecified non-VCL	tID = 0	No change

Fix for reserved IRAP and unspecified NAL unit types

Proposed changes to semantics

`nal_unit_type_lsb` specifies the least significant bits for the NAL unit type.

The variable `NalUnitType`, which specifies the NAL unit type, i.e., the type of RBSP data structure contained in the NAL unit as specified in Table 7-1, is derived as follows:

$$\text{NalUnitType} = (\text{zero_tid_required_flag} \ll 4) + \text{nal_unit_type_lsb} \tag{7-2}$$

NAL units that have `NalUnitType` equal to UNSPEC14, UNSPEC15, UNSPEC30 or UNSPEC31, in the range of UNSPEC28..UNSPEC31, inclusive, for which semantics are not specified, shall not affect the decoding process specified in this Specification.

NOTE 3 – NAL unit types equal to UNSPEC14, UNSPEC15, UNSPEC30 or UNSPEC31 in the range of UNSPEC28..UNSPEC31 may be used as determined by the application. No decoding process for these values of `NalUnitType` is specified in this Specification. Since different applications might use these NAL unit types for different purposes, particular care must be exercised in the design of encoders that generate NAL units with these `NalUnitType` values, and in the design of decoders that interpret the content of NAL units with these `NalUnitType` values. This Specification does not define any management for these values.

...

Order of NAL units and coded pictures and their association to access units

...

- NAL units with `NalUnitType` equal to UNSPEC14, UNSPEC15, UNSPEC30 or UNSPEC31, in the range of UNSPEC28..UNSPEC29 (when present).

...

- When any DPS NAL units, VPS NAL units, SPS NAL units, PPS NAL units, APS NAL units, prefix SEI NAL units, NAL units with `NalUnitType` equal to RSV_NVCL_5, RSV_NVCL_6, RSV_NVCL_21, or RSV_NVCL_22, or NAL units with `NalUnitType` equal to UNSPEC14, UNSPEC15, UNSPEC30 or UNSPEC31, in the range of UNSPEC28..UNSPEC29 are present, they shall not follow the last VCL NAL unit of the access unit.

...

NalUnitType	Name of NalUnitType	Content of NAL unit and RBSP syntax structure	NAL unit type class
0	PPS_NUT	Picture parameter set pic_parameter_set_rbsp()	non-VCL
1	AUD_NUT	Access unit delimiter access_unit_delimiter_rbsp()	non-VCL
2	PREFIX_SEI_NUT	Supplemental enhancement information	non-VCL
3	SUFFIX_SEI_NUT	sei_rbsp()	non-VCL
4	APS_NUT	Adaptation parameter set adaptation_parameter_set_rbsp()	non-VCL
5..7	RSV_NVCL5.. RSV_NVCL7	Reserved	non-VCL
8	TRAIL_NUT	Coded slice of a non-STSA trailing picture slice_layer_rbsp()	VCL
9	STSA_NUT	Coded slice of an STSA picture slice_layer_rbsp()	VCL
10	RADL_NUT	Coded slice of a RADL picture slice_layer_rbsp()	VCL
11	RASL_NUT	Coded slice of a RASL picture slice_layer_rbsp()	VCL
12..13	RSV_VCL_12.. RSV_VCL_13	Reserved non-IRAP VCL NAL unit types	VCL
14..15	UNSPEC14 UNSPEC15	Unspecified	non-VCL
16	DPS_NUT	Decoding parameter set decoding_parameter_set_rbsp()	non-VCL
17	SPS_NUT	Sequence parameter set seq_parameter_set_rbsp()	non-VCL
18	EOS_NUT	End of sequence end_of_seq_rbsp()	non-VCL
19	EOB_NUT	End of bitstream end_of_bitstream_rbsp()	non-VCL
20	VPS_NUT	Video parameter set video_parameter_set_rbsp()	non-VCL
21..23	RSV_NVCL21.. RSV_NVCL23	Reserved	non-VCL
24	IDR_W_RADL	Coded slice of an IDR picture slice_layer_rbsp()	VCL
25	IDR_N_LP		
26	CRA_NUT	Coded slice of a CRA picture slice_layer_rbsp()	VCL
27	GRA_NUT	Coded slice of a gradual random access picture slice_layer_rbsp()	VCL
28..29	RSV_VCL_28 RSV_VCL_29	Reserved IRAP VCL NAL unit types	VCL
30..31	UNSPEC30 UNSPEC31	Unspecified	non-VCL

Proposal summary, repeated



Two proposed changes

1. Compact NAL unit header

- Signal an extension flag in the NAL unit header that specifies if the NAL unit header is signaled with one byte or if the NAL unit header is extended with one additional byte.
- The extension byte is needed to express a NuhLayerId larger than 0 or for certain less commonly used NAL unit types (e.g. reserved or unspecified NAL unit types)

2. Fix for reserved IRAP and unspecified NAL unit types

- Reserve two IRAP NAL unit type values and allow two of the four unspecified NAL unit types to have a non-zero temporal ID

