

The Mediatek logo is located in the top left corner. It consists of the word "MEDIATEK" in a bold, white, sans-serif font, set against an orange parallelogram background.

CE7-related: Constraints on context-coded bins for coefficient coding

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The bottom third of the slide features a solid orange background with a dense, white line-art pattern. The pattern includes various everyday objects and symbols such as a pot, a bowl of food, a laptop, a desk, a lightbulb, a camera, a bottle, and a whisk, creating a busy, illustrative texture.

Presented by Tzu-Der (Peter) Chuang
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Overall Summary

- The averaged maximum number of context-coded bins per 16 samples in VVC is 2.56x of that in HEVC.
 1. Color components and sub-block sizes dependent constraint values to reduce number of context-coded bins
 2. Increase the constraints values according to the last significant sub-block position to improve the coding efficiency
 3. Move the greater than 2 flags to first coding pass to improve the parsing throughput
- Compared with HEVC, the averaged maximum number of context-coded bins per 16 samples is only increased by 1.3%

	AI			RA			LB		
	Y	U	V	Y	U	V	Y	U	V
CE7.1.3b	-0.18%	-0.06%	0.00%	-0.07%	-0.02%	0.09%	-0.15%	-0.27%	-0.36%
CE7.1.3b + Proposed method	-0.18%	0.07%	0.09%	-0.06%	0.17%	0.18%	-0.19%	0.05%	0.12%

Problem Definition

- In HEVC, for a 4x4 coefficient sub-block, the maximum number of context-coded bins per 16 samples is 25
 - Including 16 significant flags, eight greater than 1 (gt1) flags, and one greater than 2 (gt2) flag
- In VVC, for a 4x4 coefficient sub-block, the maximum number of context-coded bins is 64, which is 2.56x of that in HEVC
 - Including 16 significant flags, 16 gt1 flags, 16 parity bit flags, and 16 gt2 flags
- In CE7.1.3b, a constraint on the maximum number of context-coded bins is proposed. At most 32 context-coded bins can be used in a coefficient sub-block

Averaged maximum number of context-coded bins

Number of maximum context-coded bins per sub-block	4x4 luma sub-block	4x4 chroma sub-block	2x2 chroma sub-block	Maximum number of context-coded bins in one 64-sample luma block and two 16-sample chroma blocks	Averaged maximum number of context-coded bins per 16 samples
HEVC	25	25	N/A	$25*4 + 25*2 = 150$	25 (1.00x)
VTM2.0.1	64	64	16	$64*4 + 64*2 = 384$	64 (2.56x)
CE7.1.3.b	32	32	16	$32*4 + 16*8 = 256$	42.66 (1.71x)
CE7.1.3.b updated	32	32	8	$32*4 + 8*8 = 192$	32 (1.28x)

Proposed Methods (1/3)

- Different constraints according to color components and sub-block sizes
 - Propose to constrain the maximum number of context-coded bins to 30 for luma 4x4 sub-blocks, 16 for chroma 4x4 sub-blocks, and 4 for chroma 2x2 sub-blocks.
- The averaged maximum number of context-coded bins per 16 samples is only increased by 1.3%

Averaged maximum number of context-coded bins

Number of maximum context-coded bins per sub-block	4x4 luma sub-block	4x4 chroma sub-block	2x2 chroma sub-block	Maximum number of context-coded bins in one 64-sample luma block and two 16-sample chroma blocks	Averaged maximum number of context-coded bins per 16 samples
HEVC	25	25	N/A	$25*4 + 25*2 = 150$	25 (1.00x)
VTM2.0.1	64	64	16	$64*4 + 64*2 = 384$	64 (2.56x)
CE7.1.3.b	32	32	16	$32*4 + 16*8 = 256$	42.66 (1.71x)
CE7.1.3.b updated	32	32	8	$32*4 + 8*8 = 192$	32 (1.28x)
Proposed	30	16	4	$30*4 + 4*8 = 152$	25.33 (1.013x)

Proposed Methods (2/3)

- Last significant sub-block position dependent constraint
 - When not all the sub-blocks in a TB need to be coded, the constraint value can be loosened
 - According to the last significant sub-block position, the number of to-be-coded sub-blocks (NumToBeCodedSb) in a TB can be derived
 - No increase for worst-case number of context-coded bins

```
if (NumToBeCodedSb * 4 <= NumTotalSb)
    ConstraintValue *= ConstraintValue * 4
else if (NumToBeCodedSb * 2 <= NumTotalSb)
    ConstraintValue = ConstraintValue * 2
else if (NumToBeCodedSb * 1.5 <= NumTotalSb)
    ConstraintValue = ConstraintValue * 1.5
else if (NumToBeCodedSb * 1.25 <= NumTotalSb)
    ConstraintValue = ConstraintValue * 1.25
```

Proposed Methods (3/3)

- In VVC, the gt1 flag is parsed after the parity bit flag
 - The state and the context set selection of significant flag coding depends on the parity bit of the previous parsed coefficient
 - The time of parsing gt1 flag can be used to calculate the state and prepare the context variable set of the next coefficient
- In CE7.1.3b, the parity bit is moved after the gt1 flag
 - There is no “hidden” time to calculate the state and prepare the context variable set
- In this contribution, the gt2 flag is proposed to be moved to the first coding pass after the parity bit.
 - The time of parsing gt2 flag can be used to calculate the state and prepare the context set of the significant flag of the next coefficient.
 - The number of coding passes can be reduced from 4 to 3.

Simulation Results

- Anchor: VTM-2.0.1
- Test: CE7.1.3b + proposed methods
 - M1: Constraint values of 30 for luma 4x4 sub-blocks, 16 for chroma 4x4 sub-blocks, and 4 for chroma 2x2 sub-blocks
 - M2: Last significant sub-block position dependent constraint
 - M3: Move gt2 flag into the first coding pass
 - The averaged maximum number of context-coded bins per 16 samples is only increased by 1.3%

	AI			RA			LB		
	Y	U	V	Y	U	V	Y	U	V
CE7.1.3b	-0.18%	-0.06%	0.00%	-0.07%	-0.02%	0.09%	-0.15%	-0.27%	-0.36%
CE7.1.3b + M1	-0.09%	0.57%	0.46%	0.00%	0.84%	0.82%	-0.12%	1.28%	0.62%
CE7.1.3b + M1 + M2	-0.11%	0.14%	0.14%	-0.03%	0.27%	0.29%	-0.22%	0.13%	0.01%
CE7.1.3b + M1 + M2 + M3	-0.18%	0.07%	0.09%	-0.06%	0.17%	0.18%	-0.19%	0.05%	0.12%

Simulation Results

- Anchor: VTM-2.0.1
- Test: CE7.1.3b + proposed methods
 - M1': Constraint values of 32 for luma 4x4 sub-blocks, 32 for chroma 4x4 sub-blocks, and 8 for chroma 2x2 sub-blocks
 - M3: Move gt2 flag into the first coding pass
- The averaged maximum number of context-coded bins per 16 samples is only increased by 28% (same as the updated CE7.1.3b)

	AI			RA			LB		
	Y	U	V	Y	U	V	Y	U	V
CE7.1.3b	-0.18%	-0.06%	0.00%	-0.07%	-0.02%	0.09%	-0.15%	-0.27%	-0.36%
CE7.1.3b + M1'	-0.17%	-0.03%	0.01%	-0.06%	0.03%	0.07%	-0.20%	-0.19%	-0.41%
CE7.1.3b + M1' + M3	-0.24%	-0.13%	-0.05%	-0.12%	-0.04%	0.05%	-0.23%	0.02%	-0.53%

Simulation Results

- Anchor: VTM-2.0.1 in low complexity setting
 - Dependent quantization and RDOQ are disabled
- Test: CE7.1.3b + proposed methods in low complexity setting
 - M1: Constraint values of 30 for luma 4x4 sub-blocks, 16 for chroma 4x4 sub-blocks, and 4 for chroma 2x2 sub-blocks
 - M2: Last significant sub-block position dependent constraint
 - M3: Move gt2 flag into the first coding pass
 - The averaged maximum number of context-coded bins per 16 samples is only increased by 1.3%

	AI			RA			LB		
	Y	U	V	Y	U	V	Y	U	V
CE7.1.3b	0.04%	0.08%	0.11%	0.08%	0.08%	-0.06%	0.00%	-0.03%	0.12%
CE7.1.3b + M1	0.13%	0.48%	0.54%	0.11%	0.61%	0.72%	-0.01%	1.31%	0.73%
CE7.1.3b + M1 + M2	0.08%	0.20%	0.23%	0.08%	0.29%	0.29%	0.02%	0.61%	0.47%
CE7.1.3b + M1 + M2 + M3	0.03%	0.14%	0.19%	0.04%	0.21%	0.33%	-0.02%	0.42%	0.33%

Simulation Results

- Anchor: VTM-2.0.1 in low complexity setting
- Test: CE7.1.3b + proposed methods in low complexity setting
 - M1': Constraint values of 32 for luma 4x4 sub-blocks, 32 for chroma 4x4 sub-blocks, and 8 for chroma 2x2 sub-blocks
 - M3: Move gt2 flag into the first coding pass
- The averaged maximum number of context-coded bins per 16 samples is only increased by 28% (same as the updated CE7.1.3b)

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CE7.1.3b + M1'	0.04%	0.14%	0.14%	0.06%	0.02%	0.13%	0.01%	0.38%	0.03%
CE7.1.3b + M1' + M3	0.00%	0.05%	0.07%	0.04%	-0.01%	0.14%	-0.05%	0.33%	-0.10%

Conclusions

- Color components and sub-block sizes dependent constraint values to reduce number of context-coded bins
- Increase the constraints values according to the last significant sub-block position to improve coding efficiency
- Move the greater than 2 flags to first coding pass to improve the parsing throughput
- Compared with HEVC, the averaged maximum number of context-coded bins per 16 samples is only increased by 1.3%

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CE7.1.3b + Proposed method	-0.18%	0.07%	0.09%	-0.06%	0.17%	0.18%	-0.19%	0.05%	0.12%



everyday genius

Simulation Results

- Anchor: VTM-2.0.1
- Test: CE7.1.3b + proposed methods
 - M1': Constraint values of 32 for luma 4x4 sub-blocks, **16** for chroma 4x4 sub-blocks, and 8 for chroma 2x2 sub-blocks
 - M3: Move gt2 flag into the first coding pass
- If the 2x2 sub-block is not counted, the averaged maximum number of context-coded bins per 16 samples is increased by 6.64%
 - 26.66 context-coded bins per 16 samples

	AI			RA			LB		
	Y	U	V	Y	U	V	Y	U	V
CE7.1.3b	-0.18%	-0.06%	0.00%	-0.07%	-0.02%	0.09%	-0.15%	-0.27%	-0.36%
CE7.1.3b + M1'	-0.13%	0.46%	0.34%	-0.04%	0.63%	0.61%	-0.21%	0.89%	0.45%
CE7.1.3b + M1' + M3	-0.20%	0.31%	0.22%	-0.07%	0.50%	0.41%	-0.25%	0.62%	0.14%

Simulation Results

- Anchor: VTM-2.0.1 in low complexity setting
- Test: CE7.1.3b + proposed methods in low complexity setting
 - M1': Constraint values of 32 for luma 4x4 sub-blocks, 16 for chroma 4x4 sub-blocks, and 8 for chroma 2x2 sub-blocks
 - M3: Move gt2 flag into the first coding pass
- If the 2x2 sub-block is not counted, the averaged maximum number of context-coded bins per 16 samples is increased by 6.64%
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CE7.1.3b	0.04%	0.08%	0.11%	0.08%	0.08%	-0.06%	0.00%	-0.03%	0.12%
CE7.1.3b + M1'	0.11%	0.29%	0.36%	0.10%	0.23%	0.39%	0.02%	0.86%	0.23%
CE7.1.3b + M1' + M3	0.05%	0.14%	0.23%	0.07%	0.14%	0.28%	-0.02%	0.43%	0.15%