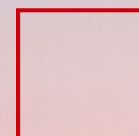


AHG16/Non-CE3: on chroma 2xN and Nx2 intra prediction in single tree

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Overview

- Problem:
 - minimum chroma intra prediction block is 2x2 in VTM4.0

- Solution for single tree:

- Test 1 (not split chroma):

When splitting a coding tree node A, if the split leads to 2x2, 2x4 or 4x2 chroma blocks in child nodes, the luma block of node A further splits (become several luma CUs), but the chroma blocks do not split (become a chroma CU).

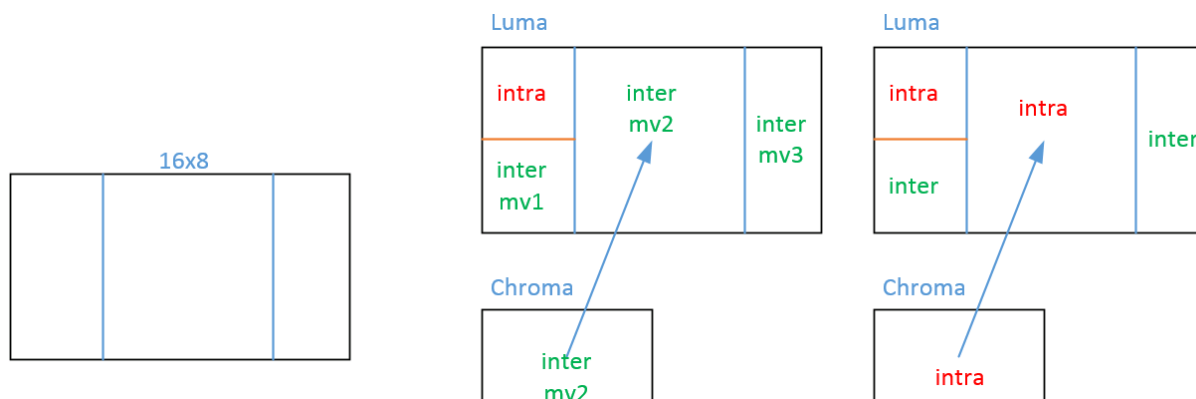
- Test 2 (not split chroma for Intra regions):

When splitting a coding tree node A, if the split leads to 2x2, 2x4 or 4x2 chroma blocks in child nodes, determine the node A to be an Intra/IBC region or an Inter region, in P/B picture

- 1) if node A is an Inter region, luma and chroma blocks split jointly;
- 2) If node A is an Intra region, luma block splits but chroma blocks do not split.

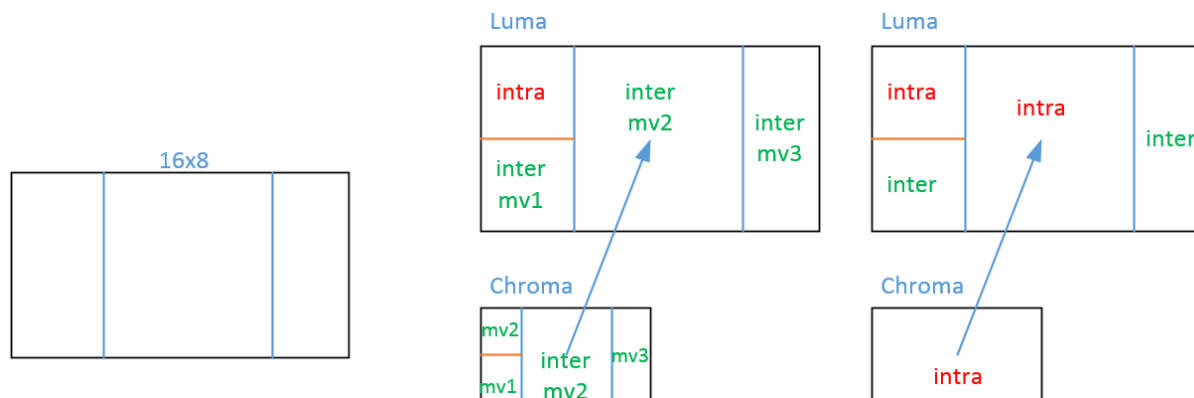
Test 1, not split chroma

- When splitting a coding tree node A, if the split leads to 2x2, 2x4 or 4x2 chroma blocks in child nodes, the luma block of node A further splits, but the chroma blocks do not split.
- Determine prediction mode of the chroma CU:
 - The prediction mode of the luma CU at the central position of node A is referred to
 - If the central position luma block is in MODE_INTRA, the chroma CU is in MODE_INTRA, and chroma intra pred mode is signaled -> similar to dual-tree chroma CU using intra mode
 - If the central position luma block is in MODE_IBC, pred_mode_ibc_flag is signaled to determine the chroma CU in MODE_INTRA or in MODE_IBC -> similar to dual-tree chroma CU using IBC mode
 - If the central position luma block is in MODE_INTER, the chroma CU is in MODE_INTER, and the chroma CU performs MC based on the motion vectors of the reference luma position



Test 1.1, not split chroma

- When splitting a coding tree node A, if the split leads to 2x2, 2x4 or 4x2 chroma blocks in child nodes, the luma block of node A further splits, but the chroma blocks do not split.
- Determine prediction mode of the chroma CU:
 - The prediction mode of the luma CU at the central position of node A is referred to
 - If the central position luma block is in MODE_INTRA, the chroma CU is in MODE_INTRA, and chroma intra pred mode is signaled -> similar to dual-tree chroma CU using intra mode
 - If the central position luma block is in MODE_IBC, pred_mode_ibc_flag is signaled to determine the chroma CU in MODE_INTRA or in MODE_IBC -> similar to dual-tree chroma CU using IBC mode
 - If the central position luma block is in MODE_INTER, the chroma CU is in MODE_INTER, and the chroma CU performs MC based on **sub-block motion vectors of the luma motion vector field (missing MV filled by central position MV)**



Test 2, not split chroma for Intra regions

- When splitting a coding tree node A, if the split leads to 2x2, 2x4 or 4x2 chroma blocks in child nodes, determine the node A to be an Intra/IBC region or an Inter region, in P/B picture
 - ❑ if node A is an Inter region, luma and chroma blocks split jointly;
 - ❑ If node A is an Intra region, luma block splits but chroma blocks do not split.
- Determine inter or intra region:
 - ❑ signal a `mode_cons_flag` at node A after split mode info
 - ❑ the `mode_cons_flag` is coded with one ctx and initialized as 0.5 probability
- Prediction mode signaling in Inter or Intra region (for redundancy removal):
 - ❑ For CUs in an Inter region, as all CUs use Inter mode, `pred_mode_flag` is inferred to be 0
 - ❑ For CUs in an Intra region, as all CUs use Intra/IBC mode, `pred_mode_flag` is inferred to be 1, `cu_skip_flag` is inferred to be 0 (when IBC is off)
- RDO process:
 - ❑ try node A as an Inter region in a first pass, and then try node A as an Intra region in a second pass
 - ❑ if all CUs do not have residual in the 1st pass, skip the 2nd pass

Test 2.1, not split chroma for Intra regions

- When splitting a coding tree node A, if the split leads to 2x2, 2x4 or 4x2 chroma blocks in child nodes, determine the node A to be an Intra/IBC region or an Inter region, in P/B picture
 - ❑ if node A is an Inter region, luma and chroma blocks split jointly;
 - ❑ If node A is an Intra region, luma block splits but chroma blocks do not split.
- Determine inter or intra region:
 - ❑ signal a mode_cons_flag at node A after split mode info
 - ❑ the mode_cons_flag is coded with **two ctx and initialized the same way as pred_mode_flag**
- Prediction mode signaling in Inter or Intra region (for redundancy removal):
 - ❑ For CUs in an Inter region, as all CUs use Inter mode, pred_mode_flag is inferred to be 0
 - ❑ For CUs in an Intra region, as all CUs use Intra/IBC mode, pred_mode_flag is inferred to be 1, cu_skip_flag is inferred to be 0 (when IBC is off)
- RDO process:
 - ❑ try node A as an Inter region in a first pass, and then try node A as an Intra region in a second pass
 - ❑ if **more than half** of CUs do not have residual in the 1st pass, skip the 2nd pass
 - ❑ **terminate the 2nd Pass if RD cost of first N CUs is already greater than the best cost**

Compare Test 2 with chroma parallel prediction (CE3-2.2)

For hardware implementation of chroma intra prediction:

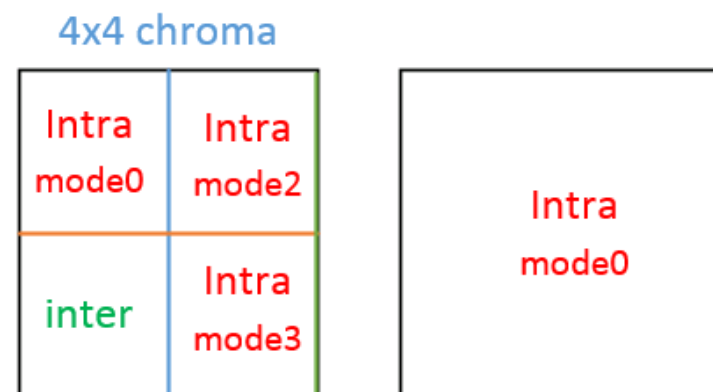
- ❑ CE3-2.2 needs additional logic to support 2x2 sub-block with different intra coding modes;
- ❑ Test 2 can just use existing intra prediction logic (normative changes are on coding mode parsing)

For software implementation of chroma intra prediction:

- ❑ Test 2 is more friendly

Prediction mode switch (worst case)

- ❑ CE3-2.2 : every 4x4 luma block
- ❑ Test 2: every 8x8 luma block (due to the mode constraint)



Coding performance, single-tree AI

For dual-tree I frame, constrain chroma tree partitioning the same way as CE3-2.1.1

	All Intra Main10				
	Over VTM4.0_dualTree = 0				
	Y	U	V	EncT	DecT
Class A1	0.01%	0.03%	0.01%	102%	101%
Class A2	0.09%	-0.47%	-0.17%	101%	102%
Class B	0.00%	-0.55%	-1.18%	102%	102%
Class C	-0.05%	0.33%	0.04%	104%	103%
Class E	-0.14%	-0.46%	-0.61%	102%	102%
Overall	-0.02%	-0.23%	-0.45%	102%	102%
Class D	0.10%	0.09%	0.50%	104%	102%
Class F (optional)	-0.08%	1.15%	0.18%	103%	103%

No coding loss on single-tree I frames

(all Tests have identical results for I frames)

Coding performance, CTC RA & LDB

CE3-2.2

Test 1

Test 2

	Random Access Main 10				
	Over VTM4.0				
	Y	U	V	EncT	DecT
Class A1	0.04%	0.04%	0.21%	101%	102%
Class A2	0.03%	0.19%	0.31%	100%	103%
Class B	0.04%	0.21%	0.31%	100%	101%
Class C	0.14%	0.65%	1.04%	101%	100%
Class E					
Overall	0.06%	0.29%	0.48%	101%	101%
Class D	0.16%	1.18%	1.34%	101%	101%
Class F (optional)	0.15%	0.66%	0.70%	101%	100%

	Random Access Main 10				
	Over VTM4.0				
	Y	U	V	EncT	DecT
Class A1	0.09%	-0.01%	0.31%	101%	100%
Class A2	0.29%	0.80%	0.90%	101%	100%
Class B	0.13%	0.82%	0.86%	100%	100%
Class C	0.35%	2.15%	2.40%	100%	100%
Class E					
Overall	0.21%	1.01%	1.17%	101%	100%
Class D	0.60%	4.40%	5.10%	101%	100%
Class F (optional)	0.46%	2.33%	2.75%	100%	100%

	Random Access Main 10				
	Over VTM4.0				
	Y	U	V	EncT	DecT
Class A1	0.03%	0.10%	0.11%	101%	101%
Class A2	0.09%	0.50%	0.39%	103%	100%
Class B	0.09%	0.60%	0.59%	102%	100%
Class C	0.32%	1.48%	1.68%	104%	100%
Class E					
Overall	0.14%	0.71%	0.75%	102%	100%
Class D	0.64%	2.58%	3.27%	106%	99%
Class F (optional)	0.46%	1.63%	1.92%	101%	100%

	Low delay B Main10				
	Over VTM4.0				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.00%	-0.02%	-0.57%	100%	102%
Class C	0.04%	0.75%	0.21%	101%	101%
Class E	0.04%	0.75%	-0.12%	100%	96%
Overall	0.02%	0.43%	-0.20%	100%	100%
Class D	0.06%	0.31%	0.20%	101%	101%
Class F (optional)	-0.10%	0.14%	-0.21%	101%	100%

	Low delay B Main10				
	Over VTM4.0				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.13%	-0.02%	0.42%	100%	101%
Class C	0.42%	1.16%	1.48%	100%	101%
Class E	0.07%	1.10%	0.22%	100%	100%
Overall	0.21%	0.65%	0.72%	100%	101%
Class D	0.57%	2.76%	2.64%	100%	99%
Class F (optional)	0.34%	1.72%	1.89%	101%	101%

	Low delay B Main10				
	Over VTM4.0				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.13%	0.04%	0.22%	103%	102%
Class C	0.51%	0.56%	0.98%	106%	100%
Class E	0.08%	1.04%	0.59%	101%	101%
Overall	0.24%	0.46%	0.57%	104%	101%
Class D	0.72%	2.06%	1.46%	109%	99%
Class F (optional)	0.43%	1.37%	0.36%	102%	100%

Coding performance, CTC RA & LDB

CE3-2.2

Test 1.1

Test 2.1

Random Access Main 10					
Over VTM4.0					
	Y	U	V	EncT	DecT
Class A1	0.04%	0.04%	0.21%	101%	102%
Class A2	0.03%	0.19%	0.31%	100%	103%
Class B	0.04%	0.21%	0.31%	100%	101%
Class C	0.14%	0.65%	1.04%	101%	100%
Class E					
Overall	0.06%	0.29%	0.48%	101%	101%
Class D	0.16%	1.18%	1.34%	101%	101%
Class F (optional)	0.15%	0.66%	0.70%	101%	100%

Random Access Main 10					
Over VTM4.0					
	Y	U	V	EncT	DecT
Class A1	0.08%	0.09%	0.24%	101%	101%
Class A2	0.19%	0.66%	0.70%	102%	100%
Class B	0.13%	0.52%	0.64%	100%	100%
Class C	0.28%	1.64%	1.81%	100%	100%
Class E					
Overall	0.17%	0.76%	0.89%	101%	100%
Class D	0.37%	3.42%	4.03%	101%	101%
Class F (optional)	0.34%	2.00%	2.38%	100%	100%

Random Access Main 10					
Over VTM4.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	0.10%	0.11%	102%	101%
Class A2	0.07%	0.35%	0.35%	102%	101%
Class B	0.07%	0.51%	0.56%	101%	100%
Class C	0.22%	1.29%	1.51%	103%	100%
Class E					
Overall	0.09%	0.60%	0.68%	102%	100%
Class D	0.45%	2.36%	2.96%	103%	100%
Class F (optional)	0.43%	1.58%	1.92%	100%	100%

Low delay B Main10					
Over VTM4.0					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.00%	-0.02%	-0.57%	100%	102%
Class C	0.04%	0.75%	0.21%	101%	101%
Class E	0.04%	0.75%	-0.12%	100%	96%
Overall	0.02%	0.43%	-0.20%	100%	100%
Class D	0.06%	0.31%	0.20%	101%	101%
Class F (optional)	-0.10%	0.14%	-0.21%	101%	100%

Low delay B Main10					
Over VTM4.0					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!
Class C	0.34%	0.76%	0.86%	100%	102%
Class E	0.13%	1.29%	0.48%	101%	101%
Overall	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!
Class D	0.44%	2.38%	2.03%	101%	103%
Class F (optional)	0.27%	1.62%	1.01%	101%	101%

Low delay B Main10					
Over VTM4.0					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.06%	-0.06%	-0.18%	102%	102%
Class C	0.33%	0.45%	0.55%	103%	101%
Class E	0.02%	1.14%	0.55%	101%	101%
Overall	0.14%	0.41%	0.24%	102%	101%
Class D	0.48%	1.97%	1.17%	104%	100%
Class F (optional)	0.39%	1.19%	0.92%	100%	101%

Loss reduced in Test 1.1 and Test 2.1 compared with Test 1 and Test 2

Test 2.1 has the lowest loss among all the tests

Conclusion

This proposal studies two methods on constraining chroma partition to completely remove 2x2, 2x4 and 4x2 chroma intra prediction blocks.

For single-tree I picture coding, no loss is observed on average.

For RA simulation, the average loss of Test 2.1 is 0.09% / 0.66% / 0.68%, which is close to CE3-2.2 (0.06% / 0.29% / 0.48%).

Suggest studying the methods in CE.

Thank Canon and MediaTek for cross-checking.

Thank you.

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