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AHG8: Sample adaptive offset with multiple parameters

Shih-Ta Hsiang and Shawmin Lei

Presented by Yu-Wen Huang
16th JCT-VC Meeting in San Jose
9. – 17 Jan. 2014

Overall Summary

- **Objective**
  Improved coding performance by the more effective use of the existing SAO tools

- **Proposed Method**
  Enable more than one SAO filtering operations performed on each CTU

- **Feature**
  Re-uses the existing SAO tools and syntax structure for additional filtering operations

- Average luma BD-rate results for YCbCr 4:4:4 under the AHG8 CTCs

  -2.2%, -1.2%, and -1.0% under AI-Main-Tier, RA-Main-Tier, and LB-Main-Tier, respectively

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Summary of Proposed Modifications

- Support more than one SAO filtering operations performed on each CTU.
  - Add a new slice segment header syntax to indicate the maximum number of the SAO filtering operations for each CTU
  - Each additional SAO filtering operation is performed on the output pixels of the previous SAO filtering operation.
  - Additional SAO filtering operations just re-use the existing SAO tools for SAO filtering.
  - The existing SAO syntax structure is re-used for coding the additional SAO parameters sets corresponding to the additional SAO filtering operations.

- A new SPS syntax flag to enable the use of the additional SAO filtering operations.

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Modifications to SPS

seq_parameter_set_rbsp( ) {	Descriptor
…..	
if(sps_extension_flag[0]) {	
....	u(1)
if(sample_adaptive_offset_enabled_flag) {	
multiple_sao_param_sets_enabled_flag	u(1)
}	
}	
…….	
}	

Modifications to Slice Segment Header

slice_segment_header( ) {	Descriptor
…….	
if(sample_adaptive_offset_enabled_flag) {	
if(multiple_sao_param_sets_enabled_flag)	
number_sao_param_sets	ue(v)
for(saoId=0; saoId < number_sao_param_sets; saoId++) {	
slice_sao_luma_flag[saoId]	u(1)
if(ChromaArrayType > 0)	
slice_sao_chroma_flag[saoId]	u(1)
}	
}	
…….	
}	

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Modifications to CTU

coding_tree_unit( ) {	Descriptor
$xCtb = (CtbAddrInRs \% PicWidthInCtbsY) << CtbLog2SizeY$	
$yCtb = (CtbAddrInRs / PicWidthInCtbsY) << CtbLog2SizeY$	
for(saoId=0; saoId < number_sao_param_sets; saoId++) {	
if(slice_sao_luma_flag[saoId] || slice_sao_chroma_flag[saoId])	
$sao(xCtb >> CtbLog2SizeY, yCtb >> CtbLog2SizeY)$	
}	
coding_quadtree(xCtb, yCtb, CtbLog2SizeY, 0)	
}	

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BD-rate Results by Proposal versus Anchor under the AHG8 CTCs

	All Intra Main-tier			All Intra High-tier			All Intra Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
Class F	-0.7%	-0.5%	-0.9%	-0.6%	-0.4%	-0.7%	-0.3%	-0.2%	-0.4%
Class B	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
RGB 4:4:4 SC	-1.2%	-0.8%	-0.9%	-1.3%	-1.0%	-1.0%	-1.1%	-0.8%	-0.7%
RGB 4:4:4 Animation	0.3%	-0.3%	-0.2%	0.2%	-0.3%	-0.2%	0.1%	-0.1%	-0.1%
YCbCr 4:4:4 SC	-2.2%	-0.9%	-1.0%	-1.9%	-0.7%	-0.8%	-1.3%	-0.3%	-0.4%
YCbCr 4:4:4 Animation	0.1%	-0.6%	-0.8%	0.0%	-0.5%	-0.7%	0.0%	-0.4%	-0.4%
RangeExt	-0.1%	0.0%	0.0%	-0.1%	0.0%	-0.1%	-0.1%	0.0%	-0.1%
RGB 4:4:4 SC (Optional)	-1.4%	-1.1%	-1.4%	-1.5%	-1.5%	-1.6%	-1.1%	-1.0%	-0.9%
YCbCr 4:4:4 SC (Optional)	-1.9%	-1.2%	-0.3%	-1.9%	-1.6%	-0.7%	-1.7%	-1.6%	-0.6%
Enc Time[%]		100%			100%			100%	
Dec Time[%]		103%			103%			102%	

	Random Access Main-tier			Random Access High-tier		
	Y	U	V	Y	U	V
Class F	-0.5%	-1.0%	-1.4%	-0.4%	-0.8%	-1.1%
Class B	0.1%	0.0%	-0.1%	-0.2%	-0.4%	-0.1%
RGB 4:4:4 SC	-0.8%	-0.5%	-0.6%	-0.7%	-0.5%	-0.5%
RGB 4:4:4 Animation	0.2%	0.1%	0.2%	0.1%	0.1%	0.2%
YCbCr 4:4:4 SC	-1.2%	-0.2%	-0.3%	-0.9%	-0.2%	-0.3%
YCbCr 4:4:4 Animation	0.1%	-0.3%	-0.5%	0.1%	-0.2%	-0.3%
RangeExt	-0.1%	-0.7%	-0.5%	-0.2%	-1.2%	-0.7%
RGB 4:4:4 SC (Optional)	-0.9%	-0.7%	-0.7%	-1.2%	-0.9%	-0.8%
YCbCr 4:4:4 SC (Optional)	-0.8%	-1.0%	-0.4%	-0.8%	-0.9%	-0.3%
Enc Time[%]		98%			98%	
Dec Time[%]		101%			101%	

	Low delay B Main-tier			Low delay B High-tier		
	Y	U	V	Y	U	V
Class F	-0.6%	-1.2%	-1.0%	-0.5%	-0.7%	-0.8%
Class B	0.1%	0.0%	0.0%	-0.1%	-0.3%	-0.1%
RGB 4:4:4 SC	-1.0%	-0.8%	-0.7%	-1.1%	-0.8%	-0.8%
RGB 4:4:4 Animation	0.0%	-0.2%	-0.1%	-0.1%	-0.2%	-0.1%
YCbCr 4:4:4 SC	-1.0%	-0.2%	-0.4%	-0.9%	-0.3%	-0.5%
YCbCr 4:4:4 Animation	0.0%	-0.2%	-0.3%	-0.1%	-0.4%	-0.6%
RangeExt	-0.1%	-0.3%	-0.2%	-0.1%	-0.6%	-0.4%
RGB 4:4:4 SC (Optional)	-2.0%	-2.0%	-2.0%	-2.4%	-2.3%	-2.5%
YCbCr 4:4:4 SC (Optional)	-2.9%	-2.4%	-2.3%	-2.2%	-2.0%	-1.6%
Enc Time[%]		98%			98%	
Dec Time[%]		102%			102%	

- **Maximum number of the SAO parameter sets equal to 4 and 2 in each CTU for the Intra slice and the Inter slice, respectively**
- **Thank Cannon for cross check**

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SAO with New slice Header Syntax (JCTVC-N0246)

- **Objective**
  Improve the SAO tool for different sample bit depths, coding bitrates and picture sampling formats

- **Proposed Method**
  Add a new set of the slicer header syntax elements for adapting the SAO tools (sao_sign_thre, saoBitShift, sao_eo_offset_max)

- **Average BD rate results for YCbCr 4:4:4 sequences under AHG5 CTCs in N0246**

	Y	U	V
AI Main-tier	-0.3%	-0.3%	-0.4%
RA Main-tier	-0.4%	-2.3%	-0.2%
LD Main-tier	-0.9%	-2.0%	-0.6%

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BD-rate Results by Proposal Combined with New Slicer Header Syntax (N0246)

	All Intra Main-tier			All Intra High-tier			All Intra Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
Class F	-0.9%	-1.3%	-1.6%	-0.7%	-0.9%	-1.2%	-0.4%	-0.4%	-0.7%
Class B	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%	0.0%	-0.1%	-0.3%
RGB 4:4:4 SC	-1.5%	-1.0%	-1.1%	-1.4%	-1.1%	-1.1%	-1.2%	-0.9%	-0.8%
RGB 4:4:4 Animation	0.1%	-0.7%	-0.6%	0.0%	-0.5%	-0.5%	0.0%	-0.3%	-0.3%
YCbCr 4:4:4 SC	-2.6%	-1.3%	-1.4%	-2.1%	-1.0%	-1.1%	-1.4%	-0.5%	-0.6%
YCbCr 4:4:4 Animation	-0.2%	-1.0%	-1.1%	-0.2%	-0.9%	-1.0%	-0.1%	-0.7%	-0.7%
RangeExt	-0.3%	-0.5%	-0.8%	-0.3%	-0.3%	-0.5%	-0.2%	-0.2%	-0.3%
RGB 4:4:4 SC (Optional)	-1.9%	-1.6%	-2.0%	-1.7%	-1.6%	-1.7%	-1.3%	-1.1%	-1.0%
YCbCr 4:4:4 SC (Optional)	-2.2%	-1.5%	-0.6%	-2.0%	-1.8%	-0.8%	-1.9%	-1.7%	-0.8%
Enc Time[%]	142%			140%			138%		
Dec Time[%]	145%			142%			138%		

	Random Access Main-tier			Random Access High-tier		
	Y	U	V	Y	U	V
Class F	-0.8%	-1.6%	-2.0%	-0.6%	-1.2%	-1.5%
Class B	0.0%	-0.2%	-0.2%	-0.3%	-0.8%	-0.2%
RGB 4:4:4 SC	-1.0%	-0.6%	-0.7%	-0.8%	-0.6%	-0.7%
RGB 4:4:4 Animation	0.1%	0.0%	0.0%	0.1%	0.0%	0.1%
YCbCr 4:4:4 SC	-1.6%	-0.6%	-0.8%	-1.1%	-0.5%	-0.6%
YCbCr 4:4:4 Animation	-0.1%	-0.5%	-0.6%	-0.1%	-0.4%	-0.5%
RangeExt	-0.4%	-2.4%	-1.7%	-0.7%	-2.4%	-1.3%
RGB 4:4:4 SC (Optional)	-1.6%	-1.3%	-1.5%	-1.5%	-1.2%	-1.1%
YCbCr 4:4:4 SC (Optional)	-1.5%	-1.2%	-0.7%	-1.1%	-1.0%	-0.5%
Enc Time[%]	126%			125%		
Dec Time[%]	153%			150%		

	Low delay B Main-tier			Low delay B High-tier		
	Y	U	V	Y	U	V
Class F	-1.2%	-2.5%	-2.1%	-0.7%	-1.6%	-1.5%
Class B	-0.1%	-0.8%	-0.7%	-0.3%	-1.2%	-0.7%
RGB 4:4:4 SC	-1.6%	-1.3%	-1.4%	-1.4%	-1.1%	-1.2%
RGB 4:4:4 Animation	-0.3%	-0.5%	-0.4%	-0.3%	-0.4%	-0.4%
YCbCr 4:4:4 SC	-1.9%	-1.0%	-1.1%	-1.3%	-0.8%	-1.1%
YCbCr 4:4:4 Animation	-0.4%	-0.9%	-0.9%	-0.3%	-0.9%	-1.0%
RangeExt	-0.5%	-1.7%	-1.5%	-0.5%	-1.6%	-1.3%
RGB 4:4:4 SC (Optional)	-4.0%	-3.8%	-4.0%	-3.4%	-3.1%	-3.4%
YCbCr 4:4:4 SC (Optional)	-3.9%	-3.2%	-2.9%	-3.5%	-3.1%	-2.8%
Enc Time[%]	125%			124%		
Dec Time[%]	161%			158%		

- **Maximum number of the SAO parameter sets equal to 4 and 2 in each CTU for the Intra slice and the Inter slice, respectively**
- Run time result are not accurate

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Conclusion

- Propose to re-uses the existing SAO tools and syntax structure to support the additional SAO filtering operations in each CTU

- Average BD rate results for YCbCr 4:4:4 SC

	Proposal			Proposal + N0246		
	Y	U	V	Y	U	V
AI Main-tier	-2.2%	-0.9%	-1.0%	-2.6%	-1.3%	-1.4%
RA Main-tier	-1.2%	-0.2%	-0.3%	-1.6%	-0.6%	-0.8%
LD Main-tier	-1.0%	-0.2%	-0.4%	-1.9%	-1.0%	-1.1%

- Recommend to adopt the proposal into the range extensions draft or further study in RCE

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BD-rate Results by Proposal versus Anchor under the AHG8 CTCs

	All Intra Main-tier			All Intra High-tier			All Intra Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
Class F	-0.8%	-0.4%	-0.8%	-0.6%	-0.3%	-0.7%	-0.3%	-0.1%	-0.3%
Class B	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
RGB 4:4:4 SC	-1.3%	-0.8%	-0.9%	-1.3%	-1.0%	-1.0%	-1.1%	-0.9%	-0.7%
RGB 4:4:4 Animation	0.3%	-0.3%	-0.2%	0.2%	-0.3%	-0.2%	0.1%	-0.1%	-0.1%
YCbCr 4:4:4 SC	-2.4%	-0.8%	-0.9%	-2.1%	-0.6%	-0.8%	-1.4%	-0.2%	-0.4%
YCbCr 4:4:4 Animation	0.1%	-0.6%	-0.8%	0.0%	-0.5%	-0.7%	0.0%	-0.4%	-0.4%
RangeExt	-0.1%	0.0%	0.0%	-0.1%	0.0%	-0.1%	-0.1%	0.0%	-0.1%
RGB 4:4:4 SC (Optional)	-1.5%	-1.1%	-1.5%	-1.6%	-1.5%	-1.6%	-1.2%	-1.0%	-0.9%
YCbCr 4:4:4 SC (Optional)	-1.9%	-1.1%	-0.1%	-1.9%	-1.5%	-0.6%	-1.8%	-1.6%	-0.6%
Enc Time[%]	101%			101%			101%		
Dec Time[%]	104%			104%			102%		

	Random Access Main-tier			Random Access High-tier		
	Y	U	V	Y	U	V
Class F	-0.6%	-0.9%	-1.3%	-0.4%	-0.7%	-1.0%
Class B	0.1%	0.0%	-0.1%	-0.1%	-0.4%	-0.1%
RGB 4:4:4 SC	-0.7%	-0.3%	-0.4%	-0.5%	-0.3%	-0.3%
RGB 4:4:4 Animation	0.3%	0.2%	0.3%	0.2%	0.2%	0.3%
YCbCr 4:4:4 SC	-1.3%	0.0%	-0.2%	-1.1%	-0.1%	-0.2%
YCbCr 4:4:4 Animation	0.1%	-0.3%	-0.6%	0.1%	-0.2%	-0.4%
RangeExt	0.0%	-0.8%	-0.5%	-0.2%	-1.4%	-0.7%
RGB 4:4:4 SC (Optional)	-1.0%	-0.7%	-0.8%	-1.3%	-1.0%	-1.0%
YCbCr 4:4:4 SC (Optional)	-0.7%	-0.6%	0.0%	-0.7%	-0.6%	0.1%
Enc Time[%]	98%			98%		
Dec Time[%]	100%			99%		

	Low delay B Main-tier			Low delay B High-tier		
	Y	U	V	Y	U	V
Class F	-0.7%	-1.5%	-1.3%	-0.6%	-1.0%	-1.1%
Class B	0.1%	-0.1%	-0.1%	-0.1%	-0.4%	-0.1%
RGB 4:4:4 SC	-0.9%	-0.7%	-0.6%	-1.0%	-0.7%	-0.6%
RGB 4:4:4 Animation	0.1%	-0.2%	0.0%	0.0%	-0.2%	0.0%
YCbCr 4:4:4 SC	-1.0%	-0.2%	-0.2%	-0.9%	-0.3%	-0.4%
YCbCr 4:4:4 Animation	0.0%	-0.2%	-0.4%	0.0%	-0.4%	-0.6%
RangeExt	0.0%	-0.3%	-0.3%	-0.2%	-0.7%	-0.4%
RGB 4:4:4 SC (Optional)	-3.2%	-3.3%	-3.3%	-3.5%	-3.5%	-3.6%
YCbCr 4:4:4 SC (Optional)	-2.8%	-1.9%	-1.7%	-2.9%	-2.4%	-2.0%
Enc Time[%]	98%			98%		
Dec Time[%]	100%			101%		

• **Maximum number of the SAO parameter sets equal to 5 in each CTU**

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Modified Macro Setting

- Our implementation made modifications to the default macro settings of HM-12.1+RExt-5.1

  - #define HM_CLEANUP_SAO   0
  - #define SAO_ENCODING_CHOICE   0
  - #define RExt__BACKWARDS_COMPATIBILITY_HM_TICKET_1149   0

- Further integrated the three bugfixes reported in N0230

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BD-rate results of RExt-5.1 with modified macro setting versus Anchor under the AHG8 CTCs

	All Intra Main-tier			All Intra High-tier			All Intra Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
Class F	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
RGB 4:4:4 Animation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YCbCr 4:4:4 SC	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%
YCbCr 4:4:4 Animation	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
RangeExt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RGB 4:4:4 SC (Optional)	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%
YCbCr 4:4:4 SC (Optional)	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%
Enc Time[%]		99%			99%			99%	
Dec Time[%]		96%			97%			97%	

	Random Access Main-tier			Random Access High-tier		
	Y	U	V	Y	U	V
Class F	0.0%	-0.2%	-0.1%	0.0%	-0.3%	-0.3%
Class B	0.0%	0.0%	-0.1%	-0.1%	-0.3%	-0.1%
RGB 4:4:4 SC	-0.1%	0.0%	0.0%	-0.1%	0.0%	0.0%
RGB 4:4:4 Animation	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
YCbCr 4:4:4 SC	0.0%	0.1%	0.2%	0.1%	0.1%	0.1%
YCbCr 4:4:4 Animation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RangeExt	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%
RGB 4:4:4 SC (Optional)	-0.2%	-0.1%	0.0%	-0.2%	0.0%	0.0%
YCbCr 4:4:4 SC (Optional)	0.1%	0.2%	0.2%	0.1%	0.1%	0.2%
Enc Time[%]		98%			98%	
Dec Time[%]		99%			98%	

	Low delay B Main-tier			Low delay B High-tier		
	Y	U	V	Y	U	V
Class F	-0.3%	-1.0%	-0.7%	-0.3%	-0.6%	-0.7%
Class B	0.0%	-0.2%	0.1%	-0.1%	-0.4%	0.0%
RGB 4:4:4 SC	-0.6%	-0.5%	-0.5%	-0.7%	-0.6%	-0.5%
RGB 4:4:4 Animation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YCbCr 4:4:4 SC	-0.6%	-0.2%	-0.3%	-0.6%	-0.3%	-0.4%
YCbCr 4:4:4 Animation	0.0%	0.1%	0.0%	0.0%	0.0%	-0.1%
RangeExt	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%
RGB 4:4:4 SC (Optional)	-1.1%	-0.9%	-1.0%	-1.6%	-1.4%	-1.5%
YCbCr 4:4:4 SC (Optional)	-1.8%	-1.5%	-1.6%	-1.7%	-1.6%	-1.5%
Enc Time[%]		98%			98%	
Dec Time[%]		99%			99%	

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BD-rate results of RExt-5.1 with modified macro setting versus Anchor under the short AHG5 CTCs

	All Intra Main-tier			All Intra High-tier			All Intra Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
RGB 4:4:4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YCbCr 4:4:4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YCbCr 4:2:2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	98%			98%			98%		
Dec Time[%]	96%			96%			96%		

	Random Access Main-tier			Random Access High-tier		
	Y	U	V	Y	U	V
RGB 4:4:4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YCbCr 4:4:4	0.0%	-1.3%	0.0%	0.0%	-0.6%	0.0%
YCbCr 4:2:2	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%
Enc Time[%]	96%			96%		
Dec Time[%]	100%			98%		

	Low delay B Main-tier			Low delay B High-tier		
	Y	U	V	Y	U	V
RGB 4:4:4	0.0%	-0.1%	-0.1%	-0.1%	0.0%	0.0%
YCbCr 4:4:4	-0.2%	-0.7%	-0.2%	-0.2%	-0.4%	0.0%
YCbCr 4:2:2	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	97%			97%		
Dec Time[%]	98%			97%		

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Proposal under the short AHG5 CTCs

	All Intra Main-tier			All Intra High-tier			All Intra Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
RGB 4:4:4	-0.2%	-0.1%	-0.3%	-0.1%	-0.1%	-0.3%	-0.1%	0.0%	-0.2%
YCbCr 4:4:4	-0.2%	0.0%	0.0%	-0.2%	0.0%	-0.1%	-0.1%	0.0%	-0.1%
YCbCr 4:2:2	-0.1%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	98%			98%			98%		
Dec Time[%]	98%			99%			99%		

	Random Access Main-tier			Random Access High-tier		
	Y	U	V	Y	U	V
RGB 4:4:4	-0.4%	-0.9%	-0.3%	-0.5%	-0.8%	-0.3%
YCbCr 4:4:4	-0.2%	-2.1%	-0.4%	-0.4%	-1.8%	-0.6%
YCbCr 4:2:2	0.0%	-0.4%	-0.4%	-0.2%	-0.7%	-0.5%
Enc Time[%]	97%			97%		
Dec Time[%]	100%			99%		

	Low delay B Main-tier			Low delay B High-tier		
	Y	U	V	Y	U	V
RGB 4:4:4	-0.4%	-0.7%	-0.5%	-0.5%	-0.6%	-0.5%
YCbCr 4:4:4	-0.3%	-1.3%	-0.4%	-0.4%	-1.1%	-0.6%
YCbCr 4:2:2	-0.1%	-0.3%	-0.2%	-0.1%	-0.4%	-0.2%
Enc Time[%]	97%			96%		
Dec Time[%]	97%			96%		

- **Maximum number of the SAO parameter sets equal to 2 in each CTU**

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Proposal + N0246 under the short AHG5 CTCs

	All Intra Main-tier			All Intra High-tier			All Intra Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
RGB 4:4:4	-0.5%	-0.4%	-0.8%	-0.4%	-0.2%	-0.6%	-0.2%	-0.1%	-0.4%
YCbCr 4:4:4	-0.5%	-0.3%	-0.3%	-0.4%	-0.3%	-0.3%	-0.3%	-0.2%	-0.3%
YCbCr 4:2:2	-0.2%	-0.7%	-1.1%	-0.2%	-0.2%	-0.5%	-0.1%	-0.1%	-0.2%
Enc Time[%]	141%			139%			136%		
Dec Time[%]	136%			133%			130%		

	Random Access Main-tier			Random Access High-tier		
	Y	U	V	Y	U	V
RGB 4:4:4	-0.9%	-1.8%	-0.9%	-0.9%	-1.5%	-0.8%
YCbCr 4:4:4	-0.7%	-3.1%	-0.7%	-0.8%	-2.7%	-0.8%
YCbCr 4:2:2	-0.3%	-1.7%	-1.7%	-0.5%	-1.7%	-1.2%
Enc Time[%]	128%			125%		
Dec Time[%]	148%			145%		

	Low delay B Main-tier			Low delay B High-tier		
	Y	U	V	Y	U	V
RGB 4:4:4	-1.2%	-1.8%	-1.6%	-1.0%	-1.3%	-1.3%
YCbCr 4:4:4	-1.1%	-2.6%	-1.1%	-1.1%	-2.0%	-1.1%
YCbCr 4:2:2	-0.4%	-1.6%	-1.5%	-0.4%	-1.2%	-1.1%
Enc Time[%]	125%			124%		
Dec Time[%]	146%			141%		

•**Maximum number of the SAO parameter sets equal to 2 in each CTU**

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