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Bug-fix of intra chroma DM mode for Intra_NxN with SCU size larger than 8x8

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Overall Summary

- There are mismatches in text and HM-7.0 software
  - In text, one intra PU sends one intra chroma prediction mode
  - In SW, one intra CU sends one intra chroma prediction mode

- In HM-7.0, for chroma DM derivation, only the luma intra prediction mode of the upper-left luma PU can be referenced, even when each intra chroma PU has its own corresponding intra luma PU (in Intra_NxN)
  - Can be viewed as a bug

- Proposed two solutions,
  - One intra CU sends one intra chroma prediction mode with bug-fix
  - One intra PU sends one intra chroma prediction mode with bug-fix

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Problem 1: Mismatch between Text and SW

- In the HM-7.0 software, one intra CU sends one intra chroma prediction mode

- In the text specification draft 7 (JCTVC-I1003_d5), one intra luma PU sends one intra chroma prediction mode
  - When CU size = 8x8, Intra_NxN partition, 4 intra chroma prediction modes are signaled even though there is only one chroma PU

- This issue has been raised in JCTVC-I0302 part 1. A fix that follows software implementation was adopted
  - "Decision (Ed.): Fix the text to match the software (which is what we believe was actually intended)."

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Problem 2: Bug of DM Mode Derivation

- In the HM-7.0 software, one intra CU sends one intra chroma prediction mode.

- If DM is signaled, all chroma PU refer the luma intra prediction mode of upper-left luma PU as chroma intra prediction mode
  - Even when each intra chroma PU has its own corresponding intra luma PU (CU = 16x16, Intra_NxN partition), only the upper-left luma PU can be referenced

8x8 CU, MODE_INTRA, PART_NxN (INTRA_NxN)

16x16 CU, MODE_INTRA, PART_NxN (INTRA_NxN)

Luma DM Chroma

Luma DM Chroma

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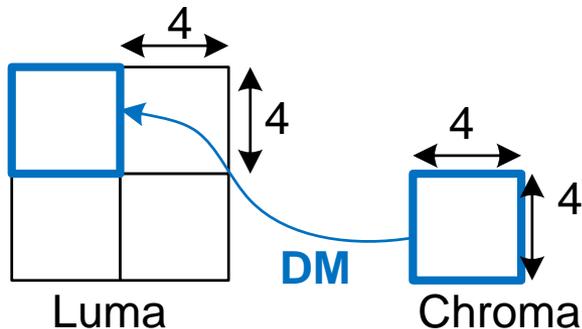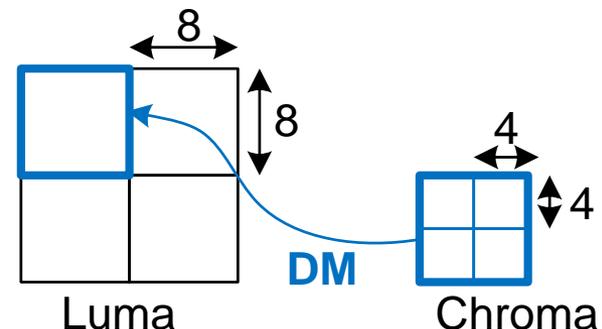
Solution 1: One Intra Chroma Prediction Mode per CU with Bug-fix

- Each intra CU signals one intra chroma prediction mode as in the HM-7.0 software

- When there are four chroma PUs in the intra CU, **each chroma PU follows the intra luma prediction mode of the corresponding intra luma PU** for DM mode

16x16 CU, MODE_INTRA, PART_NxN (INTRA_NxN)

8

One chroma intra prediction mode

DM

4

Luma   Chroma

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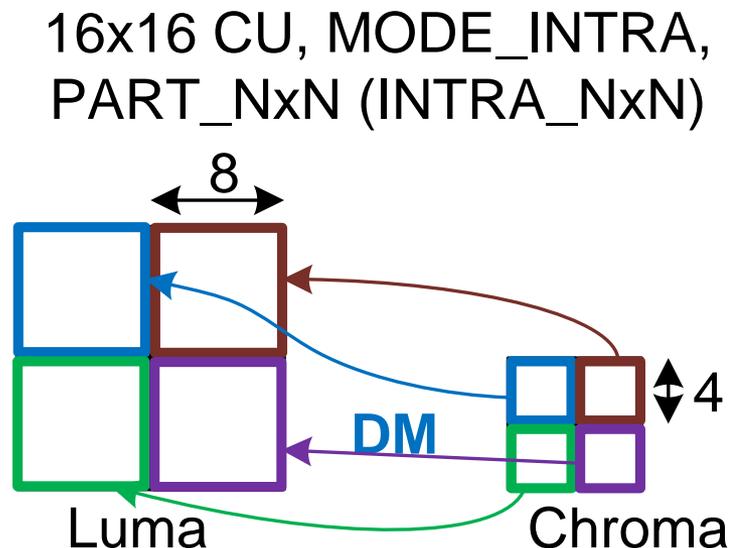
Solution 2: One Intra Chroma Prediction Mode per Chroma PU

- Each intra chroma PU signals one intra chroma prediction mode

- When there are four chroma PUs in the intra CU, **each chroma PU follows the intra luma prediction mode of the corresponding intra luma PU** if it's in DM mode

16x16 CU, MODE_INTRA,
PART_NxN (INTRA_NxN)

Luma
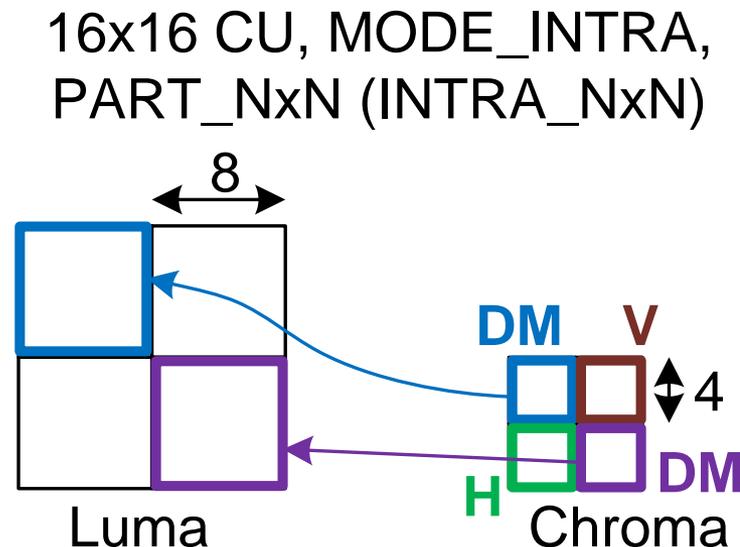
Chroma

Four chroma intra prediction modes

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Results

- Experiments were conducted according to the common test conditions but with the SCU = 16x16
  - The proposed method does not cause any difference in common test condition (when SCU = 8x8)

- Anchor : HM-7.0 with SCU = 16x16

- Test : Proposed solutions with SCU = 16x16

- Encoding and decoding runtime are roughly unchanged

	AI-Main, Y/U/V			RA-Main, Y/U/V			LDB-Main, Y/U/V		
Solution 1	-0.6%	-0.9%	-0.9%	-0.3%	-1.0%	-0.8%	-0.1%	-0.6%	-0.3%
Solution 2	-0.4%	-1.7%	-1.8%	-0.1%	-2.3%	-2.3%	-0.1%	-0.7%	-0.7%

	AI-HE10, Y/U/V			RA-HE10, Y/U/V			LDB-HE10, Y/U/V		
Solution 1	-0.3%	-0.4%	-0.4%	-0.1%	-0.5%	-0.5%	-0.1%	0.1%	0.1%
Solution 2	-0.2%	-1.8%	-1.9%	0.0%	-2.4%	-2.4%	0.0%	-0.7%	-0.6%

Conclusions

- Two solutions are proposed to fix the mismatch between software and text and fix the bug of DM mode derivation in Intra_NxN

- No difference for common test conditions and slight coding gains when the SCU size is set to 16x16

- Recommend adopting method 1, which follows the decision in the 9th JCT-VC meeting to resolve the mismatch problem, and adds a bug-fix, .

- Method 2 provided the information of another implementation that follows the text specification.

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Appendix

Results - HM-7.0 SCU = 16x16 vs. HM-7.0 SCU = 8x8

- Anchor : HM-7.0 with SCU = 8x8 (CTC)

- Test : HM-7.0 with SCU = 16x16

	AI-Main, Y/U/V			RA-Main, Y/U/V			LDB-Main, Y/U/V		
SCU 16x16	3.8%	1.5%	1.6%	3.7%	3.8%	4.1%	3.2%	2.8%	2.9%

	AI-Main, Y/U/V			RA-Main, Y/U/V			LDB-Main, Y/U/V		
SCU 16x16	3.7%	1.2%	1.4%	3.6%	4.0%	4.1%	3.1%	2.7%	3.0%

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Detail Results – HM-7.0 SCU = 16x16 vs. HM-7.0 SCU = 8x8

	All Intra Main			All Intra HE10		
	Y	U	V	Y	U	V
Class A	1.5%	-0.3%	-0.7%	1.5%	-1.4%	-1.0%
Class B	2.4%	-0.1%	0.1%	2.2%	-0.3%	-0.5%
Class C	5.3%	3.4%	3.8%	5.0%	3.4%	3.7%
Class D	6.3%	4.2%	4.4%	6.1%	4.6%	5.2%
Class E	4.0%	0.5%	0.5%	4.0%	-0.1%	-0.1%
Overall	**3.8%**	**1.5%**	**1.6%**	**3.7%**	**1.2%**	**1.4%**
	3.8%	1.5%	1.6%	3.7%	1.2%	1.4%
Class F	10.6%	8.1%	8.4%	15.6%	11.7%	12.0%
Enc Time[%]		66%			60%	
Dec Time[%]		96%			97%	

	Random Access Main			Random Access HE10		
	Y	U	V	Y	U	V
Class A	1.5%	1.1%	1.1%	1.5%	0.9%	1.1%
Class B	2.5%	1.5%	1.5%	2.3%	1.5%	1.3%
Class C	5.1%	6.0%	6.7%	4.9%	6.2%	6.6%
Class D	6.1%	7.4%	7.6%	6.0%	7.9%	8.3%
Class E						
Overall	**3.7%**	**3.8%**	**4.1%**	**3.6%**	**4.0%**	**4.1%**
	3.7%	3.8%	4.0%	3.6%	3.9%	4.1%
Class F	9.8%	8.7%	9.0%	13.5%	11.9%	11.9%
Enc Time[%]		82%			82%	
Dec Time[%]		99%			99%	

	Low delay B Main			Low delay B HE10		
	Y	U	V	Y	U	V
Class A						
Class B	2.1%	0.7%	0.5%	2.0%	0.5%	0.7%
Class C	4.1%	4.3%	5.2%	3.8%	4.6%	5.4%
Class D	4.9%	5.8%	5.8%	4.6%	5.9%	6.0%
Class E	1.7%	0.4%	-0.1%	1.8%	-0.4%	-0.5%
Overall	**3.2%**	**2.8%**	**2.9%**	**3.1%**	**2.7%**	**3.0%**
	3.2%	2.8%	2.9%	3.1%	2.7%	3.1%
Class F	8.3%	8.8%	9.3%	10.2%	11.2%	12.1%
Enc Time[%]		83%			84%	
Dec Time[%]		99%			100%	

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Detail Results – Solution 1 SCU = 16x16 vs. HM-7.0 SCU = 16x16

	All Intra Main			All Intra HE10		
	Y	U	V	Y	U	V
Class A	-0.3%	-0.6%	-0.4%	-0.2%	0.0%	-0.2%
Class B	-0.4%	-0.6%	-0.7%	-0.2%	-0.2%	-0.3%
Class C	-0.9%	-1.2%	-1.2%	-0.4%	-0.4%	-0.5%
Class D	-0.8%	-1.1%	-1.1%	-0.5%	-0.5%	-0.6%
Class E	-0.5%	-1.0%	-1.2%	-0.4%	-1.0%	-0.9%
Overall	**-0.6%**	**-0.9%**	**-0.9%**	**-0.3%**	**-0.4%**	**-0.4%**
	-0.6%	-0.9%	-0.9%	-0.3%	-0.4%	-0.4%
Class F	-0.8%	-1.2%	-1.1%	-0.4%	-0.4%	-0.4%
Enc Time[%]	99%			100%		
Dec Time[%]	99%			100%		

	Random Access Main			Random Access HE10		
	Y	U	V	Y	U	V
Class A	-0.1%	-0.8%	-0.5%	0.0%	-0.1%	-0.5%
Class B	-0.2%	-0.9%	-0.7%	-0.1%	-0.5%	-0.4%
Class C	-0.4%	-1.2%	-1.4%	-0.2%	-0.5%	-0.3%
Class D	-0.3%	-1.2%	-0.9%	-0.3%	-0.7%	-0.7%
Class E						
Overall	**-0.3%**	**-1.0%**	**-0.8%**	**-0.1%**	**-0.5%**	**-0.5%**
	-0.3%	-1.0%	-0.9%	-0.1%	-0.4%	-0.5%
Class F	-0.5%	-1.1%	-1.1%	-0.2%	-0.4%	-0.6%
Enc Time[%]	99%			100%		
Dec Time[%]	101%			101%		

	Low delay B Main			Low delay B HE10		
	Y	U	V	Y	U	V
Class A						
Class B	-0.1%	-0.5%	-0.1%	-0.1%	0.0%	-0.3%
Class C	-0.1%	-0.5%	-0.7%	-0.1%	-0.1%	-0.4%
Class D	-0.1%	-0.6%	-0.1%	-0.1%	0.3%	0.1%
Class E	-0.1%	-1.1%	-0.3%	-0.1%	0.4%	1.3%
Overall	**-0.1%**	**-0.6%**	**-0.3%**	**-0.1%**	**0.1%**	**0.1%**
	-0.1%	-0.6%	-0.3%	-0.1%	0.1%	0.0%
Class F	-0.1%	-0.9%	-0.5%	-0.1%	-0.4%	-0.7%
Enc Time[%]	100%			100%		
Dec Time[%]	101%			101%		

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Detail Results – Solution 2 SCU = 16x16 vs. HM-7.0 SCU = 16x16

	All Intra Main			All Intra HE10		
	Y	U	V	Y	U	V
Class A	-0.1%	-0.7%	-0.4%	0.0%	-0.5%	-0.5%
Class B	-0.2%	-1.2%	-1.3%	0.0%	-1.3%	-1.2%
Class C	-0.7%	-2.6%	-2.8%	-0.3%	-2.8%	-3.1%
Class D	-0.6%	-2.7%	-2.9%	-0.4%	-3.2%	-3.6%
Class E	-0.3%	-1.4%	-1.7%	-0.1%	-1.1%	-1.2%
Overall	**-0.4%**	**-1.7%**	**-1.8%**	**-0.2%**	**-1.8%**	**-1.9%**
	-0.4%	-1.7%	-1.8%	-0.2%	-1.7%	-1.9%
Class F	-0.8%	-2.2%	-2.2%	-0.4%	-1.6%	-1.7%
Enc Time[%]	101%			101%		
Dec Time[%]	99%			102%		

	Random Access Main			Random Access HE10		
	Y	U	V	Y	U	V
Class A	0.0%	-1.2%	-0.9%	0.1%	-0.6%	-1.3%
Class B	-0.1%	-2.1%	-2.1%	0.1%	-2.2%	-2.0%
Class C	-0.3%	-3.0%	-3.2%	-0.1%	-3.0%	-3.1%
Class D	-0.2%	-3.1%	-3.0%	-0.2%	-3.8%	-3.6%
Class E						
Overall	**-0.1%**	**-2.3%**	**-2.3%**	**0.0%**	**-2.4%**	**-2.4%**
	-0.1%	-2.3%	-2.2%	0.0%	-2.4%	-2.4%
Class F	-0.4%	-2.3%	-2.3%	-0.2%	-1.7%	-2.0%
Enc Time[%]	99%			100%		
Dec Time[%]	102%			101%		

	Low delay B Main			Low delay B HE10		
	Y	U	V	Y	U	V
Class A						
Class B	0.0%	-0.6%	-0.3%	0.0%	-0.3%	-0.3%
Class C	-0.1%	-0.9%	-1.1%	0.0%	-0.8%	-0.8%
Class D	-0.1%	-0.8%	-0.3%	0.0%	-0.4%	-0.6%
Class E	-0.1%	-0.8%	-1.6%	0.0%	-1.5%	-0.8%
Overall	**-0.1%**	**-0.7%**	**-0.7%**	**0.0%**	**-0.7%**	**-0.6%**
	-0.1%	-0.7%	-0.7%	0.0%	-0.7%	-0.5%
Class F	-0.1%	-1.4%	-1.4%	0.0%	-0.6%	-0.9%
Enc Time[%]	100%			100%		
Dec Time[%]	102%			102%		

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